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ABSTRACT

The main objective of this study was to explore the experiences of two novice elementary school teachers for factors related to self-efficacy and motivation to teach science. The experiences were analyzed for evidence of: (1) successful performance, vicarious experience, verbal persuasion, and emotional arousal as contributors to the development of science teaching self-efficacy; and (2) links between self-efficacy and the nature and style of science and other programs implemented by each novice teacher. The design was based on qualitative measures using semi-structured interviews conducted at the mid-point and at the end of each subject's first year of elementary school teaching. It was found that the subjects benefited from involvement in a cooperative teaching situation and from a small school environment with a supportive principal. Induction programs that provide this kind of support enable novice teachers to implement worthwhile programs. Teachers who have experienced success and have high levels of self-efficacy should be mentors for novice teachers. It is concluded that if teacher educators, experienced teachers, and school administrators combine their expertise and efforts to foster and develop novice teachers' sense of science teaching self-efficacy, the education system can operate more effectively for the betterment of science education. (Contains 18 references.) (JLS)

Experiences of novice teachers: Changes in self-efficacy and their beliefs about teaching

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Introduction

Self-efficacy is a major theory emerging from social behavior research (Bandura, 1977). According to this theory behavior is based on two factors, firstly, people develop a generalized expectancy about action-outcome contingencies through life experiences (outcome expectancy) and, secondly they develop a more personal belief about their own ability to cope (self-efficacy). Bandura suggested that behavior can be predicted by considering both factors and hypothesized, for example, that a person rating high on the two factors would behave in an assured, confident manner. He emphasized that self-efficacy is a situation specific determinant of behavior not a global personality trait and identified successful performance, vicarious experience, verbal persuasion and emotional arousal as key contributors to the development of self-efficacy. Teachers, for example, would be reassured by success, particularly if that success is ongoing and occurs in a variety of contexts. Observing the successful performance of others can affirm teachers' confidence that they also have the ability to accomplish similar tasks. Beliefs about personal abilities can be raised by sensitive communication with credible models, and finally, vulnerability to dysfunction induced by stress may influence teachers' sense of self-efficacy under certain conditions (Bandura, 1986).

The importance of the contribution of the teacher to the teacher-learner-curriculum interaction was emphasized in a model used to account for the development of students' poor attitudes to science (Germann, 1988). Students' fatalism, their perceptions of the value of science, teacher quality, classroom social environment and organization appeared to be significant factors in contributing to this model. The teacher brings into this interaction his or her own world view which include beliefs, attitudes, needs, knowledge, experiences and priorities (Clark & Peterson, 1986; Shulman, 1987). Therefore, attempts to evaluate practicing teachers' motivation to teach science by acquiring an understanding of their sense of self-efficacy and their beliefs about the effectiveness of good teaching, and the identification of ways of developing self-efficacy, are becoming increasingly important aspects of science education research and the professional development of teachers (de Laat & Watters, 1995).

The main objective of this study, therefore, was to explore the experiences of two novice elementary school teachers for factors related to self-efficacy and motivation to teach science. Specifically, the experiences were analyzed for evidence of:

- successful performance, vicarious experience, verbal persuasion and emotional arousal as contributors to the development of science teaching self-efficacy; and
- links between self-efficacy and the nature and style of science and other programs implemented by each novice teacher.

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Methods

The design of this study was based on qualitative techniques. Rich descriptions of the individual cases were acquired through semi-structured interviews. During the interviews, the subjects' beliefs about science and science teaching were probed and reflections on their own school, university and personal science experiences sought. Their impressions of the design and practical implementation of science lessons in their own classrooms and more general aspects of teaching were also examined. The interviews were conducted at the mid-point and the end of each subject's first year of elementary school teaching.

Subjects

The subjects (Pamela and David) were two novice elementary school teachers employed in state government run schools. Both subjects graduated from a three year preservice degree program.

Background to this study

Prior to the research reported in this paper, quantitative data on each subjects' level of self-efficacy had been obtained through the use of the psychometric test Science Teaching Efficacy Belief Instrument (STEBI-Form B) during a pretest repeated posttest quasi experimental investigation into preservice teachers' science teaching self-efficacy. The instrument, grounded in self-efficacy theory (Enochs & Riggs, 1990), facilitates the monitoring of changes in preservice teachers' science teaching self-efficacy. It consists of two scales labelled Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) and has been validated on a population of Australian preservice elementary teachers (Ginns, Watters, Tulip & Lucas, 1995). Both subjects completed several administrations of STEBI-B at various stages of the preservice program and the respective scores are shown in Table 1. The corresponding instrument for practicing teachers (STEBI-Form A), designed by Riggs and Enochs (1990), was used to provide quantitative data on each subjects' science teaching self-efficacy just prior to the mid-point of their first year of teaching. These results are also included in Table 1.

Results and conclusions

The PSTE and STOE scores for Pamela on STEBI-B are representative of high level efficacy scores and those of David are representative of medium level efficacy scores. This classification is based on a cluster analysis of the mean STEBI-B scores for a group of students comprising the two subjects at the mid-point of the original three year degree program (Ginns & Watters, 1994). The scores for each subject do show minor gains and/or fluctuations, however, they are relatively stable within the high level and medium level efficacy classifications. The relative stability continues to be reflected in the STEBI-A scores. The individual PSTE scores are comparable to the mean PSTE of 49.6 (S.D. 5.9) found by de Laat and Watters (1995) in an investigation of self-efficacy of teaching staff ($\underline{n}$=37) in a large metropolitan elementary school. The individual STOE scores are higher than the mean STOE of 33.9 (S.D. 5.6) found by de Laat and Watters.

Table 1
Administration points, PSTE and STOE scores on STEBI-B and STEBI-A for the two subjects

Year	Administration points:	Pamela		David	
		PSTE	STOE	PSTE	STOE
	STEBI-B				
1*	Commencement of 3 year program	51	40		
2*	Mid-point of 3 year program	53	38	43	36
3*	Completion of 3 year program	57	40	46	36
	STEBI-A				
4#	Three months after commencement of teaching	53	43	42	42

Note: * STEBI-B - maximum scores: PSTE - 65; STOE - 50
STEBI-A - maximum scores: PSTE - 65; STOE - 60

Abridged profiles for the two subjects as novice teachers derived from the relevant semi-structured interviews are outlined below.

Pamela taught a grade 7 class cooperatively with another teacher at a medium sized, semi-rural elementary school. In her first interview Pamela described how shared learning experiences with her son, the practical and relevant experiences of science at university, and interaction with children during hands-on science lessons in field experience sessions provided incentive and motivation for Pamela. These experiences enabled Pamela to overcome negative recollections of science in her own schooling. The initial teaching experiences in her own classroom were different to those anticipated and she now considers that it is not possible to motivate all children. Yet, she considered that her confidence to teach science remains high being reinforced by the positive response of children. She asserted that most children find science exciting and fun and they were prepared to engage in cooperative activities with the teacher. Pamela feels that there is a need to incorporate practical and relevant activities in science programs that illuminate the concepts being studied. Her classroom strategies involved integration, particularly with English, and a preference for children to do mainly group work and related discussion. The opportunity to visit external resource sites was important for Pamela.

At the commencement of her second interview, Pamela commented that the novice year is "a survival thing. You have to persevere with it even though it seems hopeless." In further comment she indicated that "You don't think you are doing all the right things." Pamela questioned whether she was "giving them too much work? Are you giving them enough? Are giving them the right kind of thing? Are you fair to everybody?" She believed that inexperience was the main contributor to self-doubt because "It was worse at the beginning of the year than it is now". When asked to describe what she did to lessen these anxieties Pamela responded by saying "just getting in there and doing it, I think, and that changes the way you look at it." Self-motivation for Pamela was extremely important because "You don't get the chance to see how other people do it when you are in the classroom, basically. You've got to do it yourself and see if it works." Pamela believed, however, that her confidence had not altered during the year, suggesting that she had been confident at all times and capable of handling the complications of science teaching such as "organising your time and resources and stuff." For example, the challenge of an environmental studies excursion to a nearby river system and the use of environmental test kits did not bother her. Major concerns for Pamela were the perceived inequities inherent in the storing, sharing and borrowing of science resources, and the consequent difficulties created when items of equipment needed for science lessons could not be found. The prospect of having to use a new science program did not daunt Pamela, although she admitted that she could not possibly do some of the things suggested like "take a motor to pieces and try to tell people how it works". A positive aspect of the new science program was its reliance on inexpensive materials. When asked to reflect on her first year of teaching and identify what was missing in the preservice program, particularly in relation to science, she recommended that every student should teach at least one science unit in a field experience session, if only to gain experience in overcoming the organizational problems involved. She also suggested that preservice teachers should engage in microteaching experiences in science with small groups of children. When asked if field experience sessions were adequate preparation for the real world of first year teaching Pamela responded "Yes, they do help. I prefer you have done them than hadn't and if they were longer they would be even better". The ideal science inservice program for Pamela at this stage of her professional development would involve persons coming to the school and demonstrating resources and how to use them in the classroom.

David taught a multigrade (3/4/5) class in a small, remote, rural elementary school. Negative feelings about his own high school and initial university experiences in science were balanced by positive experiences in a science curriculum course. The practical nature of the curriculum course and its relationship to teaching influenced his beliefs. Actually planning a teaching unit for assessment in the course boosted his confidence to teach science. He has enjoyed the experience of teaching science so far. He believes that science for children should be practical and related to things outside the school. He has modeled in his classroom a series of science lessons that he observed in a field experience session. It is important to interact with children and for the teacher to act as a guide. David does want children to follow a formal approach to activities, however, he also wants children to search for answers.

In comparison to Pamela, David did not provide any general comments, or indications of self-doubt and self-questioning, about his first year of teaching. When asked to recall his most enjoyable science related teaching experience in the latter part of his first year of teaching, David again referred to the episode involving batteries and bulbs and a culminating project in which the children constructed a model city with street lights, shops, a stadium and a racetrack. He noted that the children enjoyed the activity and, in particular, being able to set up a display for their parents and the local community. He reiterated that he had "seen another teacher do it in one of my pracs (field experience session)" and considered that it was a natural activity for children to do "to get them to use what they know." A teaching experience which involved children observing forces due to moving water was unsatisfactory, prompting his comment that it was "just a waste of time." As a novice teacher he was quite happy to work within an existing, structured science program, however, he did express reservations about not having the opportunity to develop an extended program of 6 weeks duration or more, being limited, at this stage, to shorter 3 or 4 week units of work. He admitted that it took him at least a month after commencing teaching to actually attempt some science with the children. His confidence gradually increased towards the end of the first semester which, in part, may have coincided with the positive outcomes from the children's work on batteries and bulbs and the parental interest generated. David's science teaching strategies tended to be teacher directed with a focus on writing up the experiments reflected in the statement "I was doing the experiments or letting a couple of kids do the experiment and then write it up." The emphasis on teacher direction is also evident in comments about his reliance on whole class work in preference to group work methods, "(I) try and partner up and that even fails...so I've done a lot of whole class stuff." He added that he intended to provide more activity oriented work for children next year. David indicated that the Principal expected him to teach science and directed him towards a set procedure for children to follow when writing up experiments, however, he personally did not view science as a "really major key learning area." When asked to provide his views about how preservice science courses could be improved, he suggested that all students should be required to implement science programs in field experience sessions. He believed that the field experience sessions did help him prepare adequately for his first year of teaching, particularly one session in a small country school where the Principal gave him a great him a free hand to plan his own program. He also suggested that preservice students should implement science lessons in microteaching situations, or in front of their peers. David saw the provision of "resources and ideas" as essential for his further professional development in science.

Vicarious experiences associated with shared learning, practical and relevant courses, and interaction with children appear to have a major influence on Pamela's beliefs and may account for her high self-efficacy. Successful performance evident in positive feedback from the children that she teaches has also been important. Pamela's high motivation enabled her to confront and overcome the many anxieties that confront beginning teachers. Working in a cooperative teaching situation may have helped provide a credible model for affirming her personal beliefs through communication. There was no reference to emotional arousal in Pamela's interviews. The role of vicarious experiences does not appear to be as dominant in David's beliefs although he refers to the implementation, in his own classroom, of successful activities he had seen in field experience sessions. He also reported enjoying teaching science in his own classroom. The small change in his PSTE score from the mid-point to the completion of his preservice degree may have reflected a growing confidence in his ability to teach science, however, he was reluctant to start teaching a science program. The effect of verbal persuasion may be evident in David's desire to work with a highly structured science curriculum framework and adherence to formal science report write-up procedures. Again, there was no reference to the effect of emotional arousal in his interview. Both Pamela and David were critical of the paucity of science lessons they were able to observe during field experience sessions. They expressed concern about the difficulty of implementing English lessons compared to science lessons at this stage of their respective careers.

In addition, possible antecedent factors that may influence self-efficacy have been postulated elsewhere (Watters & Ginns, 1995). These antecedent factors were described as follows:

- High or low self-efficacy are related to experiences in elementary and/or high schools;
- Positive self-efficacy changes are associated with fun science experiences;
- The maintenance or enhancement of self-efficacy is promoted by interactions with children.

Similar factors emerge in the interviews with the novice teachers, however, the emphasis of the beliefs appear to be changing. Both clearly recollect negative science related experiences in their own school careers. Involvement of a personal nature, the applied components of university courses and positive interactions with children were referred to by each subject, although expressed more definitively by Pamela. The change in emphasis is reflected in the view that science is exciting and fun for children and teachers should cater for this aspect by providing hands-on activities. In addition, novice teachers need to experience success through positive feedback from children.

Educational importance of the study

Bandura's self-efficacy model has provided the most significant insights into the general behaviour of teachers (Ashton, Webb & Doda, 1983; Ashton & Webb, 1986; Dembo & Gibson, 1985; Greenwood, Olejnik & Parkay, 1990). In addition, Berman, McLaughlin, Bass, Pauly, & Zellman (1977) found that the most important characteristic determining the effectiveness of change-agent projects was the teacher's sense of self-efficacy. Thus, given Fullan's (1993) contention that the engine of deep change in the education system is the individual teacher, more research needs to be done to explore teachers' self-efficacy and practice in school systems. Further, continuing concerns about the quality and amount of science taught in elementary schools (Tilgner, 1990; DEET, 1989), and the complexity of teacher-learner-curriculum classroom interaction (Germann, 1988), make it an important task to identify and establish the significance of factors which influence the implementation by teachers of elementary science programs. In particular, the personal beliefs that teachers have about themselves and their ability to teach science require investigation because a teacher's beliefs may influence his/her attitudes to science which may result in inappropriate science teaching behaviors (Riggs & Enochs, 1990). The study reported in this paper is an attempt to initiate a response to these issues in terms of monitoring teachers' sense of efficacy during the transition from student teacher to the assumption of full time responsibility for a classroom of children.

The results provide important directions for science teacher educators. Greater attention must be paid to the wide variety of science backgrounds and relevant experiences of prospective teachers and their motivation for wanting to become teachers of elementary science. Students studying science content and methods courses need effective and meaningful instructor-learner-curriculum interactions and discourse within supportive and interesting learning environments. Clearly, students need to observe and participate in a number of successful science lessons during field experience sessions. It is a difficult and vulnerable time for novice teachers and they need to able to reflect and draw upon prior successful experiences and interactions with children.

There are also important implications for schools and the development of induction programs for novice teachers. The two subjects in this study appear to have benefited from involvement in a cooperative teaching situation (Pamela), and a small school environment with a supportive Principal (David). Induction programs should provide this kind of support to enable novice teachers to implement worthwhile science programs. In particular, teachers who have high levels of self-efficacy and have already experienced success in teaching science in elementary schools should be appointed as mentors for novice teachers. While science teacher educators must be aware of preservice teachers' ability to cope with practical experiences in science and science teaching and design courses to either maintain or enhance students' sense of self-efficacy, it is vital that similar support mechanisms continue into the induction year of teaching and beyond. If teacher educators, experienced teachers and school administrators combine their expertise and efforts to foster and develop novice teachers' sense of science teaching self-efficacy, indeed the engine of deep change in the education system (Fullan, 1993), the individual teacher, can operate much effectively for the betterment of science education.

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