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Vol 15, 1985 - front matter, tribute, front matter, tribute (a short tribute to Roger Osborne), contents, preface, Research Notes (1 paragraph on each of 6 conference presentations), author addresses, guidelines for authors
Vol 16, 1986 - front matter, contents, preface, author addresses, guidelines for authors of papers for RISE, Research Notes (1 paragraph on each of 8 presentations at the conference)
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Vol 18, 1988 - front matter, contents, editorial comment, first-named author addresses
Vol 19, 1989 - front matter, contents, editorial comment, guidelines for authors, author addresses
Vol 20, 1990 - front matter, contents (all reviewers of papers now listed), editorial comment (author[s] institution now given with the paper), guidelines for authors, 1 Research Note, Appendix – categorized index RISE Vols 1-20
Vol 21, 1991 - front matter, contents, note from the general editor, editorial comment, review panel, guidelines for authors, Abstracts and Research Notes (4 outlines, variously one paragraph to three pages)
Vol 22, 1992 - front matter, contents, editorial comment, review panel, guidelines for authors, Abstracts and Research Notes (9 outlines, variously one paragraph to three pages)
Vol 23, 1993 - front matter, contents, editorial comment, review panel, guidelines for authors, Abstracts and Research Notes (6 outlines, variously one paragraph to three pages)
Vol 24, 1994 - front matter, contents, editorial comment, review panel, guidelines for authors, Abstracts and Research Notes (10 outlines, variously one paragraph to three pages), Supplement (the text of the after-dinner address given at the conference dinner), back matter
research 1971
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Edited by R.P. Tisher

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presented at the Associations’
Annual Conference held in Sydney
in May, 1971

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RESEARCH 1972

Edited by

R. P. Tisher

A publication containing papers presented at the Association's Third Annual Conference held in Melbourne, in May, 1972.

Executive Officers: Dr. C. N. Power
                   Dr. R. P. Tisher

Address: Faculty of Education, University of Queensland, BRISBANE, Qld. 4067.
PREFACE

The first publication of the Australian Science Education Research Association, *Research 1971*, was a modest one for a group with limited funds and clientele. However, the encouragement, co-operation and assistance of many persons and organisations guaranteed the success of the publication. Consequently, the association, with greater confidence, is producing its second modest, yet significant, monograph which contains the papers read and tabled at the third annual conference in Melbourne, May 1972.

The conference was held at the headquarters of the Australian Science Education Project. The venue was significant and appropriate on several counts: first, A.S.E.P. had assisted greatly in the production of *Research 1971*, and second, a major theme of the conference was "research that can be based on A.S.E.P. materials". The first four papers which appear are associated with the major theme. The remaining six deal with a variety of topics but appeared to belong to certain clusters depending on themes which appeared in them. The responsibility for the grouping rests entirely with the editor, but the categorization does highlight some of the areas in which research is proceeding in Australia. It is appropriate to point out that the views, opinions, interpretations and implications expressed are those of the individual authors and, not necessarily those of the Australian Science Education Research Association or the Editor. Furthermore, rigorous cutting and editing of manuscripts have not occurred because the Editor believed the publication should present an accurate record of the proceedings of the annual conference. The reports evidence a wide range of interests and styles in research. This is an encouraging feature and an acknowledgement that a range and variety of studies are essential, and appropriate, if research in science education is to have an impact in the real world.

*Research 1972* is further encouraging evidence of a continued interest and activity in research in science education in Australia. Hopefully, other research workers will now build onto rather than repeat, studies which have been reported here. Certainly, more systematic, well-conceived and well-executed research is required. There is a challenge to increase the volume of research while maintaining its quality and relatedness to the real world. Moreover, there is the exciting prospect that much valid research evidence will accrue to influence educational theory and practice.

R. P. Tisher
University of Queensland
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R. D. Linke
A CHECKLIST FOR ANALYSING THE 'STYLE' OF INSTRUCTIONAL MATERIALS

Editor's Comment:

This report is based on work undertaken by S.R. Shepherd of the staff of the Australian Science Education Project. Mr. Shepherd described his exploratory study during the A.S.E.R.A. Conference and the comments which follow are adaptations of his presentation and the paper he tabled. It is appropriate to point out that the project is an embryonic but, nevertheless, significant one. The study is reported here in the hope that other workers will co-operate with and build upon the work begun by Shepherd.

* * * * * * * * *

Introduction

The materials that are being produced as part of the activities of ASEP will be classified in terms of

1. topics, i.e. the information presented,
2. techniques, i.e. procedures for which instructions are given,
3. degrees of prescription, i.e. whether pupils' tasks are "open-ended" or structured,
4. group size, i.e. number of persons in a group for each pupil activity,
5. ancillary materials required, i.e. additional equipment, chemicals, references and audio-visual media that are required;

and

6. style of written material.

In an attempt to describe the "styles" or "approaches" used in the written ASEP material, a checklist was devised. This list, which is reported here, will hopefully provide some details about ASEP units and will allow comparisons to be made with other instructional materials which have characteristics somewhat similar to those of ASEP. What, then, are the relevant characteristics which will provide guidelines for the establishment of a checklist for style?

Characteristics of ASEP Materials

The main characteristics of the ASEP materials for pupils are that:
they are ‘self explanatory’, that is, all the information and instructions that pupils need are contained in the pupils’ books. The ASEP materials do not necessarily rely on teachers or other reference sources to provide information and instructions.

2. printed words carry the main ‘messages’. There are illustrations and other materials but these support, rather than replace, the printed words.

3. short sentences are used to increase the “reading ease” of the materials (Flesch, 1968). Most of the sentences contain 10 to 15 words and are “simple”, i.e., they contain a single statement.

The Checklist

The sentences in the ASEP materials were taken as the basic unit of analysis and were classified into three broad groups designated:

- statements,
- questions, and
- instructions and suggestions.

Statements were further subdivided into those providing information and those dealing with explanation. In a similar manner the category, “instructions and suggestions” was subdivided so that distinctions could be made as to whether these instructions were concerned with equipment, handling things, observation, writing, discussion and reading. The questions category was not subdivided, but, perhaps in subsequent classifications it may be appropriate to distinguish between recall and other types of questions. The various categories and the subdivisions are shown in the checklist in the Appendix to this paper.

Advantages of the checklist are that (a) it can be mastered quickly, (b) it can be scored readily and (c) it is quite reliable. Certainly some results indicate that different coders obtain a high measure of agreement when classifying similar materials. An example of such a reliability check appears in the table below. The data were obtained by 2 teachers, 2 clerical assistants and the ASEP staff writer when they classified the sentences in the ASEP unit, “Electric Circuits”.

The results indicate that the scorers were fairly consistent in their classification for most types of sentences. Greatest discrepancies occurred for the categories designated ‘explanation’, ‘discuss’ and ‘read’. It is proposed to produce a guide sheet for scorers so that greater consistency can be obtained on these few categories in the future.
<table>
<thead>
<tr>
<th>Type of Sentence</th>
<th>Number of sentences classified by SCORER</th>
<th>Mean</th>
<th>Standard deviation as a % of mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>JR</td>
<td>PC</td>
<td>ES</td>
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<tr>
<td>Information</td>
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<tr>
<td>Explanation</td>
<td>122</td>
<td>61</td>
<td>111</td>
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<tr>
<td>TOTAL STATEMENTS</td>
<td>419</td>
<td>409</td>
<td>419</td>
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<td>TOTAL QUESTIONS</td>
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<td>Equipment</td>
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<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Handle things</td>
<td>208</td>
<td>241</td>
<td>205</td>
</tr>
<tr>
<td>Observe</td>
<td>48</td>
<td>38</td>
<td>49</td>
</tr>
<tr>
<td>Write</td>
<td>81</td>
<td>80</td>
<td>86</td>
</tr>
<tr>
<td>Discuss</td>
<td>12</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Read</td>
<td>10</td>
<td>5</td>
<td>28</td>
</tr>
<tr>
<td>TOTAL INSTRUCTIONS</td>
<td>378</td>
<td>392</td>
<td>397</td>
</tr>
<tr>
<td>Grand TOTAL</td>
<td>898</td>
<td>896</td>
<td>911</td>
</tr>
</tbody>
</table>

Application to Other Materials

As a further application of the checklist a number of additional ASEP units, e.g., Life in Freshwater, Light Forms Images, and Mice and Men, sections of the Junior Secondary Science Project (J.S.S.P.), e.g., Green 5, How Hot is it? and Red 7, How Mammals Function, Chapters 1 to 4 in Volume 1 of the Intermediate Science Curriculum Study (I.S.C.S.) and Chapters 9, 18, 27, 36 and 45 of Abridged Science for High School Students (S.F.H.S.S.) were classified. The results are presented in the diagrams which follow.

It seems appropriate to note the diagram indicates that for A.S.E.P. materials the proportion of sentences in the different categories is remarkably similar to the proportions in the categories for the I.S.C.S. chapters. In both materials, for example, 11-12 per cent of all sentences are questions. Both I.S.C.S. and A.S.E.P. materials differ from J.S.S.P. in the number of times pupils are asked to write statements. Sixteen per cent of the sentences in J.S.S.P., compared to 7 per cent for A.S.E.P. contains an instruction to write. Another interesting observation is that, for the sections sampled, the project materials (A.S.E.P., J.S.S.P., and I.S.C.S.) present far more instructions than do traditional texts such as Abridged science for high school students.

It is obvious that for A.S.E.P. materials the rationale is remarkably similar to the science handbooks of both materials, for example, the A.S.E.P. and A.S.E.P. materials differ in the type of write statements. Sixteen per cent of the plans for A.S.E.P. contain an equipment statement; for the sections sampled, JSSP contained far more instructions than SPHSS did for student.

<table>
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<th>Mean</th>
<th>Standard deviation as a % of mean score</th>
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<tr>
<td></td>
<td>898</td>
<td>904</td>
</tr>
</tbody>
</table>
Concluding Comments

Certainly, there seems to be a great similarity among the three project materials. If the claim that A.S.E.P. materials have a rather special or distinctive approach is to be substantiated, then additional research is required. This research could involve a more detailed and sophisticated analysis of the written materials and studies of the effects of A.S.E.P. on pupils.

Hopefully, the checklist described here will be modified and/or extended by other workers in studies of curriculum materials. If this report stimulates further research, then it has achieved one of its objectives.

REFERENCES


APPENDIX

Australian Science Education Project

**SENSE REASONING**

UNIT: ____________________________

**VERSION:**
- *local trial*
- *national trial*
- *final version*
- *record book*

Analyst: ____________________________ Date started: ____________________________

**Rules for sentence analysis:**
1. Do not score the front cover or the copyright statement on the back cover.
2. Include captions.
3. Complex sentences can be scored twice e.g. handle + record.
4. Regard colons or semi-colons as ends of sentences.

<table>
<thead>
<tr>
<th>Type of sentence or wordgroup</th>
<th>Score</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFORMATION</td>
<td></td>
<td></td>
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<tr>
<td>EXPLANATION</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>e.g. how to use the book,</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>what the unit is about,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>introduction e.g. what you</td>
<td></td>
<td></td>
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<tr>
<td>will be doing,</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>reminders e.g. 'We have seen</td>
<td></td>
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<tr>
<td>'You have already found out</td>
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<td></td>
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<tr>
<td>HEADINGS, contents lists</td>
<td></td>
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<tr>
<td>QUESTIONS (other than headings)</td>
<td></td>
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<tr>
<td>INSTRUCTIONS AND SUGGESTIONS</td>
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<tr>
<td>Equipment lists</td>
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<tr>
<td>handle things — includes</td>
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<td></td>
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<tr>
<td>leave or store things</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>things you must not do</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>go to . . .</td>
<td></td>
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<tr>
<td>collect, find, obtain</td>
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<td></td>
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<tr>
<td>observe, look at, notice,</td>
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<tr>
<td>examine, measure, compare</td>
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<tr>
<td>write, record, turn to your</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>record book, draw, list,</td>
<td></td>
<td></td>
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<tr>
<td>calculate, explain, describe</td>
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<tr>
<td>in writing</td>
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<tr>
<td>discuss, think about, ask your</td>
<td></td>
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<td></td>
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<tr>
<td>teacher, 'Suppose ...'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>read, look up, check books,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>references listed.</td>
<td></td>
<td></td>
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</tbody>
</table>

Total: ____________________________

100%
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Australian Science Education Research Association
SCIENCE EDUCATION : RESEARCH 1973

Edited by

R. P. TISHER


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PREFACE

Each year, for the past four years, the Australian Science Education Research Association, has been able to claim "a first". In 1970, the Association held its first annual conference; in 1971 its first publication appeared; in 1972, the proceedings of the annual conference appeared in a new format; and, this year we had our first international visitors who contributed to our annual conference. It is probably significant, too, that the annual meeting decided to change the name of the present publication.

Science Education: Research 1973 represents another significant step forward for the Australian Science Education Research Association. Not only is the publication a larger one than the previous issues of Research 1971 and Research 1972 — indicating an increase in research activity — but, it contains reports covering a wider range of issues in science education, and a special section dealing with research techniques. This last mentioned section was included in the conference with the express objective to develop our own understandings of some techniques which can be of great assistance to the science education researcher.

For convenience of presentation the papers have been grouped under headings, or themes. Although the responsibility for the groupings must again rest with the editor, it did seem that clusters fell, quite naturally, under the several headings. One of these was the Analyses of Curricula and the four papers related to this theme indicate a new area of research activity for Australian science educationists.

Science Education: Research 1973, though still a modest publication, is ample evidence of an increase in the number and quality of research projects in Australia. It demonstrates too, that we have international interests and ties. If the nature and quality of the papers contained in this publication are any guide, the future for science education research in Australia, looks brighter, if more challenging, than ever before.

R. P. Tisher
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MAJORIE GARDNER is Professor of Science Education in the Department of Chemistry and the Department of Secondary Education at the University of Maryland. She has helped to implement the CHEM Study, to develop the Earth Science Curriculum Project (ESCP) and the new Interdisciplinary Approaches to Chemistry (IAC) programme. Experimenting with self-pacing in large lecture sections at the University level, she recently received the O Haus Award for innovation in the teaching of College chemistry.
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RESEARCH
IN
SCIENCE EDUCATION

VOLUME 4

Proceedings of the Fifth Annual Conference of the Australian Science Education Research Association, Monash University, Clayton, Victoria, May 18 - 20, 1974,

Edited by: Russell D. Linke
and Leo H.T. West
General Editor: Richard P. Tisher

AUSTRALIAN SCIENCE EDUCATION RESEARCH ASSOCIATION

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PREFACE

For the past three years the Australian Science Education Research Association has published the proceedings of its annual conference. Two major changes have been made in the current publication. Firstly the editorial structure has changed — Richard Tisher continues as the general series editor, but beginning with this volume and continuing in future years new editors will be appointed for each volume. These will normally be from among the executive officers of the association, who are responsible for organising and conducting the annual conference. Secondly, there has been a further (and hopefully final) change of title for the publication. This edition is entitled Research in Science Education, Volume 4. The name highlights more specifically the primary interest — viz. research in science education — of the conference, and so also of the proceedings. The inclusion of a volume number rather than just a year seems appropriate to emphasise the series nature of the publication, and is also more suitable for reference citation.

The papers presented at the conference have been grouped into six different sections according to the nature of predominant emphasis. This does not mean that every paper in a particular section has the same philosophical or methodological basis, but simply that there is some general similarity of approach to educational research problems within each section. The groupings here have generally followed those determined at the conference, though with one important exception — the section on general methods of evaluation includes several working papers based on, or presented at, the relevant topical discussion sessions held in the latter part of the conference. These papers were not intended to describe or evaluate original research projects, but rather to present a brief review of arguments related to particular aspects of educational research or to particular methodological techniques. It was felt, nevertheless, that they might provide a useful basis for further research or discussion on these issues, and have therefore been included in this volume.

It should also be explained that because of the increasing number of papers and costs of publication, substantial editing was needed to reduce the overall amount of material and thus to keep the total cost of these proceedings within realistic limits. Further constraints of time prevented effective consultation with contributors during this process, and it is hoped that the essence and coherence of argument in all of the papers have been completely maintained. Certainly all relevant precautions have been taken, and the editors take full responsibility for the final result.

Russell D. Linke
Leo H.T. West.
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VOLUME 5


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PREFACE

This volume contains the papers presented at the sixth Annual Conference of the Australian Science Education Research Association held at Flinders University in May 1975. The papers reflect the diversity of interests of ASERA members; ranging from philosophy of science and science teaching to experimental studies in learning theory; from primary school science to preparation of doctors and agricultural scientists; and from studies based on local curriculum developments to investigations conducted overseas. The authors do not, therefore, share common research traditions; the commonality is provided by the subject area of the curriculum being investigated within these diverse paradigms.

The standard of the papers is encouraging. ASERA exists to provide a forum for describing work in progress; for discussing methodological issues of importance to the members; and for reporting work of interest mainly to Australian science educators and thus, inappropriate for many foreign journals. These objects are met, in part, by accepting papers for the conference without applying any "quality" criteria. Thus, the papers in the proceedings have not been subject to judgement by an editorial panel, although some were revised in the light of discussion after their presentation; yet few are below the standards of appropriate refereed journals.

The stimulus to research provided by the introduction of the Australian Science Education Project is evident again in this issue; but the interest of members in tertiary teaching/learning is also apparent. The latter is possibly an artifact stemming from the active soliciting of papers in this area by the conference, who also took other decisions that would invalidate studies of trends in Australian science education research based on comparison of this issue with early proceedings: a limit was placed on the number of papers associated with any single contributor, review articles were not accepted, and the short papers used as stimuli for workshop discussion groups have not been included here. The omission of the workshop papers was a deliberate decision of the conference convenors and is not a reflection on their importance; members' were told that the papers and discussion were not for publication in the belief that awareness of ultimate publication may have encouraged unproductive caution.

Professor Fisher has relinquished the position of general editor of the ASERA series. He has had a heavy responsibility, editing the first three volumes alone, and acting as general editor for Volume 4, being responsible for seeing the work through the press. This task was more difficult for him in his new position, at Monash, than it had been previously when he was at the University of Queensland. The Association greatly appreciates the extensive and ground work he laid as general editor; as members we look forward to his continued participation in conferences and thank him for his important role in establishing the Association and its publication.

I thank Effie Best and Ian Walker for their assistance in planning the conference reported here.

A.M. Lucas
Flinders University
11 August, 1975
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RESEARCH
IN
SCIENCE EDUCATION

VOLUME 6


Edited by: M.N. Maddock
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AUSTRALIAN SCIENCE EDUCATION RESEARCH ASSOCIATION

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PREFACE

The choice of the University of Newcastle as the venue of the 1976 7th Annual Conference of the Australian Science Education Research Association marked an important stage in the evolution of the association and set an important precedent. For the first time, the conference was held at a centre other than a state capital, and another provincial venue, the Riverina College of Advanced Education in Wagga, New South Wales, was chosen for the 1977 conference. Representation from the Colleges of Advanced Education was much stronger than at previous conferences, and the choice of one of these colleges for the venue in 1977 acknowledges this trend.

As has been the practice in the past, the papers published in this journal are the formal research papers presented during the conference. They represent a cross-section of the interests of researchers in the area of Science Education in Australia.

In addition to the formal research reports, the conference again provided “kite-flying” discussion papers, which have not been published here. Two of these papers challenged some fundamental issues. One paper presented a point of view that alternative paradigms to those usually used in traditional science exist, which science educators should acknowledge. Two of the formal papers were also philosophically based and challenged the assumptions underlying science in relation to the teaching of the subject in schools.

The Newcastle and District Science Teachers Association, in a “kite-flying” paper challenged the kind of research being carried out, claiming that much of it has little relevance for the classroom practitioner, and taking the researchers to task for making too little use of avenues of publication which reached the classroom teacher and could be readily understood by them.

In the final session of the conference, the question was again raised as to whether some of the formal papers presented really fitted the concept of science education research which had been originally fostered by the association.

The consensus of opinion reached was that diversity of interest was a good thing for the association, and was to be encouraged. It was also agreed that members of the association could give more attention to research relevant to classroom practice, and should seek avenues of publication which reached the practising teacher more readily.

The Australian Science Education Project again provided the stimulus for a significant proportion of the formal papers presented, primary science was again represented, and tertiary teaching in medicine and teacher training also provided research reports. However, there were no reports at all from the areas of the main science disciplines and other applied science subjects at University level, and response to notification about the conference to faculties and departments of this kind was very limited. Many academics in these disciplines have been rather vocal about what the schools do or do not do, such as the physics academic who once claimed to the editor that “The Wyndham Scheme has destroyed Physics in New South Wales”.

While academics may be at the forefront in the search for knowledge in their own fields, many are archaic in their teaching approaches and ignorant of advances in the educational aspects of science. There is a need for wider representation from scientists interested in improving the quality of science education at tertiary level, and for scientists and educators to pursue research into science education problems at this level.

Despite this deficiency, the Newcastle conference can be regarded as a highly successful one. Thanks are expressed to all those people at the Newcastle College of Advanced Education, the University of Newcastle and Trans Australia Airlines who assisted in the organisation, with specific thanks to co-executive officer Terry Sheedy for undertaking a lion’s share of the work.

M.N. MADDOCK
The University of Newcastle
August 1976.
<table>
<thead>
<tr>
<th>Name</th>
<th>Position and Institution</th>
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RESEARCH
IN
SCIENCE EDUCATION

VOLUME 7


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PREFACE

The papers published in this journal represent the majority of papers presented at the 8th Annual Conference of the Australian Science Education Research Association. It was the second occasion that the conference was held at a provincial venue and the first time that the host institution was a College of Advanced Education.

As twenty-eight formal research papers were presented at the conference, authors were requested to constrain the length of papers so that the volume stayed within reasonable size limits. However, every effort has been made to ensure that each paper published is in accord with the conference presentation.

The relatively large number of contributions at the conference ranged over a wide area of interests in science education. White introduced a thought-provoking model of cognitive processes which has implications well beyond science education. Osborne and Freyberg discussed a systems approach to curriculum research which similarly has broad implications. On the other hand, many other contributors concentrated on specific topics of concern in science education. Amongst these papers one will note some concentration upon issues associated with science education at secondary and tertiary levels. Conversely, only one paper dealt with research into aspects of primary science education. It is to be hoped that the increased interest in science in the primary curriculum will be supported by a greater degree of research activity in the area in the future.

Anthony J. D. Blake
School of Teacher Education
Riverina College of
Advanced Education.
LABORATORY BASED TEACHING IN PHYSICAL SCIENCE
AND ITS RELATION TO PUPIL ATTAINMENT

P. P. Lynch

Introduction

Within the last two decades there has been what might be termed a revolution in science education which has strongly influenced both teaching objectives and instructional methods. This revolution is essentially neo-heuristic with the emphasis on *guided discovery*, and in this respect is more controlled and more controllable than Armstrong's heurism (Herman, 1969). Support for the adoption of the discovery has been further stimulated by the compelling writings of behaviourists (Ausubel, 1968; Bruner, 1961; Gagné, 1965). Such a method is usually seen, ideally, as *replacing* conventional laboratory and traditional expository methods rather than as an alternative. Yet, in spite of the virtually unreserved promotion of such methods in schools there is little if any evidence to justify their *teaching and learning* effectiveness over traditional methods (Babikian, 1971).

In more recent years discovery methods and related curricula have been introduced, to the Third World, where *cost-effectiveness* is of critical importance. It should be noted that most curriculum work in the Third World involves English as the medium of instruction. Inevitably, this curriculum work is neo-heuristic and, unfortunately, the much broader spectrum of European opinion is largely ignored. European opinion on such matters as teaching methods and the value of experimental work in schools varies widely — contrary to popular opinion (Thompson, 1972). *We are not* all moving in the same direction.

The problem

The results reported here have been abstracted from a national survey into the nature, purpose and organisation of practical work (Lynch, 1977), carried out in South African High Schools and Universities. Inevitably, within the general data available there is much information related to specific problems, in this case, the effectiveness of different teaching methods in relation to pupil attainment. The South African situation is of considerable interest because as far as science teaching is concerned teaching methods are influenced as much by European as British/American tradition. The Afrikaans speaking community draws much of its inspiration from German-Dutch tradition and this is maintained by the interchange of teachers and educators from those countries. The English speaking community tends, by comparison, to look to Britain and the U.S. for its teaching models. However, all school pupils complete the same matriculation examinations irrespective of language of instruction or teaching method employed.

Procedure and results

First year university students were asked to indicate their experience of *experimental techniques*, *specific types of practical work* and *standard experiments* at High School level by means of a questionnaire.
The questionnaire was constructed after a careful literature survey of similar studies (Kerr, 1963) and with the aid of an inquiry team and an advisory steering committee composed of 32 persons actively involved with school and university teaching in South Africa. The inquiry team and the committee reviewed each question and item with regard to syntax and relevance, and eliminated or added items. By this means the questionnaire was reviewed and rewritten three times, and we feel that full use was made of the collective wisdom and experience of all concerned.

The questionnaire was given to the students during a normal but previously undisclosed lecture period at the beginning of their specific first year courses. Students were given a short standardised preamble explaining the purpose of the survey, and aimed at winning the students’ interest, cooperation and confidence. Each question was administered separately, clearly read and explained with an example. Approximately 40 minutes was taken to complete the items and by these means questionnaires were usually returned fully completed. A section for free comment was available and students were encouraged to use this. Careful scrutiny of this and the care taken with completion of individual items was taken as a measure of student cooperation. Less than 1% of the sample needed to be eliminated as a consequence of any tell-tale indications of careless completion or facetious comment.

The items included in the questionnaire were as follows:

(a) Frequency of use of experimental techniques: A list of experimental techniques considered to be of central importance in secondary level physical science was drawn up with the help of the advisory steering committee. Of the fifteen techniques finally listed (Table 2), items 1, 2, 5, 9 and 10 are general techniques, items 3, 4, 6, 7 and 8 more specific to chemistry and items 11, 12, 13, 14 and 15 are more specific to physics.

Students were asked to indicate whether or not they knew about, had seen done, or had carried out the techniques themselves.

If the students marked the last category, they were asked to indicate the frequency using the 5 point scale

1 = never (but seen done)
2 = seldom
3 = moderately often
4 = often
5 = very often

The mean scores for each item are given in Table 2.

(b) Frequency of use of different types of practical work. Students were asked to indicate the extent to which three types of practical work were carried out at school, namely, demonstrations, group work or individual work. For the purpose of this inquiry and on the advice of the advisory steering committee it was decided that experiments involving 1 or 2 pupils would be termed 'individual work'. No attempt was made at this stage to distinguish between standard exercises, discovery experiments and project work.

The frequency of use of the three categories of practical work were measured on the 5 point scale

every period = 1
x 2 per week = 2
x 1 per week = 3
x 1 per month = 4
never = 5
Students were asked to indicate which category *most nearly* represented their High School experience.

The mean scores obtained are given in Table 3.

(c) The use of standard experiments in physics and chemistry: Fourteen experiments (seven in physics and seven in chemistry) taken from relevant school syllabi were considered by the advisory steering committee to represent a comprehensive coverage for any physical science syllabus (Table 4 below). The method of use or not of the standard experiments was measured in the categories ‘know about (only)’, ‘seen done’ and ‘carried out myself’. The first category indicates no school experience of that particular standard experiment. The second category, ‘seen done’ indicates experience of a demonstration of the experiment. The third column, ‘carried out myself’ indicates direct experience in the form of individual or group work.

Mean scores based on the corresponding 3 point scale are given in Table 4. A discussion dealing with the percentages involved in the different categories has appeared elsewhere (Colussi, 1975).

The sample

The questionnaire responses for first year University students in Faculties of Science, Engineering and Medicine were obtained from an urban and a rural university in which the medium of instruction is specifically English (the Witwatersrand and Rhodes), and specifically Afrikaans (Pretoria and Stellenbosch). This total sample was considered to be representative of first year science, medical and engineering students at universities for white pupils in South Africa. Further details of the sample are provided in Table 1.

**TABLE 1**

Details of sample size and structure

<table>
<thead>
<tr>
<th>University</th>
<th>Sample Size</th>
<th>Faculties Represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Witwatersrand</td>
<td>728</td>
<td>Science/Engineering/Medicine</td>
</tr>
<tr>
<td>Rhodes</td>
<td>114</td>
<td>Science/Engineering</td>
</tr>
<tr>
<td>Pretoria</td>
<td>906</td>
<td>Science/Engineering/Medicine</td>
</tr>
<tr>
<td>Stellenbosch</td>
<td>604</td>
<td>Science/Engineering/Medicine</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2352</strong></td>
<td></td>
</tr>
</tbody>
</table>

Analysis and display of results

The data from the questionnaire was transferred onto punch cards, verified, and finally stored on magnetic tape.

Analysis of the data was achieved using the computer package SPSS (Statistical Package for the Social Sciences). Mean scores, standard deviations and variances with regard to
<table>
<thead>
<tr>
<th>Experimental Techniques</th>
<th>Entire Population</th>
<th>TVE</th>
<th>JMB</th>
<th>NSC</th>
<th>CAPE SC</th>
<th>OFSLC</th>
<th>NATAL SC</th>
<th>Other</th>
<th>Significance of differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Weighing (on a rough balance)</td>
<td>2.2</td>
<td>1.9</td>
<td>3.0†</td>
<td>2.2</td>
<td>2.1</td>
<td>2.4</td>
<td>3.3</td>
<td>3.1†</td>
<td>*</td>
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<tr>
<td>2. Weighing (to at least 3 figure accuracy)</td>
<td>1.8</td>
<td>1.4</td>
<td>2.5</td>
<td>1.5</td>
<td>1.8</td>
<td>2.7</td>
<td>2.6</td>
<td>3.2†</td>
<td>*</td>
</tr>
<tr>
<td>3. Titrating with a burette</td>
<td>2.0</td>
<td>1.6</td>
<td>2.9</td>
<td>1.4</td>
<td>2.1</td>
<td>2.4</td>
<td>3.4†</td>
<td>3.6†</td>
<td>*</td>
</tr>
<tr>
<td>4. Using a pipette</td>
<td>2.1</td>
<td>1.8</td>
<td>3.0†</td>
<td>1.8</td>
<td>2.1</td>
<td>2.7</td>
<td>3.4†</td>
<td>3.6†</td>
<td>*</td>
</tr>
<tr>
<td>5. Measuring of volume with a measuring cylinder</td>
<td>2.5</td>
<td>2.2</td>
<td>3.2†</td>
<td>2.2</td>
<td>2.4</td>
<td>3.1†</td>
<td>3.5†</td>
<td>3.4†</td>
<td>*</td>
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<tr>
<td>6. Filtering, using filter paper in a funnel</td>
<td>2.1</td>
<td>1.8</td>
<td>3.0†</td>
<td>1.8</td>
<td>2.1</td>
<td>2.6</td>
<td>2.9</td>
<td>3.1†</td>
<td>*</td>
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<tr>
<td>7. Crystallising</td>
<td>1.7</td>
<td>1.6</td>
<td>2.1</td>
<td>1.5</td>
<td>1.6</td>
<td>1.8</td>
<td>2.1</td>
<td>2.1</td>
<td>*</td>
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<tr>
<td>8. Distilling</td>
<td>1.4</td>
<td>1.3</td>
<td>1.7</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.8</td>
<td>1.9</td>
<td>*</td>
</tr>
<tr>
<td>9. Heating with a bunsen burner</td>
<td>2.9</td>
<td>2.4</td>
<td>3.1†</td>
<td>2.6</td>
<td>2.8</td>
<td>3.6†</td>
<td>4.3†</td>
<td>3.9†</td>
<td>*</td>
</tr>
<tr>
<td>10. Measuring with a metre rule</td>
<td>3.2†</td>
<td>3.0†</td>
<td>3.7†</td>
<td>3.1†</td>
<td>3.1†</td>
<td>3.9†</td>
<td>3.9†</td>
<td>3.7†</td>
<td>*</td>
</tr>
<tr>
<td>11. Measuring with a micrometer screw</td>
<td>1.4</td>
<td>1.3</td>
<td>2.0</td>
<td>1.3</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
<td>2.3</td>
<td>*</td>
</tr>
<tr>
<td>12. Measuring pressure with a manometer or pressure gauge</td>
<td>1.4</td>
<td>1.3</td>
<td>1.6</td>
<td>1.5</td>
<td>1.3</td>
<td>2.0</td>
<td>2.0</td>
<td>1.8</td>
<td>*</td>
</tr>
<tr>
<td>13. Reading an ammeter or voltmeter</td>
<td>2.7</td>
<td>2.4</td>
<td>3.2†</td>
<td>2.9</td>
<td>2.4</td>
<td>3.1†</td>
<td>2.8</td>
<td>3.0†</td>
<td>*</td>
</tr>
<tr>
<td>14. Reading a thermometer</td>
<td>3.0†</td>
<td>2.7</td>
<td>3.8†</td>
<td>2.8</td>
<td>2.9</td>
<td>3.8†</td>
<td>4.1†</td>
<td>3.9†</td>
<td>*</td>
</tr>
<tr>
<td>15. Connecting up an electrical circuit</td>
<td>2.4</td>
<td>2.1</td>
<td>3.0†</td>
<td>2.6</td>
<td>2.2</td>
<td>3.7†</td>
<td>3.6†</td>
<td>2.8</td>
<td>*</td>
</tr>
<tr>
<td><strong>OVERALL MEAN SCORE</strong></td>
<td><strong>2.2</strong></td>
<td><strong>1.9</strong></td>
<td><strong>2.9</strong></td>
<td><strong>2.1</strong></td>
<td><strong>2.1</strong></td>
<td><strong>2.8</strong></td>
<td><strong>3.0</strong></td>
<td><strong>3.0</strong></td>
<td>*</td>
</tr>
</tbody>
</table>

**Note:** † = mean score in moderate-often range.

a mean score less than 1.8 indicates that the majority have never carried out that technique

**Key:** never seldom moderately often often very often

* = differences significant at the 0.5% level
### TABLE 3

Mean scores for type of practical work used by students associated with different Examination Boards

<table>
<thead>
<tr>
<th>Type of Practical Work</th>
<th>Entire Population</th>
<th>TVE</th>
<th>JMB</th>
<th>NSC</th>
<th>CAPE SC</th>
<th>OFSLC</th>
<th>NATAL SC</th>
<th>Other</th>
<th>Significance of differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of demonstrations</td>
<td>2.9</td>
<td>3.2</td>
<td>2.5</td>
<td>3.0</td>
<td>2.5</td>
<td>2.3</td>
<td>2.4</td>
<td>2.8</td>
<td>*</td>
</tr>
<tr>
<td>Frequency of group work</td>
<td>3.9</td>
<td>4.1</td>
<td>3.6</td>
<td>4.0</td>
<td>3.9</td>
<td>3.0</td>
<td>3.3</td>
<td>3.7</td>
<td>*</td>
</tr>
<tr>
<td>Frequency of individual work</td>
<td>4.4</td>
<td>4.6</td>
<td>3.7</td>
<td>4.4</td>
<td>4.3</td>
<td>3.9</td>
<td>3.7</td>
<td>3.4</td>
<td>*</td>
</tr>
<tr>
<td>Number of students in sample</td>
<td>2279</td>
<td>683</td>
<td>180</td>
<td>89</td>
<td>488</td>
<td>106</td>
<td>89</td>
<td>81</td>
<td></td>
</tr>
</tbody>
</table>

Key:

- **1** = mean score in moderate-often range.
- **2** = mean score less than 1.8 indicates that the majority have never carried out that technique

---

**Note:**

- **Key:**
  - never
  - seldom
  - moderately often
  - often
  - very often

- *** = differences significant at the 0.5% level**
TABLE 4

Mean scores for use of standard experiments by students associated with different Examination Boards

<table>
<thead>
<tr>
<th>Standard Experiments</th>
<th>Entire Population</th>
<th>TVE</th>
<th>JMB</th>
<th>NSC</th>
<th>CAPE SC</th>
<th>OFSLC</th>
<th>NATAL SC</th>
<th>Other</th>
<th>Significance of differences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHYSICS</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. ‘Acceleration’</td>
<td>2.2</td>
<td>2.1</td>
<td>1.9</td>
<td>1.9</td>
<td>2.5</td>
<td>2.6</td>
<td>2.3</td>
<td>1.5#</td>
<td>*</td>
</tr>
<tr>
<td>2. ‘g’</td>
<td>2.1</td>
<td>1.8</td>
<td>1.9</td>
<td>1.7#</td>
<td>2.6</td>
<td>2.5</td>
<td>2.1</td>
<td>1.3#</td>
<td>*</td>
</tr>
<tr>
<td>3. ‘Specific or latent heat’</td>
<td>1.7#</td>
<td>1.5#</td>
<td>1.8</td>
<td>1.8</td>
<td>1.9</td>
<td>2.2</td>
<td>2.1</td>
<td>1.5#</td>
<td>*</td>
</tr>
<tr>
<td>4. ‘Focal length’</td>
<td>1.9</td>
<td>1.9</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
<td>2.0</td>
<td>1.6#</td>
<td>*</td>
</tr>
<tr>
<td>5. ‘Electrical resistance’</td>
<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
<td>2.7</td>
<td>2.3</td>
<td>1.6#</td>
<td>*</td>
</tr>
<tr>
<td>6. ‘Electric motor’</td>
<td>1.8</td>
<td>1.7#</td>
<td>1.8</td>
<td>2.1</td>
<td>1.8</td>
<td>2.0</td>
<td>1.8</td>
<td>1.4#</td>
<td>*</td>
</tr>
<tr>
<td>7. ‘Interference patterns’</td>
<td>2.0</td>
<td>2.0</td>
<td>1.9</td>
<td>2.1</td>
<td>2.2</td>
<td>2.5</td>
<td>1.9</td>
<td>1.7#</td>
<td>*</td>
</tr>
<tr>
<td><strong>CHEMISTRY</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. ‘Solubility’</td>
<td>1.9</td>
<td>1.7#</td>
<td>2.0</td>
<td>1.9</td>
<td>2.0</td>
<td>2.2</td>
<td>2.0</td>
<td>1.6#</td>
<td>*</td>
</tr>
<tr>
<td>2. ‘Chemistry of an element’</td>
<td>1.6#</td>
<td>1.5#</td>
<td>1.8</td>
<td>1.6#</td>
<td>1.7#</td>
<td>1.7#</td>
<td>1.9</td>
<td>1.5#</td>
<td>*</td>
</tr>
<tr>
<td>3. ‘Organic or inorganic prep’</td>
<td>1.7#</td>
<td>1.6#</td>
<td>1.8</td>
<td>1.5#</td>
<td>1.8</td>
<td>1.9</td>
<td>1.8</td>
<td>1.6#</td>
<td>*</td>
</tr>
<tr>
<td>4. ‘Rate of reaction’</td>
<td>1.7#</td>
<td>1.6#</td>
<td>1.7#</td>
<td>1.7#</td>
<td>1.8</td>
<td>2.0</td>
<td>2.2</td>
<td>1.4#</td>
<td>*</td>
</tr>
<tr>
<td>5. ‘Molecular models’</td>
<td>1.9</td>
<td>1.8</td>
<td>1.8</td>
<td>1.9</td>
<td>2.1</td>
<td>1.8</td>
<td>1.8</td>
<td>1.6#</td>
<td>*</td>
</tr>
<tr>
<td>6. ‘Vapour density or molecular weight’</td>
<td>1.3#</td>
<td>1.3#</td>
<td>1.4#</td>
<td>1.3#</td>
<td>1.3#</td>
<td>1.7#</td>
<td>1.6#</td>
<td>1.5#</td>
<td>*</td>
</tr>
<tr>
<td>7. ‘Acids and bases’</td>
<td>1.8</td>
<td>1.7#</td>
<td>2.0</td>
<td>1.8</td>
<td>2.1</td>
<td>2.2</td>
<td>2.2</td>
<td>1.6#</td>
<td>*</td>
</tr>
</tbody>
</table>

# = majority of students have neither seen the experiment nor carried it out themselves.

A mean score greater than 2.4 indicates that the majority have carried out that experiment themselves.

Key:  
1. know about (only)  
2. seen done  
3. carried out myself

* = differences significant at the 0.5% level
individual items were calculated for total samples and for various sub-groups. The significances of the differences were assessed using one way analyses of variances (F tests). In the tabulated data, here, the level of significance of the difference if it exceeds the 0.5% level is marked thus. * *. This relatively high level of significance has been used in view of the inherent difficulties that are associated with the interpretation of data obtained by survey methods (Gardner, 1975).

Findings — General

Students indicate that the choice of content, the teaching method and the time spent on practical works at High School varies widely. Student experience of even very elementary practical techniques such as heating with a bunsen burner or connecting up an electric circuit varies considerably. A full analysis and description of this experience and its implications are provided elsewhere (Colussi, 1976).

In order to explore the factors most important in determining these differences the sample was examined with respect to variables such as sex differences, type and size of schools, language medium and Examination Board.

There are some considerable differences in experience (judged by mean scores) between private and government schools, between single sex and co-educational schools and between English and Afrikaans medium schools. However the greatest overall differences between mean scores are produced when the sample is examined with respect to Examination Board. * 1

Mean scores for the entire population and for the different examination boards are given for that reason. The scale used in Table 2, is non-linear but as a rough guide OFS and Natal SC students indicate experience, on average, of twice as many demonstrations and almost four times as much group work as TVE students. By comparison with the ‘entire population’, OFS, Natal SC, JMB and ‘Other’ students have considerably more experience of all three types of practical work.

The results in Table 3 are consistent with those obtained in Table 2. The overall mean score gives a crude indication of the average frequency of techniques and OFS, Natal SC, JMB and ‘Other’ students have a mean score equivalent to ‘moderately often’. Students associated with the TVE, NSC and Cape SC have mean scores approximately equivalent to ‘seldom’.

The scale used in Table 4 is particularly constricted. A mean score less than 1.8 is associated with the majority of students having no experience of that experiment, while a mean score greater is associated with the majority having experience of individual or group work.

The results for the ‘Other’ group suggest that the latter have a more technique oriented background than South African students. The TVE column in Table 4 needs to be interpreted with caution since further examination showed that English and Afrikaans medium schools have very different experience of the standard experiments listed.

The prime reason for presenting the data in this form is to show that the experience of the items chosen in the questionnaire do, indeed, vary widely, and that there are significant differences between certain sub-groups.

Findings with respect to matriculation grade

The mean scores for students with different matriculation grades are given in Tables 5-7. The codification, A to F represents grades from distinction (A) to fail (F).
TABLE 5
Mean scores for frequency of use of experimental techniques by students with different matriculation grades

<table>
<thead>
<tr>
<th>Experimental Techniques</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matriculation Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>2.1</td>
<td>1.6</td>
<td>1.9</td>
<td>2.1</td>
<td>2.3</td>
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<td>1.3</td>
<td>2.7</td>
<td>3.2</td>
<td>1.3</td>
<td>1.4</td>
<td>2.6</td>
<td>2.9</td>
<td>2.4</td>
</tr>
<tr>
<td>B</td>
<td>2.1</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
<td>2.4</td>
<td>2.0</td>
<td>1.6</td>
<td>1.3</td>
<td>2.8</td>
<td>3.3</td>
<td>1.3</td>
<td>1.5</td>
<td>2.7</td>
<td>3.0</td>
<td>2.4</td>
</tr>
<tr>
<td>C</td>
<td>2.1</td>
<td>1.7</td>
<td>2.0</td>
<td>2.1</td>
<td>2.5</td>
<td>2.1</td>
<td>1.7</td>
<td>1.4</td>
<td>2.8</td>
<td>3.1</td>
<td>1.4</td>
<td>1.4</td>
<td>2.7</td>
<td>2.9</td>
<td>2.4</td>
</tr>
<tr>
<td>D</td>
<td>2.1</td>
<td>1.7</td>
<td>1.9</td>
<td>2.1</td>
<td>2.5</td>
<td>2.1</td>
<td>1.7</td>
<td>1.4</td>
<td>2.8</td>
<td>3.1</td>
<td>1.4</td>
<td>1.3</td>
<td>2.6</td>
<td>2.8</td>
<td>2.3</td>
</tr>
<tr>
<td>E</td>
<td>2.2</td>
<td>1.9</td>
<td>1.8</td>
<td>2.0</td>
<td>2.4</td>
<td>2.0</td>
<td>1.6</td>
<td>1.5</td>
<td>2.6</td>
<td>3.1</td>
<td>1.6</td>
<td>1.3</td>
<td>2.5</td>
<td>2.9</td>
<td>2.2</td>
</tr>
<tr>
<td>F</td>
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<td>2.3</td>
<td>2.6</td>
<td>2.2</td>
<td>2.0</td>
<td>1.5</td>
<td>3.5</td>
<td>3.2</td>
<td>1.3</td>
<td>1.1</td>
<td>2.7</td>
<td>3.0</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Significance of differences

* * *

TABLE 6
Mean scores for type of practical work used by students with different matriculation grades

<table>
<thead>
<tr>
<th>Type of Practical work</th>
<th>Frequency of demonstrations</th>
<th>Frequency of group work</th>
<th>Frequency of individual work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matriculation Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>3.0</td>
<td>4.0</td>
<td>4.5</td>
</tr>
<tr>
<td>B</td>
<td>2.9</td>
<td>3.9</td>
<td>4.4</td>
</tr>
<tr>
<td>C</td>
<td>2.8</td>
<td>3.8</td>
<td>4.4</td>
</tr>
<tr>
<td>D</td>
<td>2.9</td>
<td>3.9</td>
<td>4.4</td>
</tr>
<tr>
<td>E</td>
<td>2.9</td>
<td>3.9</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Significance of differences

Students with F (fail) grades at Matriculation level have rather less experience of practical work but the differences are not usually significant at the 0.5% level.

There are a few instances where the differences of experience are significant (see Tables 6 and 7) and these are due to F grade students. But the similarities are more striking than the differences particularly when compared with the previous tables.

Our interpretation of these results is that there is an absence of any correlation between amount of practical work, type or nature of practical work experienced and matriculation grade obtained.
TABLE 7

Mean scores for frequency of use of standard experiments by students with different matriculation grades

<table>
<thead>
<tr>
<th>Physics Experiments</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.3</td>
<td>2.2</td>
<td>1.7</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>2.1</td>
</tr>
<tr>
<td>B</td>
<td>2.2</td>
<td>2.1</td>
<td>1.7</td>
<td>1.9</td>
<td>1.9</td>
<td>1.8</td>
<td>2.1</td>
</tr>
<tr>
<td>C</td>
<td>2.1</td>
<td>2.0</td>
<td>1.7</td>
<td>1.9</td>
<td>1.9</td>
<td>1.8</td>
<td>2.0</td>
</tr>
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<td>2.1</td>
<td>1.7</td>
<td>2.1</td>
<td>2.0</td>
<td>1.8</td>
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<td>2.0</td>
<td>2.0</td>
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<td>F</td>
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<td>2.0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemistry Experiments</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<td>1.7</td>
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<td>1.8</td>
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<td>1.7</td>
<td>2.0</td>
<td>1.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Significance of differences

Discussion

The terminal examination in question, University Matriculation, is little different to the equivalent examinations used in, for example, the U.K, the U.S or Australia. Use is made of both multiple choice, structured, and essay type questions and every attempt is made to cover the usual accepted range of cognitive skills. The syllabus content, itself, shows the influence of various well established curricula such as Chem Study, PSSC Physics, Nuffield O-level and A-level etc. The standard of attainment aimed at is about equivalent to one year of sixth form work in the U.K. It is performance, measured by this examination, which is unrelated to choice or even use of practical work. There is, thus, no evidence that practical work reinforces learning or that it encourages students to learn more in relation to established ‘academic’ assessment.

Neither the motivational affects nor the acquisition of laboratory or related organisational skills are considered here but will be reported at a later stage. But, the absence of any apparent benefit as far as the acquisition of scientific knowledge is concerned has some serious implications for curriculum developers, generally. If cost-effectiveness is of a paramount importance as in third world situations, then more attention needs to be paid to the nature and extent of the practical work used.

Discovery-type programmes are more expensive to set up and to maintain, apart from, in many cases, being more difficult to organise at a teaching, in-service and administrative level. Programmes placing more emphasis on the lecture-demonstration method may offer a more convenient, cheaper and as effective an answer.

Footnote

1. The codifications used in Tables 2, 3 and 4 refer to the Examination Boards, and their respective Matriculation Examinations required for university entrance.
They are as follows: TVE = Transvaal University Matriculation, JMB = Joint Matriculation Board, NSC = National Senior Certificate, Cape SC = Cape Senior Certificate, OFSLC = Orange Free State Leaving Certificate, Natal SC = Natal Senior Certificate.

‘Other’ = (usually) U.K. or Rhodesian O/A level Certificate.

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Most of the papers in this volume of Australian Science Education in 1980 can be tackled either as individual papers or as parts of sessions of science educators.

The co-ordinator of whether Rod Fawns paper may need to be rethought is encouraging this behaviour, the

By delightful flavour of knowledge and a sense of America. On A.S.E.R.A. Conf aspect of science Conferences and inquiry into problems and issues reported here it is encouraging to ways in which they may be narrowed, but (Owen’s paper), re

Colin Power
General Editor
PREFACE

This volume contains the papers presented at the 9th Annual Conference of the Australian Science Education Research Association held at Mount Gravatt College of Advanced Education in May 1978. The papers reflect the diversity of interests of A.S.E.R.A. members; ranging from philosophical analysis of the language of science teaching to experimental research into the effects of different laboratory skill development strategies; from cognitive development in primary school children to analyses of teaching in University microbiology classes; from evaluations of facilities and curricula to the rough theatre of the science classroom.

Most of the studies reported fall within the psychometric paradigm and have utilised its methodologies. One or two have utilised other (e.g. philosophical) methods of analysis; and in a few papers, there are indications of a willingness to consider methodological alternatives, to tackle hitherto untouched problems and to adopt fresh perspectives. As a consequence, at least three or four of the papers presented represent a challenge not only to the research traditions of science education, but also to science teachers, curriculum developers, and teacher educators.

The continuing interest of members in problems relating to the nature of science and science education is evident in the first two papers. Science education research workers might well like to apply Barry Newman's classification to their efforts. Might the research be described as less than science, or even worse as unknown and unimportant science? If so, what might be done? Jim Butler's paper could not be described as unimportant, but it does raise the question of whether school science is a limited or unsuccessful science if not a misleading one. Rod Fawns' paper is undoubtedly unique but it also suggests that we, as teachers and researchers, may need to be more adventurous in our attempts to teach and to study science teaching. Several papers deal with the gap between the objectives of promoting inquiry, psychomotor skills, and affective development, and the reality. Collectively, these papers yield fresh insights and outline some promising tools which might be useful in studying the discrepancies identified. It is encouraging to see that more often than not, a careful study is being made of the patterns of behaviour, the nature of the learning environment, or the curriculum materials used.

Throughout the Conference papers the Australian bias persists, albeit spiced with the delightful flavour of South East Asian analyses of inquiry, a pragmatic look at environmental knowledge and attitudes in the United Kingdom and at psychomotor skills in the United States of America. Once again we find that certain perspectives are missing. For instance in the A.S.E.R.A. Conferences held to date, no paper has undertaken an historical analyses of any aspect of science teaching in Australia. Relatively few science teachers attend A.S.E.R.A. Conferences and rarely, if ever, have science teachers dared to report on their attempts to inquire into problems faced by them. At several A.S.E.R.A. Conferences, workshops (not reported here) have looked at the problems of dissemination and suggestions have been made as to ways in which the apparent gulf between science education research and practice might be narrowed. But, while we have studies of the diffusion of curriculum innovations (cf. John Owen's paper), research on the dissemination of research is all too rare.

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To the many persons who assisted in organising and conducting this conference, my thanks. In particular the advice and assistance of the following were invaluable:

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This publication contains some of the papers and summaries of papers presented at the tenth conference of the Australian Science Education Research Association.

Since this conference marked the end of the organisation's first decade, it seemed appropriate to reflect on the problems that confronted science education researchers in this country as they contemplate the directions of where we should be going. To this end, Professors Fensham and Power were invited to present papers on these issues. These two papers head the list of enclosed papers and were the basis of a fruitful discussion session.

Although the discussions traversed many aspects of science education research, two common threads emerged. The first aspect concerned the problem of communication between the researcher and the teacher. There was concern that research findings were not filtering through to the classroom. The other area involved the kind of science education research being carried out. The need was expressed to research areas which were perceived as being more relevant to the classroom. Perhaps this is the challenge of the eighties: to initiate more useful classroom oriented research as well as to more effectively inform teachers of it.

The remaining papers cover a wide range of interests and areas. The initial group of papers are involved with more general aspects of science education. There are then three papers on different aspects of attitudes followed by papers on learning difficulties with science concepts. Next there are a number of papers examining curriculum issues and learning strategies. The final papers discuss research about thinking processes.
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This publication contains most of the papers and summaries of papers presented at the eleventh conference of the Australian Science Education Research Association. The conference was held at Toorak State College, Melbourne, Victoria on 15-17th May, 1980.

In the first set of papers, the strong influence of contemporary movements in cognitive psychology is evident. Robert Karplus set the scene by arguing that cognitive development ought not to be viewed in terms of rigidly defined stages like steps in a staircase. He proposes that we focus on reasoning patterns (identifiable and reproducible thought processes aimed at particular tasks) and their development through a learning cycle of exploration, concept introduction and application. Considerable attention is given to the concepts, frameworks and reasoning patterns which students bring with them to the learning situation in the papers which follow. Osborne and Tennyson describe the current work being done in the Learning in Science Project in their in-depth interview studies of children’s science; Fenelon argues that research workers and curriculum developers need to take seriously the developed sets of ideas of students in attempting to explain learning difficulties and to frame science teaching objectives; Gunstone and White probe the understandings of first year Physics students revealing some of the misconceptions which derive from the way in which Physics is currently taught; Doonan and Bamford examine the types of errors made by students in examination Physics problems and speculate on the problem solving strategies used; Dekkers and Johnstone revive the notions of cognitive preference and cognitive style and set out to show how these guide programme development; Symington suggests that the background knowledge of teachers is important and influences the ways in which they set out to assist pupils to identify problems. The questioning of conventional procedures and frameworks which is implicit in many of the above papers proceeds in the paper by Gauld and by Blake and Hill. In a thought provoking paper, Gauld questions the mechanical, teacher-oriented procedures for developing and validating achievement tests, arguing for more subject-oriented procedures utilizing interviews to supplement psychometric analyses of student responses. Blake and Hill’s study of the validity and reliability of the pencil-and-paper Understanding in Science test as an alternative to the clinical interviews for assessing intellectual development point in a similar direction. In essence, the papers collectively suggest that we need to study the framework of ideas and reasoning processes of students and teachers using the administration of tasks and clinical, probing interviews and to take the results seriously in designing science courses and developing testing procedures.

Most of the remaining papers fall into two groups: those concerned primarily with studying science teaching practices (Butler et al; Fordham; Hacket) and those concerned with the relationship among student cognitive and personality measures, characteristics of schools or curriculum materials and achievement (Ainsley; Eggins; Rham). Butler and a team of researchers at the University of Queensland have initiated a major project which will provide us with a fascinating account of pupil task involvement and teacher management in science classrooms; Fordham’s
study of teaching practices relevant to the arousal of curiosity will be of particular interest to curriculum developers and classroom teachers; Hacker's study provides a good deal of scope for speculating about differences in science teaching practices in Australia, Canada and the United Kingdom.

The final papers in this volume deal with a programme evaluation project (Hirst et al.) and a detailed study of the attitudes to science and scientific attitudes of teachers, the methods used to assess these and the contribution made by science to the curriculum (Schibeci).

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RESEARCH
IN
SCIENCE EDUCATION

VOLUME 11

Proceedings of the Twelfth Annual Conference of the Australian Science Education Research Association, University of Tasmania, Hobart.

May, 1981

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This publication contains most of the papers and summaries of papers presented at the twelfth annual conference of the Australian Science Education Research Association. The conference was held at The University of Tasmania, Hobart, on 14-16 May, 1981.

As is usual, no theme was nominated for the conference and a wide distribution of topics, approaches and levels was represented. The papers as they are arranged proceed from the field of endeavour which concerns itself with the education and practices of science teachers. A beginning is made when a viewpoint is provided to support a hypothesis suggesting that a study of philosophy of science by teachers and scientists may result in improved articulation of science. There follows a group of papers that place emphasis upon teaching practices as these relate to curriculum and particular skills. These papers cover the teaching of science at all levels including that of primary school children. To some extent the perspective then changes to one that is on considerations of curriculum including student practical work, and the relationship with teaching, learning and attitudes can be observed. The interesting development in cognitive studies of learning as related to science education, teaching strategies and curriculum is well represented. Finally Volume II concludes with further studies on attitudes and expectations as these apply firstly to an aspect of teaching style and then to activities, topic and subject areas.

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RESEARCH IN SCIENCE EDUCATION

VOLUME 12

A selection of papers presented at the Thirteenth Annual Conference of the Australian Science Education Research Association, Macquarie University, Sydney.

May, 1982

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The thirteenth annual conference of the Australian Science Education Research Association was held at Macquarie University, Sydney, on 20-22 May, 1982. This publication contains a selection of the papers presented at the conference.

The papers begin with an overview of trends in science education, cognitive developmental research and theory in the United Kingdom. Such a beginning provides a perfect backdrop for the Australian research activities as reported in the papers submitted for publication.

The first group of papers that follows the introductory article is about some of the developments in studies of thinking and reasoning, including work on concept mapping and conceptual change. Closely associated with this group is a collection of papers that relates, broadly speaking, to teaching and learning. It includes studies where the focus is on teachers, students or both and relates to classroom communication both verbal and nonverbal, the effect of teacher background on performance, differences in problem solving performances, effects of instruction on understanding and computer simulation as a means to aid concept development. The following group is representative of the wide variety of work that is proceeding on attitudes and perceptions. The final paper uses an analysis of earlier science text books to identify a trend away from seeing 'nature' as a symbol of permanence, such that observed complexities and changes in the meaning of the symbol can be more readily accepted. Recognition of the problematics in the dominant stance normally adopted by science educators should lead to a questioning of the separation of 'man' from 'nature'.

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RESEARCH IN SCIENCE EDUCATION

Volume 13

Australian Science Education Research Association
RESEARCH
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Volume 13

Selections of papers from the Fourteenth Annual Conference of the Australian Science Education Research Association, University of Waikato, New Zealand

May 1983

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PREFACE

The majority of the papers presented at the annual conference of the Australian Science Education Research Association in May 1983 at University of Waikato, New Zealand, are contained in this volume of Research in Science Education. The issue begins with White's review of trends in the research over the past decade. He indicates that research has become more complex and more relevant in the last years as it has become based on more detailed models of relations between constructs. He also predicts an advance in the theory of learning in science within the next few years.

Quite a number of the subsequent papers deal with matters associated with explorations of cognitive structure. Brumby, for example, raises the question of whether concept mapping can be refined to demonstrate the processing of concepts and their linking relationships. She describes a written task in which pupils showed different patterns of working through a prepared concept map. Edwards and Fraser studied the concept mapping technique for its potential to provide an indicator of the level of understanding pupils bring to a learning situation, while Fawns compared concept maps for ASEP units drawn by experienced and student-teachers and used to make overt their views of the science syllabus. Dall'Alba and Edwards identify the dimensions of a cognitive task which determine how demanding it is and pupils' concepts of velocity and acceleration and rock are probed by Jones and Happs, respectively. Schollum adds another perspective to the research by showing that pupils often give meanings to arrows in scientific diagrams that are not intended, and Carr indicates that many 12 to 13 year-olds have incorrect ideas about numbers with decimal fractions with consequential effects in those science topics that require decimal fractions. Hope and Townsend and Northfield and Gunstone discuss some of the implications that research on student teachers' understanding of science concepts and children's frameworks for interpreting natural phenomena have for pre-service teacher education.

Teaching-strategy and curricular issues are addressed by Blake who proposes a 'hands on', science based, compensatory education program for intellectually immature early-leaving secondary school students and by Biddulph, Osborne, and Fryberg who describe the Learning in Science Project (Primary) at the University of Waikato. But compared to a decade ago there are fewer reports about teaching and interaction in science classrooms although in this issue Harlen uses her experience with the APU work in science to present some ideas about the relationships between process skills and concepts and Beasley studies the relationships between teacher
behaviour and pupil involvement in learning tasks. His findings suggest that teachers who wish to encourage small-group learning activities must nevertheless maintain their 'contact' with the whole class.

Several papers deal with issues associated with attitudes (Appleton; Jones & Butts; Maddock), others (Fensham; Gauld & Ryan) with learning difficulties and diagnosing misunderstandings; one with cognitive preferences and achievement in chemistry (McRobbie), one (Symington & White) with children's explanations of natural phenomena; and another (Bell) with processes used to learn from text. The remaining two papers in this issue introduce new techniques and themes into the research. stead reports on the use of the repertory grid technique to analyse pupils' reactions to science and Lynch and Strube report on Strube's refreshing historical analysis of science texts. once again this volume of Research in Science Education reveals the diversity of interests and of issues reported at the annual conference.

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General lay-out and length

Setting out: The paper (including diagrams, tables, etc.) is to be typed on A4 sized paper, using double-spacing with wide margins - at least 2.5 cms on the left and 1.4 cms on the right. (Note that these margins are to be left on all pages, including those containing tables, diagrams, etc.)

Length: The total length of any one paper must not exceed twelve A4 double-spaced typed pages (this length includes text of the paper, reference lists, and all diagrams, figures, and tables).

Headings: Main headings (central and in capitals) and sub-headings (underlined and left-justified) should be used at reasonable intervals to aid in the reader's comprehension of the text. All pages should be numbered consecutively.

Footnotes and References

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In the general text of the paper references should appear as Bernstein (1971) or Fisher and Fraser (1983), then these references should be placed in the reference list as,


*Please note the order of dates, volume number, publisher, place of publication for books and journals, use of upper- and lower-case letters.
RESEARCH IN SCIENCE EDUCATION

Volume 14

Selections of papers from the Fifteenth Annual Conference of the Australian Science Education Research Association, Monash University, Victoria.

May 1984

EDITED BY: Richard P. Tisher, Monash University

EDITORIAL BOARD: Effie Best, Education Department, South Australia
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PREFACE

Fourteen years ago a number of science educators met at Monash University for a two-day conference to discuss their current research interests, research priorities, and the establishment of an Australian research association. A report was published by Colin Power in The Australian Science Teachers Journal (Vol. 16, No.2, 1970, pp.51-5), and he noted that the participants were involved with the I.E.A. Science Project, the evaluation of new science curricula, Piagetian stages, classroom interaction, teacher preparation, non-technical terms in science teaching, standardised tests, and measures of achievement, laboratory skills, and readability. One of the priorities for future research was more 'precise information about the readiness and difficulties' of pupils. Now, almost one and a half decades later this publication contains a number of reports on pupils' science concepts and the alternative frameworks they use to interpret natural phenomena. Mitchell and Gunstone, for example, describe conceptions held by Year 11 chemistry students in the general field of stoichiometry. Jones demonstrates how some 9-year-olds interpret 'solid' to mean hard, unbreakable, inflexible, not-hollow and Biddulph and Osborne, in their report of children's ideas about floating, note that many believe the top of an iceberg is the only part floating and if it were cut off, the bottom part would sink! Gunstone describes some pre-instructional alternative frameworks that Year 10 girls possess in the area of mechanics while Gardner probes the post-instructional frameworks of Year 12 physics students following instruction on circular motion. Carr examines the chemist's concepts of acids and bases and suggests that students' difficulties in this area may be more usefully perceived in terms of confusion about the models used in teaching the concepts rather than as a conflict between pre-conceptions and the scientific view. West and Pines also caution us. They argue that the research on students' misconceptions and alternative frameworks can lead to narrow perspectives about students' efforts to learn. They present a 'sources-of-knowledge' view of science learning which they believe has important implications for an alternative conception of science education.
This year, in contrast to 14 years ago, there are no reports of Piagetian studies. Dawson and Rowell, however, draw upon Piagetian ideas and recent work on alternative frameworks to explore, empirically, students' conceptual changes in dealing with the displacement of water by solid objects. Curriculum issues still concern science educators today but they differ from those addressed in 1970. Walsh et al. describe attempts to develop a substantial science course for intending primary teachers, Appleton et al. evaluate teachers' guides for the Learning in Science Project (Primary) in New Zealand, Klainin reports on the effects on Thai students of an activity based chemistry curriculum and Atkin, in a report from the workplace, tells how teachers in a school successfully developed curriculum units to meet the needs of their pupils.

Issues about teacher education are addressed by Appleton, Happs, and Fawns and several papers report on students' perceptions of health (Garrard & Brumby; Maddock, et al.) and of their learning environments (Tisher). A few papers explore a new theme on pupils' learning strategies. As has been noted already West and Pines present their 'sources of knowledge' view of science learning but, in addition, Hayes and Symington examine children's drawing strategies and Dall'Alba and Northfield report on pupils' cognitive learning strategies. They present a learning strategy profile for a student on four learning tasks.

The preceding paragraphs do not refer to all of the matters that were discussed in the sessions of the fifteenth annual conference of the Australian Science Education Research Association. They do, however, give some of the flavour of the conference and indicate how the issues addressed differed from those of 14 years ago. The fifteenth conference also contained a number of sessions dealing with research in progress or being conceived. Some of these are noted in the new Research Notes section at the end of this publication.

Richard P. Tisher
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1 Pupils' views about crystals by Brendan Schollum
   This session reported on the progress of a study designed to examine the objectives, teaching, and learning associated with the common junior activity of crystal growing. Some preliminary findings about pupils' ideas about crystals, how they form and where they originate were presented. Pairs of the twenty 13 and 14 year olds who participated were also observed (and questioned) as they attempted to follow instructions on how to make crystals; some details of these observations were also presented and some discussion occurred on future directions for the project.

2 Review of teacher education in primary science by J. Owen, N. Johnson, and R. Welsh
   In this progress report the authors outlined what they had done to date in their study of the state of teacher education in primary science during 1984. The project involves the collection and the dissemination of information which the authors hope will lead to improvements in the teaching of science in primary schools.

3 The science curriculum and the student science laboratory by Elizabeth Hegarty
   A curriculum model was presented showing the role of laboratory work in the educational process in a science discipline. The model was regarded as an attempt to extend ones designed by Johnson, Stake, Saylor and Alexander, and Harnischfeger and Wiley.

4 Developments in the use of interactive videodisc in the teaching of science by G.W. Detrick
   Recent developments in the use of laser videodisc technology were presented and the Tacoma Narrows videodisc was demonstrated. Details of the Annenberg project were also outlined together with the value of the medium for in-service education of science teachers.
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A progress report on what teachers have been doing in the project was presented. Four researchers and advisers are collaborating with eight enthusiastic, competent science teachers on ways to observe one's teaching, to interview pupils and to document observations and interviews. The teachers are trying out teaching strategies designed to change students' beliefs about the world.

6 **Laboratory technicians and laboratory safety** by John Gipps

Several issues about the role and training of laboratory technicians were discussed. It was suggested that:

(a) subject associations could help with the training of technicians;
(b) science co-ordinators should facilitate the training of laboratory technicians, and
(c) appropriately trained laboratory technicians should be concerned with safe storage of materials, security of science laboratories, the testing of demonstrations for safety, assistance to teachers during laboratory lessons, and advice about safety measures to less experienced teachers.

7 **Problem solving in chemistry: determining variables and difficulties in teaching and learning** by Kam Wah Lee

This session consisted of a progress report on research concerning problem solving in chemistry (electrochemistry in particular). In the project an attempt is made to identify variables responsible for problem solving behaviour and to develop a model of problem solving strategy. One part of the study explores the model quantitatively and another investigates the difficulties of teaching and learning problem solving in chemistry.

8 **The effects of an environmental field study program on the environmental attitudes of Grade 6 students** by Dave Burton and John Edwards

This session was a report on the affective changes in 67 Grade 6 students who attended a three-day live-in environmental field studies program. An environmental attitude scale developed for the study was administered to the 67 students and to a control group of 42 students. The results suggested that the program had an effect on some areas of students' attitudes.
RESEARCH NOTES

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Volume 15

Australian Science Education Research Association
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Volume 15

Selections of refereed papers from the Sixteenth Annual Conference of the Australian Science Education Research Association, Capricornia Institute, Rockhampton, Queensland, May, 1985.

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On June 11th, 1985 Science Education Research suffered a severe loss when Roger Osborne was killed in an accident near his home in Hamilton, New Zealand. Roger was a staunch supporter of the Australian Science Education Research Association from the first meeting he attended at Wagga Wagga in 1977. Evidence of his interest and activity in science education research are to be found in Volumes 7 to 14 in Research in Science Education. His studies of understanding of science had a major influence on the style of research undertaken in Australia and New Zealand. He will be sadly missed in both countries, not only for the stimulation he gave to our work, but also for his cheerfulness and enthusiasm. He encouraged us all.

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PREFACE

Concept mapping still appears to be a predominant activity among science educators in Australia. In this issue of Research in Science Education, Appleton, for example, adds to the body of knowledge about children’s ideas associated with temperature and Butts reports on children’s understanding of electric current. Searle complements information in previous issues of RISE by detailing first year engineering students’ concepts of circular motion, Fensham and Johnson tell us about learners’ ideas of environment, and Ameh and Gunstone focus on teachers’ concepts in science.

The characteristics of learners have also interested researchers. Kam-Wah Lee considers six cognitive variables that are associated with pupils’ problem solving in electro-chemistry at IISC level, Maddock reports on students’ awareness of and attitudes to health and Garrard and Brumby on their perceptions of stress. Fearman-Wannon also focuses on characteristics but uses cognitive and noncognitive variables to predict academic performance. Other papers, those by Walsh and Lynch, Northfield and Gunstone, Butler and Beasley, and Mitchell and Baird address teacher training and teaching issues. The Walsh and Lynch paper is a follow-on from a 1984 RISE paper describing the introduction of a compulsory science subject into first year primary teacher training in Tasmania. The 1985 paper considers the perceptions of science and science teaching held by those students who elected to continue with a study of science. The Northfield and Gunstone paper, on the other hand, describes the authors’ experiences in a secondary classroom and their attempts to implement their understanding of learning. They conclude that that understanding has been modified by their experiences and that, in particular, the effects of peer group interactions in the classroom have been under-estimated as a factor in the learning environment.

Two papers by Snowaluck et al and Newman address issues associated with the role of laboratory work in science education, and Rosier reports on an IEA study using data about science curricula in Australia. Fawns presents an historical perspective on general science in Australia, White directs attention to the importance of context in educational research, while Edwards, in an embryonic paper, attempts to assess the domination that Newtonian Physics and the Cartesian belief in the certainty of knowledge have had on our belief systems. The impact on science teaching is also discussed with particular reference to the writings of Capra.
Further details about some completed projects, and studies under way, are provided in the research notes. There are details about teachers as researchers, probing understanding of environmental concepts using visual stimuli, the quality of learning outcomes, and a school developed science programme for poor readers and children's understanding of inheritance.

Richard P. Tisher

Editor
In addition to the reports which appear in the preceding pages there were other presentations at the conference about research in progress, aspects of data collection, and speculations about future studies in science education. The following notes have been compiled so that R.I.S.E. readers will become acquainted with other significant matters that were discussed during the annual conference.

1. **Assessing the quality of learning outcomes** by Gloria Dalli'Alba

Traditionally in science classrooms, the assessment of learning has been primarily concerned with the quantity of knowledge that is recollected. More recently researchers have expressed the need to focus on the quality of the learning outcome. But how can the quality of learning outcomes be assessed? This presentation addressed that question and considered a way of defining learning outcomes, an operational definition of the quality of learning outcomes, and difficulties in measuring the quality of learning outcomes. The presentation was essentially a report of research in progress, and included several extracts from transcripts taken from interviews with students in years 8 and 9. The investigator pointed out that an operational definition of the quality of learning outcomes should incorporate the dimensions of extent, precision, accord with reality or generally accepted truth, ratio of internal to external associations, complexity, and relevance to the task. It was also noted that the difficulties in measuring the quality of learning outcomes were due to the multi-factorial nature of quality, and to variation in the relative importance of the quality dimensions on the same task and between tasks.

2. **Probing students' understanding of environment concepts using visual stimuli** by Barbara Johnson and Peter Bensham

In this presentation the techniques of using visual stimuli in the form of photographs, to investigate students' understanding of, and interest in the environment, were presented. Students in years 7, 9 and 11 at two neighbouring High Schools and students in year 5 of three feeder Primary Schools were asked one question for each of three different sets of six photographs. The questions were:

a) Which two of these six environments would you like to be in?

b) These six photographs each show environmental problems. Select any two and name the problem shown.
c) These photographs show different environmental issues. If you could select your science course for the rest of the year, which two would you like to learn about, and why?

As a consequence of their research the investigators concluded that the presentation of photographs of environmental situations to the groups of students produced a surprisingly common set of responses. They found that for each of the tasks one or two of the environmental situations were preferred as choices, and these preferences tended to be the same for at least years 7, 9 and 11 and for two of the tasks at year 5 also. There was also little evidence of significant shifts in the strength of these preferences with age (year 7 to 11). The investigators stated that the existence of such clear preferences, at least for students in a common social milieu, and the ease with which this methodology revealed them, are both of interest. It immediately becomes obvious to ask how widespread are such common preferences. Would they extend throughout a large metropolitan city like Melbourne, or would western and eastern suburban students respond differently? Further research of this sort could answer such questions.

3. Teachers as researchers in primary science: The use of the clinical mode by P. Lynch, B. Jones, C. Avery, J. Blackaby, L. Hurburgh & R. Matthyoz

This presentation described the attempts of a group of primary science teachers to implement a clinical method or mode to provide a basis for subsequent teaching of science topics in class. The presentation outlined the stages followed to reach decisions about classroom teaching. First, there was a Piagetian type, clinical interview of selected primary school students to explore their understandings of nature of matter. Data from the interviews allowed concept maps to be constructed. Second, a multiple choice questionnaire (with a short free response section) was administered to obtain more detail about pupils' understandings. Finally, from the insights gained from the first two stages teaching sequences and approaches were selected for a series of lessons. For instance, Grade 2 lessons were designed to be almost entirely oral with some drawings, while Grade 3 lessons required pupils to make written responses on large sheets of paper. The responses were decoded by the teacher during discussion. The teachers involved in the exercise indicated they were pleased with the results, and that there were shifts in their thinking about the meaning and importance of the concepts being taught and about the teaching processes.

4. Children's understanding of inheritance by Marjory Martin and Judith Kinnear

This presentation reported a study to investigate children's understanding of inheritance. A sample of grade 6 children (N = 84) from three different schools was used and data were collected using pencil and paper tasks on aspects of
inheritance and computer simulations for pairs of children to identify rules that
govern the inheritance of coat colour, pattern and tail length in a familiar
domestic animal. It was noted that children recognise the existence of many rules
relating to inheritance but, in some cases, have alternative concepts based on
observations outside a genetics context.

5. Enquiry teaching in the chemistry laboratory by Raymond Nadeau and
Marshall Nay
This session described an action research study to determine the extent to which
students were able to attain enquiry objectives while performing specially
designed enquiry oriented chemistry experiments. The subjective meanings and
feelings that students had regarding this type of learning were also investigated.
The laboratory programme was conducted with a grade 12 chemistry class during
an entire semester. Behavioural objectives in the conceptual, affective and
scientific skill domains were measured by means of two paradigms – the empirical
analytic, and the situational interpretive. The instruments used to gather data for
the evaluations included a chemistry achievement examination, processes of
science test, test on scientific attitudes, laboratory questionnaires, students'
written comments, taped interviews, laboratory reports and teacher's log.
Although students in this study spent considerably more time in laboratory related
activities than did students in conventional chemistry teaching, they performed
very well on the achievement test. In pre- and post-testing, they showed
significant gain on the process skill test but not on the test of scientific
attitudes. A significant majority of students found the laboratory programme not
only challenging, interesting and enjoyable, but also felt that the enquiry
experiments were preferable to the highly structured experiments performed in
previous years. The investigators concluded that the research results showed that
enquiry oriented learning and teaching is viable in high school chemistry.

6. The learning environment of a school developed science program for poor readers
by Steve Ritchie
This presentation reported some initial results from a comprehensive evaluation of
a school developed program to provide alternative science instruction for poor
readers in normal classes. A number of procedures were used to gather
comprehensive data for the evaluation, e.g. observations of lessons, interviews
with students and staff, and the administration of an environment questionnaire,
namely the "My Class Inventory". This learning environment inventory was
modified to cater more adequately for both staff and student responses by using a
four-point response format. The data obtained using the inventory and other
techniques were interpreted as providing a comparable picture of the learning
environment. For instance the mean scale scores obtained for staff (N = 5) and students (N = 23) on all scales were of the order of 17.5 or greater. These scores were interpreted to indicate that the Year 8 science bridging program provided a pleasant and productive learning environment. As well, these data and that obtained through the other procedures, were interpreted as indicating that generally the intended science bridging program curriculum had been implemented. Data from the interviews and observations also indicated that many students finished the required activities earlier than expected, and teachers rarely found opportunities in the classroom to interact with the science bridging program students. As a consequence other recommendations for change were proposed.
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RESEARCH
IN
SCIENCE EDUCATION

Volume 16


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PREFACE

Research on science education continues to flourish and this issue of R.I.S.E. has been increased in size in order to accommodate and illustrate the diversity of activity in Australia and elsewhere. This issue contains a diversity of themes which provide a rich smorgasbord for the reader.

There are two papers dealing with gender differences in science education in Thailand and Kenya, two dealing with action research projects associated with pupils' learning in science (i.e. the LISP and PEEL projects), one associated with the curriculum frameworks proposals in Victoria, another on computer simulations, several on classroom strategies, one related to Piagetian concepts and schematic representations of knowledge and, once again, a larger cluster (about seven) dealing with students', trainee teachers', teachers' and other adults' science concepts, memory structures and misconceptions.

That is not the complete smorgasbord since there are several newer themes appearing in other papers. For the first time there is a report of a pilot project to study the nature of the questions pupils ask, a theoretical analysis of the nature of explanation and two attempts to provide theoretical underpinnings to research on pupils' learning in science. Two papers re-introduce themes that were current several decades ago by referring to teachers' constructs of able students and the attributes of exemplary teachers. In the remaining papers readers are given details about conditions of science learning in Canada and provided with some new challenging directions for future research in science education.

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RESEARCH NOTES

These notes contain brief references to a number of presentations at the 17th annual conference of the Australian Science Education Research Association. More detailed texts or manuscripts may be obtained from the authors.

1. An evaluation of the use of a programming grid in the science curriculum, Patrick Cronin, St. John's College, Whyalla, S.A.
   This paper deals with a programming grid as a tool for the development of a science programme in a school. Recommendations are made on how to expand the grid, organization of in-service workshops and the development of language analysis techniques for teachers.

2. School Science; Social purposes and liberal values, Rod Fawns, University of Melbourne,
   School science was originally composed by academic scientists and textbook authors out of what they conceived to be the most important, or the simplest part of their subjects. They made a sort of anthology of science. The professionalization of science and science teaching clearly has been served by school science. But why has school science remained an anthology of essential definitions?

3. The repertory grid as an alternative/complementary probe in science education, John Happs, Western Australian College of Advanced Education, & Keith Stead, Gippsland Institute of Advanced Education.
   The current interest in the ideas pupils bring to their science lessons has led to the exploration and development of a variety of techniques to reveal these 'naive' ideas.
   This paper provides illustrations of the use of the "Repertory Grid" in two different areas of interest in science education. The first examines aspects of a pupil's outlook on science, and the second examines aspects of a pupil's understanding of rocks and minerals.

4. Scientists in the making, Jan Harding, Chelsea College, University of London.
   School science is all too frequently presented as a set of abstracted immutable laws enabling control but divorced from emotional response. As such it offers a refuge for the emotionally reticent male, but has little meaning for the female. Many of the girls who do choose science see in it a way of making a contribution to the world.
Analysis suggests that not only values, but cognitive approaches, may differ. The male may seek generalizations and work by isolating and controlling variables—a method used with considerable success in the physical sciences. Recent studies of a few women scientists working within the life sciences suggest they approach their material with greater humility and a sense of identification with it.

The implications for curriculum development and for research in science education are examined.


As part of the Second International Science Study in Australia, data were collected on the distribution of computers in students' homes and in their schools. This paper examines the data showing the distribution of computers in the homes and schools of students in Australia, and looks at characteristics of the students who are using computers frequently. The associations between the frequency with which students use a computer and their science achievement and attitudes to the importance of science is explored.

6. *Polynesian students' outlooks on science*, Keith Stead, Gippsland Institute of Advanced Education.

This paper provides a further example of the application of the Theory of Reasoned Action (TRA) by seeking an explanation for the under-representation of Polynesian students in the sciences. These TRA insights are complemented by data collected from interviews conducted with the parents of Polynesian students.

These approaches suggest the term "Polynesian" needs to be seen as encompassing at least two distinct subgroups, the Maori and the Pacific Islander, and that different mechanisms appear to be responsible for each subgroup's under-representation in the sciences.


How does one evaluate the effectiveness of an organization such as the Australian Science Education Research Association? This paper casts some light on this question by examining the interaction between the Association and aspects of the professional activity of the late Roger Osborne.

It is argued that such an analysis indicates that in Osborne's case the Association has achieved its aim but that this is due, in no small measure, to Osborne's ability to capitalize on the opportunity arising from his membership of the Association.
Equity versus quality: Problems in selecting students for science teacher education programmes in developing countries, Euwe van den Berg, c/- Science and Mathematics Education Centre, W.A.I.T.

Secondary schools in developing countries generally show a far wider range of quality than those in the so-called "developed" countries. This creates serious problems in admission to tertiary institutions. Admission tests usually produce a ranking which closely follows the ranking in school quality, however, both politically and educationally this is not acceptable. Further, ethically one would like to create some upward mobility and give opportunities to disadvantaged kids. The above problems are not unlike admission problems involving minorities in Western countries including Australia.

This paper describes admission test and policy research carried out in Indonesia for the past 5 years and compares it with work done in African Countries.
RESEARCH IN SCIENCE EDUCATION

Volume 17

Selections of refereed papers from the Eighteenth Annual Conference of the Australian Science Education Research Association held in Wagga Wagga, New South Wales, July 1987.

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PREFACE

Research in Science Education has always contained a high proportion of articles reporting investigations in science education. Although there has been this bias to investigatory reports, there has also been a recognition of the complex relationships that occur between research and practice. The editorial committee believes that results reported in this journal have implications for practice and we hope that numerous readers have, as a consequence, altered science education practices. If that is the case the results have become more than just the stuff of journals and conference papers. This issue also presents more results from investigations and, once again, we hope that readers will act on the implications of the findings. The issue also differs a little from recent volumes of RISE in that there are several descriptive accounts of developments in science education. These accounts refer to changes in assessment practices, developments in science curricula and the nature of physics teaching in another cultural context. The editorial committee invites comments from readers about this greater mix of descriptive and investigatory papers.

Richard P. Tisher

Editor
Research In Science Education, 1987, 17, 253-258.

Editorial comment:

Members of the Australian Science Education Research Association are well aware of many initiatives being taken by teachers in schools to improve the quality of science education and to increase the rate of participation of girls in science courses. ASERA has encouraged teachers to come to the annual conference to tell the researchers about initiatives being taken. For the benefit of RISE readers we have included here one account of science teachers' initiatives presented to the ASERA annual conference.

"GIRLS ONLY" SCIENCE CLASSES AT SCORESBY HIGH SCHOOL

Sylvia Wood and Jacqui Franck

In early 1986 a statistical analysis of the enrolment figures in senior science classes (Years 11 and 12) at Scoresby High School indicated that a disproportionately low number of girls were studying the physical sciences, and that girls were under-represented in senior classes as a whole (see Table 1).

The science staff, in particular, were aware of the debate about girls' participation and success in science, mathematics and technological subjects or careers. What could be done at the school?

THE SITUATION

Scoresby High School is a government high school located in the outer eastern suburbs of Melbourne, Victoria. There were 950 students (389 male and 568 female) with a staff of 80 in 1987.

The school curriculum, discipline and social structures can be described as traditional. Students are expected to wear a uniform, to be prompt to class and polite to other people. Honesty and a respect for the rights of others is also policy. The curriculum offered at Years 11 and 12 is of an academic nature and is based on the Victorian Curriculum and Assessment Board's (VCAB) externally assessed Group 1 subjects.
TABLE 1
MALE/FEMALE STUDENT NUMBERS IN SENIOR SCIENCE CLASSES AT SCORESBY HIGH SCHOOL 1986/87

<table>
<thead>
<tr>
<th>1986 SUBJECT</th>
<th>1987 YEAR</th>
<th>MALE</th>
<th>FEMALE</th>
<th>1987 YEAR</th>
<th>MALE</th>
<th>FEMALE</th>
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<tbody>
<tr>
<td>PHYSICS</td>
<td>11</td>
<td>14</td>
<td>8</td>
<td>11</td>
<td>9</td>
<td>16</td>
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<td>12</td>
<td>14</td>
<td>5</td>
<td>12</td>
<td>6</td>
<td>4</td>
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<tr>
<td>CHEMISTRY</td>
<td>12</td>
<td>11</td>
<td>8</td>
<td>11</td>
<td>11</td>
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<tr>
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<td>12</td>
<td>8</td>
<td>2</td>
<td>12</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>BIOLOGY</td>
<td>12</td>
<td>11</td>
<td>4</td>
<td>17</td>
<td>11</td>
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<td>16</td>
</tr>
<tr>
<td>GENERAL SCIENCE</td>
<td>11</td>
<td>19</td>
<td>8</td>
<td>11</td>
<td>19</td>
<td>12</td>
</tr>
</tbody>
</table>

The science Department offers science as a compulsory core subject to all Year 7 to 10 students. It also offers extra science as an elective for Year 10 students.

The male/female ratio of science teachers in 5:6 with four of the female teachers taking senior science classes of chemistry and biology.

The pilot project reported in this paper was conceived by the Science staff at Scoresby High School during 1986. It is hoped that this report of how the "girls only" classes were established within a regular school setting may prompt other schools to address the issues of girls in science.

WHY "GIRLS ONLY"?

After a number of informed discussions at the school with science staff and teachers from other curriculum areas the decision was that the goals that were desirable and achievable included:

- increasing the girls' participation in senior science and in the senior physical sciences in particular;
- broadening the career opportunities of girls by encouraging a greater participation in the sciences;
- attempting to change the attitudes of girls towards the sciences as subjects to be studied at school;
- fostering the confidence of girls in their ability to be successful in science subjects;
- increasing teacher, student and parent awareness of the obstacles facing girls wishing to study sciences.

A literature search to see how others had attempted to solve the problems of discrimination against girls in science classes presented three possibilities, namely:

i) attempt to alter the teaching practices of the teachers to take into account specific problems faced by girls in mixed science classes, i.e. teacher awareness of adverse classroom dynamics;

ii) radically changing the current science curriculum, i.e., sexually inclusive curriculum;

iii) trial "girls only" classes and research the effect this would have on the girls' achievement and participation. If this proved successful consideration would be given to committing all science classes to the scheme.

The disadvantages and advantages of each of these alternative strategies were discussed by the science staff before it was decided upon the "girls only" approach.

A change in curriculum would need to be extensive (from Years 7 to 10) and it was perceived that changing curricula at Years 9 and 10 for girls only may be viewed as a "soft option".

Altering teaching practice by making teachers more aware of classroom dynamics does not necessarily change teacher attitude and expectations. It is also difficult to change entrenched teaching strategies.

Another reason why the third approach suited this school was because the female/male ratio within the school as shown in high. Therefore no "all boys" classes were created. This also caused minimal disruption to school structure, administration and staff.

THE PROCESS

Once the Science Faculty had decided that the approach of "girls only" science classes at Years 9 and 10 for two years was feasible the processes of gaining support from the school and the school community were commenced. Table 2 gives an indication of the steps undertaken to implement the pilot project of "girls only" classes at Years 9 and 10 for 1987/88.


| 1. | Informal discussion between proposers. |
| 2. | Research of available data. |
| 3. | Inform appropriate committees, i.e., science staff initially. |
| 4. | Organise publicity material within the school community and the wider media. |
| 5. | It was proposed that the girls' classes would run in Years 9 and 10 with two all girls' classes in each. |
| 6. | Time line of requirements |
| 7. | Submission to curriculum committee. (March 1986) |
| 8. | School co-ordinator ratified the fact that the proposal could be time-tabled. |
| 9. | Report back to Curriculum Committee, approval was granted and referred to Education sub-committee (school council). |
| 10. | Presentation to Education sub-committee. |
| 11. | Presentation to School Council. |
| 12. | Publicity to school and local community, including a "Careers Information Evening" for parents. |
| 13. | Evaluation – it was considered appropriate to seek outside assistance with the evaluation of the project. |
| 14. | Promotion of science to girls when selecting subjects for the following year. |
| 15. | Selection of girls into classes: |
|     | i) student volunteers |
|     | ii) parents volunteer students |
|     | iii) teachers select suitable students by consultation with other teachers and students where possible. |
| 16. | Balancing of mixed classes so that student male/female ratios would be relatively even. |
| 17. | Staff selection to take "girls only" classes. Staff were asked if they were willing to take these classes. |

Several aspects of the implementation process demand further explanation.

Firstly the publicity of the project both within the school and its community as well as the broader local community was a considered decision as well as the broader local community was a considered decision of the school in an attempt to ensure that what was being attempted at the school, although unusual, was not reactionary or revolutionary. In fact the school might gain from the whole project. Articles were produced for the local newspaper, school newsletter, Maroondah Equal Opportunity Centre, Ms Muffett and the Victorian Secondary Teachers' Association. The science co-ordinator and teachers also promoted science generally within the school.

Secondly, without proper evaluation the results of the project would not be valid. The school was also mindful that teachers do not have the time nor expertise to properly evaluate such a project. The organisations approached to carry out the evaluation were:
i) McClintock Collective
ii) Schools Commission
iii) Curriculum Branch of the Ministry of Education (Research and Development)
iv) Participation and Equity Program within the Ministry of Education
v) Monash University Education Faculty. (Approached Schools Commission for projects of National Significance – this unfortunately was rejected). Monash University Faculty was the only group willing to commit themselves and take responsibility for the evaluation of the project. The school was specific about when the evaluation should be carried out, the content of surveys used and the type of information to be gathered. (Schools are also constrained by the type of surveys which can be given to students.)

PROBLEMS

This project is not a research project established by a researcher from a higher education institution. It more appropriately should be seen as "Action Research" or "Teachers as Researchers". Consequently, the vagaries of the day life of a school have affected the project in a number of ways. Table 3 gives an outline of the main problems.

TABLE 3
PROBLEMS OF IMPLEMENTATION

1. 1986 Science co-ordinator took long service leave early in 1987 and was transferred to another school.
2. Insufficient girls volunteering for girls only class.
3. One Year 10 Home group disbanded due to staffing problems.
4. Selection of teachers for girls only classes.
5. Time-tableing constraints – was overcome relatively easily by grouping four classes of science together.
6. Staff changes during the year.
7. Publicity of the project during 1987.
8. Unexpected outcomes.

Several of these problems, in hind-sight, could have been anticipated, however in the hurly burly of the day to day activities of a school things get overlooked. For instance, the staffing of the "girls only" classes was two female teachers at Year 9 and two male teachers at Year 10. It would have been preferable to have had one male/one female teacher at each level.
The disbanding of one of the Year 10 Home groups means that several girls were forced into the "girls only" science groups.

The publicity that the project has drawn has unfortunately made several classes of "girls only" science "feel" very different, because they are the group that have been photographed and talked to. This of course was not the aim of the school.

Finally, a comment should be made about one of the unexpected outcomes of the project, and that is, staffing of excursions. There are two unfortunate, but not insurmountable problems for excursions:

1. When the Home group goes on an excursion teachers are not necessarily released; and
2. a male teacher of the "girls only" class must be accompanied by a female teacher.

CONCLUSION

At present the evaluation team is about to collect information following the first 4-6 months of the project, so there is very little to report from this point of view. However, as a school-based attempt to offset the discrimination of girls in science, the project is progressing with very little interference from and to the school. It is hoped that there will be some concrete changes in subject and career choices, as well as attitudes toward science by the girls in the project due to the efforts of the science staff.
GUIDELINES FOR AUTHORS OF PAPERS FOR RESEARCH IN SCIENCE EDUCATION

The following requirements have been established to facilitate editing and maintain standards in format and presentation.

GENERAL LAY-OUT AND LENGTH

Setting out: The paper (including diagrams, tables, etc.) is to be typed on A4 sized paper, using double-spacing with wide margins - at least 2.5 cms on the left and 1.4 cms on the right. (Note that these margins are to be left on all pages, including those containing tables, diagrams, etc.)

Length: The total length of any one paper must not exceed twelve A4 double-spaced typed pages (this length includes text of the paper, reference lists, and all diagrams, figures, and tables).

Figures: Camera-ready copies must be supplied with the paper.

Headings: Main headings (central and in capitals) and sub-headings (underlined and left-justified) should be used at reasonable intervals to aid in the reader's comprehension of the text. All pages should be numbered consecutively.

FOOTNOTES AND REFERENCES

Footnotes: These should not be used although Reference Notes, e.g., Smith (Note 1) may be used to refer to unpublished material. The reference notes are to be collated at the end of the paper, e.g.,

Note 1, J.J. Smith, personal communication


References: References to journals and books should follow the criteria of the A.P.A. In the general text of the paper references should appear as Bernstein (1971) or Fisher and Fraser (1983), then these references should be placed in the reference list as,


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RESEARCH IN SCIENCE EDUCATION

Volume 18

Selections of refereed papers from the Nineteenth Annual Conference of the Australian Science Education Research Association held in Sydney, New South Wales, July 1988.

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EDITORIAL COMMENTS

In the last issue of Research in Science Education readers of the journal were invited to comment about the mix of descriptive and investigatory papers included in Volume 17. As no comments were received the editorial committee assumed either that no one reads the preface to an issue, or that readers do not object to the variety in the papers. If the latter is the case then readers will be even more pleased this year to see the greater diversity in the matters addressed. Certainly research on students' misconceptions still predominates, but research in science education appears to be in a healthy state as there are people directing our attention to other important areas including classroom processes, professional development, scientific literacy in adults and the history of scientific ideas.

Richard P. Tisher

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Volume 19
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EDITORIAL COMMENT

This issue of Research in Science Education once again demonstrates the rich range of science education research currently being undertaken in Australia. The topics under investigation are diverse. Several studies focus on the learning of science concepts, while others are concerned with the study of teacher behaviour, the evaluation of government initiatives, the philosophy of science, in-service teacher education, and many other issues. The papers also reflect a wide variety of research methods: the historical analysis of scholarly writings, naturalistic observations of teachers and learners and interviews to reveal learners' conceptual structures are all represented here. The scope is broad: although, for understandable reasons, research on secondary school science remains dominant, it is good to see increasing attention being given to primary and tertiary science education. And there is a good geographic mix: in addition to the many contributions from various states, there are papers relating to education in Nigeria, Israel, Thailand, Papua New Guinea and New Zealand.

As I write these words, the Australian Science Education Research Association is celebrating its 20th anniversary. In May, 1970, after several months of preliminary work by Peter Fensham, Dick White and other colleagues at Monash, the first ASERA conference was held at Monash University. The subsequent history of the organisation has been remarkable. We have no formal membership procedure, no annual subscription, no formal election of office-bearers. What we do have is a healthy professional association, a lively and well-attended annual conference, and a quality journal which makes a respected contribution to the international science education research community.

The first two issues of this journal were named Research 1971 and Research 1972; the next issue was named Science Education Research 1973. The founding editor was Dick Tisher, then at the University of Queensland. In the preface to the first issue -- inserted as a loose erratum sheet as it had been omitted from the bound copy! -- Dick wrote that it was

part of an embryonic project. A dream is that one day there will be an Australian journal reporting exclusively on research projects in science education. Hopefully, this present collection of papers is a precursor of a journal of research in science education.

Prophetic use of language. The dream was fulfilled, word for word, in 1974, when Research in Science Education was adopted as the permanent name for this journal. In that year, Dick took up a chair at Monash and subsequently relinquished the editorship, but he accepted it again after our first New Zealand conference, in 1983. Dick has done much of the editorial work for this issue. (My contribution has been limited to proof-reading the final copy and seeing it through to publication.) This is an appropriate time to express our appreciation to him as he leaves Monash to become head of the Victorian Curriculum and Assessment Board. His new position will be a challenging one; he takes it up at a time of public controversy over assessment methods for the new Victorian Certificate of Education. We thank him for his work in founding this journal, and wish him well in his new appointment.

Paul Gardner,
Acting Editor.
GUIDELINES FOR AUTHORS FOR THE PREPARATION OF
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Fig. 3 A model of the learning process

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Research In Science Education

Volume 20

1990

Annual publication of the Australasian Science Education Research Association
Research In Science Education  Volume 20  1990

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EDITORIAL COMMENTS

"During the past two years informal meetings have been held by a group of persons engaged in research in science education. The ‘foundation’ meeting occurred at Monash University, Melbourne, in 1970, and the second conference was organised at Macquarie University, Sydney, in May 1971. At these last mentioned meetings, it was suggested that details of science education research should be disseminated more widely than had occurred in the past."

(Editor’s preface to Research 1971, the first ASERA publication.)

I was one of the people present at that foundation meeting at Monash twenty years ago, and so it is especially pleasing to be associated with this twentieth anniversary issue of Research in Science Education, as the publication became known in 1974. It appears at a time of renewed government interest in science (and mathematics and technology) education. When ASERA was founded, the federal government had been involved for some years in attempts to upgrade school science laboratories. It then began to support national curriculum projects, especially the Australian Science Education Project; Gregor Ramsay’s paper in that first ASERA publication presented an outline of ASEP’s formative evaluation procedures.

Later in that decade, national interest in science education began to wane. Recently, there has been a revival, reflected in the Prime Minister’s phrase that we must become a ‘clever country’. There is recognition that all is not well with science teacher education: that argument is elaborated in DEET’s three-volume Discipline Review of Teacher Education in Mathematics and Science (1989). The Prime Minister has established a Science Council, consisting of scientists, politicians and industrialists; for its second meeting, in May 1990, it commissioned a set of papers on science education, Science and Mathematics in the Formative Years. The Australian Education Council (i.e. the state and federal ministers of education) has initiated National Mapping Exercises in various school subjects in an attempt to encourage national curriculum co-ordination. One must hope that these promising developments will be properly supported by the resources needed to bring about substantial improvements in the quality of science education at classroom level.

This issue of RISE contains a record number of papers (35) and is of record size (352 pages). It maintains the tradition of earlier issues of demonstrating the wide range of issues of concern to science education researchers. There are also a number of changes, some large, some small. Most importantly, as a result of discussion at the 1990 conference in Perth, we have adopted a policy of submitting all papers to independent referees. I am very grateful to the many members of my Review Panel (p. ii) for their work; I know, from the many comments made by authors when submitting revised versions of their conference papers, that the panel’s efforts are appreciated. I am convinced that the policy has raised the quality of this publication. Less evident, but also important, is a technological breakthrough: this is the first issue wholly produced from floppy discs supplied by authors. I can now take an AppleMac
MSWord file on diskette, scan it for viruses, convert it to a text file, send it down a
cable to an IBM PC, read it on to a floppy disc, take it to my PC and convert it to
WPerfect, in about 15 minutes on a good day. (The editorial work takes a little
longer!)

Sharp observers will note the addition of two letters to our masthead: we are now the
Australasian Science Education Research Association, a move which formalises the close
links between Australian and New Zealand researchers which began when the late
Roger Osborne started coming to ASERA in 1977.

This issue contains an embryonic Research Notes section, with only one contribution
this time; for future issues, authors should feel free to submit brief descriptions of new
projects under way and summaries of papers whose length exceeds our 10-page limit.
There is also (thanks to Jeff Northfield) a cumulative index of all papers published by
ASERA since its inception. (Keen observers may note that only one member of
ASERA, founding member and Business Manager Dick White, appears as an author in
both the first issue and the present one. I hasten to add that he has also written a few
papers in between.)

There are also several stylistic changes: the inclusion of abstracts and authors’
biographies, the single-spaced Times Roman 10-pt font, all designed to make this
publication look like a proper journal, as well as be one. I hope you approve.

Paul Gardner
Editor.

Monash University, December, 1990.
GUIDELINES FOR AUTHORS FOR THE PREPARATION OF PAPERS AND DISKS FOR RESEARCH IN SCIENCE EDUCATION

SUBMISSION TO CONFERENCE ORGANISERS

**Hard copies** only are required for submission to the ASERA conference organisers. Setting out can be in the same format as required for publication, or in some other format if you prefer.

**SUBMISSION TO EDITOR FOR PUBLICATION IN RISE**

Papers submitted to the editor for publication in *RISE* should be on disk, with three hard copies. See **Word Processing** and **Setting Out** below. If it is impossible for you to provide a disk copy in the format requested, please advise the editor. Papers should be submitted within the month following the conference.

**Word Processing**

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N.B. It is the primary responsibility of authors to ensure that copy has been thoroughly proof read. Please ensure that typographical errors have been corrected, and that there is agreement between the references in the text and the final reference list.

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**Length** Each paper is to have a maximum length of 10 pages in RISE format. This length includes text, reference list and pages containing diagrams, figures and tables. All pages are to be numbered consecutively.

**Title** Article title in capitals, author(s) in lower case, affiliated institution in lower case, all centred.

**Abstract** Include an abstract of between 100 - 200 words, headed ABSTRACT (centred), immediately following the title; the whole abstract should be indented.

**Tables** Tables should be given arabic numbers, with centred, capital headings:

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Figures  Figures should be supplied as camera-ready copy. Try to ensure good quality copy: dot-matrix graphics printed in pale-grey ink often reproduce poorly! Leave appropriate space in the text. Figure descriptions should be below the figure and centred.

Fig. 3 A model of the learning process

Headings  Main headings should appear in CAPITALS in the centre of the page. Subheadings should be in lower case, underlined, and left-justified. They should be used at regular intervals to assist in the reader’s comprehension of the text. Section and subsection headings should not be numbered.

Reference notes - Footnotes are not to be used. For all notes (including references to unpublished material, personal communications, etc.) use the following system:

Arguments advanced by Smith (Note 1) ...

REFERENCE NOTES (prior to REFERENCES)


References  References to journals and books should follow the APA guidelines. In the body of the paper references should appear, for example, as Bernstein (1971), or Fisher and Fraser (1983). References in parentheses are presented as (White & Tisher, 1986). These references should be placed in the reference list as follows:


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* two-space indentation below each author.

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AUTHOR

DR. MARY SMITH, Senior Lecturer, Faculty of Education, University of Central Australia, Alice Springs, NT 0870. Specializations: biotechnology curriculum development, biology teacher education.

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RESEARCH NOTES

READING, 'RITING AND 'RITHMETIC:
BEING LITERATE IN SCIENCE AND MATHEMATICS

R. A. Schibeci
Centre for Mathematics Science and Technology Education
Murdoch University
Murdoch, Western Australia 6150

1990 is International Literacy Year. 'Literacy' is on everyone's lips....or, at least, in many peoples' minds. Traditionally, 'literacy' has been associated with 'reading' and 'writing'. What about the person who is scientifically and mathematically literate: how do we recognise such a person?

In 1990, the Centre for Mathematics Science and Technology Education at Murdoch University was awarded $80 000 for the project Secondary Literacy Inservice Package for High School Science and Mathematics. This project is funded by the Australian Government's International Literacy Year Programme through the Department of Employment, Education and Training.

The science education community has contributed to the area of language use in science education. For example, in the U.K., the early Science Teacher Education Project (STEP) materials included a discussion of this topic: an overview, entitled "Language and communication in science lessons" (Sutton, 1974) highlighted the importance of oral and written language in science classrooms. In the U.S.A., Lemke has written extensively on this topic. For example, in his "Talking physics" (1982) he points to the crucial role played by language in developing students' understanding (or lack of understanding) of science.

In Australia, Gardner (1974) published his work on 'Language difficulties of science students'. The ASEP team took up the specific problem of readability and designed each module so that its readability level was two grade levels below that of the intended audience. (Thus a year 10 module had a readability level that was suitable for year 8). Such an approach, which had the worthwhile aim of giving students an easy introduction to the language of science had the unintended effect of avoiding the problem. Students who studied a large number of ASEP modules were not being exposed to much formal science language which characterises the majority of science textbooks. Students must be given the skills which will enable them to extract meaning from their traditional science textbooks: it is this skill (among others) which will help them to become 'scientifically literate'.

Some in the 'language/literacy" community argue that it is possible for a person to be 'literate' in a general sense. Others argue that it is not possible to be 'literate' without reference to some context: thus it is only possible to speak of a person who is 'literate' in science or history or mathematics. In an earlier age, to be 'literate' was to be 'well read'. Today, some (for example, Green, 1988) argue that to be literate is to have a set of subject-specific literacies.
The project is based on the belief that language skills are part of what gives a person access to the language of science. People who simply regurgitate information are not 'literate'. They must understand how to "read", "write" and "talk" science and mathematics. These principles are part of the underpinnings of our project.

Ultimately, the visible result of the project will be a series of modules dealing with different aspects (reading, writing, listening, talking) of literacy in science and mathematics.

REFERENCES


APPENDIX

TWENTY YEARS OF RISE
A CUMULATIVE INDEX  1971-1990

Jeffrey R. Northfield
Monash University

It seems appropriate that this twentieth edition of RISE contain a listing of the contributions made to the journal since its inception. The first attempt to prepare a consolidated list was made in 1983, but this is the first time that such a list has been published as part of the journal. The categories which seemed appropriate then appear to be less useful now but have been retained to organise the 1990 review. What follows is a reminder of the significant effort that has been made to science education research by the Australasian Science Education Research Association (ASERA). Others may wish to re-classify the articles and develop more useful categories for organising our work. The index certainly provides the basis for further research.

Contributions are arranged alphabetically by author in the following categories:

1. Theories of instruction
2. Nature of the learner
3. Classroom interaction
4. Curriculum evaluation:
   a) General issues
   b) Materials
   c) Implementation
   d) Outcomes
5. Research techniques/Test development
6. Reviews of research and curriculum development
7. The nature of science/science education
8. Science teacher education
9. Curriculum and teaching (1986 onwards)

Table 1 shows the numbers of papers in each category for each year.
| CATEGORY                          | 1971 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
|----------------------------------|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1. Theories of instruction       | 1    | 3  | 1  | 1  | 2  | 0  | 3  | 1  | 5  | 2  | 5  | 1  | 1  | 1  | 2  | 2  | 0  | 3  | 0  | 2  |
| 2. Nature of the learner         | 2    | 1  | 2  | 2  | 3  | 4  | 5  | 5  | 7  | 5  | 7  | 10 | 11 | 9  | 10 | 7  | 7  | 5  | 5  |
| 3. Classroom interaction         | 0    | 1  | 0  | 1  | 0  | 1  | 1  | 1  | 0  | 4  | 1  | 2  | 1  | 1  | 2  | 2  | 1  | 3  | 3  | 0  |
| 4. Curriculum evaluation         | 4    | 2  | 4  | 5  | 6  | 2  | 7  | 3  | 6  | 3  | 2  | 1  | 2  | 3  | 4  | 0  | 1  | 1  | 0  | 8  |
| 5. Research techniques/           | 0    | 1  | 6  | 10 | 3  | 1  | 4  | 4  | 1  | 1  | 1  | 2  | 4  | 0  | 1  | 0  | 1  | 0  | 3  | 2  |
| test development                  |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 6. Reviews of research and        | 2    | 3  | 4  | 3  | 3  | 2  | 0  | 3  | 3  | 1  | 5  | 1  | 2  | 3  | 5  | 2  | 8  | 6  | 5  | 5  |
| curriculum                        |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 7. Nature of science/             | 0    | 0  | 0  | 3  | 4  | 2  | 6  | 3  | 2  | 1  | 3  | 1  | 1  | 0  | 1  | 1  | 4  | 7  | 6  | 3  |
| science education                 |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 8. Science teacher education      | 1    | 0  | 0  | 0  | 1  | 2  | 0  | 0  | 0  | 0  | 0  | 2  | 5  | 3  | 6  | 0  | 2  | 3  | 1  | 3  |
| 9. Curriculum and teaching        |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Total                            | 10   | 11 | 16 | 25 | 21 | 13 | 25 | 20 | 22 | 19 | 24 | 20 | 24 | 25 | 24 | 27 | 31 | 34 | 30 | 35 |
1. THEORIES OF INSTRUCTION


FENSHAM, P.J. & NICKLESS, K. (1975). Detectives are born, not made or two sides of a chemistry learning coin, p.43.


ROSEN, G. (1979). The effectiveness of the use of games as a revision technique in junior high school science, p.133.


2. NATURE OF THE LEARNER


BLAKE, A.J.D. (1976). An examination of relationships between cognitive preferences, field-independence and level of intellectual development, p.89.


FENSHAM, P.J. (1983). Equations, translations and number skills in learning chemical stoichiometry, p.27.


SYMINGTON, D.J. (1977). Primary school pupils' ability to see scientific problems in everyday phenomena, p.41.

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3. CLASSROOM INTERACTION


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c) Implementation


FORDHAM, A. (1978). The interaction of student characteristics and science teaching on student perception of the learning environment, p.89.


d) Outcomes


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7. THE NATURE OF SCIENCE/SCIENCE EDUCATION


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THORLEY, N.R. et.al. (1979). The aims of science courses, p.53.


8. SCIENCE TEACHER EDUCATION


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9. CURRICULUM AND TEACHING


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ASSOCIATE PROFESSOR JEFFREY NORTHFIELD, Faculty of Education, Monash University, 3168. Specializations: educational evaluation, teacher education, health education.
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A NOTE FROM THE GENERAL EDITOR

At the time I accepted appointment as Editor of RISE for three years at the Perth ASERA conference in 1990, I expected to be taking study leave in the first half of 1991, which would have meant my absence from the Surfers Paradise conference. However, I expected to be back in Australia in time to supervise the editorial process in the latter half of the year.

My faculty curiously decreed however that the staffing needs of Monash were somehow more pressing than the editorial needs of RISE, and I had to postpone my travels for six months. This meant that I was able to attend the ASERA conference. (I flew overseas out of Brisbane immediately afterwards). It also meant finding some willing colleagues to deputise for me while I was away.

Fortunately, two very able people, Helen Forgasz and Jeff Northfield, readily took on the work. I did not anticipate, and neither did they, the magnitude of the task awaiting them. Although the number of papers published in RISE has grown steadily over the years, in 1991 it took a quantum leap upward to an amazing new level. I, and all of us in ASERA, therefore owe a tremendous debt of gratitude to Helen and Jeff for the very demanding work they have done, and to the expanded Review Panel whose contributions have helped ensure that RISE remains a quality publication.

Paul Gardner
EDITORIAL COMMENTS

During Paul Gardner's absence on leave, we took on the task of putting together this issue of RISE. Our task was greatly facilitated by our secretarial and technical assistants whose previous experience proved invaluable. We also gratefully acknowledge the cooperation of the contributors and reviewers who, on the whole, provided copy in the correct format and met our strict deadlines.

The very large number of papers submitted to RISE this year tested the limits of the publication. We attempted to publish as many as possible. In so doing we decided to extend the reviewing panel and drew heavily on the membership of ASERA to spread the load; in all, 78 people reviewed the papers contained in the following pages.

During 1991 the first monograph derived from RISE was produced:

Northfield J. R. & Symington, D. (Eds.) Learning science viewed as personal construction: An Australian perspective, Curtin University of Technology.

A second monograph, focusing on primary science education is in preparation. An updated cumulative index, RISE 1971 - 1991 has also been prepared and is available from Jeff Northfield, Faculty of Education, Monash University, Clayton, Vic. 3168.

The contents of this issue provide a good indicator of the level and scope of research activity in science education across Australasia. Amongst the papers several common themes are evident: pre-service teacher education, primary science, professional development, and effective pedagogy. Research direction would also appear to have been influenced by the findings of the 1989 DEET Discipline review of teacher education in mathematics and science. Science education in Australasia should be strengthened by the research findings, successful innovations and promising initiatives reported in these pages.

Helen Forgasz
Editor,
Jeff Northfield
Assistant Editor.
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e.g. A LEARNING MODEL FOR SCIENCE EDUCATION

Mary Smith and John A. Smith

University of Central Australia and Alice Springs College.

Abstract: Include an abstract of between 100 - 200 words, headed ABSTRACT (centred), immediately following the title; the whole abstract should be indented.

Tables: Tables should be given arabic numbers, with centred, capital headings.

TABLE 2

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Simple tables should be incorporated directly into the word-processed text. Complex tables which cannot be treated in this way should be supplied separately as camera-ready copy (maximum size 22.5 x 13.5 cm) with appropriate space left in the body of the text.

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- an implementation phase...

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Fig. 3 A model of the learning process

Headings Main headings should appear in CAPITALS in the centre of the page. Sub-headings should be in lower case, underlined, and left-justified. They should be used at regular intervals to assist in the reader’s comprehension of the text. Section and sub-section headings should not be numbered.

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References References to journals and books should follow the APA guidelines. In the body of the paper references should appear, for example, as Bernstein (1971), or Fisher and Fraser (1983). References in parentheses are presented as (White & Tisher, 1986). These references should be placed in the reference list as follows:


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- ampersand (&) symbol for joint authorship
- lower case for article or book titles
- upper case initials for journal titles, underlined
- volume number of journal underlined
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AUTHOR

DR. MARY SMITH, Senior Lecturer, Faculty of Education, University of Central Australia, Alice Springs, NT 0870. Specializations: biotechnology curriculum development, biology teacher education.
Research in Science Education 1991, 21, 345 - 347

RESEARCH NOTES

PRESCHOOL CHILDREN'S INTERESTS IN SCIENCE

R. I. Coulson
School of Early Childhood Studies
University of Melbourne

ABSTRACT

Studies of children's attitudes towards science indicate that a tendency for girls and boys to have different patterns of interest in science is established by upper primary school level. It is not known when these interest patterns develop.

This paper presents the results of part of a project designed to investigate preschool children's interests in science. Individual 4 - 5 year-old children were asked to say what they would prefer to do from each of a series of paired drawings showing either a science and a non-science activity, or activities from two different areas of science.

Girls and boys were very similar in their overall patterns of choice for science and non-science items. Within science, the average number of physical science items chosen by boys was significantly greater than the average number chosen by girls (p = .026). Girls tended to choose more biology items than did boys, but this difference was not quite significant at the .05 level (p = .054). The temporal stability of these choices was explored.

Efforts to increase participation in science and particularly by girls in physical science have to counter attitudinal patterns which are already present in children at upper primary level. Studies in Australia (Parker & Rennie, 1986) and overseas (Ormerod & Wood, 1983; Kelly, 1986) show that the tendency for girls to prefer biological areas of science and for boys to be more interested in physical science topics is clearly established in children in grades five and six. These attitudes are not a result of formal science teaching received at secondary school.

When these attitudes form, and what factors influence their formation, is not known. Although gender is a very important variable influencing attitudes towards science in secondary and upper primary students, the picture in younger children appears to be largely unexplored. As part of a project to examine the development of children's attitudes towards science, I am investigating preschool children's patterns of interest, to see whether children of this age show any preference for science or non-science activities, and within science, for biological or physical aspects of science.

The first task is to design an attitude measuring instrument suitable for use with preschool children. This initial work is being done with children from two preschool centres, both fairly 'typical' in their programs, with no particular emphasis on science. One group consisted of 10 girls and 13 boys, the other of 6 girls and 13 boys. All
children were between 4 and 5 years old. Because I wanted to look at children's preferences, I used a forced choice method where the children were asked to choose which activity they would rather do from a limited range offered. There were 6 sets of activities, with 3 activities in each set; one with a biological science focus, one with a physical science focus and one with a non-science focus. For example, one set was:

"What would you rather do? Would you rather help set up a fish tank, help set up a torch, or help set up a cubby house?"

This was to try as far as possible to ensure that children were choosing on the basis of the conceptual content, e.g. fish tank, torch or cubby house, rather than on the context of the activity which was helping to set something up. Pictures of the activities were used to try to avoid any difficulties associated with auditory memory. The pictures were presented in pairs, with children being asked to make a 2-way choice of what they would rather do from each combination in a set. The order of pictures from biological, physical and non-science categories was varied within pairs and between pairs.

Results are shown in Fig. 1. Girls and boys were very similar in their overall patterns of choice for science or non-science activities, with a non-significant tendency for both girls and boys to prefer non-science activities. There was, however, a qualitative difference in the types of science activities chosen by girls and boys. The average number of physical science items chosen by boys was significantly greater than the average number chosen by girls (p = .026, 1-tailed t-test). Girls tended to choose more biology items than did boys, but this difference was not quite significant at the .05 level (p = .054).

![Fig. 1 Category choices made by girls and boys](image-url)
As one way of assessing the reliability of the test, it was readministered to one group of children after eight days. For individual children, the correlation coefficients between test and retest choices varied enormously, from +0.67 to -0.29. For the whole group the test-retest correlation was +0.07. This could indicate that the test was hopeless, or it could indicate that the patterns of interest in these very young children were very unstable, varying from day to day, or at least from week to week. To test these alternative explanations, I altered the presentation of the test so that all three items in a set were presented at once and the children were asked to choose which of the three activities they would rather do. With this method the test-retest correlations for individual children increased considerably, varying from just above zero to +0.75, and for the whole group was +0.74. This finding suggests that the preferences of the children may be more stable than was indicated by the original method of testing. Initial results indicate that the same basic patterns of interest shown by the two-way testing are present.

There is still, however, a very wide range in test-retest correlations, suggesting that individual children vary in the stability of their choices. Interests can fluctuate depending on recent experiences, and test responses could be influenced by how close it was to snack time or other factors affecting motivation. Following refinements to the test, I plan to further explore the temporal stability of science interests in young children, and to investigate factors which may influence the formation of these interests.

**IMPLICATIONS**

Although this work is still in its very early stages, it appears that at least some 4-5 year old children have already formed distinct patterns of interest in science which parallel those seen in older children. The common practice in preschools tends to be to allow children to choose the activities they wish to be involved in. This practice could be reinforcing gender differences in science interests. A more interventionist strategy may be desirable, both in terms of the types of activities offered and in encouraging children into those activities, if greater participation by girls in physical sciences is to be achieved.

**REFERENCES**


**AUTHOR**

MS. RUTH COULSON, Lecturer, School of Early Childhood Studies, University of Melbourne, 4 Madden Grove, Kew 3101. Specializations: early childhood science education, biological aspects of child development.
PREDICTING ACHIEVEMENT OF FIRST SEMESTER UNIVERSITY SCIENCE STUDENTS

Al Gibbs
Charles Sturt University - Mitchell

ABSTRACT

This paper reports on 11 measures used as predictors of students' achievement in their first semester subjects. The students were enrolled in the same four core subjects of a university general science course. Although a number of statistically significant correlations were found, only one predictor variable, HSC aggregate mark, correlated significantly with each of the achievement variables. One predictor variable entered four of the achievement regression equations, while two variables entered the fifth, accounting for 34 to 54% of the variance.

Copies of this paper are available from Dr. Gibbs, School of Applied Sciences, Charles Sturt University - Mitchell, Panorama Avenue, Bathurst, N.S.W. 2795.
THE CONSTRUCTION OF AN ABORIGINAL SCIENCE BIBLIOGRAPHY

W. P. Palmer
Northern Territory University

ABSTRACT
This research note concerns the construction of a bibliography of written materials about Aboriginal science and technology drawn from books, theses, dissertations, scientific and non-scientific journals, conference papers and newspapers etc. in fact, articles about the science and technology that relate in some way to Aborigines, from whatever source, have been included. The articles collected have been listed and classified using Hypercard and major issues and themes have been drawn out of these classifications. It is hoped that the bibliography will be of value in itself and that the categorisation of written materials will help curriculum developers.

INTRODUCTION
The purpose of this paper is to explain the way in which the Aboriginal science bibliography was constructed and to indicate how it can be used and to whom it may be useful. The bibliography is a listing of some three hundred and fifty references which relate to Aboriginal science from a wide variety of sources. This should prove useful in itself, but to add to its usefulness as a resource the bibliography has been transferred to Hypercard. Most of the items referenced have a brief annotation and are classified in a number of ways. This should add to the use of the reference for curriculum developers or teachers considering using the "two ways/both ways" approach. The bibliography will thus be available in either as a listing of references or on Hypercard with the references classified and annotated.

CONSTRUCTION
The references were collected by a variety of methods including sorting through all available issues of journals likely to contain pertinent information, collecting references from the reference sections of articles about Aboriginal science and searching conference proceedings of a wide variety of Australian conferences. The usual yearly indexes were utilised and computer searches have been made using the Australian Educational Index (AEI), the British Educational Index (BEI) and Educational Research Information Centre (ERIC), but these searches proved to be of very limited value in this subject area. This search has now taken a little over two years. Initial results after less than a year were published (Palmer, 1990) and in another paper some brief comments were made about the lack of research interest in Aboriginal science: "Aboriginal science is very much a neglected topic" (Palmer, 1991).

The construction of a standard bibliographical listing needs no explanation, but for the hypercard listing a number of additional classifying systems were used. These and the reason for them will be explained. The idea of "two way direction" has been included as a number of educators believe that the "both ways system" is effective in teaching Aboriginal children. In this approach Aboriginal content may be taught using western methods and conversely western content may be taught using Aboriginal methods, but teachers try to avoid using new/western methods to teach new/western content. Within school contexts the use of these approaches would be under Aboriginal control,
within the communities. For the purposes of the bibliography the approach has been simplified so that the symbol A>W indicates that the content or method being described is largely Aboriginal, whereas the symbol W>A indicates that the major part of ideas in the article are western.

In a number of cases the classification could be a subject of further discussion. Overall the aim would be to indicate roughly to curriculum developers which areas had a large Aboriginal content, or were approached from an Aboriginal view point.

The author sought wide overall headings which would include large parts of both western and Aboriginal science. The headings chosen were: Education, Technology, Ownership. Taken with the "two way direction" this provides a total of six different classes which the author hopes will be found useful in sorting out similar areas. Fig. 1 illustrates schematically the overall classification system. In Fig. 1 the area in common between the two circles representing the western view of science and the Aboriginal world view (though here and throughout the paper it might be more accurate to say "a western perception of an Aboriginal world view") respectively, is the content area most likely to be a source of science content for mixed or for Aboriginal schools. This domain has within it three common areas called Humanity and Technology, Humanity and Education and Humanity and Ownership. These would be topic areas around which a common curriculum could be constructed. The contents of the bibliography will also be divided into these areas, though it must readily be admitted that some references do not fit naturally into any of the categories, whilst others might well fit in more than one category. Fig. 1 and Table 1 together indicate the way in which the references which have been collected have been classified.

Fig. 1 World views, Aboriginal and western with respect to science.
Table 1 shows generally how the topics fit into particular categories, though it must be remembered that topic areas could be in the A > W or the W > A category depending on the way in which the article was written.

### TABLE 1
KEY TO CLASSIFICATION OF REFERENCES

<table>
<thead>
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<th>MAIN THEMES</th>
<th>A &gt; W</th>
<th>W &gt; A</th>
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<tr>
<td>Humanity and Technology</td>
<td>Aboriginal material culture</td>
<td>Housing design</td>
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<td>Boomerang</td>
<td>Bush latrines</td>
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<td>Digeridu</td>
<td>Appropriate technology</td>
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<td>Canoes</td>
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<td>Fishtraps</td>
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<tr>
<td></td>
<td>Bush-medicines</td>
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| Humanity and Education | Land conservation                        | Primary curricula                         |
|                        |                                           | Secondary curricula                       |
|                        |                                           | Tertiary curricula                        |

| Humanity and Ownership | Land                                       | Mining                                     |
|                        |                                           | Uranium                                    |
|                        | Body/skeletal                             | Gold                                       |
|                        | Drugs                                      | Diamonds                                   |
|                        | Petrol sniffing                            | Manganese                                 |
|                        | Diet                                       | Aluminium                                  |
|                        |                                           | Cape York space station                   |
|                        |                                           | Western medical help                       |
|                        |                                           | Atomic bomb testing                        |

**CONCLUSION**

At the start of this project over two years ago, the author was not sure that there would be sufficient material to form a bibliography. There is in fact a wealth of material though comparatively little of it exists within the confines of science education. The bibliography as prepared is far from complete, but it is hoped that, even as it is, it will be of assistance to enthusiastic teachers or curriculum developers. The author would be interested in corresponding with others involved in this area, and would supply the full text of this paper on request.

**REFERENCES**


**AUTHOR**

MR. BILL PALMER, Senior Lecturer, Faculty of Education, Northern Territory University, Casuarina, NT, 0811. Specialisations: Science teacher education, chemical education, science education in developing countries, educational issues.
POPULARISING SCIENCE THROUGH TELEVISION

B. K. Robertson and W. P. Palmer
Northern Territory University

AN INTRODUCTION TO SCIENCE TERRITORY
The genesis of this project (Science Territory) was an idea of one of the authors (BKR) and this was described in an earlier paper (Note 1), though it has taken some years to implement. In brief, the idea was to produce one minute films giving a favourable picture of the applications of science in everyday life linked to an excerpt from science being taught at a local primary or secondary school. Twenty six of these films have been made and these were shown on commercial television in the Northern Territory between 4.00pm and 7.00pm daily, when children in the 9-13 year old age group would be watching. The titles of these films are:

1. Plant sex
2. Swimming Pool
3. Momentum
4. Fuses
5. Bubbles
6. Gas Pipeline
7. Laser and Optic Fibres
8. Microwaves - AUSSAT
9. Sound Waves
10. Cranes
11. Solar Energy
12. Electromagnetic Fields
13. X-Rays
14. Recompression Chamber
15. Barramundi Skins
16. Drag Car
17. Gliders
18. Rainforests and Ants
19. TB -Bacteria
20. Dash - 8 Aircraft
21. Gold and Carbon
22. Oil Rig Wrenches
23. Crocodile meat
24. Drilling Mud
25. Radiation
26. Remote Sensing

EVALUATION
It was hoped that these children would be interested in the films and parents and children might talk about what they had seen which gave a favourable image of science and science teaching in the Territory. The project had two main objectives which were:
1. To increase students' interest in science.
2. To present to the public a realistic image of school science.
These aims are ambitious and the major academic problem is to assess whether they have been achieved. Efforts were made to evaluate the success of the project in achieving these aims and the results are summarised in Table 1.

TELEVISION, SCIENCE AND RESEARCH
One interesting feature about Science Territory is that, as far as the authors have been able to discover, no similar project has been attempted in the area of science, so there is thus no literature which is strictly comparable. The project has used the known expertise of the advertising industry and of its research, said by Barlex and Carre (1985) to be 'highly competent', to improve the image of science.

Teachers often complain about students' poor memory for remembering scientific facts. However children do appear to be able to remember TV advertisements. Zietske & Henry (1980) have shown that children's long term recall is improved by "a little and
often" rather than "saturation" over a few weeks. Science Territory has had advertisements evenly spread over six months.

### TABLE 1

**EVALUATION SUMMARY (Note 2)**

<table>
<thead>
<tr>
<th>Evaluation Questions</th>
<th>Summary of Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the programs change students' attitudes towards science?</td>
<td>A small sample of students were given tests before and after the program presentation period to measure their attitudes towards science. There was no evidence to suggest that the programs had any effect on student attitudes towards science. A larger and more detailed study might show some result.</td>
</tr>
<tr>
<td>How do teachers regard the programs?</td>
<td>Questionnaires were given out to all teachers in 4 Primary Schools and 1 Secondary School. Teachers criticised some aspects of the programs but were enthusiastic about the idea and the programs in general.</td>
</tr>
<tr>
<td>How do parents regard the programs?</td>
<td>Students in one class interviewed their parents and their 2 closest neighbours. The results demonstrated great enthusiasm for the programs among parents and the community generally. Many positive suggestions were made about future plans for the project.</td>
</tr>
<tr>
<td>How do students regard the programs?</td>
<td>Teachers were requested to ask their classes if they would complete questionnaires. Students rated the programs informative, interesting and scientific and most thought they gave a fair representation of real school science activity.</td>
</tr>
<tr>
<td>How did teacher educators, science academics, science education consultants and mining executives regard the programs?</td>
<td>These groups were sent questionnaires after viewing the programs at meetings attended by the co-ordinator. They were asked questions about the concept. Almost every returned questionnaire in these groups rated the concept very highly. They supplied many comments about the future use of this type of program at a national level.</td>
</tr>
<tr>
<td>What sort of anecdotal comment has been gathered?</td>
<td>These were collected by the Science Territory management group in general conversation over the period of production and presentation of the programs. Comments were always positive and enthusiastic and often included constructive criticism. People are generally very interested in the project.</td>
</tr>
</tbody>
</table>

Science Territory has always tried to ensure that the science that it depicts is related to experiences from everyday life. This is also the opinion of Tarleton (1991) who has produced a TV science entertainment series in the U. K.
In an earlier paper one of the authors (BKR) points out that in his view student interest will be the main beneficiary of the Science Territory project (Robertson, 1989):

When these programs catch the interest of students, then the benefits for school based education will be enormous. Interest level is perhaps the most important factor in determining what a student learns and raising the level of interest in school subjects is what these programs are about.

CONCLUSION

Currently the 26 films in the Science Territory series have been shown to audiences who watch Channel 8 commercial television in the vicinity of Darwin. They are still being shown to audiences who watch Imparja Television. There are no plans at the moment to show Science Territory for any extra time on either Channel 8 or Imparja, once the Imparja programmes are complete. There are plans however to develop materials to complement the programmes, which could be used in schools and there are also plans to repeat the success of Science Territory and to expand it on a national basis to a series of programmes to be called "Science Oz".

This research note has described of the Science Territory project which has attempted to improve students' and parents' attitudes to science. It has also attempted to explain how the issue of determining the effectiveness of the project has been addressed. Overall, Science Territory proved to be an interesting, exciting, successful and worthwhile venture, particularly for the small scientific community of the Northern Territory. It also appears to be unique both in Australia and worldwide. There are therefore lessons that science educators can learn from this about new ways of improving students' attitudes to science.

REFERENCE NOTES


Note 2 In July 1991 one of the authors (BKR) sent a full analysis of the data to the sponsors (BHP Petroleum). Table 1 is a non-quantitative summary of the results.

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EDITORIAL COMMENTS

I feel very privileged to have been the editor of this volume of RISE, because the publication provides tangible evidence of a research organisation in a flourishing state of health. The 23rd ASERA conference — the second to be held in New Zealand — attracted a large number of participants (about 120), including several from countries outside the region. An unprecedented number of papers were presented (more than 80), most of which (65) were submitted for publication; and although space pressures precluded all of these from being published, this edition of RISE contains a record number of entries (48 papers and nine abstracts/research notes). It is the first time that a RISE volume has exceeded 400 pages. Its production drew upon the efforts of a very large editorial review panel; let me express my thanks here to the reviewers for their prompt and useful comments; several authors expressed their appreciation to me for the constructive help given to them.

This issue of RISE is not merely large, but rich: in the quality of the research being reported and in the scope of the topics, approaches and contexts represented. Although ASERA is a regional organisation, we are attracting an ever-growing number of international participants: this edition includes contributions from researchers in England, Germany, Spain, South Africa, Hong Kong and the United States.

ASERA began life 22 years ago through the efforts of academics principally interested in secondary school science. This collection encompasses work done in play centres, in primary and secondary schools, and in undergraduate, teacher education and professional development programs. The papers also refer to work done in a wide range of fields. Eight years ago, in an editorial introduction to a collection of papers given to a UNESCO conference on science and technology education in Germany, I commented on the paucity of educational research in the field of technology education and said that perhaps, "a decade or so from now, at another symposium on these topics, this bias might be overcome." In the present volume, a fifth of the papers reflect technological themes. And finally, the collection is rich in research styles. The organisation (and this editor) has no pre-conceived views about the best way to conduct science education research. Cognitive studies, attitude studies, curriculum development and evaluation, quantitative research, historical and philosophical research, phenomenological research, papers supporting constructivism and a paper questioning constructivism: all find their place in this volume.

This is an appropriate place to pay tribute to one man, who more than any other, helped to establish ASERA and nurture its development. In 1967, Peter James Fensham, then reader in chemistry at the University of Melbourne, came to Monash University to take up his appointment as Australia's first professor of science education. His qualifications were remarkable: a double Ph.D., one in chemistry from the University of Bristol, and one in social psychology from the University of Cambridge. He proceeded to attract around him a group of staff and post-graduate students with an interest in science education. Within a couple of years of his appointment, he conceived of a national organisation which would bring science education researchers together. It was the right idea at the right time; it was a period in which there was strong government interest in science education. The federal government had funded the building of school science laboratories, and was now, in co-operation with the states,
turning its attention to nationally funded curriculum projects. The million-dollar Australian Science Education Project was established in 1969, and there was fruitful cooperation between ASEP staff and science education researchers in the universities. (Two years later, the first ASERA journal would be published by ASEP.)

In May 1970, a meeting was held at Monash to discuss the possibility of establishing a professional association. (In enumerating the ASERA conferences, this meeting has always been counted as the first.) A more formal conference, held at Sydney's Macquarie University, was planned for the following year; at this second conference, papers were presented and published in Research 1971, the forerunner of this journal (which explains why the papers of the 23rd conference appear as Volume 22.) ASERA and its annual journal were established; in his preface, founding editor Dick Tisher described the future as "challenging and bright". He was right. The association has never looked back.

As the humorous and loving "roasting" given to Peter at the ASERA conference dinner in Hamilton so amply testifies, his international contributions to science education, his intellectual support to colleagues and students, and above all his character as a warm and caring human being, are all held in the highest regard. This year, 1992, marks both the 25th anniversary of his appointment to Monash and his retirement from the university. It was Dick White who formulated the now famous Law of Fenshamian Motion: if you stand on any spot on earth and wait long enough, Peter Fensham will go by. All of us hope that he will have a stimulating, enjoyable and healthy retirement, and that he will give all the members of the organisation he founded many opportunities to prove the truth of White's Law, again, and again, and again.

Paul Gardner
Editor

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Indented dot points Use asterisks, in preference to letters, numbers, or dots to mark indented dot points, e.g.
The project involved
* a conceptualization phase...
* an implementation phase...

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Fig. 3 A model of the learning process

Headings Main headings should appear in CAPITALS in the centre of the page. Subheadings should be in lower case, underlined, and left-justified. They should be used at regular intervals to assist in the reader’s comprehension of the text. Section and subsection headings should not be numbered.

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ABSTRACTS AND RESEARCH NOTES

VCE CHEMISTRY AS A CURRICULUM INNOVATION

Deborah Corrigan¹, Peter Fensham¹, Jennifer Sheed² and Rosemary Hutchinson³
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RESEARCH NOTE

The Victorian Certificate of Education (VCE) Chemistry course was introduced in 1990. It was part of a complete restructure of the post-compulsory years of secondary schooling in Victoria and was intended to cater for a much wider spectrum of the 17+ age cohort than the previous chemistry course.

In this study, we wished to focus on the dissemination process of introducing VCE Chemistry and how the meaning of its message about curricular changes was shared. We set out to design a study that would answer the following questions:

* What meanings did teachers attach to major changes in the VCE curriculum?
* How do meanings change?
* Which meanings became shared through dissemination alone and which seemed to need other experiences?

We were aware that to have any hope of getting at the meaning others attach to words and messages it is necessary to listen not simply to answers to questions but also to explanations of these answers. This meant clinical questioning or open-ended interviews with deliberate probing as the means of data collection.

We were more interested in the sorts of meanings that might exist and their changes than we were in how many teachers had which meaning. Quota sampling within our resources rather than representative sampling was thus the way we identified teachers to interview.

METHOD

There were three distinct phases to this project. Phase 1 involved interviewing the course study writers in 1989 to gain an appreciation of the meaning they attached to eight aspects of the curriculum change that were either novel or much changed in the intentions of the writers. These were: content; contexts and focal questions; work requirements; practical work; assessment; changes in teaching; science, technology and society approach and student learning.

The second phase involved interviewing 32 teachers from both country and metropolitan Victoria. This phase was undertaken in late 1989, fifteen months before teachers were to teach this course. Several workshops and seminars to communicate the nature of the new course had been held that year,
The third phase involved interviewing 30 teachers who had now taught at least one year of VCE Chemistry. This phase was undertaken in late 1991 and early 1992. Some were from phase 2; others were first-year and experienced teachers who had not been a part of the earlier phases of the project.

FINDINGS

Three new aspects of VCE Chemistry, namely contexts, focal questions and work requirements, are used to illustrate what was achieved in this research.

Contexts
Chemistry courses throughout the world differed little in the actual content that was taught. The major change was a contextual approach: the way things were taught in the classroom. This change seemed to be quite well recognized by teachers as early as 1989, fifteen months before they were to teach this course.

Phase 3 teachers’ responses to contexts varied. The use of the term “context” differed, and this may be in part due to its obvious absence from the Chemistry Study Design document.

Focal Questions
The intentions of the study design with respect to the use of focal questions are to define the area of study in terms of the context of chemistry, technology and society. The intentions are not to define the chemical phenomena, knowledge, concepts or activities. These aspects do need to be considered, however, in order to resolve the focal questions.

The term “focal questions” was not identified by any of the study writers. The study writers constantly refer to the idea of “contexts” and yet this term is a notable exclusion from the formal study design document. The formal document formulated by the Field of Study Committee (FOSC) refers only to “focal questions”. These are not synonymous terms and this highlights the difficulty that exists when trying to share meaning between many different groups.

When asked what they thought focal questions were, teachers in 1989 offered a wide range of responses. At this stage, it appeared to the researchers that some teachers read and listen to VCE information quite differently from others. Some had a teacher-centred approach to this new course. These were the ones who had difficulty in seeing the purpose of focal questions.

Alternately there were teachers who saw the VCE, the sequence of things, the focal questions and so on as being for the students. They had the idea that these features would make learning different, better or easier.

Teachers in the third phase still held diverse views about focal questions. The purpose of the focal questions had become much clearer with experience, but the use of them in terms of what was happening in the classroom varied significantly.
Work Requirements
The study writers took the prescriptive element of work requirements being common to all VCE subjects as an opportunity to force teachers to focus on how they and their students learn. The work requirements imposed on teachers the methodology they were to adopt. The teachers would find it very difficult to reorganize their old HSC course to fit the new structure.

Many phase 2 teachers were resentful of this study design because they believed it was imposing on teachers the way they should teach. Once again the polarization between teachers who see themselves as teachers and those who see themselves as facilitating learning was highlighted.

Phase 3 teachers' experience of work requirements meant that generally there had been acceptance of the new strategies incorporated in work requirements as useful mechanisms for teaching in some cases and learning in others. There was still a sense of outrage that professional teachers were being told 'how to teach'.

CONCLUSION

The difficulty of sharing meaning of curriculum intentions between different groups is highlighted in this study. The acceptance of the novel features of the Chemistry Study Design is mixed. The longitudinal nature of the study helped to identify the difficulty teachers had in understanding the meaning of these novel features although the experiences of teaching units in the VCE chemistry course have enabled some teachers to shift in their construction of the meaning of the words and messages around them.

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THE EFFECT OF QUESTION FORMAT IN REVEALING THE QUALITY OF STUDENT LEARNING OF SOME BIOLOGICAL CONCEPTS

Lynda J. Creedy
University of New England.

RESEARCH NOTE

The SOLO (Structure of the Observed Learning Outcome) taxonomy has been used to assess the quality of students' responses in various fields for both instructional and assessment purposes. It has also been proposed as a logical means of breaking down the general aims of science education into specific classroom aims and activities and for providing a reliable means of criterion-based assessment (Collis & Biggs, 1989; Pallett & Rataj, 1992). This research note describes the results of the initial phase of a larger study of the use of the SOLO taxonomy to evaluate students' understandings of some concepts basic to the study of senior secondary biology.

Both open and closed (superitem) format questions have been used when investigating student understanding in a number of subject areas. The 'open' format questions encourage students to give their 'best' answer without describing the required structure. The 'closed' format questions are framed in such a way that students are at the least directed to structure their answers in a certain way, namely, conforming to the targeted SOLO level. The intention is to obtain the best answer a student is capable of giving and thereby approximate that student's level of understanding in that topic. Research in the use of superitems in mathematical problem solving (Wearne & Romberg, 1977) indicated that the superitem structure provided a more refined measure of students' abilities and yielded more information about these abilities than open-ended questions. If the students' best responses are required, which is the best format to use? This phase of the project was designed to compare the quality of response of students to the two question formats and answer two questions:

* Do open style questions yield responses which underestimate the true level of understanding of a student?
* Do closed style questions provide a prompting effect and thereby secure the student's best answer?

The subjects for this study were 14 Diploma of Education students in a senior secondary science methods unit. During the week following the administration of the test questions, students were interviewed to clarify their understanding of some of the questions and to examine their beliefs about the kind and amount of information required for satisfactory completion of each question. They were then asked to compare the open format questions with the last superitem question to find out if they perceived the questions to require answers of different quality.
Test Questions

Open format: These questions were presented in standard essay question format in which student were asked to supply as much information as possible. There were three questions, each centering on a different concept: natural selection, biogeochemical cycles and food webs/biomass pyramids.

Closed format: The closed items were designed according to the SOLO superitem format (Collis & Davey, 1986). Three superitems in biology were constructed based on a previous trial and covered the same concept areas as the open format questions.

After scoring the students’ responses on the basis of correctness, answers to both superitem questions and open format questions were scored according to their structure: they were assigned to SOLO levels according to established criteria. Superitem response patterns were examined using Guttman Scaling. The results demonstrated that within the superitems there does seem to be prompting occurring. No responses were scored as extended abstract, however, so under the conditions of this study, the superitem structure does not seem to elicit students’ best responses. This is most clearly seen when the structure of ‘extended abstract’ question of superitem is compared to that of the open question. Most responses to open questions were of a higher structural level than those responding to the superitem questions. The results of this study demonstrated that question format does appear to effect the SOLO level of response of this group of students. If the SOLO Taxonomy is to be used in the setting of specific teaching objectives and as a means of criterion based assessment such effects need to be considered.

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AUTHOR

DR. LYNDA CREEDY, Lecturer, Department of Science, Technology and Mathematics Education, University of New England, Armidale, NSW 2351. Specializations: science and technology, biology teacher education.
Images of Science Teaching: An Exploration of the Beliefs of Preservice Secondary Science Teachers

Annette Cunliffe
Australian Catholic University Queensland

Abstract

Science graduates who enrol in a preservice Graduate Diploma of Education bring with them many years of experience as learners of science. These will have enabled them to develop implicit theories about what a science teacher is and does. Such implicit theories almost certainly affect the process of becoming a teacher, and may prove persistent despite the input from University and school during the Dip. Ed. year and beyond. This paper presents the research method and results obtained from a group of graduates on entry to their Diploma course. Concept maps and Repertory Grid interviews were obtained from eleven graduates, with varying life experiences. The paper presents analyses of these and explores emerging themes.

Author

Sr Annette Cunliffe, Lecturer in Science Education, Australian Catholic University Queensland, P.O. Box 247, Everton Park, Q. 4053. Specialisations: reflective teaching, general science and biology, curriculum and assessment.
TEXTBOOK TREATMENTS AND STUDENTS' UNDERSTANDING OF ACCELERATION

Gloria Dall'Alba¹, Eleanor Walsh², John Bowden¹, Elaine Martin¹, Geoffrey Masters³, Paul Ramsden⁴, and Andrew Stephanou⁴.

¹Royal Melbourne Institute of Technology, ²LaTrobe University, ³Australian Council for Educational Research, ⁴University of Melbourne.

A single science textbook often provides the syllabus for courses at upper secondary and tertiary levels, and may be used as a principal source of information or explanation. The research reported in this paper challenges such practices. The ways in which the concept, acceleration, is treated in physics textbooks is compared with understandings of the concept demonstrated by final year secondary (year 12) and first year university students. Some students' understandings are shown to be incomplete in ways that parallel misleading or inaccurate textbook treatments of the concept.

In addition to misleading or inaccurate statements, the limitations of some textbook treatments of acceleration were found to include: lack of attempts to make explicit relationships with other concepts; failure to point out when it is appropriate to use particular definitions or that an alternative definition might be more appropriate in specific situations; inclusion of operational definitions without conceptual explanations; and a focus on quantitative treatments while overlooking the development of qualitative understanding. Two principal aspects that distinguished the ways in which the students understood acceleration were identified: the relation between acceleration and velocity; and the relation between acceleration and force(s). The results of the study have implications for teaching and, in particular, for the use of textbooks in teaching. These implications are discussed in the paper.

This paper has been accepted for publication in the Journal of Research in Science Teaching. Copies are available from Gloria Dall'Alba, ERADU, RMIT, GPO Box 2476V, Melbourne. Vic. 3001.
WHERE ARE THE SCIENCE AND MATHS TEACHERS?
A FIFTEEN YEAR FOLLOW-UP STUDY.

Rod Fawns
University of Melbourne

RESEARCH NOTE

Purpose and Summary
Facing challenges to the efficacy of end-on teacher education has led me to ask serious questions about where the responsibilities of teacher educators to their students lie. Would graduate students' long term career interests and those of society at large be best served by a change in the locus of teacher training from universities to schools?

Information collected in questionnaire and interviews with students who had enrolled in mathematics and science at Melbourne University points to the limits of the "practical" argument that the professionalization of science teaching lies in substantially more school practice.

Method and Sample
A questionnaire was mailed to the 425 of 535 full-time Science/Maths Dip. Ed. graduates from the years 1976-90 for whom an address could be found. Of these, 268 (64%) were returned, and at least 50% of the graduates in each year group were in the sample. The gender balance in the sample was comparable with the original class lists; there was no reason to believe that the sample was unrepresentative. Telephone and site interviews were conducted with those who indicated interest.

Data
Information was collected about personal and family background, undergraduate studies, method affiliation, career choices and the value attributed to their education studies in their chosen work. Only some data about careers can be reported here.

Careers of Science and Mathematics Teachers
The average age of the group was 32 years (compared to the state average of about 45 years). The years covered by the survey were years of virtual full employment for science teachers. Twelve percent never taught, choosing an alternative career from the outset. The others have taught for an average of 5.7 years. In 1991, of the group that has taught, 46% had left full-time teaching. Table 1 shows the employment in 1990 for the 262 of the 268 who provided answers to this question.

Of all those teaching in 1991, 8% were employed in Catholic schools, 24% in independent schools, 19% in Victorian country state, 36% in north/west suburban and 14% in south/east suburban Melbourne state schools. From a peak of 77% of former students teaching secondary full-time in 1984 the figure has dropped to 42% in 1991. In 1984 63% of the whole sample were employed in state schools, but the figure fell steadily to 39% by 1991, reflecting more frequent departures from teaching. Amongst the alternative careers were: lecturing in the post-secondary education and training sector, in the health sector; sales representative, pharmacist, chiropractor, dentist, psychologist, rehabilitation counsellor, in finance, insurance and banking, in technical services and training; in computer systems; geologist, chemist, meteorologist,
communication engineer, embryologist. Ninety percent of all respondents felt their occupation demanded skill in communication and personnel management and 74% felt it drew on their maths/science background.

**TABLE 1**

<table>
<thead>
<tr>
<th>Employment</th>
<th>n</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching fulltime</td>
<td>124</td>
<td>42</td>
</tr>
<tr>
<td>Teaching parttime</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Home duties (full)</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Research/study</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>TAFE/tertiary teaching</td>
<td>35</td>
<td>13</td>
</tr>
<tr>
<td>Private enterprise</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>Public service</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Self employed</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

**Factors Important in Career Choices**

Excluding the 34 who wanted to be at home fulltime or parttime, 104 of the 228 employed have either never taught or have left teaching. For them the most important factors were "the opportunity for a more interesting career elsewhere" (73%) and "better pay elsewhere" (50%). The next most important factors were "difficulty in maintaining discipline in class" (32%) and the "low public esteem of teaching" (30%). Those teaching full-time in 1991 (n=124) mentioned a number of factors in their continuing commitment. "Response from students to my efforts", "an interest in school science/maths", "an interest in teaching as a profession", "an interest in adolescents", and "security of income" were regarded as important by more than 80% of this group. Amongst the factors rated as least important were, "response from the local community", "superannuation", "level of income" and "response from other teachers to my efforts". Asked about their future plans to teach the whole group (n=268) gave the responses shown in Table 2 to the questions, "Do you plan to be teaching next year, in 5 years time and in 10 years time?"

**TABLE 2**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>Undecided</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Next year?</td>
<td>54</td>
<td>7</td>
<td>39</td>
</tr>
<tr>
<td>Five years time?</td>
<td>37</td>
<td>38</td>
<td>25</td>
</tr>
<tr>
<td>Ten years time?</td>
<td>24</td>
<td>52</td>
<td>24</td>
</tr>
</tbody>
</table>

Some were interested in returning to teaching and many more would be looking after children of their own in the next 10 years. Only 25% had completely abandoned teaching in the medium to long term. Evidence for a continuing vocational interest is provided by responses to a question about the level of satisfaction with their choice of
career. The teachers as a group were slightly more satisfied than those employed elsewhere (Table 3).

**TABLE 3**

**LEVEL OF CAREER SATISFACTION**  
(figures % )

<table>
<thead>
<tr>
<th></th>
<th>not at all/quite</th>
<th>somewhat</th>
<th>highly satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Full Time n=124</td>
<td>12</td>
<td>52</td>
<td>36</td>
</tr>
<tr>
<td>Not Teaching n=100</td>
<td>23</td>
<td>46</td>
<td>31</td>
</tr>
</tbody>
</table>

In interviews many who had left teaching said they still found the idea of teaching appealing. They felt the Diploma of Education program most helped them by expanding their view of maths and science, increasing their understanding of public education issues and in new knowledge gained. In these there were no discernible differences between those currently teaching and in schools and those employed elsewhere. Fewer than 20% wanted an entirely school-based Diploma of Education programme.

**AUTHOR**

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TECHNOLOGY IN THE CURRICULUM: A VEHICLE FOR THE DEVELOPMENT OF CHILDREN'S UNDERSTANDING OF SCIENCE CONCEPTS THROUGH PROBLEM SOLVING.

Beverley Jane and Leanne Smith
Deakin University - Cooinda Primary School

ABSTRACT

This research was carried out over a period of ten months with children in Grades 2 and 3 (aged 7 and 8) who were participating in a sequence of technology activities. Since the introduction into Victorian primary schools of The Technology Studies Framework P-10 (Crawford, 1988), more teachers are including technology studies in their classrooms and by so doing may assist children's understanding of science concepts. Children are being exposed to science phenomena related to the technology activities and Technology Studies may be a way of providing children with science experiences. 'Technology Studies' in this context refers to children carrying out practical problem solving tasks which can be completed without any particular scientific knowledge. Participation in the technology activities may encourage children to become actively involved, thereby facilitating an exploration of the related science concepts. The project identified the importance of challenge in relation to the children's involvement in the technology activities and the conference paper (available from the first author) discusses particular topics in terms of the balance between cognitive/metacognitive and affective influences (Baird et al., 1990)

REFERENCES


AUTHORS

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DISTURBING THE BOUNDARIES: 
THE SCIENCE/LITERATURE MEMBRANE

Peter Lumb and Paul Strube
University of South Australia

RESEARCH NOTE

Constructivist theories of learning have encouraged us to look for the connections learners make when information is received. In science education, we have naturally tended to concern ourselves with the connections between scientific concepts. Research is beginning to uncover the connections between incoming scientific information and non-scientific content of the mind. Concept maps have been valuable here, showing the kinds of connections that are made when such words as ‘energy’, ‘force’, and ‘living’ are explored.

From 1988 through the current year, the authors have organised a short story competition for science students in Australian secondary schools. Sponsored by the Royal Australian Chemical Institute as part of its National Chemistry Week activities, the competition is based around writing a fictional short story in which chemistry played a major role. As a result, there are now over 229 short stories to examine using content analysis techniques for the images of science and of scientists portrayed. This paper discussed some interesting revelations about the way scientists are imagined by students, and about the social world they inhabit. Attitudes, values and behaviours of (mostly) male scientists appeared consistently and clearly in student stories. These results were examined against a background of comparative research in the area of children’s perceptions of science and scientists.

About one third of the stories showed two distinct and unintegrated styles. These were a literary fiction style, for example comic book, war, adventure, mythical morality adventure, romance and adolescent social realism. These literary styles were often alongside classroom or school science textbook styles.

An objective of the competition was to stimulate imaginative interest in science, and to provoke thought among students about the ways in which science was contiguous with real and imaginative experience. Certainly, the products of this short story competition have suggested that science stories provide rich possibilities for humanistic exploration. The competition revived ideas about the ‘two cultures’; they seem clearly evident, and separate, in many of these stories. Both cultures, it seems, have much to gain if science teachers feel able to involve humanities teachers and secondary students in a joint writing enterprise. On the whole, stories from English classrooms are quite different to, and remote from stories from science classrooms. The two cultures are so distinct in many students’ minds that ideas must be written in two separate styles, which cannot be reconciled even within the one story.

AUTHORS

PETER LUMB and PAUL STRUBE, School of Nursing Studies, University of South Australia, Holbrooks Road, Underdale, SA 5032. Specializations: the language of science textbooks, relations between science and literature.
COMMUNITY INVOLVEMENT IN RESEARCH AS A FORMAL AND INFORMAL MECHANISM FOR SCIENCE EDUCATION: PROJECT EGRET WATCH

Max Maddock
The University of Newcastle and the Wetlands Centre at Shortland

RESEARCH NOTE

Informal science learning has received increasing attention in recent years but few studies have been carried out into the process of learning outside of school or into the interactions of learners with other sources of information. Informal and formal science and environmental learning takes place through community involvement in ornithological research at the Wetlands Centre at Shortland in NSW Australia, a centre for environmental education, conservation, research and passive recreation in wetland settings situated at the edge of extensive swampland in the Hunter River estuary. The Centre has classroom, library, theatrette, display, office and cafeteria facilities.

A colony of egrets on the site and colonies at other NSW locations have been the focus of Project Egret Watch, a research study into the breeding biology, ecology and migration of the egrets, which has produced publications in the scientific literature on breeding biology, ecology, migration and field techniques. Adult and school-aged volunteers assist with wing-tagging of the birds at the breeding colonies and as field observers throughout Australia and New Zealand. Feedback to volunteers, the media and to visitors to the Centre provides a vehicle for both formal and informal science and environmental education. Participating schools have their own newsletter.

Evaluation of the success of Project Egret Watch as a vehicle for learning has been informal to date, based on observational, anecdotal and participant feedback. There is a need and significant potential for a range of science education research studies related to the Project Egret Watch, in the cognitive and affective domains as well as into sociological aspects. Questions such as what specific cognitive and affective learning outcomes result in the formal, non-formal and informal domains, who is reached by the informal mechanisms operating in relation to the project, such as the media and the outreach initiatives, and what are their characteristics, are all worthy of study. A program such as Project Egret Watch would need the development and application of new measures and multiple evaluation methods.

There has been little research into the outcomes of the work of field study centres of the Wetlands Centre type. Participants in Project Egret Watch are helping with real research and contributing to results which are published in the scientific literature. The feedback to participants is couched in lay terms and often features "human interest" aspects, but attempts are made to keep it scientifically accurate and incorporate aspects of methodology and conservation outcomes as part of the broader educational objectives. The outcomes are not really measurable in traditional science education research terms.
The Wetlands Centre currently does not have the resources to undertake such studies in its own right. It is, however, interested in providing universities with access to its programs and facilities in order that such research can be carried out. There is plenty of scope for small-scale course-related studies as well as minor theses and higher degree studies. The potential for obtaining funds by joint grant applications exists. There is scope for science education research into the processes of learning and the interactions of the learners with the sources of information generated by the project, which could contribute to knowledge of informal processes of learning.

AUTHOR

DR. MAX MADDOCK AM, Associate Professor in Education, University of Newcastle, NSW 2308 and Chairman of Directors, The Wetlands Centre at Shortland, NSW 2287. Specializations: science and environmental education, biology of herons.
Research in Science Education, 1992, 22, 417 - 419

COMMUNICATION ON A PROBLEM SOLVING TASK IN COOPERATIVE LEARNING GROUPS.

Jo Sadler and Rod Fawns
University of Melbourne

RESEARCH NOTE

This research note reports preliminary findings on the development of communication amongst students working in cooperative learning groups on repeated attempts at a problem solving task. The research is part of a larger study to examine the effects of various strategies for managing student communication which is currently being conducted with Year 8 classes in six Melbourne government schools.

Data on the communication in the group were obtained by recording, transcribing and coding students’ conversations whilst they undertook a problem solving activity (Gott & Murphy, 1987). The coded results for one problem solving session for one group (Table 1) show high levels of student interaction. The task related conversations indicated that exchanges about various aspects of the task were in ratio of approximately:

\[
\text{procedures : descriptions/explanations : reconceptions and reformulations} = 4 : 2 : 1
\]

The data confirm that although the greatest concerns were for setting up and making measurements, there was significant discussion about information obtained by way of data collected and to a lesser extent how to relate the data to the broader problems posed within the investigation.

Kempa and Ayob (1991) concluded that the group work interaction rarely rose above the level of a factual information exchange about procedures. This suggests that problem solving did not really take place as a group activity. However their observations may reflect their one-shot design.

Our observations of classes and problem solving sessions conducted over an eight week period show a shift towards higher level exchange over that period. The Cooperative Learning Model of Slavin (1983) which proposed four levels of skills may explain this development.

1. Group establishment skills
2. Maintaining a functioning group
3. Skills of reflection and reasoning to formulate understanding at a deep level
4. Reconceptualising skills to stimulate reformulating understanding through new investigations and to communicate the rationale behind the conclusions.
In our longitudinal study the social-emotional needs of the group interacted with the completion of the problem solving survival task. The high level of information flow in setting up and completing the task consolidated behaviour at the first two skills levels. In early observations it appears that rather than threaten the positive social-emotional climate of the group, female students in particular, often chose not to argue for their particular beliefs, even when invited by the authors. Students appeared to be struggling to balance Slavin’s skill level 3 with the needs of skill level 2.

Later, when the same group undertook the same task for the third time, the group redesigned the investigation in an attempt to reach a satisfactory solution. This time the group sought to deal with all possibilities. The group appeared to be moving towards Slavin’s fourth level of skills required for functioning cooperative learning groups.

Teachers involved in the trials in the last two years have suggested that intra-group relations and styles of leadership in the groups are crucial factors in their operation. Preliminary observations would support Gayford’s (1992) suggestion that there are potentially important identifiable patterns of group planning and implementation.

<table>
<thead>
<tr>
<th></th>
<th>Procedures %</th>
<th>Descriptions &amp; Explanations %</th>
<th>Reconception &amp; Reformulation %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention focussing</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offers of Assistance</td>
<td>3</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Requests for Action</td>
<td>19</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Requests for Information</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requests for Help</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Other Relevant Comments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Questions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requests for Information</td>
<td>8</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Requests for Help</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Responses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Specific Response</td>
<td>16</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Incomplete Answer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Answers with a Question</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Counter-assertion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>52</td>
<td>30</td>
<td>16</td>
</tr>
</tbody>
</table>
Summary

There is some evidence from this study that reflectivity within cooperative learning groups develops over time. Preliminary observations suggest that Slavin’s third and fourth levels of skills, those of reflection and reasoning and reconstruction and reformulation and Kempa and Ayob’s higher levels of explanation and insight appear more advanced in groups strategically managed by teachers for such outcomes. Later analyses will permit more detailed accounts of the relationships between the teacher’s management strategies, and reflection within groups of different gender composition.

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AUTHORS

MS JO SADLER, Lecturer, Institute of Education, University of Melbourne, Parkville, 3052. Specializations: science teacher education.

DR ROD FAWNS, Senior Lecturer, Institute of Education, University of Melbourne, Parkville, 3052. Specializations: studies in twentieth century science education in Australia, teacher education.
Selected refereed papers from the Twenty-fourth Annual Conference of the Australasian Science Education Research Association, held at the University of New England (Northern Rivers campus), Lismore, NSW, 8-11 July, 1993.

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EDITORIAL COMMENTS

The papers in this issue of Research in Science Education are the more tangible outcomes of yet another successful ASERA conference, held for the first time at the Northern Rivers campus of the University of New England in Lismore. (Also for the last time, since the campus is in the process of disamalgamating with UNE at Armidale; it will soon be a separate university, with its own name.) This is an appropriate place to record our thanks to Keith Skamp and his committee for their superb efforts in organising the conference program so effectively.

About 80 papers were presented at the conference; 58 were submitted for publication, and most of these (about 80%) have been published here. As in the past few years, all papers have been independently evaluated by two reviewers, and I would like to express my appreciation to the large number of colleagues (listed on pages viii and ix) for their thoughtful assessments and prompt reviews. Eagle-eyed readers may detect an improvement in printing quality this year. RISE continues to keep in step with the technological revolution: for the first time, the masters have been prepared with a laser printer.

The Lismore conference took an important decision and implemented an idea first raised in Perth in 1990: to develop RISE into a regular journal, with several issues per year. Cam McRobbie of the Queensland University of Technology readily offered to attempt to produce two non-conference issues of RISE in 1994. All of us in ASERA wish him well in this endeavour. The success of this innovation will depend on two factors: the willingness of ASERA members and other science education researchers to use RISE as an outlet for our publications, and the willingness of all subscribers to pay the increased costs of an expanded journal.

In the opening article in the 1993 issue of Studies in Science Education, titled "Getting serious about priorities in science education", Myron Atkin and Jenifer Helms refer to the clamour of clashing claims (my alliterative phrase, not theirs) upon the science curriculum:

New or revised goals are announced regularly and often. Teach science to improve economic competitiveness. Teach it to help people make wise choices as consumers. Teach it to improve personal health. Teach it to protect the environment. Teach it to help prepare the scientists and engineers the country needs. And above all, whatever the purpose of teaching science in the schools, it should be for all the students.

Each goal seems worthy and is usually embraced by both science education professionals and the public. Then new goals come along. Teach science to foster problem-solving ability? Yes. Teach it to prepare people for jobs? Yes. Teach it to cultivate critical thinking? Yes. These too, are added to the list.

To these American voices, we can easily add some Australian ones. Teach science in the kindergarten and primary school, to encourage early interest. Teach science according to nationally-agreed guidelines, to encourage national cohesion. Teach science in ways that are gender-inclusive. Teach more science to teachers, so that they can teach it better to students.

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It is of course possible to view this collection of demands in a positive light. Science education is complex, and it plays an important role in modern society. It is therefore hardly surprising if we find a rich variety of claims for attention on the nation's science curricula. The papers included in this issue of Research in Science Education hold up a mirror which reflects that rich variety. Students' misconceptions in biology. Gender bias in chemistry. Computer usage in science teaching. Science-technology relationships. Science in the kindergarten. Food and nutrition. Science investigation skills. Practical work in biology. In-service courses for teachers. Chemical pollutants. Historical approaches in physics. Reasoning skills. Arguing by analogy. Teaching about controversial issues. These and other themes are all represented in this volume.

However, Atkin and Helms also sound a warning. There are so many different demands upon the curriculum that the public -- and science educators, too -- are "engulfed by undifferentiated statements of purpose that in their totality are both confusing and unrealistic". One important consequence is that many goals turn out to be impossible or ignored. This may "diminish the credibility of the profession because the public does not know what really to expect, and teachers don't know what to teach". They argue that the science education profession must learn how to identify priorities and to make choices; their essay is an attempt to frame guidelines towards that end. Their long and thoughtful paper contains much that will challenge science education researchers in Australia and New Zealand. Studies of the conflicting pressures on science education curricula in this part of the world, and of the development of approaches to their resolution, might form the basis for future papers in this journal.

Paul Gardner
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Monash University
November, 1993
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A LEARNING MODEL FOR SCIENCE EDUCATION

Mary Smith & John A. Smith
University of Central Australia Alice Springs College

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DR MARY SMITH, Senior Lecturer, Faculty of Education, University of Central Australia, Alice Springs, NT 0870. Specializations: biotechnology curriculum development, biology teacher education.

(xi)
AN INTEGRATED SCIENCE PRE-SERVICE TEACHER TRAINING COURSE: A FOCUS ON ASSESSMENT.

Deborah Corrigan & John Loughran
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RESEARCH NOTE

All students undertaking science methods in the pre-service teacher training year at Monash University participate in an integrated science program known as Stream 3. This course has been developing for 15 years. The emphasis of the Stream 3 programme is to encourage pre-service teachers to take on responsibility for their own learning. The most recent innovation in this course is in the area of assessment strategies aimed at maximizing student learning by providing an integrated approach to assessment across method areas. These approaches are documented by students in a teaching portfolio. This paper describes some of these tasks and examine the implications for pre-service science education.

The Teaching Portfolio

In order to foster independent learning in our pre-service teachers so that they might do the same with their own students, a change in our approach to assessment seemed appropriate. We wanted students to learn from the assessment they undertook, and not just complete it as a hurdle along the way to getting their Diploma in Education. As a result, the notion of a teaching portfolio was developed. Teaching portfolios are tangible representations of what students see as their “philosophy” of teaching and learning in science.

The use of portfolios in the Stream 3 programme is intended primarily as a learning procedure that would also result in a final product that pre-service teachers could use with prospective employers. The process of preparing a teaching portfolio and refining it after receiving feedback allows students the opportunity to reflect on their own ideas and attempt to present them in a coherent way. The process is essential for the learning to occur. The end product allows pre-service teachers to present documentation to prospective employers that could provide important evidence in selection decisions. The product also provides a prospective employer with a starting point for discussion with the pre-service teacher. The discussion is much more likely to focus specifically on the abilities, views and skills of the pre-service teacher.

The purpose of the portfolio is for students to think about their philosophy of what it means to be a science teacher. In this case the development of attitudes and views is as valuable as the development of skills and abilities. The portfolio is designed to cover a range of tasks and activities that might reflect an individual’s approach to science teaching.
To support the development of the teaching portfolios, students are asked to undertake a number of activities, including:

* interviewing students and teachers about teaching and learning;
* undertaking research, perhaps involving a research project, in a familiar or unfamiliar content area;
* preparing and experiencing aspects of Frameworks and VCE curriculum design;
* experiencing teaching in a diversity of styles incorporating a number of teaching strategies such as PEEL strategies or co-operative group work;
* preparing a media file of newspaper clippings, videos etc. for use in teaching science;
* demonstrating how they might plan, organize and conduct an excursion or site visit; and
* using various software programs in science education.

Researching the Teaching Portfolio Strategy

As a means of gauging this assessment approach, a small research project was set up to monitor students' views. A sample of eight students (out of 30) volunteered to participate in the research project. Participation required the students to be interviewed at three stages throughout 1993 by an independent interviewer. At the time of writing this paper only the first of three interviews has been undertaken.

One of the difficulties for the lecturers in this process has been trying to explain what a portfolio is to the students. The idea of the portfolio only becomes clear to the students as they actually undertake the tasks. When this is coupled with students' previous experiences of assessment from their own schooling and undergraduate careers where they have clear notions of what is expected in an examination or an essay, it takes a great deal of effort to get them to "do" the tasks first. It is only after trying out these tasks, obtaining feedback from their tutorial groups and reflecting on this feedback, that a clear picture of what a portfolio item might look like emerges.

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PROBLEMS WITH IMPLEMENTING SCIENCE AND TECHNOLOGY IN PRIMARY SCHOOLS IN N.S.W.

Brian Ferry
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RESEARCH NOTE

This study identified difficulties faced by primary teachers as they implemented a new curriculum in science and technology education in N.S.W. A survey instrument was tried out at two schools, and refined after consultation with twenty four primary teachers enrolled as part-time students in a science education subject in a Bachelor of Education conversion course for non-graduate teachers. The sample consisted of a stratified sample of 15 state schools selected from a pool of 40 local schools. At the end of the project, science co-ordinators from surveyed schools were asked to comment about the reliability of the findings.

RESULTS

There were 32 male and 68 female respondents. The average number of years that they had been teaching was 17.6 (standard deviation 6.4). Forty nine had been teaching over 17 years and these figures are a typical age-profile of primary teachers in Australian (DEET, 1993). Forty seven percent of respondents were not graduates, and most of these had not updated their initial tertiary training. Interviews with teachers enrolled in the BEd conversion course revealed that recent changes in the criteria for teacher promotion led to their renewed interest in tertiary studies, because additional qualifications were perceived as a vehicle for promotion and increased salary.

Teaching science

No significant gender difference in the time allocated to science teaching was found. Teachers indicated that they spent an average of 45 to 60 minutes per week teaching science, i.e. less than 12 minutes per day; less than half of the time recommended for such a key learning area. Twenty percent of respondents were spending more than 12 minutes per day teaching science, and 13% were spending less than 5 minutes per day. A typical comment by a school science co-ordinator was "science like art, craft and music requires additional preparation time. Therefore teachers will avoid these subjects when pressed for time."

Teachers concentrated on science-based units and taught less of the designing and making, and technology sections of the syllabus. More females than males were collaborating to develop programs (teaching units), but overall, the amount of collaboration was low.

Support and assistance

Thirty percent of respondents felt that they were able to receive adequate advice and assistance. This indicates that there was an immediate need for teacher in-service. Ninety five percent of respondents considered that self-contained experimental kits would assist their teaching, and only five percent considered that booklets of stencil masters would be useful. Responses from interviews indicated that teachers wanted to employ a "hands on" approach to science but needed help with ideas and resources. Fifty one percent had received no in-service training at the time of the survey. The most popular suggestion was a one day in-service conducted during school time at a "host school" by consultants or local teachers. Most respondents (83%) also felt that these in-service courses should occur four times per year or once every term.
CONCLUSION

Although all teachers were spending some time on science teaching, most were teaching less than 12 minutes per day. Nearly 75% of teachers were implementing science units similar to those 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 in-service and needed help. This issue was raised by Cumming (1993, p.8) in his discussion about the need for "high quality professional development" for teachers who will implement a national curriculum. 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. Such kits are being developed by the National Science Centre in Canberra and are called "Exciter Packs." Teachers interviewed stated that finding and organising the materials required for science lessons took time that they could not spare.

Some important issues arising from this study that need to be considered by planners of primary science education are:

* teachers should, but do not always want to, allocate more time to the teaching of science.
* there is a need for regular in-service that is held in schools.
* support kits of "hands on" materials are needed by nearly all teachers.
* universities and secondary schools can provide of human and physical resources that could support the implementation of the syllabus.
* while the use of teachers to train their peers may be well received, there is a danger that they will be taken away from classes and their students will suffer. Also problems with over-commitment and "teacher burn-out" may also occur.
* making a section of a syllabus mandatory does not guarantee that it will be taught. Teachers avoid sections of the syllabus if they lack confidence.

REFERENCES


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BRIAN FERRY, Lecturer in Science Education, Faculty of Education, University of Wollongong, Specializations: science education, information technology and science education, environmental education.
THE ROLE OF GROUP WORK USING COMPUTATIONAL EXPLORATORY LEARNING ENVIRONMENTS WITHIN CHILDREN'S LEARNING IN SCIENCE

Zoe Zoni Kavogli
University of Glasgow

RESEARCH NOTE

The study focuses on the development of pupils' cognitive strategies while using computational exploratory environments (the various problem-solving activities which pupils have undertaken provide opportunities for the development of particular skills connected with problem-solving, investigation and reasoning skills) and on the effects of group work (based on how the group functioned, the motivation and involvement of pupils, how these environments influenced pupils working together and vice-versa). The results of the study were drawn from appropriate observations, interviews and questionnaires from 90 pupils aged 10-13, from junior and secondary schools during the application phase of their learning process in Science topics and are mentioned below.

The creation of a HyperCard stack can be a creative and communicative form of learning, lending itself not only to the development of computer and science skills but also to the extension of the child's language. However, for the purpose of this study, it is the problem-solving aspect which takes precedence. The various activities which pupils undertook by creating HyperCard stacks provided opportunities for the development of particular skills connected with:

* Problem-solving (deciding upon or identifying a problem; planning strategies, carrying them out, and recognizing whether they are successful and where they are not; checking solutions, relating them to the original problems, and deciding how reasonable they are; revising and recrafting; self-evaluating).

* Reasoning (reasoning logically; drawing inferences; being systematic and consistent; describing and explaining methods, reasons, strategies, predictions, results or conclusions).

* Investigation skills (asking questions and deciding which of them to pursue; making hypotheses; setting up fair tests; monitoring: continuous attempt to match efforts, answers and discoveries to initial questions or purposes; classifying: identifying properties, similarities and differences; counting possibilities; recognizing patterns and relationships).

The important skill of decision making is not listed separately since it is implied in many of those which have been described.

Groups of students began by talking among themselves and exchanging ideas on how to present the topics to other users. Then they decided on the plans, the distribution of work among them and the timetable. Thus, the creation of a HyperCard stack contributed to the pupils' personal and linguistic development, as well as providing a stimulus for the growth of problem-solving skills. A problem-solving situation is set up by offering a task which requires interpretation through the creation of a stack.
Fig. 1 shows some of the findings of the study. In this figure, 'Self' means that pupils created the HyperCard feature by themselves; 'Help' means that they created that feature with some help from other classmates or their teacher; 'No' means that they did nothing with that feature. The figure shows that the majority of the pupils created buttons, graphics and scanned pictures by themselves. Many pupils also created sounds and visual effects by themselves. Some of them created links and fields by themselves.

The majority of pupils enjoyed working with HyperCard in groups although the work was hard because of its technical competence. Concerning the distribution of work, all pupils worked taking turns most of the time. Mutual help among them was observed. Additionally, teachers' strategies were pupils' monitoring, pupils' encouragement, being a facilitator/guide for learning and for group work.

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LEARNING IN SCIENCE CENTRES AND SCIENCE MUSEUMS: A REVIEW OF RECENT STUDIES

Terry McClafferty & Léonie Rennie
Curtin University of Technology

RESEARCH NOTE

School visits to science education centres and science museums (SECSM) often result in children armed with worksheets rallying from exhibit to exhibit in a search for knowledge. Is it assumed that learning occurs. Does it? Investigations into cognitive, affective and psychomotor learning in these settings have resulted in a variety of conclusions. A review of recent studies in the science education centre and science museum settings that investigates student or visitor change in science content knowledge or attitudes towards science has been compiled from a wide range of literature. The rapid growth of SECSM and their impact in promotion of science to the public has resulted in more science education researchers devoting research to this important setting outside of the classroom or school science laboratory. Many teachers utilise the resources of SECSM in their teaching with class visits to SECSM. These field trips are enjoyed by many children who attempt to engage with as many exhibits and activities as possible, with some children rallying from exhibit to exhibit. Education researchers have used a variety of instruments and methods to investigate students' or visitors' change in science content knowledge or attitudes towards science. From a comprehensive review of literature research, a number of studies (n=39) have been identified which are concerned with cognitive, affective and psychomotor learning. The studies have been classified into groups according to the method of research technique and the specific purpose of the research. These categories are: (a) cognition studies, (b) group interactions, also referred to as child-adult interactions; (c) impact of SECSM on school groups, (d) impact of SECSM on docents, (e) impact of SECSM on visitors, and (f) evaluation studies. Each paper has its results summarised and the research procedure is described and discussed.

The purpose of the review was to gain insight into the techniques of the researchers who investigate children's learning in the informal education setting of SECSM. Many of the studies reported are published in journals, monographs and limited circulation periodicals not associated with education or science education. These obscure publications include museum journals, visitor studies journals, monographs and restricted publications of science museums, science education centres, science and technology centre associations, museum associations and visitor study associations. In addition, a small group of research studies are undertaken as private reports to fulfil the requirements of government audit guidelines for museum performance and are not published. This review and classification would be of use for science education research in SECSM of Australia. Some of the articles are available from Australian SECSM library collections. A wide range of methods are reported and the findings of the studies show a range of differing outcomes for children and adults who visit SECSM.

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STUDENTS’ AND TEACHERS’ EXPLANATIONS OF CHEMICAL EQUILIBRIUM

Janice M. Wilson
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RESEARCH NOTE

This research note reports on a preliminary exploration of the verbal explanatory frameworks provided by teachers as the bases for instructional units on the topic of chemical equilibrium. This pilot analysis seeks to describe and explore qualitatively (i) the language and types of explanations used by teachers during sequences of lessons and (ii) the types of responses given by students to structured hypothetical questions in one-to-one interviews. The words and phrases inherent in the explanations used by teachers and students in the initial analysis are currently being used as the basis for a computer-aided content analysis of a larger sample of 54 verbatim lesson transcripts.

Method

Six Senior Chemistry teachers and their students from four independent schools in Brisbane were voluntary participants in this study. Complete three-week sequences of lessons on the topic of chemical equilibrium were audiotaped and verbatim transcripts prepared. Seventeen students of varying achievement levels from three of the schools were nominated by their teachers and agreed to be interviewed about their understanding of chemical equilibrium. Thus, two data sources have been examined to date: 27 verbatim lesson transcripts obtained from three classrooms during the teaching of a unit and 17 transcripts of individual structured interviews with students.

Types of explanations

Ten types of teacher explanations were identified by Dagher and Cossman (1992) and these have been used to categorise explanatory episodes in the lesson transcripts. The following quotes drawn from the text of the transcripts illustrate the four most frequently used explanation types.

Let us see what we can deduce from our observations? Let us look at the equation for the formation of the complex (FeI(SCN))^{2+}. Look at the first step of this experiment — we can identify the colours of this species......... (Rational)

You can explain Le Chatelier’s Principle if you use the collision theory, that if you have more of those to collide with these, therefore the collisions between hydrogen ions and acetate ions will occur more readily, more frequently. (Mechanical)

So the Fe^{3+}, because it has gone up, will try to reduce it and the only way it can is by combining the thiocyanate ion and moving it in the direction of this red complex. (Anthropomorphic).

If you dropped the temperature, that is like taking heat away from this, the reaction will shift in the direction in order to regain equilibrium. (Teleological).
Variation between three teachers

Examination of the language used by three teachers (identified by pseudonym) revealed marked individual differences in the frequencies with which they gave rational, mechanical, anthropomorphic and teleological explanations. As well, the frequencies of particular types of explanations varied with the focal activity in the lessons.

In the transcripts examined, Kevin gave mostly mechanical explanations and referred to theory in the textbook as the basis for those explanations. Discussion of demonstrations was oriented to confirmation of theory rather than deduction from observation. Embedded within nearly all his references to shifts in equilibrium position and to Le Chatelier’s Principle was anthropomorphic language, e.g. the system "tries to get back to equilibrium."

William emphasised the development of rational and mechanical explanations at the molecular level. Students were encouraged to make deductions from observations and to derive theory from experiment. He cautioned students against using anthropomorphism and frequently asked students to rephrase anthropomorphic statements or questions with implicitly mechanical language that referred to collision theory.

In Kerry’s classroom the distribution of different types of explanations was apparently influenced by the context of the lesson, with considerable emphasis placed on the derivation of theory from observation. Much of the theory of the unit was developed through teacher/student discussion of observations made during demonstrations and laboratory exercises. Rational and mechanical explanations were predominant throughout the sixteen lessons. Anthropomorphic and teleological explanations were given infrequently and those occurred in lessons in which previously completed exercises and problems were being discussed.

Students’ explanations

Transcripts of structured interviews with seventeen students from four classes also revealed variation in type. An interview protocol was designed in which initial questions established that an equilibrium reaction \((2X + Y \rightleftharpoons 2XY)\) was taking place in a closed vessel. Students were asked to predict changes in the direction of the reaction with addition of reactants or product and then to explain the basis for their prediction. If the student’s response to the question was unclear the interviewer prompted the student with a series of remarks which escalated in degree of directiveness, e.g. "Could you explain that?" or "Could you give me more details?" through to "Could you explain what is happening at the molecular level?" and finally "What would happen to the probability of collisions between particles?"

There was a noticeable tendency for students to change the type of explanation with interviewer prompts from initial anthropomorphism to a mechanical response. After prompting, many students gave mechanical explanations, but initially tended to use anthropomorphism or teleology as a convenient "chemical colloquialism," e.g.

Student: Umm, they’re doing it, in order to reach equilibrium because it’s out of proportion if more of something is added. (Teleological).
Interviewer: When more of something is added, what does it do to the relationships between the atoms and molecules?
Student: How do you mean?
Interviewer: Well, if you add more X, does it change anything?
Student: Um, yes. There’s a higher probability of collisions between X and Y and therefore the forward reaction happening. (Mechanical).
Summary and Implications

The initial analysis of the lesson transcripts of three teachers has revealed that the balance of types of explanations differed between individual teachers. Within the classrooms of individual teachers, explanations also varied with the task that was the focus of the lesson. In the structured interviews, types of students' explanations varied with prompts by the interviewer. The distribution of types of explanation differs from that reported by Dagher and Cossman (1992).

Given the claim (Gabel, Sherwood & Enochs, 1984; Gabel, Samuel & Hunn, 1987) that ability to conceptualise at the molecular level is a key element in problem solving in chemistry, it will be important to investigate fully the influence of the language of explanation on the construction by students of their own personal models. For students who have acquired an explanatory framework consistent with the scientific view, and who are able to explain phenomena and events at the molecular level in terms of collision theory, the use of convenient phrases with implicit anthropomorphism such as "it will want to go the other way," may be a convenient shorthand. Whether the use of such language (with and by students holding partial or naïve models) constrains the construction of more functional models is open to future investigation.

REFERENCES


AUTHOR

Dr Jan Wilson, Lecturer, Faculty of Education, Griffith University, Nathan, Queensland, 4111. Specializations: cognitive processes in science learning and teaching.
GIRLS, BOYS AND CONCEPTUAL PHYSICS: HOW SENIOR SECONDARY STUDENTS HAVE RESPONDED TO A CONCEPTUAL PHYSICS COURSE

J.A. Woolnough
Dickson College

ABSTRACT

This paper presents an evaluation of the Physics course at Dickson College (ACT). It highlights students’ expectations before the course, and their impressions and feelings during the course. This is the second evaluation carried out as part of a long term study of student attitudes before and after the introduction of a more ‘conceptual’ approach to the teaching of physics at this college. Overall, this approach has produced a more positive attitude in all students, but more significantly in girls.

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After 1 January 1995, all correspondence about this publication, including subscriptions and orders for back issues, should be sent to the incoming Editor, Dr. Cam McRobbie, Centre for Mathematics and Science Education, Queensland University of Technology, Locked Bag 2, Red Hill, Queensland 4059.
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SUPPLEMENT

The Book of Genesis and the Chronicles of the People of ASERA. (After-dinner speech at the 1994 ASERA Conference)
EDITORIAL COMMENTS

This is a year of celebration for all of us who are involved in science education research in Australia and New Zealand. We have already held our 25th ASERA conference; next year, in May 1995, we could celebrate the 25th anniversary of the foundation of ASERA (except that we now meet in July); and the next issue of Research in Science Education will be Volume 25. Readers may be a little puzzled at first over why all of these twenty-fives don't happen simultaneously. The reasons are partly semantic and partly historical. In everyday usage, a 25th anniversary occurs 25 years after the event, so that a couple married in 1970 will celebrate their 25th anniversary in 1995. Conferences, however, begin to be enumerated right from the start, so that ASERA's 25th conference occurred 24 years after it was founded.

As for the numbering of RISE, that is due to the fact that the first conference did not result in any publications: it was primarily a meeting of like-minded people who came to Monash, as a result of an invitation issued by Peter Fensham, to explore the possibility of creating a national science education research organisation. The first publication, called Research 1971, appeared after the second conference, held in Sydney; Dick Tisher was the founding editor. Two years later, the name changed to Science Education Research 1973. However, someone undoubtedly recognised the problem of a journal title that alters its name each year, and so in 1974, with Volume 4, the present title was adopted.

The 25th conference, the second to be held in Hobart, was a marvellous affair. Brian Jones and Max Walsh, with the backing of a professional conference company, did a superb job. (It may be a sign of my advancing age, but I found the comforts of a hotel to be a pleasant contrast to the rather Spartan living conditions in one of the University of Tasmania's student colleges that we encountered at our previous conference in 1981.) ASERA participation keeps rising: this time almost 150 people came, not just from Australia and New Zealand, but from Singapore, Hong Kong, the Philippines, Fiji, South Africa and England as well. Three of the participants had also been present at the founding of ASERA: Peter Fensham (now retired from his chair at Monash but as active as ever); Dick White (described in Research 1971 as ASERA's "administrative assistant" and now Dean of Education at Monash) and myself. Ninety papers — a record number — were presented, and 72 of these, another record, were submitted for publication. (Unfortunately, the RISE budget does not stretch to cover the cost of publishing a 700-page journal, and we have had to be selective.)

This issue of RISE is the sixth that I have edited, and it will be my last. It is perhaps an appropriate time to reflect on the many changes that have taken place in the journal since Research 1971 first appeared 23 years ago. I have all of the issues on my shelf. The most immediately obvious change is in the external appearance: from a paper-covered, stapled booklet, through the red-covered editions, to our present format. The size has grown through the years: from eleven papers in 1971 to more than forty in recent years, from 146 pages to around 400. The technology of production has changed: manuscripts and electric typewriters have given way to word-processing, floppy disk versions, and laser printers. And in what is perhaps a portent of the future, the final version of Marilyn Fleer and Tim Hardy's paper was sent to me by email. The process of unscrambling the BinHex code, reading it into a Word for Windows file, and converting it to WordPerfect was completed within five minutes of its transmission from Canberra.
But these are mere technical details. The most significant changes are associated with the contributors and their contributions: who they are, and what they are writing about. The first ASERA contributors were frequently former secondary school teachers who had found new positions in the rapidly expanding university sector of the 1960s. The make-up of ASERA in the 1990s is very different. Federal funding of the tertiary sector in the 1970s, and the Dawkins amalgamation initiatives in the late 1980s, have resulted in a much wider range of people becoming involved in educational research activities. RISE papers now encompass science education research conducted in kindergartens, in primary schools, in secondary schools, in university undergraduate science courses, in initial and in-service teacher education, and in the wider, public world of hospitals, farms and museums. The journal is much the richer for it.

Editorial procedures have changed, too, as we have evolved into a proper journal. Dick Tisher's first effort in 1971 was essentially a one-man-show. The 1977 conference in Wagga Wagga saw the establishment of a small editorial board; for more than a decade, editorial boards acted informally, to provide advice to the editor about whether or not to accept a paper. The Perth conference in 1990 carried a policy decision: all papers were to be reviewed, independently, by two referees. In a development that reflects ASERA's strong commitment to democracy and co-operative endeavour, the Review Panel — now numbering ninety — contains a sizeable proportion of the ASERA membership. If a few of the names on the list (pp. viii - ix) appear unfamiliar, that is because I occasionally go outside ASERA to obtain the judgments of academics with particular expertise in subject-matter fields or research methods not always available within the organisation. This is an appropriate place to record my thanks to all of them for their competent, constructive and prompt reviews. At the same time, I want to acknowledge the considerable help during the past five years of the various deputy editors and of the office staff at Monash.

The next volume of RISE will reflect another major change in the evolution of this journal. In Perth in 1990, we first raised the possibility of publishing RISE as a conventional journal, with several issues per year, and not restricted to contributions from conference participants. That idea was adopted in Lismore in 1993, and Cam McRobbie at Queensland University of Technology offered to return to the editorship of the new expanded journal. (I say 'return', because Cam served as editor once before, in 1978, during a period in the late 1970s in which the journal was edited by someone from the city where the conference was held.) To prepare for his second coming, Cam has been assembling contributions throughout the past year, and Volume 25 Number 1 should appear early in 1995. Right now, Cam may not know what he has let himself in for, but he is certainly going to find out rather soon. This is an appropriate time to wish Cam, ASERA and the new RISE enterprise every success. Please give it your support.

Monash University
December 1994

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Hard copies only are required for submission to the ASERA conference organisers. Setting out can be in the same format as required for publication, or in some other format if you prefer.

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Papers submitted to the editor for publication in RISE should be on disk, with three hard copies. See Word Processing and Setting Out below. Papers should be submitted as early as possible within the four weeks following the conference.

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N.B. It is the primary responsibility of authors to ensure that copy has been thoroughly proof read. Please ensure that typographical errors have been corrected, and that there is agreement between the references in the text and the final reference list.

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A LEARNING MODEL FOR SCIENCE EDUCATION

Mary Smith & John A. Smith
University of Central Australia Alice Springs College

Abstract Include an abstract of between 100-200 words, headed ABSTRACT (centred), immediately following the title; the whole abstract should be indented.

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(x)
Indented dot points: Use asterisks, not letters, numbers, or dots to mark indented dot points, e.g. The project involved
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DR MARY SMITH, Senior Lecturer, Faculty of Education, University of Central Australia, Alice Springs, NT 0870. Specializations: biotechnology curriculum development, biology teacher education.

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ABSTRACTS AND RESEARCH NOTES

THE STRATEGIC TEACHING FRAMEWORK: THE USE OF MULTIMEDIA IN TEACHER EDUCATION

Lynda J. Creedy
University of New England

RESEARCH NOTE

Multimedia in teacher education

A major concern of teacher educators is to provide student teachers with teaching experiences and to encourage them to teach thoughtfully and to reflect upon the consequences of their teaching practices. Ideally, students should experience different classroom practices, different teachers and classrooms. These ideals are difficult to reach in the face of limited budgets for school experience visits. Time constraints on the supervising classroom teacher can limit the amount of time spent in reflection with the student. It was with these concerns in mind and a consideration of the characteristics of teaching that members of the Centre for Research into Educational Applications of Multimedia (CREAM) began to develop a hypermedia learning system based on the Strategic Teaching Framework.

Titled Teaching in Context, the STF is a multimedia program integrating video coverage of an exemplary teacher covering an integrated Science and Technology unit, audio commentary, and a data base of relevant theoretical concepts which are exemplified on the video or discussed in the audio comments. The concept is based on the Strategic Teaching Framework (STF) which was developed by Indiana University together with the Central Regional Educational Laboratory in the U.S.A. (Fishman & Duffy, 1992)

The STF relies heavily on video footage of the classroom under study. The video shows an integrated program at work in a ‘family group’ class. The model of this STF is that of a student being apprenticed to a teacher. The mentor teacher models the teaching behaviours for the student user of the system AND reflects on their own behaviour. The mentor teacher provides a model not for the purpose of being imitated, but to provide a basis for the student to analyse the instructional strategies. Included in the STF is a ‘forum’ feature. Users can contribute to the STF by typing in their thoughts as they work through the hypercard stack. Students can read what others have written, return and examine their own thoughts when having first viewed the STF. At any time during the viewing of the Quicktime movie of the classroom, the student may listen to the mentor teacher speak about what is going on, listen a selection of experts as they give their points of view when observing the class, search the database for information relevant to the particular segment being viewed or read or insert forum comments.

Students can watch the classroom in operation as a whole; and/or focus on the various themes which can be followed through the video clips and data base. Themes such as teaching strategies, classroom management, cooperative learning, activities, etc. Progress through the STF becomes the student’s personal journey; the learner has direct control of the display of video, audio, data base, etc., increasing student ownership for the process of learning and supporting the learner’s focus (goals). Because of this, it is essential in creating a resource as information-rich as the STF that students can ‘navigate’ easily and find the information they need quickly. This was a prime consideration in the organisation and layout of the STF.
Organisation

The unit covered in the STF is broken down into segments corresponding to lessons or parts of lessons during the unit. These lessons are accessed through a system of hierarchical menus. The student can proceed through these segments sequentially or focus on selected segments. The student may also view the unit by following selected themes through the STF. At all times from any card in the stack, the student may access the lesson overview, student forum, data base, teacher’s comments and expert teachers and researchers comments, or return to the lesson or theme menus.

Conclusion

Teaching needs to be studied in context, as a whole. This approach would require the student to spend much time in classrooms and in reflection. The STF is a learning environment which while not replacing actual teaching experience, can support that experience and allow students to maximise the benefit of the time they do have in the classroom. Students can learn about instructional strategies in a classroom context, tapping into an experienced teacher’s knowledge and experience. The motivation for creating the STF was not to ‘teach’ the students the ‘correct’ strategies to use in the classroom, but to support them in constructing and testing their own understanding of the instructional strategies in a classroom context.

The next phase of the project will be trials of the STF with pre-service primary teaching students. A copy of the prototype will be installed at Newling Primary School so that the teachers there can become familiar with the project and offer comment. After this exposure to the concept, a survey will be conducted to determine the structure and content of an STF which would support in-service training.

REFERENCE


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Research in Science Education, 1994, 24, 368-369

DETERMINANTS OF THE COMPETENCE AND CONFIDENCE OF TEACHER EDUCATION STUDENTS STUDYING PRIMARY SCIENCE EDUCATION

Ian Farnsworth & Bruce Jeans
Deakin University

RESEARCH NOTE

This study investigated the views of primary teacher education about their secondary science experiences and science and science education generally. The students were all beginning certain science education units. It was considered that the perceptions students have at this stage could contribute to their success (or lack of success) in the science education units and in their implementation of school science in later years. The sample consisted of 148 students of whom 108 were female. Most students had taken some science through secondary school and a few had taken some post-secondary science. The questionnaire used contained items covering secondary experiences, interest in science, views about scientists or science, and views about primary science education. The students were also asked about their expectations of the unit which they were about to take.

RESULTS

Secondary science experiences

Most students reported either no change, or an increase in, interest in science during secondary studies. They were most interested in biology and environmental science and least interested in physics and chemistry. Most could remember some topics in a positive way and these topics were often from biology (particularly genetics), environmental science and astronomy. About one-third of the students remembered at least one science teacher considered to be 'excellent' and most considered their teachers to be adequate. About one-half of the sample had taken Biology in year 12 and one-quarter had taken Chemistry. Other subjects were taken in smaller proportions (probably because of low interest and variations in school offerings).

Views about science and scientists

The wider interest in science reported appeared to quite high (mean 6.8 on a scale from 0 to 10) and students indicated strong agreement with the proposition that science is important for world progress. There was more diversity of views about the value of science in controlling word population and about the complexity of science language. Some stereotypical views of scientists were evident (maleness, eccentricity, traditional equipment and clothing) but many students (at least 40) saw scientists as normal people (few knew a scientist personally). Some students noted that the questions about scientists encouraged stereotypical responses. This suggests a heightened awareness of the dangers of stereotyping.

Views about primary science

There was a strong view that science ought to be taught in primary schools (147 of the respondents believed this) and that science is important (mean value 8.6 on a scale from 0 to 10). Females supported this view even more strongly than males (difference significant at the 0.004 probability level).
The students were able to suggest several topics that they considered children would like to learn. About 64% chose at least one topic that could be considered to be environmental in content and 40% mentioned at least one biological topic. Other topics mentioned covered a wide range but physical science content was relatively uncommon (mentioned by 20%). When asked about the likely enjoyment of children in learning about chemistry, physics biology, earth science, environmental science and technology it was notable that the mean estimates given by respondents were quite uniform and high (6.5 - 7.6 on a scale from 0 to 10). These estimates did not correspond with the students’ reports of their own interests. There was also a belief that ‘mixed’ activities would be very enjoyable as would learning about things noticed in children’s lives outside school. Females were more positive than males in predicting enjoyment in all of these topics and some differences were statistically significant at the 0.05 level.

The respondents generally did not accept that males learn science better than females or that experiments or activities are too messy or that doing science is dangerous. While it was evident that most of them did not want to become specialist science teachers, it was clear that almost all were favourably disposed towards science teaching and this view was stronger than the authors might have expected.

Expectations of the unit about to be taken

The students from whom these views were sought were undertaking a variety of science or science education units and there was a range of expectations consistent with this. However the largest group of expectations were concerned with ‘How to teach primary science’ (28%) and others were related to environmental topics (24%), biological topics (25%), physical or earth science topics (13%). A number of students (13%) expected to improve their basic science knowledge and some also mentioned interest rejuvenation.

Conclusion

This study suggests that most students entering science or science education units in pre-service primary teacher education courses have a positive attitude to the teaching/learning of primary science and see value in all domains of science for children at this stage. This was an unexpected finding. It was of concern however, that their interest in physical science topics was so low. This may be due to previous specific experiences in secondary science. Science and science education units should build on the positive attitudes of students and could develop physical science ideas through their significance in environmental and social problems.

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PERSONAL CONSTRUCT PSYCHOLOGY AS A CONSTRUCTIVIST APPROACH TO LEARNING

Tony Fetherston
Edith Cowan University

ABSTRACT

This paper proposes that Kelly's Personal Construct Psychology deserves examination as a constructivist basis for science teaching and learning. It argues that because of the explicit nature of the psychology, the clear definition of learning and meaning and the integration of affective, psychomotor and cognitive dimensions of learning, the psychology has much to offer science education.

AUTHOR

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Research in Science Education, 1994, 24, 371-372

DETERMINING YOUNG ABORIGINAL CHILDREN’S SCIENTIFIC UNDERSTANDINGS:
A PILOT STUDY

Marilyn Fleer, Jane Sukroo & Tracey Faucett
University of Canberra

RESEARCH NOTE

Research into Aboriginal science, has questioned the Western orientation presently accepted
as the norm in science research (Watson & Chambers, 1989) and curriculum development
(Christie, 1991; Ritchie & Kane, 1990) and begins to explore how scientific knowledge is
constructed in Aboriginal communities. However, most of the literature available is
predominantly anecdotal (ERIC search, 1985-1993).

With the release of the National Curriculum Statements and Profiles more needs to be
understood about the cross-cultural nature of young Aboriginal children’s scientific
understandings. Consequently, it was decided to develop a pilot study which would
systematically examine the overall design, and closely scrutinise the instruments developed for
their ability to research young Aboriginal children’s understandings in science.

DEVELOPING THE RESEARCH INSTRUMENTS

The study focused upon 10 four and five year olds in a preschool context and 15 six to eight
year olds in a school context. It was decided to concentrate only upon rural Aboriginal
children. The specific areas investigated included:
• the sun and its place in the solar system - under the strand of Earth and Space,
• materials: their properties and uses - under the strand of Natural and Processed
  Materials;
• light - under the strand of Energy and Change; and
• intuitive taxonomies of their living environment - under the strand of Life and Living.

Cross-cultural factors were considered in the development and use of research instruments.

Day and Night: Earth and Space
Since the sample of young Aboriginal children was drawn from country preschools and
schools, an artificial environment had to be created. It was decided to set up an area within
the school or preschool that could be darkened, so as to simulate night. Black plastic with
luminous stars in the configuration of the night sky was hung above the heads of the
interviewer and interviewee in the darkened room. As part of this context, a campfire scene
was simulated. Within this context a story about night and day, involving a family going
camping in the bush was read to the children. This was followed by the opportunity for
children answer a series of questions which would reveal their understandings of night and
day and share the stories they knew about night and day.

Materials-Their Properties and Uses: Natural and Processed Materials
The camping theme was continued in the second set of interviews on natural and processed
materials. An additional story book was made as the main instrument for eliciting Aboriginal
children’s understandings of natural and processed materials. This story focused on the
materials that were needed in order to go camping, the setting up of the camp site, followed
by a storm which destroyed all the materials and equipment. This story set the scene to talk
to children about which natural materials available in the bush could be used for setting up
their camp.
Light: Energy and Change

The third set of interviews also made use of the camp scene. The darkened environment was utilised for finding out children's understandings of light. In this interview, each child was invited into the camp scene and on settling, the lights were turned off. The child was asked "What has happened?" "What can you see?". The child was then asked a series of questions in order to determine their understandings.

Intuitive Taxonomies: Life and Living

The instrument used to elicit children's understandings in this area was essentially a meter square laminated sheet where major topographical features of the area familiar to the children were drawn upon. Plastic animals and wooden blocks were provided in addition to a range of three centimetre square laminated pictures of a variety of animals, plants, and processed materials such as a tin can. Children freely drew and placed items all over the base sheet. On completion, children were asked to talk about what they had done and why they had chosen to place certain items together. Children were also asked to put the items on the base sheet into groups in a further attempt to find out how they were classifying things.

CONCLUSION

The pilot study provided a range of useful data for analysis. In all areas except the children's recall of traditional stories, richly contextualized data was collected. It was felt that the children's young age and not the questions themselves about traditional stories was the limiting factor. The age factor variable is yet to be examined closely. Children older than eight will be interviewed using the story book on night and day to determine if it will successfully reveal any traditional stories they know, and this data will be analysed to see if the stories influence their scientific understandings of night and day. Overall the study aimed to develop a research design and instruments that would readily tap into young Aboriginal children's scientific understandings in a relevant and cross-culturally sensitive way. The richness of the data collected would indicate that this aim has been met. The next step will be to determine the significance of the data collected and whether data should be collected from a larger sample of young Aboriginal children in each of the community contexts described by the NAEC (1985): Traditional, Rural, Urban Dispersed and Urban.

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AUTHORS

DR MARILYN FLEER, JANE SUKROO and TRACEY FAUCETT, Faculty of Education, University of Canberra, Belconnen ACT 2616. *Specializations:* early childhood science education.
IMPLEMENTATION OF SCIENCE AND TECHNOLOGY K-6 IN RIVERINA SCHOOLS

Rod Francis
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RESEARCH NOTE

The NSW Science and Technology syllabus was released for implementation in primary schools in 1991. The combination of science and technology in one syllabus created a very different key learning area, in a part of the curriculum which many reports have shown teachers already lack confidence in both content and teaching approaches. Within the Riverina region of NSW, the author, together with the regional science consultant, developed a five module training package (completed by every school) and a range of courses available throughout the region as a total implementation plan. Key aspects of the plan included:

* courses of an extended time as 2 or 3 phased programs to allow for input-action-sharing-reflections sequences. This provided all teachers in the region with a minimum of 10 hrs and up to 18 hrs of formal professional development
* courses having significant hands-on components and dealing with the materials in a modelling way
* a system of facilitators to deliver the training package, which created a group of contact people for teachers and a network of people for the consultant to work through
* programs were usually run in a school setting by teachers or a consultant
* identifying both content and methodology as key areas for development
* support by a consultant for three years
* some accreditation into a University subject

This approach was used because most studies have shown that extended periods of reflection and sharing of ideas is most likely to have an effect on implementing a new syllabus. The program with all its facets operated during the period 1991-93. In 1993 the regional office employed the author to evaluate the implementation of the syllabus by teachers. This was done through the use of a survey sent to 30 schools in the region and asking for three teachers, over the range K-6, to fill out the survey.

RESULTS

The survey provided, amongst other things, the percentage of teachers who indicated they had a fair amount or a lot of confidence in the six content strands of the syllabus and the three key processes. These results are shown below. The figures in parentheses are from a similar study by Skamp (1991) of teachers in the NSW North Coast region.

<table>
<thead>
<tr>
<th>Syllabus Components</th>
<th>% Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information &amp; Communication</td>
<td>63 (55)</td>
</tr>
<tr>
<td>Built Environment</td>
<td>62 (52)</td>
</tr>
<tr>
<td>Living Things</td>
<td>90 (87.5)</td>
</tr>
<tr>
<td>Products &amp; Services</td>
<td>57 (49)</td>
</tr>
<tr>
<td>Natural Phenomena</td>
<td>82 (62.5)</td>
</tr>
<tr>
<td>Earth &amp; Surroundings</td>
<td>88 (85)</td>
</tr>
<tr>
<td>Investigating Process</td>
<td>55 (70)</td>
</tr>
<tr>
<td>Design &amp; Make Process</td>
<td>47 (42.5)</td>
</tr>
<tr>
<td>Using Technology Process</td>
<td>34 (45)</td>
</tr>
</tbody>
</table>

In comparison with data collected from teachers in other regions in NSW at the time the syllabus was released (Skamp, 1991; Ferry, Harper & Wilson, 1993), Riverina teachers had showed a significant shift in their content confidence. Confidence in using the processes,
particularly those associated with technology, failed to show any gains. Other results from the survey found the following:

* teachers found the new syllabus document useful, clear and appropriate;
* teachers found the implementation package a useful professional development activity in terms of its content and structure;
* the Riverina implementation plan led to an increase in confidence of teachers in the content areas, all teachers surveyed were teaching from the syllabus and they were spending more time teaching it;
* there was not a significant shift in confidence about teaching the 3 key processes
* it was evident that teaching practices and management structures appropriate for teaching the philosophy of their syllabus were not being employed.

**DISCUSSION**

There was evidence in the evaluation that Riverina teachers had made positive shifts in what they were teaching (declarative knowledge). However, when teachers are asked to implement a new curriculum, they are expected to change how they teach (procedural knowledge). Despite considerable emphasis in this area in the professional development programs, the evidence showed that teachers had not gained significant confidence in teaching the key processes, the area of teaching related to how they teach. This supports others (Wallace & Louden, 1992) who had indicated that the fundamental problem with primary teachers and science and technology teaching is not really about content confidence, as constantly reported in the literature, but with expectations about how it is taught and the conflict this has with their existing routines and management structures. Non adoption of new practices has been shown to be a rational process (Vanclay, 1994). It is argued that the logic and message of the change is rationally processed, weighed up in terms of other imperatives (time, other curriculum areas, administration, control, self esteem) and either consciously not taken up, or interpreted and converted into a more familiar pattern.

The key implication of this evaluation is that, if we want to change how teachers teach in any future curriculum implementation programs, more account of within school and within classroom support needs to be put in place. Such support in the workplace should draw on a workplace learning model (NBEET, 1994), in addition to any system wide external support programs.

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**AUTHOR**

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Research in Science Education, 1994, 24, 375

ASSESSMENT IN THE SCIENCE CLASSROOM.

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University of Waikato

ABSTRACT

This paper reports on research into two teachers’ views and practices about assessment at the classroom level. Emphasis was given to practical work and its assessment. Findings suggest it is unhelpful to define practical work as distinct from other activities in the science classroom. Various methods used for assessing activity within the participant teachers’ classrooms are described. The participant teachers were found to be primarily concerned about issues of ‘fairness’: task validity, reliability of assessment based on co-operative work and assessment of the affective domain. The place of teacher intuition in assessment is raised and briefly discussed. Directions for the ongoing research are foreshadowed.

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ALLAN HARVEY, Tutor, Centre for Science and Mathematics Education Research, University of Waikato, Hamilton, New Zealand. Specializations: science education, technology education, assessment and curriculum development.
In the 1950s and 1960s the general model of science education was based on enquiry, greatly reinforced by people like Schwab (1962). The treatment of science as enquiry was a means to clarify and illuminate scientific knowledge. This meant there was a body of knowledge to be learned and basically this could be done through enquiry, by making careful observations and generalising to form laws and theories. Dissatisfaction with this method was noted by some workers as some want fraudulent, since it painted a picture that real discoveries were being made by the school students in science (Winchester, 1989). The influence of Popper and hypothetico-deductive reasoning was an event which changed the way scientists viewed scientific method. This has also made untenable some of the central assumptions of the teaching of science as enquiry (Matthews, 1989) or as inductive based learning.

Hypothetico-deductive scientific method

The acknowledgment of the problem of induction by Hume (1939 in Chalmers, 1978) was further discussed by Popper (1968) who advocated the hypothetico-deductive method. The hypothetico-deductive model (Fig. 1) represents that for any particular series of observations that one has made, there will be usually more than one model or explanation. Thus some procedure is necessary to distinguish among various often contradictory alternative explanations. Only when the alternatives have been subjected to critical examination leading to the failure of some will the remaining ones be seen as possible valid explanations. There are, almost invariably, competing explanations that could explain the observation (Chamberlain, 1890/1965). The falsificationist procedure is advocated to distinguish among them to eliminate the model which is false. The procedure advocated is to use each explanation as a starting basis for the construction of an hypothesis or prediction. Having arrived at the hypothesis it is necessary to subject it to a test. Because of the ease of disproving something, instead of testing the hypothesis an alternative null hypothesis is created. Rejection of the null hypothesis gives support to the original explanation.

Fig. 1 Hypothetico-deductive method (Underwood, 1991)
Alternatively, support of the null hypothesis leads to the rejection of the explanation (Underwood, 1991). In the hypothetico-deductive model it does not follow that the model which has not yet been rejected is the correct model, only that it is still one of the possible valid models. It does however mean that an explanation can be tested and refined to become more complex. The end-point the scientist reaches using a hypothetico-deductive method is a supported explanation which describes a pattern; this explanation or model is the 'survivor', the result of rigorous testing and the best conceptions the scientist has, but this 'best conception' will be a 'misconception' in time. Students who arrive at the presently held scientists view do not have a misconception, as defined in the scientific education literature. Those students who do not arrive at the scientists view have a misconception. One part of the process of science is that science knowledge is dynamic (always a misconception). Failure to characterise scientific knowledge as tentative is an inaccuracy in science teachers and science educators work (Gallagher, 1991). One part of the process of science is that science knowledge is dynamic (always a misconception). Science educators need to portray science as temporary, but supported knowledge.

What is science at school?

Studies of classroom practice in the United States have presented science as revealed truth with emphasis placed on the body of knowledge, but with little presentation of how science is formulated or validated (Gallagher, 1991). My observations are that the language and terminology (e.g. verify, conclude, prove etc.) used in "practicals" largely reflects the inductive view of science. Students are rarely asked to reject a null hypothesis to give support to a hypothesis and thus an explanation. One explanation of this is that teachers view science as inductive. My research is on the testing of this explanation in New South Wales secondary schools.

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AUTHOR

DR PAULINE ROSS, Lecturer, School of Education, Macquarie University, North Ryde, NSW 2109. Specializations: experimental ecology, environmental education, philosophy of science.
THE EFFECT OF INTERVENTION STRATEGIES ON CREATIVE THINKING
SKILLS OF PRE-SERVICE TEACHERS.

Roy Skinner, William Foulds & Judith Cousins
Edith Cowan University

RESEARCH NOTE

Creativity
Science education has not traditionally fostered creativity yet it lends itself to imaginative problem-solving and inquiry. This research note presents the results of a study where a group of pre-service teachers were exposed to creative thinking strategies within their normal science education course. Preliminary findings from this research indicate the value of these creative thinking strategies in improving self-concept, verbal fluency and originality of ideas. The development of creativity is valued as a broad educational goal yet little appears to be done in tertiary courses to specifically develop creative thought patterns in our trainee teachers. School science and technology curricula have the potential to develop and utilise creative and critical thinking. However, many would question the effectiveness of cognitive skills development in science at the moment. Williams (1972) defines creative thinking behaviours as fluency (the ability to generate many ideas), flexibility (the ability to generate different classes of ideas), elaboration (the ability to build on existing ideas) and originality (the ability to generate novel ideas). In addition, he also proposes important feeling behaviours necessary for the efficient production of creative thought as risk taking (willingness to move to unknown regions), curiosity (willingness to explore), imagination (willingness to think of what might be) and complexity (willingness to take on a challenge). These characteristic creative thinking and feeling behaviours form the basis of the many tests developed to identify and measure creativity (Wakefield, 1991). For this study three such tests were used to see if the creative thinking strategies incorporated into the course were able to increase he measured creativity of the experimental group. The three tests used were the TCT-DP drawing test (Urban & Jellen, 1966), the IOWA Creative Thinking Assessment Model (Yager, 1991), and the Creativity Inventory (Williams, 1972).

Methods and results
A cohort of first year pre-service primary teachers was pre-tested and divided into an experimental and a control group, with all six classes receiving the same basic science education course for the semester. In addition, the experimental group also received instruction in the use of selected creative thinking strategies. In the last two weeks of the semester the three tests were administered again to the cohort as a post-test. The results of the t-test comparisons between the experimental (E, N=52) and control (C, N=49) groups for the three creativity measures are shown in Table 1.

Summary and discussion
For two of the three measures of creativity used in this research it can be seen that there were statistically significant gains made by the experimental group which are inferred to be a direct result of the creativity intervention strategies employed. For the IOWA test, the large increase in the numbers of Unique Responses (110%) supports the hypothesis that intervention strategies do enhance creativity. The findings for the third measure (TCT-DP) are not consistent with those of the other two measures: the gain in scores was small and not statistically significant, while the control group displayed a large and significant gain. In order to explain the unexpectedly large increase in TCT-DP scores by the Control group one would need to know how strong the influence of the 'Lecturer' variable was compared with the 'Intervention' variable. Appropriate classroom environments are also recognised as a key factor in producing creative behaviour (Walberg, 1987). At present this comparability is largely unknown. Creativity Inventory tests given to the lecturers, themselves, indicated that the
TABLE 1
SCORES OF EXPERIMENTAL AND CONTROL GROUP ON THREE TESTS

<table>
<thead>
<tr>
<th>TEST</th>
<th>GROUP</th>
<th>PRETEST</th>
<th>S.D.</th>
<th>POSTTEST</th>
<th>S.D.</th>
<th>PROB.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creativity Inventory</td>
<td>E</td>
<td>66.3</td>
<td>10.0</td>
<td>71.3</td>
<td>8.6</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>65.9</td>
<td>9.6</td>
<td>67.3</td>
<td>11.4</td>
<td>0.225</td>
</tr>
<tr>
<td>IOWA test, unique responses</td>
<td>E</td>
<td>1.00</td>
<td>1.3</td>
<td>2.10</td>
<td>2.5</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>1.28</td>
<td>1.8</td>
<td>1.77</td>
<td>1.9</td>
<td>0.090</td>
</tr>
<tr>
<td>TCT-DP</td>
<td>E</td>
<td>24.0</td>
<td>9.7</td>
<td>25.6</td>
<td>9.1</td>
<td>0.200</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>21.6</td>
<td>6.6</td>
<td>28.0</td>
<td>11.4</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

The lecturer for the Experimental group had a higher creative self concept than either of the two Control group lecturers. More is required than just creativity intervention strategies to enhance creative thought - students must feel that the class environment is such that they are allowed to be unconventional or to break rules or to express different opinions to the 'correct' scientific ones (Goodlad, 1984). The Control group lecturers, whilst not providing specific thinking skills training, seem to have established within their classrooms an ethos which encourages a higher self-concept in their students, although this was not clearly evident from the Creativity Inventory scores. Anecdotal evidence supports the notion that although creative thinking strategies were utilised within the Experimental group's classroom the lecturer was not prepared to break away from the more traditional rigour of science delivery. This seems to have given students conflicting messages about their freedom of expression and their feelings towards the subject of science seemingly reflected this in the picture-drawing test. It appears that it is possible to raise the levels of creativity through the use of creative thinking strategies. However, creativity interventions, by themselves, are not sufficient to enhance all aspects of creative thought without an accompanying conducive classroom environment.

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DR ROY SKINNER, Lecturer, Science Education, Edith Cowan University, Western Australia. Specializations: practical project work, technology education and creativity in science.

DR WILLIAM FOULDS, Senior Lecturer, Science Education, Edith Cowan University, Western Australia. Specializations: ecology, science skills and creativity in science.

MS JUDITH COUSINS, Lecturer, Science Education, Edith Cowan University, Western Australia. Specializations: primary science curriculum, technology education, early childhood education.
Research in Science Education, 1994, 24, 380-381

OBSERVATIONS FROM THE CLASSROOM: WHEN ANALOGIES GO WRONG!

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RESEARCH NOTE

Analogies and learning

Research, as well as teacher self-reports and anecdotal evidence, indicates that analogies have much potential to enhance learning. However, the use of analogies is fraught with difficulties when due consideration is not taken concerning the essential aspects that make up an analogy. To address this issue, we have been working with a cadre of teachers in Western Australian schools who are interested in improving their analogical teaching. In doing so, we have used two models, firstly a modified Teaching-with-Analogy model derived from the work of Glynn (1991) and secondly the FAR Guide to analogy teaching (FAR being an acronym for Focus, Action and Reflection as being the features that need attention when the analogy is being taught, Tregust, 1993). With or without these models to help enhance learning with analogies, we have observed teaching episodes where analogies simply did not work. In this note, we have illustrated how these analogies do go wrong. By focussing on those features where analogical instruction breaks down, it is possible to provide further guidance to science teachers about the careful use of analogies rather than simply dismissing them as a source to enhance learning.

Research on difficulties with analogies

The teaching-learning episodes described in this note come from more than 100 lessons. The episodes involve teachers' verbal explanations and use of textbooks related to some aspect of analogy instruction taught in general science in Years 8, 9 and 10, and chemistry, physics and biology in Years 11 and 12. We report several examples of episodes that were not as successful as intended by the teacher and have categorised them under five, non-exhaustive headings. Subsequently, analogies go wrong when:

1. Students attend to observed or imaginary functional attributes of a structural analog. For example, several Australian chemistry textbooks describe an analogy of a marble on the MCG to depict the nucleus of an atom. The key aspects of the analogy relate to the sharing of structural rather than functional attributes and the concrete analog attempts to describe an abstract science concept. Several students expressed their understanding of the atom in terms of the functions of imaginary attributes - the players - of the analog which were not part of the intended analogy.

2. Students lack familiarity with the analog concept. Analogs which are familiar to students are more likely to be fruitful in terms of enhancing conceptual understanding than those which are not. In situations where a suitable analog is not familiar to the students, explaining the analog may rectify a situation where analogies may otherwise go wrong.

3. Students and teacher hold an objectivist view of the nature of science. Analogies are best used in a classroom environment which teaches science not as true facts, but as theoretical interpretations subject to falsification. In this environment analogies are more likely to be seen as metacognitive tools with which students can make sense of the phenomena under discussion rather than exact representations of scientific facts.
4. Teachers are using analogies to teach concepts outside their area of expertise. Problems in the mapping of shared attributes between the analog and science concept and in the identification for the students of unshared attributes between analog and science concept seems most likely to occur when the teacher lacks a clear conceptualisation of the concept being presented.

5. Analogies lack sufficient conceptual depth. For example, when students mapped the bridge over a valley as analogous to a catalysed chemical reaction, one student commented that she knew that a catalyst provided a path for lower [activation] energy, but still did not know how the reaction worked. Clearly, in a search for a more conceptual understanding, possibly at a molecular level, this student found the analogy lacking conceptual depth.

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AUTHORS

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FIRST YEAR UNIVERSITY SCIENCE - REVISITED

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Flinders University

RESEARCH NOTE

Introduction

Not all new students come to university equally well prepared. The inherent difficulties associated with the transition to tertiary study may be further exacerbated when assumptions are made by the teaching staff as to the level of preparedness of their students. This is particularly the case for those students who have gained entrance to university Science courses by means other than the traditional route. Recent work has looked at the difficulties encountered by first-year students of Arts, Science, Law and Commerce. The results of the studies found that the problems most often experienced by the students, though numerous and diverse, can be classified into six broad categories: academic preparedness, academic progress, personal, family, financial and social. The present study is concerned only with the academic issues, though the other factors may also impinge on the issues in that area.

Methods

The aim of this study was to ascertain the problems faced by new students of Science when they first enter the tertiary system. What subjects do they find the most difficult? Which do they find the least difficult? What are the major problems that new students encounter when they first enter the university? The answers to some of these questions will help to formulate the role of my position in providing academic support. The second aspect of this study was to look at what strategies can be utilised to minimise the problems and possibly overcome them. The long term goal is to minimise the high first-year Science drop out rate and to allow each student progress through their chosen course in the minimum of time.

For the present study, two groups of commencing Science students were readily identifiable and were selected as being representative of first-year university Science students at Flinders University. The two groups are differentiated by their Science backgrounds which is evident by their choice of first year Science and Mathematics subjects. These two groups are labelled Groups A and B for convenience.

Group A consists of those choosing to study Science at university without the "traditional" high school Science and Mathematics background. It contains students who have recently matriculated (58%) but have not studied Science and Mathematics subjects. It also contains those students (42%) who have entered the university through mature entry schemes, through a foundation course or by means of a special entry scheme for non-matriculants. All group A students were enrolled in at least one of the introductory Science or Mathematics subjects.

Group B contains the traditional first-year Science students, having studied Science and Mathematics to Matriculation level.

The results were largely used to determine my own approach to providing academic assistance to the students. The results were also used to set in train strategies to enable teaching staff to teach their students more effectively and to enable the students to become more effective learners.
Summary

Compared to the other two South Australian universities, Flinders University attracts a greater proportion of undergraduate students who are older, who come from a wider range of educational backgrounds, who come from a lower socio-economic background and who may be less academically prepared to handle the tasks demanded of them. In the area of the Sciences these students are distinguishable from the more traditional first-year Science students though the problems they face have a degree of similarity. This cohort of students is generally attracted to the study of the Biological Sciences and have to some extent tended to avoid the study of subjects with a mathematical component. All commencing Science students however have difficulties adjusting to the new world of tertiary study. Some adapt readily but many do not. This is evident by the high failure rate and the withdrawal rate of many first year subjects. The high attrition rate of Science students is also evident in the low graduation rate figures derived from statistics kept by the university. This latter evidence suggests that less than half the students in the Sciences attain their degree in four years (1990 statistics). Much of this stems from problems encountered in the first years of a degree program.

Six key areas of difficulty are faced by commencing students at tertiary institutions in South Australia. Of these the two most directly related to this study are the issues of academic preparedness and academic progress.

This study has focussed only on the student centred problems and has not tackled the more vexed problem of tertiary teaching. As such it has concentrated on providing the students with some of the academic skills required to be successful tertiary students.

As a result of this study, and subsequent follow up work, the following list of strategies have been implemented by the author or are proposals for future implementation:

* a comprehensive academic orientation program for all commencing Science students which specifically addresses some of the concerns of students;
* a comprehensive handbook for commencing students outlining the essential skills necessary for a student to successfully study Science at a tertiary level;
* peer group study for students with difficulty in specific subjects or areas;
* close liaison between faculty teaching staff and academic advisers;
* targeting ‘at risk’ students or students with special needs as identified by teaching staff;
* a continual program of academic skills seminars taught within the mainstream discipline subjects as the need arises;
* close liaison between the secondary schools and the tertiary sector;
* bridging courses to bring students up to the required level, particularly in the area of mathematics.

AUTHOR

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SUPPLEMENT

THE BOOK OF GENESIS AND THE CHRONICLES OF THE PEOPLE OF ASERA*

Dearly beloved, we are gathered together in the sight of the Great Vice-Chancellor and all this company to celebrate this holy festival, for as it said in the Book of Genesis and Chronicles of the People of Asera, Ye shall assemble the people of Asera, even all the tribes, from the tribe of Curtin in the west to the tribe of Waikato in the east, and ye shall have a holy convocation, and ye shall eat, drink and be merry, and read the words of this book, all the days of your life.

Let us pray.

In the beginning, the Great Vice-Chancellor created the heaven and the earth. And the earth was void and without form, and darkness reigned upon the face of the deep. And so the Great Vice-Chancellor created greater lights called universities to rule by day, and lesser lights called CAEs to rule by night. And the Great One saw that it was good.

But the lands were empty and devoid of life. And so he created tutors and research assistants and Ph.D. students and other endangered species. There were northfields, and trees with appletons, and evolution occurred with missing linkes. And the Great One saw that it was very good.

But it was not good for these forms of life to dwell alone. And so the Great One took a rib from a tutor, a backbone from a research assistant, and a brain from a Ph.D. student, and created the first academic, whose name was Methusaleh. And Methusaleh lived for nine hundred and sixty nine years, and published nothing, and his tenure was revoked and he was given early retirement.

And the Great One caused a flood of knowledge to wash over the earth, and so he created an A.R.C., or ark, to protect his creatures.

And the Great One created linguistic confusion on the earth, a veritable tower of psychobabel. He caused the Romans to write from left to right, the Hebrews from right to left, the Chinese from top to bottom, and Peter Fensham all over the place.

[* Editor's note: This sermon was given at the annual dinner in Hobart by a theologically confused gentleman wearing a bishop's mitre, a cardinal's cloak and a rabbinical beard. He insisted that it be "circulated in the Chronicles to all the tribes of ASERA". I promptly rejected it as a paper, pointing out to him that it added absolutely nothing to the field of science education research, that it had not been reviewed, that his literature review was very skimpy, and that no references in APA format had been included. He threatened me with divine wrath. I then proposed to publish it, using his own language, "looseth leaffeth", but he refused to agree to this, citing the first Almighty Editor's precedent, which he considered quite unsatisfactory. We finally settled on this supplement, and he went off, muttering assorted fragments of Gregorian chants, the Hallelujah Chorus, psalms and Talmudic texts, not happy, but at least fairly calm. I never saw him again. P.L.G.]
But this Peter was a wise and gentle man, who knew both the science of chemical bonding and the art of human bonding. And the Great One said unto him, Go, remove thyself from the dungeons of Melbourne to the rockpile of Monash. For thou art Peter, and upon this rockpile I will build a great temple of science education, and the people of Asera will worship therein, and will be fruitful and multiply. And they will write many papers, and use up many trees, even all the cedars of Lebanon, yea, even all the trees of the Sahara Forest.

But know too that when thou leavest thy house, and goest abroad, thou shalt not walk upon water, but shall fly with wings, for as it is said, He who walketh upon water collecteth no frequent flyer points.

And the apostle Peter smiled upon his servant Lindsay the son of Mackay, and said unto him, Go thou and collect together the names of the children of Asera. And the Great Vice-Chancellor built a holy temple with a great machine, and Lindsay bowed in awe before it, and punched holy cards, and he sent his maidservants to carry the cards to the Temple, whereupon the machine growled and chewed up the cards and printed out the names of the children of Asera. And this list existeth to this day. And Peter called a meeting, saying, Come, let us reason together, so that the tribes of Monash and Macquarie and Queensland and Tasmania can unite together into a single nation, great, mighty and populous.

And the people came from far and wide, from the four corners of the earth, and had an annual holy convocation. And so began many years of wanderings of the people of Asera, from the centrally located, marvellously cosmopolitan city of Melbourne, that Garden of Eden, with its perfect climate, outstanding restaurants and sophisticated population, to all the other less endowed corners of the land. They wandered to the city of sin, where David, the Cohen, the High Priest of Macquarie dwelled. They wandered further north, to the Land of Cane, where there were cane-loads. They wandered to the mid-west, to a land where the Labor Party swallowed uppers when they were down, and the Liberal Party swallowed Downers to get up. They wandered further west, to a land of unamalgamated universities and amalgamated un-universities. They wandered to the islands of kiwi-fruit and sheep to the east, where the people ate fush and chups, sex times a week. And they even wandered to the island of Sodom and Gomorrah in the south. And the Great Vice-Chancellor commanded the people, saying, in the seventh month, in the second week of the month, assemble the people of Asera, for it shall be unto you a wholly satisfying convocation.

And there arose among the tribe of Queensland a prophet, a wise man, Richard the son of Tisher, who had a dream, and prophesied that the people of Asera would one day prepare annual Chronicles. For he said, what shall it profit a man that he speaketh, and his words are recorded not? What gain shall there be for a woman who writeth, yet scoreth no points in the Great Vice-Chancellor’s Quality Assurance Program? And he said, Publish it not in Gath nor in Ashkelon, but in Brisbane, and he offered himself before the people as their humble servant.

And the people of Asera listened to Tisher, and acclaimed him, and danced around him with great joy and wonderment, and proclaimed him Editor of the Chronicles. For as it is said, he who openeth up his mouth to volunteer soon wisheth that he had kept it shut. And yet the people of Asera were unsatisfied, for they cried out to him, Almighty Editor, write down your words of wisdom and we will sing them as a song of exultation, all the days of our life. And so Richard the son of Tisher sat for forty days and forty nights in his tent in the desert of St Lucia, neither eating, nor drinking nor playing golf, and thought about the trends in science education, and wrote down the words of the first Chronicles.
And the prophet came out of the desert, and gave the Chronicles to the people of Asera. And yet the people were unsatisfied and demanded more. And Richard the son of Tisheer wrote an Editorial Preface, and prophesied that a day would come when there would be an annual journal of Asera. And he sent out the Chronicles, but forgotth to print the Editorial, and includeth it afterwards, looseth leafeth.

And Richard sighed and groaned under the labour. And the Great One heard his cries, and sent him to the southland to profess his faith. And Richard relieved himself, of his work as Chronicler.

Now there arose in the tribe of Monash another Richard, servant to the apostle Peter, whose star waxed in the firmament of heaven, for he rose from administrative assistant to the apostle, to Ph.D. student to lecturer to senior lecturer to associate professor to professor to Dean, displaying a hierarchy of learning. He was a tall man, and the height thereof was two cubits, and the Great One spoke unto him saying, Many servants of mine have done worthily, but verily thou art the longest Dick of them all.

And it came to pass that a new Pharaoh arose, a higher Power, a Colin of the tribe of Flinders, who became Almighty Editor of the Chronicles. And Pharaoh Colin had a terrible dream, and he dreamt of figures dancing and falling over, and none in his kingdom could decipher it, save only his butler who could interpret his dream. And the butler said unto Pharaoh, the figures are the income and expenditures of the Chronicles, and their falling over is due to their inability to balance. And so the Pharaoh made Jim Butler his business manager. And Pharaoh had another dream, of chateaux and Eiffel towers and can-can girls. And he followed his dream, and left the tribe of Flinders for Paris, from the insane to the Seine, and the children of Asera knew him no more.

And there arose in the tribe of Monash a young Fraser, for he was indeed adept at phrasing, for he knew the art of saying the same words in different ways, each counting as a separate publication. And he wrote a paper for the Chronicles on The Impact of ASEP on Pupil Learning and Classroom Climate. And one of his memorable phrases was:

The equation may be expanded to yield seven sets of predictors of learning:

\[ L_n = f_1(l_1) + f_2(A_1) + f_3(E_1) + l_4(A_1) + f_5(E_1) + f_6(A_1E_1) + f_7(A_1E_1) \]

To which another Fraser of the time responded, Life wasn't meant to be easy.

And the tribe of Monash honoured the young Fraser with a hooded garment of finely woven scarlet silk, and praised him mightily, and sent him westwards as quickly as possible.

And it came to pass in the island to the east that a prophetess arose, Beverley from the tribe of Waikato, whose voice was like a bell, yet she wrote with a LISP. And she divined children's thoughts and constructed their meanings, and came into conflict with St. Matthews from the land of the Aucks who deconstructed constructivism and said it maintained an Aristotelian-empiricist paradigm, and called for much epistemological imbibing of new philosophical wine, and other lewdness. Whereupon the prophetess Beverley stood forth at the annual holy convocation and delivered a well-directed stream of feminist empiricist post-modernism. And St. Matthews retreated to the land from whence he came, and his gospel was heard no more in the land of the Aucks.

And now there arose a new Editor in the land, the apostle Paul. And he climbed the holy mountain to commune with the Great One, and came down from the mountain bearing two tablets of stone, size A4, 90 characters per line, 50 lines per tablet. And the people were hushed, and they prostrated themselves as they heard these words:
I am the Almighty Editor, who brought thee out of the land of electric typewriters into the land of laser printing.

Thou shalt not make any graven images using dot-matrix printers and worn-out old printer ribbons.

Honour the length requirements of thy Chronicles, for the Almighty Editor is a ruthless Editor, and in remembrance of the covenant with our father Abraham will circumcise thy work if it groweth too long.

Remember the day of Judgement, one month after the conference, for the Almighty Editor is a stroppy editor, and will not hold thee guiltless when thou submittest thy work late.

Thou shalt not murder the English language.

Thou shalt not steal the ideas of others, without proper referencing.

Thou shalt not adulterate thy text with split infinitives, misplaced apostrophes, misuse the word ‘methodology’, or use ‘trial’ as a verb when ‘try out’ is meant, nor do anything which will offend thy Editor.

And it came to pass that one day a shepherd was tending his flocks by the Dead Sea, which is Port Phillip Bay, and he encountered a cave, and it contained a dusty parchment containing many words in an ancient tongue. And he took the parchment to the elders of his tribe, who deciphered the words, and Lo! they were the lost words of Richard the son of Tisher, in the first Chronicles. And the elders took the words to the people at their holy convocation, and the people rejoiced, and sang a great song of exultation, and their hearts were satisfied at last, and they bowed down and praised the Great One and all the apostles, prophetesses, saints and almighty editors.

The objectives of this paper are to refer to some trends in science education and to suggest several implications for research. Amen. An attempt will be made to specify a number of research questions, and to indicate the types, or styles, of research which may be used to answer the questions. Hallelujah. In addition, it is proposed to raise four important issues which are of concern to all science education researchers. Amen. It will not be possible, in the time available, to describe in detail some research designs. Hallelujah. However, it may be possible for groups to meet to discuss the designs of future projects. This issue will be raised again later.

Tisher (1971).

[Editor’s Note: At this point, the clerical gentleman made his exit, to the sounds of heavenly voices singing ‘Amen’.]