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NEW APPROACHES TO THE INSERVICE EDUCATION IN SCIENCE AND TECHNOLOGY OF PRIMARY AND EARLY CHILDHOOD TEACHERS (or MUM IS NOT DUMB AFTER ALL!)

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INTRODUCTION

This paper reports preliminary research findings from an inservice program which is part of the Primary and Early Childhood Science and Technology Education Project (PECSTEP), based in the School of Education, University of Canberra (Note 1). PECSTEP has been funded by the A.C.T. Education and Training Council and the A.C.T. Department of Education, and is directed by Ms Margaret Bearlin and Dr Tim Hardy. This project builds on the work of the Women and Science Teacher Education Project (WASTE) (Bearlin, Annice and Elvin, 1988) which identified evidence that linking work in science with explicit treatment of gender issues in inservice programs can affect the attitude to science of women primary teachers, and the attitude of girls they teach. Because little similar work was being done at the preservice level, the WASTE Project Report recommended "research on the effect on the attitudes of women preservice teachers to science and science teaching, of teacher education courses in which work on gender and work in science are systematically linked or integrated with each other and with practice in schools which have wide affirmative action policies" (p 13). It soon became obvious, however, that such research at the preservice level would not be possible without companion inservice programs. PECSTEP was therefore designed to link the preservice education of teachers with appropriate practice in schools by providing a special inservice program for supervising teachers.

The approach to teaching and learning used in the project has been developed at the University of Waikato, Hamilton, N.Z. The Science Education Research Unit there (now the Science and Mathematics Education Research Centre) was directed initially by Dr Roger Osborne and has attracted the major part of the N.Z. Department of Education's research budget since 1978. The first three year project, Learning in Science Project (LISP), investigating teaching and learning of science in classrooms of 11 - 15 year olds, resulted

in 56 working papers and many publications which are condensed in Osborne & Freyberg (1985). A second three year project LISP (Primary) followed and developed a way of teaching science in primary schools (an interactive teaching approach as outlined in Biddulph and Osborne, 1984) to take account of: a) the understandings about learning in science classrooms developed in the first project, b) the wariness of primary teachers to teach science, and c) a view of science as enabling children to make sense of the natural, and technological world in which they live. The project officer of PECSTEP during 1989 - Valda Kirkwood - had been project officer of the third LISP project which investigated the teaching and learning of the energy concept in science classrooms (Kirkwood 1988).

OVERVIEW OF PECSTEP

The purpose of PECSTEP is to improve teaching and learning in science and technology of girls and boys by increasing the number of early childhood and primary teachers who are effective educators. The project links the preservice education of teachers in science and technology with quality practice in schools by providing special inservice education for supervising teachers.

The project involves:

- the development, teaching and evaluation of a year length inservice program involving 70 primary and early childhood teachers in which each will develop a science and technology curriculum unit
- the modification, and evaluation of an existing semester length preservice unit in science and technology education for (approximately) 60 preservice teachers
- the establishment of regional support networks for the practising teachers taking the inservice program.
- the developing of curriculum modules able to be used in inservice and preservice teacher education programs All programs and units systematically link work on gender with the learning and teaching of science and technology.

THE INSERVICE PROGAM

The inservice program aims to increase the competence and self confidence of teachers in the science and technology areas by enabling teachers to:

- extend their understanding of children's learning in science and technology
- explore ways of assisting children with such learning.
- extend their understanding of the importance of and skills in science and technology in the lives of girls and boys
- extend their understanding of their own learning in science and technology
- extend their understanding of and skills in gender-inclusive science curriculum development and teaching
- develop further skills in teaching science and technology
- feel positive about teaching in this curriculum area
- supervise the work of preservice teachers in this curriculum area

The program consists of 14 two hour workshops in Semester 1, followed by class-based curriculum development in Semester 2. The program involves:

- participation in a science curriculum unit (toasters) based on interactive teaching-learning principles;
- exploration of the steps involved in the development of such a curriculum unit;
- development of another science curriculum unit (bread);
- development of another curriculum unit using their own class (in Semester 2).

During these workshops we focused on:

- the ideas, experiences, questions which teacher and children bring to lessons;
- the place of context in teachers' and children's learning;
- the different experiences and interests of teachers and girls and boys and the influence of these on their learning;
- ways of looking at technology, science, knowledge, teaching, learning and gender and their interrelationships.

Three groups of primary and early childhood teachers (70 of the 130 who initially expressed interest) are undertaking, in their own time, the year long inservice course. About one third of the teachers are either upgrading or doing a Masters course associated with the Project. Three participants are School of Education staff, nine have withdrawn during Semester 1, seven through over-commitment and two because the course was not meeting their needs.

The programme has involved teachers investigating their own questions about toasters (e.g. how does a toaster really work?) by taking toasters to bits, setting up electrical circuits etc. During these activities teachers have kept diaries to record steps in their own learnings and to reflect on the many questions - which have surfaced and been discussed - relating to their understanding of teaching, learning, science, technology, knowledge and classroom interactions.

A curriculum unit on bread began with a bread-making session which was followed by sessions in which teachers investigated their questions arising from the activity of baking bread. In addition there were focus sessions on gender issues, resources, understandings of science and technology, and of teaching and learning.

RESEARCH METHOD

Surveys

During the year three surveys will be completed; at the beginning of semester 1, the end of semester 1 and at the end of the year. These will help us find out where people start from in terms of their science background, their experience in science teaching and learning, and their ideas about and attitudes to science and technology, teaching and learning. The completion of these surveys is intended to initiate and provide reflective practice during the year as well as being an evaluative instrument.

The keeping of a diary

Throughout the year each teacher is keeping a diary to record:

. ideas, experiences of and questions about various aspects of science education encountered during the program

. suggestions and insights gained during the program which are personally significant for their learning and their children's learning, and for teaching

. reflections on the implementation of ideas gained in workshops in their own classroom

. a case study on a curriculum unit of their choice.

Evaluation Forms

An evaluation form was distributed at the end of semester 1. This asked teachers to comment on aspects of the course that worked (or didn't) for them, what they had learnt, what had facilitated that learning, and what impact (if any) the course had had on their lives.

Interviews

A smaller number of teachers (about 12) are being interviewed at least 3 times during the year to provide more in-depth data.

PRELIMINARY FINDINGS

A preliminary analysis of the evaluation form for Semester 1 of this inservice program indicates a number of aspects of the program highlighted by the participating teachers:

1. Teachers widened/altered their ideas about science and technology
2. Teachers widened/altered their ideas about teaching and learning
3. These changes in teachers' ideas/views were facilitated by a number of factors
4. These changes have led to other changes
5. The impact of the course has reached out beyond the teacher, the classroom, and the school.

The discussion now focusses on these aspects and are illustrated using teachers' comments (which are not idiosyncratic, but representative).

1. Teachers widened/altered their ideas about science and technology:

(a) Many overcame, their sometimes long standing, fear/awe of science and technology

> *I feel very excited about the way I reached and responded to this particular course, especially since I was always frightened of the word science, let alone what was involved in science. I almost had feelings of relief to think that I could actually learn about science, and for this subject to have meaning for me.* (Janelle)

(b) Others found science and technology could be fun.

> *I found I enjoyed more doing the unit on toasters perhaps because it gave more scope to find things out. As well it was an area which originally was taboo for me as I had never had the opportunity to do an in-depth study of a "toaster". The fun in doing such an activity was great.* (Emma)

(c) Some realised the "everydayness" of science and technology.

I liked the idea of using toasters and bread as subject matters, because before this course I tended to keep 'Science' in its own little box and indeed saw scientists as being shadowy figures in a research laboratory. These subjects brought home the practical uses of science and technology and just how much science and technology is related to my everyday life. (Rhonda)

(d) Some focused on the philosophical aspects.

(I have learnt) - that science is a way of making sense of the world. (I have learnt) - that what we think are scientific facts are actually a consensus of what people at a particular time agree is the most probable reason for something happening, i.e. once people agreed that the world was flat, until enough people found evidence that led them to believe that it is actually round. Then it took a while before enough people thought it was round for that to become a consensus. Probably some people chose to believe it was flat still for hundreds of years after most people realized it was round. (Wendy)

(e) Some became aware of a relationship between science and technology.

The toaster experiments opened my eyes in another way. In my diary I've written about my new "emerging awareness" of the relationship between science and technology. I'm not even aware why that relationship became apparent ... but I began to look at things differently. "Technology is not just machinery - it's changing things and the way they're used". I'd not thought about technology as being something "everyday". (Pam)

(f) Some delved into particular aspects.

The most amazing aspect to me personally is coming to understand about electricity - its applications in the world around me; that it has sense and meaning in my world; that the table I touch and the chair I sit on is a chemical combination that ultimately is held together by electrical charges. This was a massive learning curve for me. (Jacky)

2. Teachers widened/altered their ideas about teaching and learning:

(a) Some focused on their own learning.

I have increased my own science knowledge revived/revised some of the "dormant" concepts (dormant since the early 60's) - particularly related to chemistry. (Lorna)

(b) Some initiated on-going responsibility for their own learning.

I've learned an enormous number of things in a short time. I've learned a little bit of information about the actual content of what we did and that little bit is acting like a seed in my mind because I keep looking out everywhere for related information or incidents. I learned that one question can lead to an endless chain of questions, it's a self perpetuating process. I suppose its called curiosity. I only ever had this about people, relationships etc. but never about things. (Vivienne)

(c) Some related this learning to children's learning.

The teacher doesn't own the knowledge - we have to allow our students to construct and take responsibility for this knowledge in making better sense of our world. (Norma)

The idea of a "concept map" is very interesting and appealing ... as a way of establishing prior knowledge etc. (Felicity)

I now have more ideas on how to evaluate science, especially the inclusion of self-evaluation. (Jan)

Specifically I have gained scientific knowledge about toasters, bread yeast but in doing so I have learned to think more about providing resources and enabling the children to find resources to answer more of their questions during observation "perhaps have a more flexible environment in my room. (Heather)

The weekly meetings were great as far as stimulating enthusiasm but when we were working with toasters, I felt quite frustrated at having to leave the work we were doing, put it away for a week and come back to it "cold". I'm sure the children must experience this frustration when we compartmentalize our lessons like this also. (Pam)

(d) Some related their learning to their classroom teaching.

However, the important learning recorded in my diary is not only related to my own learning, it is related to what I have been able to take back to my classroom. Teaching is being a resource person, setting the scene for learning, encouraging children to ask their own questions, setting up a supportive learning environment, valuing everyone's thoughts.

Learning is a self-directed experience, a group process, sharing experiences and knowledge, questioning, exploring, discovering, making use of all resources, building on prior knowledge at own pace, making sense of the world. Science is interesting, everyday, relevant, fun, exploring, discovery and trying to make sense of the world. The fact that I have learned these things can only enhance my classroom practice and therefore, the learning of my children, I have learned these things through experience. If my experience within the course hadn't been positive, I would have had little to return to my students. As it is, they have gained and so have I. (Judy)

(e) Some focused on the gender equity aspects.

More awareness of gender equity in the classroom across the curriculum. I'm conscious of my attitudes towards girls and boys all the time. I feel that in the past I have allowed boys to dominate areas like maths and science and now make more effort to be even handed to the point of sometimes giving girls preferential access to activities. During the term a GEAR programme has been operating and as a result of a preliminary survey, some science classes will be conducted as girls/boys only groups in an attempt to determine whether girls will participate more fully under these circumstances. This will operate with my team partner. (Marlene)

(f) Some saw the ability to integrate science in other areas of their teaching.

I attended the course to get some new methods/ideas for science to get out of the rut of "experiments that don't work". I broadened my ideas of what 'science' is, can now fit science into a programme in a more integrated way. (Betty)

(g) Some could relate the teaching/learning approach to other areas of the curriculum.

I can definitely see the value of the interactive teaching model in all subject areas. In a recent curriculum project on "LEGO TC logo", I used this teaching model as the 'ideal'. The planning, design and construction of a LEGO model in a group context involves all the suggested 'steps'. The inclusion of gears, wheels and cogs to be controlled by motors and finally by the computer is future technology in comprehensible action. In Maths activities, with the current emphasis on the use of concrete materials and problem solving, the approach would

also be suitable. I feel very confident that my background knowledge is adequate enough for me to act as guide and facilitator in this subject. (Trish)

3. These changes in teachers' ideas/views were facilitated by:

(a) the atmosphere of the workshops.

The most important aspect of this course for me was the atmosphere that of acceptance, genuine interest in individuals, and a feeling of excited curiosity. The feeling that it was O.K to explore and investigate at our own pace in our own direction. The learning was real. I did not feel that I had to perform. I did not have to present a "beautiful picture" of something irrelevant and beyond my understanding. (Susan)

(b) "hands-on" approach.

The hands-on approach was wonderful, for although we provide experiences for children, we rarely have a chance to explore the 'unknown' ourselves. Exploration and careful observation were actively encouraged with tools, books, microscopes, batteries etc. any any resource needed being provided. (Lois)

(c) the learners (teachers) determining their own learning.

The way you taught - lectured really interested me - it is a technique I have used often with Grade One children but not with Kinder It is so good and yet I think we don't do it enough in the classroom. You let us, the students, control where we were going, what we wanted to do. Very powerful but confusing at first until you begin to think about the learning process. (Marion)

(d) the use of varying strategies.

(i) stating what you know at the beginning.

Having to state what I knew first. Clarified ideas and helped me know what I wanted to find out. (Jan)

(ii) concept maps.

In the specific areas of toasters and bread-making, and the science related to these, I can see by my concept maps just how much knowledge I have gained. This is a very simple, quick, but efficient way of highlighting understanding and knowledge before and after. (Jean)

(iii) reflecting (via diary and reportbacks).

I have found that the Reflective Thinking by us, as teachers, has helped

to re-investigate the thinking going on behind the teaching practice in classrooms. This can be extremely powerful. To encourage reflective learners we need to become reflective teachers. I want more time (for this). (Marion)

(iv) groupwork.

Group interaction worked because I could try my ideas on others and hear theirs - ideas to investigate and ideas on how to find solutions. In my diary, I have recorded, "Groups valuable pooling of ideas, knowledge." Also, "Appreciation of group discussion, because all learn together. Did not feel uncomfortable." Reporting back worked because it raised further questions in my mind, and gave a broader overview than was possible in the smaller group situation. I discovered other aspects which were not areas I would have pursued. In my diary I have recorded, "Reporting back of other groups - more ideas, other ideas on how we could investigate." (Jan)

(v) modelling the process.

The most significant aspect of this course for me, was the modelling process which helped to develop a theory of learning which would underpin the teaching of science and technology. Course participants were given the opportunity to apply the theory to situations which enabled them to write their own curriculum. (Bill)

4. <u>These changes in understandings have already led to other changes</u>:

(a) Changes in confidence -

(i) their own knowledge.

This course increased my confidence in my own scientific knowledge. My previous background in science was chemistry and physics in high school and biology at teachers college. While my knowledge of, and interest in, biology was quite high I had "opted out" of physics and chemistry at high school as it had become very formalized. This course renewed the interest I had had in the early part of high school science. I feel much more confident now. (Ray)

(ii) taking part in discussions about science teaching.

I feel more qualified to talk about science teaching or at least offer an opinion in discussions. (Wendy)

(iii) teaching science and technology.

This course has been a unique experience for me in my many years in

educational institutions, and has given me confidence to give students the same kind of teaching and learning. (Liz)

(iv) having experiences and understandings with colleagues.

I have felt much more confident about being Science Co-ordinator at school. (Lorna)

(b) changes in classroom practice.

(I am) being more at ease with letting the children in my class experiment,have a hands on approach. (Emma)

Process of forming questions to investigate I found most useful, for myself and particularly with the classes I teach. It has really enabled me to assess what the children already know and the level of their science thinking. Particularly useful also was the McLintock Coop. idea (and Susan Swan's Master's thesis) of the'"Thinking Book" and which has provided a very useful vehicle for me to encourage children to look at their own learning and take more responsibility for it. They also love using this book and develop all sorts of other ideas (science-related) for using this book. (Lorna)

I have actually applied this model to the other curriculum areas as far as possible. I continue to be amazed and delighted at the amount of knowledge children have about topics which I myself have little knowledge about! I have also found that the children respond very positively and enthusiastically to this style of teaching. (Eva)

(c) changes within the school situation.

Since I started the course, there have been changes in the attitude towards science at our school. This has occurred through displaying our experiments in the corridor near the library; beginning a 'tinkers' club' in May. This club started out with a 20% membership of boys. I was surprised but delighted to see so many girls. At the commencement of 3rd term, a science room is being set up. Whilst I still feel a little insecure about passing on my knowledge to colleagues, I am finding that they regard me as someone who can help them with their problems about Science teaching. I'm also allowed to go on Science inservices. I say allowed because last year I wasn't allowed to go to the NASA inservice at the CCAE. Instead a teacher who was retiring in 6 months went. With the setting up of our Science room, attending inservices and curriculum meetings I find I am very busy, but also very satisfied. I feel I'm using my brain. (Rhonda)

6. The impact of this course has reached out beyond the teacher, the classroom and the school to:

(a) fixing things.

Confident to tackle other electrical appliances e.g. the iron, unable to fix washing machine - which I did fix. (Barbara)

(b) other learning.

The use of an Interactive Approach facilitated my learnings. It's interesting to note that I was also enrolled in Intro. to Physical Sciences which gives a 6 week introduction to Physics and 5 weeks to Chemistry. This has been taught in a Traditional Science Method. The barriers I had/have to science were reinforced many times over. The work I did on electricity through 'Investigating Toasters' gave me the knowledge to understand what I was supposed to be doing in Physics. (Jacky)

(c) trying new things.

My private life has also changed - I am now more confident to try new things, like different courses at night, - "I can learn about anything I want to" - and not feel silly about it. (Janelle)

(d) helping their own children.

Thinking scientifically has also enabled me to help my daughter with her Year 9 Science and also with her maths. Now we look at something and say "What are we asked? What do we know? How can I use my information to solve my problem?"..... The best thing is that Mum is not dumb after all..(Rhonda)

CONCLUSION

These preliminary findings have implications for the effective inservicing of early childhood and primary teachers in the science and technology areas. They are also likely to have implications for preservice courses. The research findings indicate that teachers can overcome their often negative views of science and of science teaching. Factors significant in this process appear to be : firstly, and most importantly, experience by the teachers of support and acceptance as they begin - often anxiously - their explorations of science, science teaching and learning.

Secondly, teachers begin their investigations in a context with which they are familiar, from the point "where they are at" and hence from which they can develop their investigations in directions they perceive to be the most fruitful. Thirdly, the sharing of explorations, reflections and progress amongst group members encourages the teachers to clarify and justify their own directions and perspectives, to learn of others' journeys, and to receive affirmation of their own learning. It is clear that this complex process cannot be hurried: inservicing teachers in an area that has been so neglected in the school curriculum requires an approach that fully recognises this

Note

1 The University of Canberra (formerly the Canberra CAE) is a member of the Unified National System and is sponsored by Monash University.

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