Australian Journal of Teacher Education

Volume 21 | Issue 1 Article 2

11-1-1996

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THE ENHANCEMENT OF SCIENCE PROCESS SKILLS IN PRIMARY TEACHER EDUCATION STUDENTS

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INTRODUCTION

The science process skills of primary teacher education students in Western Australia are often poorly developed. Their lack of skills is part of a more general and widespread problem. Hackling and Garnett (1991) state that " students at all levels show poorly developed skills of problem analysis, planning, and carrying out of controlled experiments. " In a study of first year tertiary students Moneira (1980) claims that many students cannot identify the basic phenomena and even the basic question involved in experiments. He suggests that they see experiments merely as using equipment rather than as a process of generating information.

Science learning and the development of science process skills are integrated activities. Woolnough and Allsop (1985) argue that the development of science process skills is a valid aim for science laboratory work. Blosser (1988) proposes that there is much theoretical support for the value of laboratory work in helping students to understand science classes. On the basis of these claims it would seem appropriate to require primary teacher education students to acquire competence in basic science process skills. Primary teachers in Western Australia are initially qualified as generalists and it is assumed that all will be required to teach science to children. Most of the science that they teach will emphasise material centred activity. These obligations make it essential for the primary teacher to have some command of science process skills. The Massachusetts State Department of Education in a report on science instruction in their elementary schools claims that their teachers lack basic science skills(1987).They suggest that teacher education students should be involved in considerable hands on science to develop the appropriate skills.

Despite the apparent failure of much of contemporary science teaching to impart science process skills to students there is evidence that the appropriate kind of instruction can be successful. Roth and Roychoudhury (1993) worked with year 8 general science students and year 11 and 12 physics students in what they describe as open-inquiry laboratory sessions. They found that "students develop higher-order process skills through non-traditional laboratory experiences that provided the students with freedom to perform experiments of personal relevance in authentic contexts. Students learned to (a) identify and define pertinent variables, (b) interpret, transform, and analyse data, (c) plan and design an experiment, and (d) formulate hypotheses."

It has been established for a long time that science process skills can be successfully taught to teacher education students. Several studies have indicated that short self-instructional courses in simple science processes significantly increase students' ability to use science processes (Jaus, 1975, Campbell and Okey, 1977). Tamir (1989) also working with teacher education students stated that scientific problem solving skills can be developed through laboratory investigations.

Primary teacher education students at Edith Cowan University are required to complete two units of science education; one in first semester of first year and one in second semester of second year. These units include considerable inquiry oriented laboratory work. All students do an experimental investigation on a topic that has some personal relevance. The general purpose of this study is to determine the extent to which the science education units promote the development of science process skills. An earlier study at Edith Cowan, (Foulds and Rowe, 1992), indicated that the units were quite successful on several dimensions. This study uses more precise measurement and should give more information and greater reliability.

The specific questions of the study are;

To what extent do the science education units taught at Edith Cowan University improve the abilities of students to

a. identify the variables relevant to an investigation?
b. produce a hypothesis relevant to an investigation?
c. design an experiment to test a hypothesis?

METHOD

Science education units at Edith Cowan have been very constant over several years with respect to content, learning experiences, and lecturers involved. Hence it was decided to test both first and second year students in the one year rather than to conduct a longitudinal study over two years.

First and second year students were given a pre-test at the beginning of their science education units and the same test as a post-test at the ends of the units. The test required them to identify variables, produce hypotheses, and design an experiment. The test was a paper and pencil test (see Appendix A), but students were shown a model of the apparatus involved.

Students were not given any instruction or information related to the answers to the test after the initial use. Nor were they made aware of how the test related to subsequent parts of the unit.
The treatment consisted of the normal laboratory activities of classes and assignments used across the two courses. Considerable open ended inquiry was carried out and students were required on many occasions to identify relevant variables, produce hypotheses, and design experiments. Both oral and written reports were required on occasions.

Two tailed T- Tests of the relative performances at each of the skills and the total or combined skill score were conducted for each of the four groups; pre-year 1, post-year 1, pre-year 2, and post-year 2.

RESULTS AND DISCUSSION

On entering the university at the commencement of their academic career the students, mainly straight from school, differed widely in their science skill performance. The pre- test indicated that the average level of skill development was poor. They were capable of identifying variables influencing an experiment, scoring about 50% on the relevant test items. They could also produce working hypotheses, with scores of about 40%. However they were unable to design a controlled experiment, gaining an average mark of 18%.

Following the first unit of science education there were statistically significant gains in all three science process skills, suggesting that the course was an effective aid to process skill development. This supports previous research on tertiary students asserting that science skills can be improved by appropriate experiences (Jaus, 1975; Campbell and Okey, 1977; Tamir, 1989; and Roth and Roychoudhury, 1993).
In the thirteen months between the two units subjects showed some decline in the science process skills measured. The declines were not statistically significant, thus suggesting that the effects of the treatment are persistent. (Table 1).

During the second unit in science education students again showed significant improvement in their process skills. These gains effectively recovered the losses that occurred in the time between the two units. (Figure 1) However they do not show significant gains over the year 1 post-test figures. This may be explained by the higher proportion of process oriented activities included in the first unit of science education when it is compared with the second unit.

Over the two years of the investigation all three skills showed statistically significant gains. The greatest gains in skill development were for the production of hypotheses, which is probably the easiest of the skills to acquire.

Although the study establishes that significant skill development can be achieved as part of the effects of brief courses in science education the final scores obtained are not good. This is particularly so with regard to the low final ability of students to design experiments. There is room for further development which might well take considerably stronger treatment programmes. It would be optimistic to assume that present courses give students levels of science process skills that are fully adequate for the teaching of primary science.

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Table 1. T- Test matrix for comparisons of variables, hypotheses, design, and total scores tested pre and post years 1 and 2.

	Year 1 -pretest	Year 1 -posttest	Year 2 -pretest
VARIABLES			
Year 1 -pretest			
Year 1 -posttest	p>0.05		
Year 2 -pretest	p>0.001	NS	
Year 2 - posttest	p>0.001	p>0.05	p>0.001
HYPOTHESES			
Year 1 -pretest			
Year 1 -posttest	p>0.001		
Year 2 -pretest	NS	NS	
Year 2 -posttest	p>0.001	NS	NS
DESIGN			
Year 1 -pretest			
Year 1 -posttest			
Year 2 -pretest	p>0.001		
Year 2 -posttest	p>0.001	NS	
	p>0.001	NS	p>0.01
TOTAL			
Year 1 -pre-test			
Year 1 -posttest			
Year 2 -pretest	p>0.001		
Year 2 -posttest	p>0.001	NS	
	p>0.001	NS	p>0.001

Figure 1. Mean scores (%) of variables, hypotheses, design, and total aggregate tested pre and post years 1 and 2.

Variables = closed triangle; hypothesis = diamond;

experimental design = open triangle; total = circle.

APPENDIX

TEST OF SCIENCE INVESTIGATION SKILLS

Test given to Year 1 Pretest and Post-test and Year Pretest and post-test

Old clocks are dependent upon pendulums to control the speed of the mechanism.

A scientist wishes to carry out an investigation into what factors of the pendulum alters its rate of swing.
The scientist is trying to answer the question : 'What factors affect the rate of swing of the pendulum?'

1. What factors could the scientist investigate ?

2. Write one hypothesis that the scientist could test in an investigation.

3. What approach would you take in conducting this investigation ? Describe in general terms how you would carry out your investigation.