Hands-on science experience for preservice teachers: A collaborative project with classroom teachers

by
Brian Ferry
University of Wollongong

Abstract

This study examined an instructional process that aimed to improve the selfconfidence of preservice teachers in hands-on instruction, and to motivate them to learn some relevant science discipline knowledge. It was hypothesised that the processes involved in the development of a hands-on teaching kit used as teaching resource with a class would support these aims. Data was gathered through questionnaires and interviews. Findings showed that there had been improvements in the self-confidence of preservice teachers in handson instruction, and the process had stimulated some to learn relevant science discipline knowledge. There were also several unanticipated outcomes associated with the professional development of teachers and these were of benefit to participating schools.

Introduction

The reluctance of many Australian primary teachers to teach science has been well documented (RISE 92: 11). A similar phenomenon has also been observed in other countries (Australian Foundation for Science, 1991; NAEP, 1990; Yates and Goodrum , 1990; Varley, 1975; Symington, 1974; Owen et al., 1985). Reasons for this have been expressed in terms of lack of confidence to teach science, particularly the areas that they know least about (Appleton, 1977; Biddulph, 1982; DEET, 1989; Perkes, 1975; Schoeneberger and Russell, 1983).

The 1989 discipline review of teacher education in mathematics and science raised the issue of teacher confidence and recommended that a stronger discipline base was needed. A specific recommendation was that minimum periods of science discipline were needed in teacher education programs (DEET, 1989). While most teacher educators agreed with the view that a stronger discipline base was necessary, there was disagreement with recommendations suggesting the explicit assessment of science knowledge, and the use of diagnostic tests for remediation (Symington and Mackay, 1991). Such dissension highlights the lack of research about how much science discipline knowledge is needed to improve the confidence of preservice and inservice teachers. Research by Skamp (1989) found that more science discipline knowledge did not improve science students' attitudes to science, but teacher education

courses did contribute to a positive change in attitude. Similarly Stephans and McCormack (1985) found that students who took more traditional science courses at college did not necessarily have greater understanding of concepts, or develop improved attitudes to teaching science. Also a recent study by Appleton (1992) did not clearly demonstrate that an increase in knowledge of science/technology content leads to greater competence in teaching the subject. However, several students in his study felt that a small amount of knowledge was sufficient for the teacher, provided they approached the teaching of science as co-learners with the children. Appleton concluded that "science discipline knowledge needs to be taught in a way which gives students a more positive selfimage of themselves as teachers of science and technology." However, he warned that "what is gained in student self-confidence, is paid for by covering less content" (ibid, 1992).

Further research is needed to find out whether it is possible to increase selfconfidence in instruction and still cover sufficient science knowledge. This research question was the focus of this study which evaluated a project that was designed to improve the self-confidence of preservice teachers in hands-on instruction, and to encourage them to learn relevant science discipline knowledge. It was hypothesised that the processes involved in the development of a hands-on teaching kit, used as a classroom teaching resource, would increase reported selfconfidence in hands-on instruction and induce preservice teachers to learn the science discipline knowledge that related to their teaching kits.

Background to the project

Classroom teachers involved

The sixty classroom teachers involved in this study were volunteers. During 1992 these teachers participated in a survey which asked them what form of support they required in order to effectively teach science and technology. Ninety five percent indicated that they needed help in the form of science kits with simple hands-on activities that they could use in their classes. The kit project extended over six weeks. It was designed to meet the needs of classroom teachers and to provide valuable experience for preservice teachers.

Preservice teachers involved

One hundred and twenty preservice primary teachers participated in the project which was an assignment for a subject taught at the University of Wollongong. They worked in pairs to develop a hands-on teaching kit that was suitable for an assigned class at

a local primary school. Each kit contained a class set of the materials needed, lesson plans and teacher notes. Each preservice teachers taught four half-hour lessons with the materials in the kit.

Before they commenced the project, preservice teachers met with classroom teachers to negotiate an appropriate topic for their assigned class. Then they collaborated with their classroom teacher as they developed their kit. It was stipulated beforehand that the hands-on activities had to use materials that schools could easily afford, and an upper limit for expenditure on materials was set at $5. As there were sixty classes participating, the cost of materials provided by the faculty was $300. A final requirement was that the materials were to be housed in a small box and to be left at the school after the project was completed. Thus, at the end of the project, participating schools were provided with a set of simple hands-on activities that matched their science and technology teaching units.

The pupils

The one thousand, one hundred and five pupils who participated in the project attended state schools and their ages ranged from five to twelve years.

Data collection

A questionnaire was used to collect pre and post-treatment data from participating preservice teachers. Questionnaires were also used to collect post-treatment data from pupils and teachers. Very young children were asked to respond to their simple questionnaire through a "show of hands" and the classroom teachers assisted in this procedure. The teacher questionnaires were open-ended in order to elicit longer responses. After the

data was gathered the science coordinator and one teacher from each participating school was interviewed about the reliability of the findings.

Results

The pupils involved in the project

Pupil Survey N = 983 (Females 501, Males 482)

	Statement	Responses as %		
1	The lessons were	exciting 76%	don't know 18%	boring 6%
2	The work was	too hard 2%	about right 68%	too easy 30%
3	The student teacher let me do the work			
89%	don't know			

9% did the work
for me 2%
4 The things in the kit were easy to use 68% all right
30% hard to use 2%
5 The things in the kit were fun to use 79% all right 15%
boring to use 6%

Nine hundred and eighty-three responses received represented 89% of the participants. Responses show that the project was successful and that the majority of children enjoyed the project. However, the responses to question 2 show that there is a need to make the activities more challenging for some students as 30% of students felt that the work was "too easy", and 2% thought the work was "too hard". Six percent of respondents felt that the the lessons were "boring". Responses were stable across the various age groups surveyed.

The responses to question 3 are encouraging as nearly 90% of preservice teachers allowed the students to freely engage with the hands-on materials that they produced, and only 2% of responses indicated that the preservice teachers "did the work for me." Written responses from classroom teachers and interview data supports the view that the kits were used in this manner.

The responses to questions 4 and 5 show that the majority of children thought that the materials in the kit were "easy to use" (68%) and "fun to use" (79%). The analysis of the written responses of teachers and students supported this view. No significant gender differences were found, nor were there any significant differences between the sites used in the project.

Samples of the responses written by the older students follow. They support the view that the project was successful.
Q Write down anything about the kits that made it hard for you to learn.
R1 Nothing was too hard - Year 3 student
R2 Nothing was hard about it - Year 4 student
R3 When people go ahead and don't explain what they mean - Year 5 student
Q Write down anything about the kits that you really enjoyed.
R1 All of it - Year 3 student
R2 You could do the same things at home - Year 4 student
R3 The balloons - Year 5 student
Q What was the best thing about the lessons?
R1 The actual experiment - Year 3 student
R2 The experiments - Year 4 student
R3 Trying out our things - Year 5 student

Q What was the worst thing about the lessons?
R1 I liked it all. - Year 3 student

R2 The end of the lesson when we had to go out the front and talk to the class - Year 4 student
R3 Writing in a diary - Year 5 student

The teachers involved
Teachers also commented positively on the success of the project and some typical responses were:
Comment 1
The lessons were well planned and suitable for the age group being taught. The children thoroughly enjoyed the "hands-on" approach, interacting positively with peers and student teachers. The children looked forward to the lessons each week, gaining valuable knowledge/experience from the planned activities.

Comment 2
The children enjoyed the experiments conducted during the four weeks. The experiments in themselves were well planned and organisation of materials was very good. Two areas that need further development are:
Introduction to the experiment, this aspect was often rushed.
Sharing, conclusion etc.

Although the children participated in well run questioning sessions during the experiments the students did need to reinforce/reflect on learning by use of journal or oral description, etc. of what was learned.
The students were all well prepared and professional in their dealing with the school.

Comment 3
A terrific experience for all! Children were excited and learned a lot... It was interesting to observe the class at work. It showed students who could plan, organise, work cooperatively. Also poorer academic students excelled in Science and Technology designing and making. Important to achieve success!
Would like to be involved again in the project!
A great encouragement to teachers to help them get going with Science/Technology Syllabus.

Comment 4
The children have been most enthusiastic about each of the activities and involvement and participation has been excellent. The activities provided were at the children's level and the children will benefit from these activities for the rest of their

schooling. The R.F.F. teacher only commented this week how successful the children in my class were in investigating activities with him.

The areas for further development mentioned in comment 2 were common to 25% of all teacher responses and show that several of the preservice teachers lacked experience in the skills required to open and close lessons. The revised version of this project will ensure more attention is paid to the development of these skills before preservice teachers begin teaching.

Comment 4 is typical of responses made by teachers about the involvement and participation of the children. Eighty three percent of teacher responses mentioned enthusiasm, participation, and successful investigations.

It is significant that all teachers who participated in the project indicated that they wanted to continue in 1994.

The preservice teachers

Preservice teachers were asked to write an evaluation of the kit project. In particular they were asked to comment on the effect of the project upon their confidence, and their preparation of lessons. They were also asked to comment on the implementation of their lessons and the learning outcomes achieved. Some representative comments follow..

Comment 1

I found it beneficial to plan with another as you get two very different points of view.... At the start I realised that I planned way too much and then had to condense everything. In terms of actual teaching, I loved it! I knew the topic well and felt confident in teaching my topic (Weather) to children.... it was hard to get the children

to pack up and I took this as a sign of success.... I found that I also ran out of time and did not conclude one of my lessons as I should have.... As a little bonus I took in two 1.25 litre drink bottles and demonstrated how to make a whirlpool. The children were greatly enthused and some even went home and made their own....

Comment 2

looked forward to our weekly visits and this gave me a great deal of satisfaction and made me feel more confident....the written feedback in the children's diaries was lacking in the detail that I expected...the children were motivated by the activities, as they were eager to participate...I underestimated the time

required for the first lesson, but as I got to know the class I was able to overcome this problem... I can see the importance of preparation, learning about the topic and providing sufficient materials so as not to curb the children's experiences ... the project gave us the opportunity to test our kits in a "real life" situation. The kit will be a great resource for the school and be helpful to us as teachers of the future."

Comment 3
I felt that we learnt a great deal from the experience and became more confident in our ability to teach science...we were made aware that it is possible to "over prepare" - that is with the best of intentions a teacher can do too much for her students and stifle creativity or individuality, initiative and even their ability to work in groups ... on individual activities the children performed well but when the task became openended and required group work a whole set of unanticipated variables came into play ... the children were not used to dealing with novel situations and needed far more time than we originally allowed...it showed that you do not need expensive

state-of-the art equipment for children to explore and test scientific concepts ... the concept of developing science kits is a valuable and inexpensive teaching strategy and one that we will take full advantage of when planning future lessons.

Comment 4

One hundred and twenty preservice teachers were involved in the project and analysis of the written evaluations showed that:

- most did not allow enough time for their initial activities. (93 responses)
- most mentioned that they overcame this problem in later lessons. (88 responses)
- most mentioned that the process of developing a kit of hands-on materials was a valuable learning experience for them. (109 responses)
- most mentioned the enthusiasm and interest shown by the

children. (105 responses)

- as mentioned in the previous comments, and in the teacher comments, the closure of lessons was not always executed in an effective manner.
- most (108 responses) stated that the experience helped them and mentioned that they had become more confident in their ability to teach science (105 responses).

Twelve preservice teachers mentioned that they felt that the

experience had been stressful. Interviews with these preservice teachers and their teacher-supervisors revealed that the classes they taught were regarded by staff as "difficult to manage" and this affected the impact of the project, but the experience did not dampen their enthusiasm for the project, and all of this group of preservice teachers still felt that the experience with the kits had been a valuable experience. Typical comments from this group were:

Comment 1

Comment 2

Comment 3

I gained personal satisfaction from teaching the science experiments because I found that towards the end I felt much more comfortable and confident in teaching science lessons.

Comment 4

At first I was not comfortable with the thought of teaching science or teaching the class, however this attitude quickly changed after the conclusion of the first lesson ... the hands-on activities allowed me to freely interact with the children and to find out the children's own perceptions and ideas about the concepts that I was teaching.

Questionnaire responses from preservice teachers

The table following shows the means and standard deviations of responses to the pre and post questions. Question 7 was modified to read "It was more fun to ..." in the post survey. A paired t-test (two-tailed) was used to analyse the one hundred and twenty responses to these questions, and results that were significant at the .05 level are indicated by an asterisk. The changes in responses to questions 1, 2, 5, 8, 9-12, and 14 were significant at this level.

The changes in responses to questions 1 and 2 indicated that there had been an increase in confidence, and this was supported by the written comments, as were the changes in responses to question 5.

The responses to questions 8 were encouraging because many preservice teachers had come to realised that a good working knowledge of scientific concepts helped to make their lessons more successful. Many written comments also mentioned the need to understand the scientific concepts that supported the planned activities. A final question asked preservice teachers to indicate if the process had encouraged them to learn more about science. One hundred and ten stated that they realised that they had to improved their own knowledge and understanding of science

if the planned kit was to be successful. Ninety three in this group also stated that they had gained confidence in finding information about science.

Changes in response to questions 6 to 10 and 12 indicate that the preservice teachers have a greater awareness of issues related to

preparation and delivery of hands-on science lessons, and the lack of change in responses to question 13 may also support this interpretation.

The responses to question 11 appear to indicate that the preservice teachers are still uncertain about how much classroom control is needed for effective learning and this is not surprising given their lack of sustained experience in the classroom. This aspect of the study needs follow up research as it was raised informally by preservice and classroom teachers during the course of the project.

TABLE 1 Pre and Post experience responses from preservice teachers.

	Statement	Pre mean	S.D.	Post Mean	S.D.	t df 119	Prob.
1.	I feel confident when I teach hands-on science to children	2.02	.84	1.6	.61	3.15	.002*
2	I am confident that I can develop a good hands-on science kit	1.94	.71	1.72	.52	3.74	.0004*
3	Teachers should find out the ideas that the children already have about a topic before they begin to teach it	1.89	.86	1.67	.61	1.81	.074
4	I find it harder to plan when I have to collaborate with a peer	3.39	1.23	3.73	.96	1.98	.052
5	Simple, home made materials can be used for many hands-on activities	2.04	.92	1.42	.61	3.638	.0005*
6	It is essential to have a good knowledge of the subject matter related to the topic	2.03	.89	1.44	.70	4.6	.0001*
7	Classes should always be organised into small groups for hands-on lessons.	2.54	.87	1.67	.584	6.9	.0001*
8	The children will learn more if I demonstrate the experiments to the class beforehand	1.61	.73	2.16	.59	-4.49	.0001*
9	Good teachers of science give children clear explanations of the results that they obtained	1.63	.67	3.32	.85	-13.4	.0001*
10	Good teachers of science select equipment that is easy to						

use 2.38 .83 1.61 .713 6.21 .0001*
11 Good teachers of science rarely use strong classroom control. 2.69 1.12 2.79 .89 -.743 .47
12 Good teachers of science tell the children what to find out 1.34 .50 2.66 .82 -10.92 .001*
13 Children learn more about science when they relate their findings to their ideas about the topic 1.42 .63 1.58 .67 -.1.743 .086

Conclusion

A degree of caution must be applied to the interpretation these findings as the sample was not large. Nevertheless, the instructional approach used in this study appeared to improve the self-confidence of most preservice teachers in hands-on instruction, while motivating some of them to learn relevant science discipline knowledge. Other benefits for the preservice teachers were:

- peer and teacher support of hands-on instruction.
- peer and teacher feedback on their hands-on instruction.
- the opportunity to share ideas with classroom teachers.
- experience in developing a cost effective hands-on teaching kit.

The benefits for participating schools were:

- classroom teachers were able to closely observe children in their classes and this led to unexpected insights as shown in the comments.
- classroom teachers were able to spend more time to evaluate the learning of children and they reported that this was very beneficial.
- classroom teachers and preservice teachers were able to exchange ideas and strategies, and many classroom teachers reported favourably on this aspect of the project.
- schools gained some additional resources at no expense.
- students received additional instruction in hands-on science.
- the children had the benefit of additional resources.
- the children had the benefit of an additional teacher in the classroom .

The use of hands-on science kits has benefited all parties involved in the project and this has encouraged the author to make a continued commitment to the project. However, there are areas which require further development if the project is to fully realise its potential. Firstly, the supervising teachers and classroom teachers need a more comprehensive written guide so that they clearly understand their respective roles. Secondly, the preservice teachers need more instruction in methods of

opening and closing lessons before they begin the teaching phase. Thirdly, there is a need to include activities that extend children as the questionnaire responses indicated that this may have been a weakness with the current project. Finally it may be a valuable exercise to require preservice teachers to formally report on the scientific knowledge that they have gained from the process. In 1994 these findings will be used to guide planning for the "Mark II" version of this project.

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