by
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Abstract
All teachers indicated that they needed support in the form of regular, within school inservice as well as a supply of "off the shelf" kits of "hands on" activities to assist them in the classroom.

Introduction

In recent years there has been increased international interest in improving the quality of science education available to primary (elementary) school children (DES, 1985; Australian Academy of Science, 1991; New Zealand Ministry of Education, 1992; American Association for the Advancement of Science, 1989). This introduction outlines curriculum trends in science education for 5 to 12 year olds in the UK, New Zealand, the USA and Australia and discusses some approaches to teacher inservice.

Recent overseas experience

In the United Kingdom, the appearance in 1985 of "Science 5-16: A Statement of Policy" published by the Department of Education (DES, 1985) marked a significant change in science education. By 1988 a centralised National Curriculum had been established and teachers were required by law, to implement strategies that achieved published statements of attainments related to stages of development.

Like the UK, New Zealand is implementing a national curriculum in science that has outcomes related to stages of schooling, and in 1992 the Ministry of Education of New Zealand introduced a draft curriculum statement called "Science in the National Curriculum" (Ministry for Education, 1992). The document has a perspective across all years of schooling and emphasises "people investigating the biological, physical, and technological components of their environment and making sense of them in logical and creative ways" (page 7). This syllabus will be compulsory for schools in 1994.

A National Science Education Standards Project has been established in the USA to develop by 1994, a set of Science Education Standards that represent the consensus of teachers, other science educators, scientists, and the general public about what is important for all students to attain in science education. A comprehensive set of standards will be produced and these will contain attainment criteria (eg what students should know and be able to do at specified stages of development) as well as statements about teaching strategies, materials professional development, and assessment (AETS, 1992).

In May 1991 the Australian Academy of Science and the Australian Science Teachers Association formed a "Science Education Focus Group" to gather ideas from primary school teachers for improving primary science and technology education. One outcome of this

initiative was the publication of a document "First Steps in Science and Technology." This document recommended that science and technology become an integral part of the primary school experience for all Australian children (Australian Academy of Science, 1991:1). It stated that "primary school teachers should have the opportunity to develop the competence, confidence and enthusiasm to provide an environment in which their students can learn both the content and processes of science and technology." During the same year, the ANZAAS (Australian and New Zealand Association for the Advancement of Science) conference recommended that science in primary schools

should be made a national priority in the years between 1993 and 1997 (Anderson, 1991). At this conference, concerns were raised about the lack of good science teaching in primary schools. By 1992 two important projects aimed at addressing these concerns had commenced. These projects were the National Primary Science Project (Australian Academy of Science, 1992) and the Science Curriculum and Teaching Program (Curriculum Corporation, 1992). During the same period (1990-1992), a new primary school "Science and Technology K-6" syllabus was developed by the NSW Department of School Education. The implementation of this new syllabus in 1992 has coincided with a national movement toward improving the quality of science and technology education (eg the Draft National Science Profile, AEC,1992).

This study should provide useful information about the forms of inservice education, resource materials, and related support materials needed by primary teachers of science and technology. The "First Steps in Science and Technology" document supports the aims of study where it states that:

"Much investigation is needed before the best forms of inservice education, resource materials, and related support are established " (Page 1)

Inservice

Prior to the implementation of the national curriculum in the UK, grants were available to Local Educational Authorities (LEA) to support in-service training for primary science coordinators (DES, 1984).

These coordinators were to encourage all teachers to include some science in their teaching and to respond to local inservice needs. Some LEA's were also able to finance science advisory teachers to work alongside teachers in their classrooms and the success of this initiative was reported by Day (1983). LEA's and Higher Education centres also combined to produce courses that focused on teaching practice and the design and construction of classroom science equipment (Brown, 1981; Day, 1983,).

However funding was limited and many of these initiatives have not been sustained. Carter and Carrtheir research findings on the self-

estimates of primary teachers
of their competence to teach the national science curriculum. Their findings were disturbing because only 34% of primary teachers from a sample of 901 felt independently competent to help children achieve in science. Responses from this survey and previous work in 1989 (Wragg, Bennett and Carr) showed that 28% of respondents were in need of in-service help and 60% of teachers indicated that they needed inservice help with the new subject area of electronics. They also found that men rated themselves as more competent on topics related to physical sciences while, women felt more competent with topics related to the life sciences. These findings may have relevance to Australia as we are also moving toward a national curriculum (Piper , 1989; AEC, 1992).

During 1992 and 1993 the draft curriculum statement for New Zealand schools is being trialed and evaluated, and teachers are being prepared for the adoption of this document through support supplied by the Teacher Support Services that provides inservice by science advisers, and implementation kits in the form of a series of documents. The Ministry of Education has strong links with universities (such as the University of Waikato) that have a history of successful research in science education and these institutions can be expected to be involved in the inservice training of teachers.

Recent Australian experience

Some states such as South Australia, are already strongly committed to in-service and professional development for teachers in science and technology. In Western Australia the Catholic education authority provides release time programs so that designated teachers can serve as school resource persons for

curriculum areas such as science . In Victoria the state science teachers association has been active in their support of science technology education through in-service programs and publications (Australian Academy of Science, 1991).

All state science teacher associations publish resource materials, but few primary teachers (or secondary teachers) are aware of resources from other states. One valuable source of such information is the "Shopping List" published annually by the Australian Science Teachers Association. To receive a copy of this document teachers have to belong to this association, but many primary teachers are not members and miss out on this information as well as that provided by the primary teachers science journal "Investigating".

It is essential for teachers to have access to the best available resources, and moves are under way to address this issue through the Curriculum Corporation (established January, 1990). The corporation has the following components as its publication focus: dissemination and discussion of the National Science

Curriculum Statement and Profile, exemplars of good curriculum, teaching and assessment, "off the shelf" units and activities, professional development programs and guides, support for related school management and career restructure, and curriculum information. All Commonwealth States and Territories, with the exception of NSW are members.

In NSW the release of the Science and Technology K-6 syllabus in 1992 led to increased interest in primary school science and technology education. Centralised, system-based support through personnel has been limited, and this has resulted in most local educational regions employing specialist consultants recruited from practising teachers. Schools, organised in clusters, have provided mutual support through the services of a designated support teacher who is given release time to be trained and to assist teachers within the local cluster. Other measures include local in-service days and inter-school visits.

Also a short course called "Prime Step" has been developed for primary teachers through the University of Western Sydney. The Department of School Education and this institution have collaborated to develop this course but the number of places is limited. To overcome this problem, some regions are organising "Prime Step" courses to be run at a local level by specially trained teachers. Several universities also offer subjects that focus on science and technology teaching and these subjects are accredited toward a Bachelors Degree or Graduate Diploma Course.

"Kits" from the Board of Studies and materials from other teacher groups have also been available to teachers. The "kits" contain many examples of teaching units, but several have been criticised by teachers for being too complex for young children. A new set of 40 teaching units has been developed by the Department of School Education and should be available to teachers at the end of 1992.

This study will find out which forms of support were preferred by teachers in the sample and identify important general issues that need to be addressed. It has been pointed out by Wallace and Louden (1992) that we have an imperfect understanding of the problem of why primary science teaching continues to disappoint us and we also have unrealistic expectations for the solution. Therefore, this study is about clarifying issues and making practical recommendations rather than posing "solutions".

Method:

The survey instrument was developed after consultation with primary teachers who were enroled as a part-time students in a science education subject that formed part of a Bachelor of Education conversion course for non-graduate teachers. After a trial at two schools, the version shown in the appendix was used. The survey sample consisted of 105 teachers from 15 volunteer schools selected from a pool of 40 local schools in the South

Coast Educational Region. Selected schools were chosen to represent large and small schools, as well as different socio-economic areas of the region. The survey was sent to schools at the start of Term 2 in 1992 and 100 replies were received. Follow up interviews were conducted by phone with 10 teachers from 10 of the schools surveyed.

Twenty four teachers who were part-time students enroled in a science and technology subject were interviewed after they had completed teaching a unit based upon the new syllabus. A report on this teaching unit was a formal assessment task for this subject. After the completion of this study two teacher-consultants from surveyed schools were interviewed about the findings.

Limitations

The survey was conducted early in the implementation phase of the syllabus so that authorities from the local educational region could use this information to assist them in their planning of teacher support. The sample size was kept small as a larger study will be undertaken in 1993, and exposure to this instrument may bias results in this future experiment. Therefore, the results cannot be extended beyond the sample surveyed.

Results

The respondents

The number of males was 32 and the number of females was 68

There was little difference between males and females in terms of years of teaching experience. The average number of years that respondents had been teaching was 17.6 (standard deviation 6.4). The minimum number of years taught was 2 and the maximum was 40 years. Many teachers (49) have been teaching over 17 years and these figures are typical of teachers in the South Coast Educational Region, as many teachers were trained at the local Teachers' College during the 1970's and have been teaching in local schools since graduation.

Forty seven per cent of respondents were not graduates, and many had not updated their initial tertiary training. Interviews with teachers enroled in the BEd conversion course revealed that recent changes to teacher career paths (eg advanced skill teacher status) had led to renewed interest in tertiary studies, because additional qualifications were perceived by these teachers as a vehicle for promotion.

Gender differences are shown below in table 1, and it can be seen that the percentage of males that are graduates (4 or 5 year trained) was greater than the females.

table 1: years of tertiary training by gender

Years of
trainingFemalesMales213%19%341%12%418%25%>528%44%

Time spent teaching science:

There was no significant gender difference in the time allocated to science teaching. During the year before the introduction of the syllabus teachers spent an average of 45 to 60 minutes per

week teaching science and this situation has not changed since the introduction of the syllabus . This weekly figure translates to less than 12 minutes per day which is less than half of the time recommended for such a key learning area. Only 20% of respondents were spending more than 12 minutes per day teaching science, and 13% were spending less than 5 minutes per day. Therefore, many teachers gave science education a low priority and allocated some of the additional time available for science education to other curriculum areas.

The syllabus support material:

The responses to questions relating to the support material are shown in table 2.

table 2: Responses to Questions Related to Support Material s.

QuestionsFemale% "Yes"Male % "Yes"3. Do you have a personal copy of the "Science and Technology K-6" syllabus and support document?92944. Have you taught any technology units based

on the new syllabus?46535. Have you taught any science units based on the new syllabus?72756. Have you taught any design and making units based on the new syllabus?42347. Are you working with other teachers to develop programs for teaching science and technology units?42348. Do you feel that you are able to get adequate advice and assistance in planning, implementing and evaluating units?2231The table shows that teachers are concentrating on science based units and are teaching less of the designing and making, and technology sections of the syllabus. More females are collaborating with peers to develop programs than males, but the amount of collaboration is still low.

Seventy five percent of respondents felt that they were unable to receive adequate advice and assistance. This figure is of concern and indicates that there is an immediate need for inservice assistance to be provided.

Nearly half of the respondents had not seen the support kits available from the Board of Studies. Unlike past support materials, they had to be purchased and, as a result, potential consumers may have been more critical and turned to alternate sources. Another reason appears to be lack of awareness as many responses indicated that teachers had not sighted the advertising literature. Also, during 1992, groups of teachers in various regions collaborated to develop 40 units that are about to be published by the Department of School Education. Some of teachers interviewed by phone were aware of the development of these units and were awaiting the release of these units to schools.

Ninety five percent of repondents considered that self-contained experimental kits would assist their teaching, and only five percent considered that booklets of stencil masters would be useful. Follow up phone interviews with teachers about these

responses indicated that they wanted to teach "hands on" science but needed help with ideas and resources for experimental work. Comments made by the 24 part-time students also supported this interpretation.

In-service:

Thirty seven teachers had attended a one day inservice about the new syllabus, nine had attended 2 one day courses, and three had training on 3 days. The remaining fifty one had received no inservice training at the time of the survey. The majority of the thirty seven respondents who received training over 1 day were trained as a result of a school staff development day organised locally.

Table 3 shows the percentages of respondents who gave highest priority to inservice in the sections listed. The sections listed are only those that were given the highest priority. Male and female responses were not separated as the rankings were the same for both sexes.

table 3: sections of the syllabus that respondents felt should have the highest priority for inservice .

Using technology31%Designing and making21%Investigating 11%Information and Communicating8%The sections identified in table 3 were also identified by teachers as the sections that they were least confident about teaching.

Responses about how the inservice should be organised are summarised in table 4. The numbers in each cell are the percentage of responses. Again a male/female breakdown is not given because the order of priorities were the same for both sexes.

table 3: Suggested ways to organise the inservice of teachers

TimeLengthFrequencyLocation Conducted by.during school time

91full day

64once a term

62at a "host"school

71Department of Education consultants

54outside school time

9half day

21once a year

37at an Educational Resource Centre

20by teachers

from local
schools.
46two days
13at the
University
Science Centre
8Other suggestions
0Sixty eight percent indicated that they would definitely attend in-service courses and thirty two percent indicated that they may attend. The most popular way was a one day inservice conducted during school time at a "host" school" by consultants or local teachers. Most respondents (62%) also felt that these inservice courses should occur once a term.

The university science centre was not a popular option, yet it contains a wealth of hands on exhibits and a small conference area. Ten teachers were followed up (phone interview) about their response to this question. The main reason for the low response was the opinion that the inservice should occur in schools because it would be more relevant and use materials commonly found in schools. However, they did indicate that the science centre would be a suitable venue for a short term course such as "Prime Step."

An interview with two teacher-consultants revealed that they have problems coping with a dual roles of consultants and teachers. On one hand they have new skills and ideas that they wanted to put into practice with their classes, but at the same time they have to make themselves available to inservice other teachers. They felt that often their class misses out on their expertise.

Gender differences:

A Mann-Whitney U test was used to test for significant differences in confidence between male and female responses to the items in question 12. Table 4 indicates those items showing differences at the 95% level of significance.

table 4: significant gender differences.

Section of syllabusp (Mann -Whitney U)Physical phenomena .0128Products and services.0487Designing and making.0134Using technology.0176

In all cases the males expressed greater confidence in their ability to teach these sections than the females and these findings support those of Carter and Carrthough females expressed a lack of confidence in their ability to teach physical phenomena, they did not give it high priority for inservice. This issue needs further investigation as it may be that many females have decided that this section is too difficult and intend to avoid it.

Conclusion

All teachers in the sample were spending some time on science

teaching, but most were still only teaching an average of 12 minutes or less per day. The lack of time devoted to science education in primary (elementary) schools has been raised in the past by DEET (1990) and by the American Association for the Advancement of Science (1989), and the findings of this study support these reports

The syllabus and its support document are in the hands of most teachers and nearly 75% of the teachers were teaching science units based upon the syllabus. Interviews with teachers revealed that many were implementing units that were similar to what they had used in the past. This strategy gave them time to learn about other aspects of the syllabus and for sample units to be developed. All teachers interviewed indicated that they had little time to devote to their own inservice and needed help. This issue was raised by Cumming (1992:8) in his discussion about the need for "high quality professional development" for teachers who will implement a national curriculum.

Approximately half the teachers surveyed were not teaching designing and making, and technology based units and this appears to be related a lack of assistance and support materials. It was a positive sign to see that teachers were collaborating to develop teaching units, but the majority were not, and the reasons need to be followed up in future studies. Schools need to actively encourage collaboration by providing time and clerical support, so that resources and ideas can be shared. This approach has been successful in the schools of Western Sydney where resources have been combined to produce a set of science teaching resources that support the syllabus (Metropolitan West Publications, 1992).

There is an immediate need for self-contained kits of materials. Ideally such kits should be in small portable containers and use items that are cheap, readily available and easy to use. All teachers interviewed stated that finding and organising the materials required for science lessons took time that they couldn't spare. They wanted the materials already supplied and some guidance about how they could use the kits. This aspect of the study needs follow up and kits should be developed and trialed as soon as possible.

A positive result of this survey and follow up has been an increase in requests from schools for assistance from university personnel. This has led the participation by the authors at 4 school science and technology days since May. It also planned to support these schools on a regular basis through the development and trial of "hands on" science activity kits that will be developed and evaluated by undergraduate students in primary science education courses. This project will bring closer links between schools and the university and provide valuable pre-service and inservice training.

This limited survey of the introduction of the new Science and Technology syllabus in N.S.W syllabus has identified some

important issues that need to be followed up:
1. teachers should, but do not always want to, allocate more time to the teaching of science.
2. there is a need for regular inservice that is held in schools.
3. support kits of "hands on "materials are needed by nearly all teachers.
4. the human and physical resources available at universities should be used to support the implementation of the syllabus.
5. the use of teachers to train their peers has been well received but there is a danger that the teachers conducting the training will be taken away from classes and their students will suffer. There is also a danger of over-commitment and "teacher burn-out."

6. making a section of a syllabus mandatory does not guarantee that it will be taught. Teachers are avoiding sections of the syllabus that they are not confident with.
7. the differences between the confidence of male and female teachers may need to be addressed by inservice that focuses upon building the confidence of women teachers and further research is needed to clarify this issue.

The implementation phase of a new syllabus often begins before there is a substantial commitment of time, and human and physical resources toward the inservice training of teachers, and this appears to be the case with the NSW Science and Technology K-6 syllabus. Successful implementation will be a long and difficult process that will take time and effort. History shows us that the choices of the past such as "quick-fix" solutions that involve more inservice, better curriculum and more research are limited in their impact (Wallace and Louden, 1992). The implementation of the new Science and Technology syllabus in NSW primary schools shows signs of a "quick-fix" approach, but teachers need more than this. With on-going commitment and a network of support, teachers may overcome some of these problems, but very much will depend upon the amount and form of support that the education system provides to the teachers over the next few years. At present it appears that the resources allocation is too little to have any substantial, long-term impact.

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Science and Technology K-6 Questionnaire 1992
This questionnaire is anonymous.
About the respondent:
o Male o Female
The number of years that you have been teaching is
Years of formal tertiary training :
o 2 years of Teachers College o 3 year Diploma
o 4 year Bachelors Degree o post graduate diploma or degree.
1. The number that is closest to your school's enrolment is:
o <100 o 100- 200 o 200-300 o 300-400 o 400-500 o >500
2. The average amount of time, in minutes per week, that you:
a. currently spend in teaching science and technology :
o less than 30 o 30-45 o 45-60 o 60-75 o 75-90 o >90.
b. spent in teaching science in 1991:
o less than 30 o 30-45 o 45-60 o 60-75 o 75-90 o >90.

Circle your response
3. Do you have a personal copy of the "Science and Technology K-6" Syllabus and Support Document?YesNo. 4. Have you taught any technology units based on the new syllabus?YesNo. 5. Have you taught any science units based on the new syllabus?YesNo. 6. Have you taught any design and making units based on the new syllabus? 7. Are you working with other teachers to develop programs for teaching science and technology units?YesNo. 8. Do you feel that you are able to get adequate advice and assistance in planning, implementing and evaluating units?YesNo. 9. Have you used the support kits, designed by the Board of Studies, to assist you in implementing some of the units in the syllabus and support document?YesNo.10. In your opinion, the support kits from the Board of Studies are:
o very useful o of little use o of no use o I have never seen them.
11. What do you feel is the most important equipment that you will require to effectively teach the new syllabus?
o self contained kits of experiments o booklets of stencil masters
12. If you have attended inservice courses about the new syllabus please indicate: the number of courses attended..... and the total duration
13. Please indicate how confident you feel in teaching the sections of the curriculum listed below:
Section Very Confid-entConfid-entUncert-ainNot confid-entBuilt EnvironmentsPhysical PhenomenaInvestigatingInformation and

CommunicationProducts and Services Designing and
MakingLiving ThingsEarth and Its
SurroundingsUsing Technology14. Circle the specific
area from the syllabus that you feel should have the highest
priority for inservice support:
1. Built Environments 2. Physical Phenomena 3. Investigating
4. Information and Communication
5. Products and Services 6. Designing and Making 7. Living
Things 8. Earth and Its Surroundings
9. Using Technology
15. What form of inservice support would be the most useful to you?
time:
o during school time
o outside school time
length:
o full day
o 2 days
o half day
frequency:
o once only
o once a term
conducted by

o consultants from the Department of School Education
o teachers from local schools who have the expertise
o other suggestions

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located at:
o at a "host" school
o at an Educational Resource Centre
o at the University Science Centre at Campus East.(Fairy
Meadow)Other
suggestions:.....
.....
16. If such inservice support were organised as suggested, I
would:
o definitely attend o may attend o definitely would not attend