DOCUMENT RESUME

ED 375 141 SP 035 553

AUTHOR Watters, James J.; And Others
TITLE Enhancing Preservice Teacher Education Students' Sense of Science Teaching Self Efficacy.
PUB DATE Jul 94
NOTE 29p.; Paper presented at the Annual Meeting of the Australian Teacher Education Association (Brisbane, Queensland, Australia, July 3-6, 1994).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Attitude Change; *Cognitive Restructuring; *Counseling Services; Education Courses; Elementary Education; Elementary School Science; Emotional Response; Foreign Countries; Higher Education; Intellectual Experience; *Negative Attitudes; Preservice Teacher Education; *Science Education; *Self Efficacy; *Student Experience
IDENTIFIERS Australia; *Preservice Teachers

ABSTRACT

This paper reports on the effects of an intervention program designed to develop cognitive and affective skills for the study of science by students undertaking a preservice elementary teacher education course. Previous research has indicated that a high proportion of students coming into this course have had negative experience in their previous exposure to science. These students expressed concern about their ability to learn science and to become effective teachers of science in primary schools. The hypothesis tested was that science teaching self-efficacy can be enhanced through rational evaluation of beliefs about science and by experiencing success in science. The program consisted of a range of intervention strategies based on counselling procedures in which matched groups of students were guided in the self-identification and modification of negative affective states and cognitive distortions with regard to science learning and teaching. The intervention strategies were designed to foster a positive sense of science teaching self-efficacy through a greater awareness of successful learning and thinking in science. The study combined both qualitative and quantitative data which when analyzed and reconciled revealed that students with strong negative experiences in science can develop more positive levels of self-efficacy. However, these changes may occur more as a consequence of the teaching strategies adopted than through counselling. (Contains 45 references.) (Author/LL)

Enhancing Preservice Teacher Education Students Sense of Science Teaching Self Efficacy

Dr James J Watters†, Dr Ian S Ginns†, Paul Neumann⌖ and Dr Robert Schweitzer⌖

†Centre for Mathematics and Science Education
⌖**Counselling Services**
Queensland University of Technology
Locked Bag 2, Red Hill 4059, Brisbane, Australia

Paper presented at the annual meeting of the
Australian Teacher Education Association, Brisbane.

4 July 1994

ABSTRACT

This paper reports on the effects of an intervention program designed to develop cognitive and affective skills for the study of science by students undertaking a preservice primary teacher education course. Previous research has indicated that a high proportion of the intake of students into this course have had negative experiences in their previous exposure to science. These students expressed concern about their ability to learn science and to become effective teachers of science in primary schools. The hypothesis tested was that science teaching self-efficacy can be enhanced through rational evaluation of beliefs about science and experiencing success in science. The program consisted of a range of intervention strategies based on counselling procedures in which matched groups of students were guided in the self-identification and modification of negative affective states and cognitive distortions with regard to science learning and teaching. The intervention strategies were designed to foster a positive sense of science teaching self-efficacy through a greater awareness of successful learning and thinking in science. The study combined both qualitative and quantitative data which when analysed and reconciled revealed that students with strong negative experiences of science can develop more positive levels of self-efficacy. These changes may, however, occur more as a consequence of the teaching strategies adopted in the subject rather than through counselling.

The way a person performs or behaves in a given situation depends on attitudes which are manifestations of both cognitive and affective attributes of that person (Bandura, 1977; Ajzen, 1985; Prawat, 1985, Shrigley, Koballa & Simpson, 1988; Hewson & Hewson, 1989). Thus, the extent to which teachers will teach science in primary school, is influenced by the teacher's knowledge of science and the issues in teaching science as well as their feelings or attitudes towards those cognitions (Morrisey, 1981). Several theories have been proposed in an attempt to explain the development of attitudes. For example, Ajzen (1985) argues that attitudes are influenced by a person's beliefs about the likely outcome of his or her actions as well as a perception of how those actions are viewed by other influential parties. Rotter (1975) argued from a social learning theory perspective that behaviour in a particular psychological situation is dependent on the extent to which there is an expectancy for a particular reinforcement and the value of that reinforcement. Bandura (1977), also from a social learning framework, constructed a theory in which behaviour was seen to depend on one's sense of self-efficacy, a construct which had previously been described in a political context as a personality trait that "enables one to deal with the world" (Barfield & Burlingham, 1974).

According to Bandura's (1977) model of self-efficacy, behaviour is based on two contingencies, firstly, people develop a generalised belief about action-outcome coincidences through life experiences or outcome expectancy and, secondly they develop a more personal belief about their own ability to cope in a given situation, or self-efficacy. In cases where both self-efficacy and outcome expectancies vary, behaviour can be predicted by considering both factors. For example, Bandura hypothesised that a person rating high on both factors would behave in an assured, confident manner in a particular situation. He emphasised that self-efficacy is a situation specific determinant of behaviour not a global personality trait. 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, and 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.

Gibson and Dembo (1984) predicted that teachers with high self-efficacy and outcome expectancy would persist longer, provide a greater academic focus in the classroom and exhibit different types of feedback than teachers low on these constructs. Czerniak (1992) found that elementary science teachers with a high sense of personal teaching self-efficacy used more teaching strategies and used discussion and lecture techniques more often than did the less efficacious teachers. In a comparative study of middle and junior high school science teachers, Schriver (1993) found that knowledge of developmentally appropriate curriculum and instruction had a strong relationship with personal teaching self-efficacy. Teachers who personally have a low sense of self-efficacy but still believe that teachers in general can motivate children are likely to develop low self-esteem. Conversely, a teacher with a pattern of low personal self-efficacy and outcome expectancy is unlikely to suffer from stress. The implications of these beliefs extend beyond immediate classroom practice. For example, self-efficacy has been identified as one of the few characteristics of teachers consistently correlated with student achievement (Ashton, *et al.* 1983). In particular, Ashton and Webb (1986) highlighted the attitudes of teachers with a poor sense of self-efficacy towards low achieving students. These teachers expected low-achieving students to fail and took no personal responsibility for the inevitable. Such teachers are also oriented toward a custodial, authoritarian role in their pupil control ideology (Barfield, & Burlingham, 1974; Woolfolk & Hoy, 1990). Self-efficacy is a teacher characteristic along with school socio-economic environment that mediates the extent to which teachers cooperate and interact with parents (Hoover-Dempsey, Bassler & Brissie, 1987).

A recurring experimental difficulty in analysing the literature has been the methods of measuring self-efficacy. Berman *et al.* (1977), Armor, Conry-Oseguera, Cox, King, McDonnell, Pascal, Pauly, Zellman, Summer, and Thompson (1976) and Brookover, Schweitzer, Schneider, Beady, Flood, and Wisenbaker (1978) defined efficacy in terms of two items based on Rotter's (1975) social learning theory and developed by the Rand Corporation in a study of projects funded by Title III of the Elementary and Secondary Education Act in the USA. These items captured two senses:

- When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his or her home environment.

- If I really try hard, I can get through to the most difficult or unmotivated students.

In a study of the socialisation of student teachers, Hoy and Woolfolk (1990) argue that the first dimension of self-efficacy as defined by the Rand instrument above does not represent outcome expectancy as conceptualised by Bandura (1977). It appears to reflect a general belief that the ability of teachers, as a group, to be effective in teaching is "to reach difficult children and has more in common with teachers' conservative or liberal attitudes toward education". They prefer the term general teaching efficacy to highlight this distinction. Further confusion arises in interpreting the second Rand item which measures a combination of both outcome expectancy and personal self-efficacy (Enochs, Scharmann & Riggs, 1994). This has impacted on studies that have used the general teaching self-efficacy instrument developed by Gibson and Dembo (1984) which contained a series of items that confounded both personal self-efficacy and outcome expectancy. Common to most recent studies is the finding that two factors can be extracted from the data which account for the majority of variance in the test instruments and have valid theoretical interpretations. The two constructs identified as personal teaching self-efficacy and the outcome expectancy dimensions are independent and need to be considered so in studies.

There is also some confusion in the literature as to the exact interpretation of these scales. Furthermore, in studies of self-efficacy another salient factor needs to be considered. Efficacy beliefs are situation dependent (Bandura, 1981). Thus, studies examining teacher's self-efficacy toward the teaching of science, or mathematics, or reading, require instruments that address their beliefs in the context of teaching that body of knowledge. Consequently, Enochs and Riggs (1990), have developed an instrument titled the Science Teaching Efficacy Belief Instrument (STEBI-B) that measures personal science teaching self-efficacy (PSTE) and science teaching outcome expectancy (STOE) of preservice teachers.

Changing self-efficacy beliefs.

Successful performance, vicarious experience, verbal persuasion and emotional arousal have been identified as key contributors to the development of self-efficacy (Bandura, 1977). In the context of preservice teacher education a number of studies have implicated the role of institutions (Stefanich & Kelsey, 1989) and courses (Duschl, 1980; Lucas & Dooley, 1982) as contributors to the development of attitudes. Gorrell & Capron (1988) argued that preservice training programs must attempt to "instill appropriate skills and attitudes" in prospective teachers and especially to focus on efficacy beliefs. They attempted to demonstrate that preservice students of high personal self-efficacy levels would perform better than low self-efficacy students in specific teaching activities involving teaching comprehension though observing cognitive modelling in which an instructor "thought aloud" during a teaching sequence (Gorrell & Capron, 1990). Such techniques did lead to improved performance by all students.

Other studies have reported attempts to change the beliefs and attitudes of undergraduate students to science. Greenburg and Mallow (1982) implemented a clinic based on Wolpe's (1958) behavioural counselling technique of cognitive restructuring and systematic desensitisation. Cognitive restructuring adopts Rational Emotive Therapy (RET) as a component and involves changing irrational thinking and negative self-statements into objective thinking and neutral or positive self-statements (Ellis, 1962; Ellis 1993). Ellis proposed that one's understanding of a situation, if based on an irrational belief system, will lead to maladaptive and irrational behaviour in response to this situation. The solution advocated involves a process of cognitive restructuring through which the subject confronts his/her self-defeating beliefs with the assistance of a therapist. The essential assumption in this model is that the person has a rational control over behaviour which is mediated by cognitive processes and, unlike Bandura's theory, is not solely reactive to situations.

Systematic desensitisation (Relaxation Therapy) involves relaxation training and exposure to anxiety-evoking situations through imagery which is then managed through relaxation techniques (Wolpe, 1958). Wolpe proposed that neurotic habits are learned in anxiety-provoking situations by the association of neutral stimuli with anxiety responses. The anxiety response is a combination of both physiological and psychological components and if, through a process of reciprocal inhibition, a relaxing environment could be induced during anxiety-provoking stimuli, the connection between the stimulus and the anxiety response would be weakened. The first step in systematic desensitisation involved constructing a hierarchy of fear-provoking stimuli, for example, a science laboratory, a science exam or a science seminar, and then teaching the subject relaxation techniques while being confronted with images of the anxiety producing events. In the clinic, implemented by Greenburg and Mallow (1982), students explored their science-related negative self-statements and irrational beliefs in group sessions and at home. They were required to identify those events that triggered anxiety. It was argued that if students can become aware of the origin of their beliefs they are in a position to challenge objectively those thoughts and beliefs. They found that there was a significant reduction in all anxieties associated with science, except test anxiety, over several years. Although this intervention was discussed at length by Anderson and Clawson (1992) the process does not appear to have been replicated.

Persistence and achievement in academic courses has been releated to multiple dimensions of self concept (Michael & Smith, 1976). Similarly, Marsh and Shavelson (1985) developed and used a multi-dimensional measure of self concept in a study of adolescents in a non-clinical context. These developments have the potential to contribute to a more fine-grained understanding of the relationship between self concept and adjustment in tertiary students. The lack of a strong self concept may result in situations involving fear of failure, loss of academic interest, alienation, and dissatisfaction thus contributing to a low sense of self-efficacy. These behaviours may not be specifically related to science but could be general characteristics exacerbated by science if those stimuli generate anxiety.

This study describes the results of a pilot research project designed to identify factors that contribute to the development of self-efficacy and confidence to teach science in commencing preservice primary teacher education students enrolled in a core Science Foundation content subject. The project involved the implementation of intervention strategies based on the theories of behaviour modification described above (Ellis, 1962; Wolpe, 1958; Marsh & Shavelson, 1985) and the monitoring of changes in self-efficacy and confidence to teach science. The aims of the project were to:

- To identify factors that contribute to a sense of self-efficacy in learning and teaching science;
- To develop an awareness in students of their own perceptions, beliefs and attitudes to science;
- To enhance students' thinking and learning skills in foundation science.

Methods

The design of this study is a combination of qualitative and quantitative approaches. Quantitative data have been obtained through a pretest-posttest multiple group experimental design while rich descriptions of individual participants have been acquired through interview, field notes and observation.

Subjects:

The subjects were students commencing year one of a four year primary teacher education program. At the beginning of the first semester of their program the cohort of 161 students enrolled in the Science Foundations subject were randomly assigned to workshop groups timetabled at two hour intervals during the day. Practical considerations concerning room availability, timetable realities and assigned staffing limited the extent to which randomised equivalent study groups could be constructed for this pilot research study. As only two suitable rooms for workshops associated with the subject were available, one group comprised 24 students and the second 48 students. The tutor in charge of the smaller group was A and B was in charge of the larger cohort of students assisted by a second tutor. The whole of A's workshop group and half of B's were used as a source of subjects for counselling intervention. These subjects were matched on the PSTE scale scores obtained from a STEBI-B pretest. The remaining half of the B's group were not exposed to any intervention strategy nor interviewed but were pre and posttested on the survey instruments.

Interventions were conducted in two sessions on the same day. Students from A's workshop group were distributed to each of the intervention subgroups: Rational Emotive Therapy; Relaxation Therapy and Self Concept Development. Their respective intervention session was conducted at the end of the scheduled workshop by three counsellors experienced in the strategies. Participating students in B's workshop group were similarly distributed and their respective intervention session was conducted in the afternoon following lunch. All students consented to the study which was described as a pilot project to investigate methods of promoting or developing a sense of self-

efficacy in preservice teachers, reducing anxiety about learning science and to provide strategies to improve performance in science.

Configuration of the respective workshop groups and intervention subgrcups is shown in Table 1.

Table 1 *Configuration of intervention and workshop groups*

Workshop group	Intervention subgroup
A's	Self Concept Development
	Systematic Desensitisation
	Rational Emotive Therapy
B's	Self Concept Development
	Systematic Desensitisation
	Rational Emotive TherapyT

All groups were required to complete the same course work and were assessed in accordance with the approved subject outline. The students were required to attend a one hour large group lecture and a two hour practical workshop. A one hour tutorial was voluntary.

Procedures

In Week 1 of the semester during a scheduled laboratory workshop all students enrolled in Science Foundations were pretested with the following psychometric instruments:

- a measure of sense of self-efficacy - Science Teaching Efficacy Beliefs Instrument (STEBI-B) (Enochs & Riggs, 1990);
- a measure of academic locus of control - Academic Locus of Control (ALOC) (Trice, 1985);
- a measure of science related attitudes - Test of Science Related Attitudes (TOSRA) (Fraser, 1981);
- a measure of interest in science teaching - Subject Preference Inventory (SPI) (Markle, 1978);
- a measure of self concept - Dimensions of Self-Concept (DOSC) (Michael, Denny, Knapp-Lee, & Michael, 1984).

The STEBI-B, ALOC, SPI and DOSC instruments have been validated for use with the level of students being investigated in this study and have been used in previous studies on student retention in university settings. TOSRA measures attitudes to sceince in seven conceptually different areas and has been validated on high school children (Fraser, 1981). Sample questions from TOSRA and DOSC are shown in Table 2.

At the completion of the semester all students enrolled in Science Foundations were posttested on the psychometric measures using the same forms of the tests. Academic achievement scores were also recorded.

Table 2 *Sample Questions from TOSRA and DOSC Scales*

Scale	Sample question
TOSRA	
Social implications of science	"Money spent on science is well worth spending".
Normality of scientists	"Scientists usually like to go to their laboratories when they have a day off".
Appreciation of scientific inquiry	"I would rather find out about things by asking an expert than by doing an experiment".
Adoption of scientific attitudes	"I am curious about the world in which we live".
Enjoyment of learning science	"I really enjoy going to science lessons".
Leisure interest in science	"I would like to belong to a science club".
Career interest in science	"Working in a science laboratory would be an interesting way to earn a living".
DOSC	
Academic anxiety	"I become quite worried about how well I am doing in my classrooms".
Academic interest and satisfaction	"I enjoy doing classroom assignments".
Academic aspiration	"I strive to be one of the best students in every class I take".
Leadership and initiative	"I am pleased when professors ask my opinion about topics we are studying in class". "I can convince my fellow classmates to go along with my ideas".
Identification vs alienation	"Professors care about their students" "Teachers make school work enjoyable".

The quantitative measures were complemented by a series of interviews of students. Interviews were semi-structured and were undertaken in the second week of semester and in the last week of semester outside scheduled class times. The interviews were designed to encourage students to focus on critical incidents in their life that related to their learning of science either at school in the case of the first interview and during the semester in the case of the second interview. In the second interview their experiences in relation to the intervention groups were explored. Several research assistants were used to record interviews but both pre and post-interviews were conducted where practicable by the same research assistant following a group training and briefing session.

The interviews were transcribed and coded using a system developed from the data as they were generated. Two researchers and two research assistants independently coded the interviews and

discussions held to obtain agreement. From these data a profile of each of the 48 students was constructed. Only 35 students could be interviewed at the end of the semester.

The Treatment

Eight students from the two groups, matched for self-efficacy scores, were assigned to each of the intervention strategies as described previously. Six sessions were scheduled over the length of the semester.

Subgroup 1 (Self concept Development) students were involved in clinical sessions designed to develop a sense of self-efficacy. Participants were encouraged to explore constructs and relationships which may have contributed to, or detracted from their sense of self-efficacy. In addition, they were encouraged to recognise areas of strength which they might bring to bear in the development of a sense of science self-efficacy.

Subgroup 2 (Relaxation Therapy) students participated in a series of clinical sessions in which a counsellor adopted a systematic desensitisation strategy. This was done in group mode with individual students confronting a pre-established hierarchy of anxieties which were, in part, constructed from their previous interviews and tests by the researchers.

Subgroup 3 (Rational Emotive Therapy) students participated in a series of clinical sessions in which a counsellor adopted a cognitive restructuring intervention strategy. Students explored their own science-related negative experiences and irrational beliefs. The students were helped to identify their own preferred learning styles, needed support mechanisms and coping strategies. The irrationality of their anxieties were explored and confronted.

The intervention groups assembled in the building where the students were taught and were conducted by counsellors experienced and accredited in the techniques described. Joint meetings were held at intervals during the semester with all intervention participants to discuss progress and strategies.

Results

Results from the administration of the psychometric tests, at the beginning of the semester, are reported in Table 3 for the whole group. Previous observations (Ginns, Watters, Tulip & Lucas, In press) for the interrelations between PSTE, STOE, ALOC and DOSC were confirmed. Subject preference index (SPI) scores indicate that 2.3% of students would choose to teach science before any other subject and 8.1% chose it as second choice. Seventeen students (9.9%) ranked it last.

Table 3 *Correlations Between Self-efficacy Scales and Selected Personality and Learning Scales (N =147)*

Scale	Variable	PSTE	STOE
Academic Locus of Control		-.410 ***	
Subject Preference Inventory	Maths teaching preference	.173*	
	Science teaching preference	.395 ***	
Test of Science Related Attitudes	Attitude to scientific inquiry	.173*	
	Enjoyment of science	.389 ***	.155*
	Social implications of science		.137*
	Adoption of Scientific Attitudes	.323 ***	.226**
	Leisure interest in science	.368 ***	.206**
	Career interest in science	.421 ***	.149*
Dimensions of Self Concept	Aspiration	.300 ***	.259 ***
	Anxiety	-.405 ***	
	Academic interest and satisfaction	.221**	.207**
	Leadership and initiative	.410 ***	.225**
	Identification vs alienation	.262 ***	.236**

Note: * $p < .05$; ** $p < .01$; *** $p < .001$.

Personal science teaching self-efficacy is correlated with both locus of control and general academic anxiety, leadership and initiative and preference to teach science. A standard multiple regression was performed with PSTE as dependent variable and subscales of TOSRA and DOSC as independent variables which were entered into the equation stepwise. Assumptions of normality of scales were tested by the Lillifors Kolmogorov-Smirnov statistic (Norušis, 1993). From the DOSC instrument, Anxiety, Leadership and Initiative and from the TOSRA instrument, Career Interest contributed significantly to predicting PSTE. In combination, these three variables contributed to 33% of the variability in PSTE. Thus, those students who initially expressed a positive confidence in their ability to teach science also were internally motivated and have low levels of academic anxiety, and state that they prefer to adopt a leadership role demonstrating initiative. These students have a strong preference to teach science over other subjects in the primary curriculum. Science teaching outcome expectancy, a belief that children can learn science irrespective of the teacher, is more weakly related to the scales measured as might be expected as these scales relate to beliefs about oneself and not other's behaviours. However, a belief in one's own aspirations and the adoption of scientific attitudes do correlate moderately with outcome expectancy. A multiple regression with STOE as dependent variable revealed that DOSC Aspiration and TOSRA Adoption of Scientific Attitudes contributed only to a minor 11% of the variability in STOES The absence of correlation with anxiety reinforces the orthogonality of the PSTE and STOE scales.

Posttests reveal minor positive changes in PSTE and significant negative changes in other dimensions. These results are summarised in Table 4. Multiple regressions were also performed with the posttest PSTE entered as a dependent variable and the posttest scores on TOSRA and

DOSC entered stepwise as independent variables. Thirty nine percent of the variability of PSTE was accounted for by the combined TOSRA scale scores on Enjoyment of Science, DOSC Academic Interest and DOSC Anxiety. Only 23% variability in STOE post scores was accounted for by any of the variables and that was a sole contribution from DOSC Identification and Alienation.

Table 4. *Pretest and Posttest mean scores on Self Efficacy (STEBI), Science Related Attitudes (TOSRA) and Self Concept (DOSC)*

TEST	SCALE		PRETEST	POSTTEST	CHANGE	SD	SIG
STEBI	PSTE	Science teaching self-efficacy	44.86	45.82	0.96	6.2	ns
	STOES	Outcome expectancy	35.23	34.40	-0.83	4.2	<.05
TOSRA	SIS	Social implications of science	36.49	35.28	-1.21	4.2	<.01
	NS	Normality of scientists	35.17	36.08	0.92	4.3	<.05
	ASI	Attitude to scientific inquiry	37.48	35.43	-2.05	6.2	<.001
	ASA	Adoption of scientific attitudes	38.30	36.45	-1.85	4.1	<.001
	ESL	Enjoyment of science	32.29	32.11	-0.18	5.9	ns
	LIS	Leisure interest in science	27.02	26.15	-0.87	5.6	ns
	CIS	Career interest in science	28.41	27.87	-0.54	5.9	ns
DOSC	ASPIR	Level of aspiration	63.41	59.25	-4.16	6.9	<.001
	ANXIETY	Anxiety	47.36	47.20	-0.17	8.3	ns
	AIAS	Academic interest and satis	50.61	47.16	-3.45	6.8	<.001
	LAI	Leadership and initiativ	42.44	41.77	-0.67	7.2	ns
	IVSA	Identification and alienation	55.96	52.03	-3.93	6.5	<.001

Note $N = 107$

Significant changes in STOE may be expected as the course does not address children's learning. Other studies, (Ginns *et al.*, In press) suggest that when preservice teachers are exposed to teaching experiences involving children STOES scores do increase. The decrease in Identification and Alienation reflects a decreased confidence by the students in their teachers. They are tending towards a belief that the university teachers are not really concerned about student progress and welfare. Like STOE, this is a belief about another person.

The pretest mean scores on the various TOSRA scales are all well within one standard deviation of the mean score published for high school students (Fraser, 1981). Published interscale correlations indicated high correlations between the three scales of Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. Similar, but higher correlations are seen in the data reported here for the pretest (.77;.77;.76) and postest (.74;.68;.70). The Social Implications of Science scale identifies attitudes towards the social benefits and problems which accompany scientific progress. The decrease between pre and post measures reflects a less favourable attitude. The Normality of Science scale measures the level of appreciation that scientists are normal people rather than eccentrics. The implication of the observed decrease in scores is that the students perceive scientists to be less like normal people which may reflect their first contact with University academics. The decrease in Attitude to

Scientific Inquiry measures attitudes to scientific enquiry and experimentation as ways of obtaining information. As the subject content deals specifically with certain elements of the philosophy and history of science and the nature of knowledge students may have become more critical of traditional positivistic science. Adoption of Scientific Attitudes scale measures characteristics such as open mindedness, willing to revise opinions and scepticism and a decrease in this scale would raise concerns that students are not valuing those characteristics.

The decreases in self concept reflect global changes in students' beliefs after a semester of university study. The DOSC instrument is a generalised measure of students' academic self concept and would reflect experiences adjusting to university throughout the whole semester and not just those involving science. The context of testing may, however, have biased the instrument.

Nevertheless, measures of level of Aspiration, Academic Interest and Satisfaction and Identification and Alienation have all significantly decreased. Michael and Smith (1976) argued that if students set too high or too low a level of aspiration they could well become discouraged, depressed and fearful of loss of status in the view of peers, parents and teachers. Setting low level goals could generate a certain degree of immediate security and preservation of self-esteem at the expense of longer term development of positive attitudes and leadership roles. Highly anxious students are likely to lose academic interest, fail to achieve satisfaction and develop feelings of alienation and hostility to the learning environment and institution.

Students who are relatively free of anxiety and set realistic goals or levels of aspiration attain success that engenders academic interest and feelings of satisfaction and assume leadership responsibilities. This cycle is mutually reinforcing. Success leads to success while failure leads to failure. Although self-efficacy is a domain specific trait and factors significantly associated with science would impact on self-efficacy these generalised considerations would be expected to contribute to the development of positive or negative changes in self efficacy.

The data were next analysed detail to identify possible treatment effects. Posttest scores were compared between intervention strategy subgroups and control students who did not participate in any intervention group using ANCOVA with pretest scores entered as covariates and corrected for differences in cell means. No significant differences were noted at alpha .05.

Qualitative analysis

Examination of discrete scores revealed some students expressed very large changes in either direction for both the PSTE and STOE scales. The quantitative measures may not reflect situation at a personal level. Selected cases which demonstrated changes in personal science teaching self-efficacy by more than one standard deviation and which represented a variety of

final states of self-efficacy are shown in Table 5. This table also summarises their background high school science and the number of years since they studied school science.

Table 5 *Summary of cases selected for detailed description*

NAME	Workshop	SUBGROUP	Years	School Sci*	PSTE	STOES	PSTE2	STOES2
Victoria	A's	SELF CONCEPT STRATEGY	1	B,MS-12	44.00	45.00	40.00	33.00
Adrienne	A's	SELF CONCEPT STRATEGY	14	B-12	34.00	37.00	44.00	33.00
Lesley	A's	SELF CONCEPT STRATEGY	20	SC-8	31.00	42.00	53.00	45.00
Harriot	B's	SELF CONCEPT STRATEGY	1	P-12	52.00	35.00	45.00	32.00
Bunny	B's	SELF CONCEPT STRATEGY	19	SC-8	30.00	38.00	51.00	28.00
Meleta	A's	RELAXATION THERAPY	6	B-12	51.00	39.00	45.00	36.00
Cameron	B's	RELAXATION THERAPY	2	B-12	43.00	33.00	51.00	36.00
Dimsi	B's	RELAXATION THERAPY	1	B-12	49 00	48.00	56.00	38.00
Nibia	A's	RET	4	SC-10	46.00	42.00	58.00	39.00
Michelle	A's	RET	3	MS-12	42.00	38.00	51.00	41.00
Adele	A's	RET	1	B-12	52.00	38.00	46.00	39.00

*Note: B = biology; C = chemistry; MS = multistrand; P = physics. PSTE & STOE are pretest scores, PSTE2 & STOE2 are posttest scores.

These profiles will now be examined in detailed. The selected subject will be briefly described and his or her background described in a reconstruction of the two interviews.

Cameron was a male student in B's tutorial group and attended the relaxation therapy intervention strategy group. His personal science teaching self-efficacy increased by 8 points. In his first interview he reflected on his previous experiences to do with science.

> In years 11 and 12 I studied biology which I preferred to other sciences I had studied in year 10 because they got too complex. In particular, my year 10 teachers were bad. The teacher just pumped the facts out to us and I could not get an understanding of Chemistry or Physics as it just went straight over my head. My mother is a nurse and she was supportive of me steering me towards biology.

His reflections are typical of many students who were interviewed in this study. The difficulties and lack of interest in science was attributed to a negative experience during the early years of high school. Family support and encouragement were significant in influencing this student to pursue biology. At the completion of the semester his experiences are reconstructed in the following narrative.

> At the commencement of semester I was quite apprehensive about this subject. My previous experiences with chemistry and physics were unfortunate. Nevertheless, I began with a feeling that science could be fun because it is easier to understand at a lower level and we won't go into as much complexity as in high school. I think I could teach it well but I believe that children can only learn science up to a point.
>
> I am now a lot less concerned about learning science because I found that the lectures were good and in particular the teaching staff seemed all right as people. The workshops and lectures were good, because the lectures were related directly to the workshops. The intervention group activities were good because they calmed us down a bit. I had previous experience in this strategy and in particular didn't like repetitive nature of relaxation. I would have preferred another group for variety. The aims of the group I saw as an attempt to reduce apprehension to science and exam conditions. This aim was achieved a little through visualising myself coping with difficult situations. What was also very valuable was that the group situation helped me a little to get to know other students. Overall I was happy with the course because the teaching staff made the course interesting and straight forward.

An analysis of the quantitative scores indicated some consistencies between his described feelings and attitudes and changes in TOSRA and DOSC scales. For example, as would be expected from his improved sense of self-efficacy, his anxiety levels decreased and feelings about the caring nature of teachers improved. The measured enjoyment in science workshops improved.

Nibia was a female student in A's tutorial group and attended the rational emotive therapy intervention strategy group. Her personal science teaching self-efficacy increased by 12 points. In her first interview she reflected on her previous experiences to do with science.

> It has been three years since I studied any science and that was at junior level which was a combined science. I liked science in grades 8 and 9 but disliked it in year 10 mainly because the theory got too hard and confusing and we did not do any practs. My year 9 teacher was good and made science fun by doing lots of practical work which made it easier to understand and made me want to learn. In primary school we did very little practical work. I was sort of interested in science because my father did environmental testing. We had microscopes at home which my father used and he helped me with collecting and examining insects. My parents believed in encouraging me in anything that I showed interest in. I believe that if the teacher can make science interesting and fun then students will want to learn otherwise they will find it boring and won't learn. At school I did no more science because of the level of difficulty.

Her reflections are similar to Cameron's although she had a very positive experience with a year 9 teacher. Once again, there is a family connection with science in which interest and relevance were pursued. Nibia, nevertheless held concerns about the difficulty of science but expressed no strong emotional reaction to science.

> At the beginning of the semester the lectures were intimidating because it was hard to understand and the readings were hard. On the other hand, workshops were good because of the discussions. There were problems with large tutorials because they were depersonalised.
>
> Although I was assigned to a specialist group to help me with science, I did not go. It's just that with the one-hour lecture in the beginning and the two hours of the workshop, that extra hour was meant to spend on the groups. It was too much. I just couldn't do it. It was too many hours to find in the one stretch.

The quantitative analysis revealed an increase in attitude to scientific investigations consistent with an increase in PSTE but aspirations to be a top student dropped substantially by 9 points. In contrast to an expected drop, anxiety increased by 10 points. She also had less confidence in professor's concerns about their students, a measure echoed in her comment about tutorial groups. Nibia profile is complex. Her self concept pattern is consistant with Michael and Smith's (1976) expectations in that high anxiety would cause her to lose academic interest and develop feelings of alienation. The large drop in aspirations may contribute to anxiety through a perceived loss of status. However, these global characteristics do not explain the substantial increase in PSTE from an already mean level and reinforce the assertion that self-efficacy is domain specific. One could speculate that factors outside the subject are impacting on her self concept.

Michelle was a subject whose self efficacy also increased substantially. She was exposed to the rational emotive therapy and was placed in A's tutorial group. Her prior experiences with science are captured in the following narrative.

> It has been two years since I studied science in high school. I did multistrand science in years 11 and 12 after junior science. My high school science was sort of ok. I did an elective class in science in high school because I was interested in it and the teacher was influential. The fun part of science is doing the practical work. Teachers were boring and made theory irrelevant which meant I could not get interested. So I was sort of looking forward to teaching science because I could show little experiments myself. What is important about children in learning science is whether they want to follow it on in later life.

Her experiences are again typical. Interest predominates her reflections especially as it relates to actually doing practical work. The impression that science teaching should involve practical activities is encouraging. Subsequently she mused:

> At university I found initially that lectures were boring but my views changed when I went into C's group. There you could say what you wanted to. Her group was not so formal and she encouraged us to present our own opinions. Laboratory was great fun but I did not always enjoy every experiment. It was the opportunity to discuss that was of benefit. As I said before, if you are not interested in the subject you won't listen. Also the structure of university lectures is not conducive to learning. People, like me, are too embarrassed to talk in front of 150 students. Nevertheless, lectures were still relevant. But I believe that it is hard to make things interesting especially with science.
>
> I only went to the intervention program once. I found that the first time I thought "ah what am I doing here? I don't really need to be here", it just didn't interest me. So we, I, didn't go any more because it just felt really irrelevant to what we were doing in relation to science. Maybe because I didn't understand why we were going there. I don't think it helped much with science because we just did not talk about science. I just didn't want to go. That was just it, I didn't, I didn't really want to go.

The quantitative data revealed large drops in beliefs about the value of science and change in perception of the normality of scientists. Her aspirations to be a top student dropped but she developed a more positive view point of the concerned nature of teachers. Clearly, these attitudes did not come through from her intervention group activities but probably reflected the positive experience in A's workshop. The theme of informality, fun, expression of ideas generated interest which may have impacted on both dimensions of her self-efficacy.

Adele was assigned to A's workshop group and the rational emotive therapy intervention group. Her personal science teaching self-efficacy dropped while the outcome expectancy held constant.

> I finished year 12 last year where I did biology which I liked and found very interesting because it had things to do with the body and environment and it was easier to learn. I did primary at a Catholic school where I believe that I was not grounded in science basics. I felt disadvantaged and originally had a bad feeling about science. However, my high school teachers were approachable and good and they encouraged me. My sister failed biology at high school which also made me hesitant about doing biology. In the end I did not like parrot learning in science but looked forward to university science as part of my course because the different types of science may be interesting. Good teachers need to encourage children and they can then learn science.

Adele, although a school leaver, shared some of the concerns of the mature age students in being at a disadvantage because of some perceived deficit in her exposure to science. She shares the concern that science needs to be relevant. The role of the teacher is important in her thinking.

> At university lectures were initially daunting because a lot of information was just spat at you but now I am used to it. I did some of the content in Grade 10 and did not understand. Now I do and therefore I enjoy it. C's group was "fantastic". The special group was not interesting or useful. I don't think that it helped me to enhance my learning. I remember them saying to us that you're going to do these things to enhance your learning but we were doing other things like communication and I just didn't think it helped. That the aims and purpose was to help learn science was not totally clear. It was useful because it did help to get to know fellow students. The group talked about one's confidence when faced with problems. I think that building up one's confidence is important.

The workshop provided a positive experience but no value was perceived with the intervention group. The collegialiality that developed through the intervention and her sympathy with the aims of the program although misinterpreted should be noted. Despite the stated viewpoint the quantitative data provided an alternative picture. Adele's anxiety increased, academic aspirations and beliefs about their teacher's concern for their students fell. There were also substantial falls in attitudes towards science seen in the TOSRA scales. The increase in PSTE seen in this student must be attributed to the successful workshop experience.

Adrienne expressed a large increase in personal science teaching self-efficacy. She attended the workshops run by A and the intervention group that focussed on Self Concept Development. In the pre-interview she reflected on her experiences. Feedback from the interviewer also indicated that she was physically quite apprehensive about the course, problems concerning her family and her background. Her reflections highlight concerns expressed by a number of the more mature age students who attended school in the 1970's:

> It is a long time since I did science about 13 years. I liked biology because it was more human and less mathematical. I did year 12 biology because I did not like the physics and chemistry part of year 10 general science. Unless I have an interest in it I don't like doing it. I was a 7 student in other subjects but only a 5 in biology. It was the sixth subject so I dropped it off. In primary school astronomy got me interested in science. I loved reading about the planets and moons and dissecting things in primary school. I used to take frogs home but I don't remember doing much other science in primary school. In year 10 I remember a debate about evolution which also made me interested in science. It was the conflict of ideas between religion and science that made science interesting to me. In those days, I was not encouraged to do science. My parents had a strict division on what was a female/male role and science was not for females. My father was an engineer. We had a strict division, the girls did the washing up and the boys work on cars. When it comes down to it like when my son asks me how the motor mower works I have no idea. And also my mother said to me a woman's not nice unless she

goes and has babies and gets married. There was no encouragement for science. All my brothers had to do science. My friends did music and art. In the end I started a law degree but did not complete that.

At the beginning of the se ester I felt fear because it had been so long since I had done any science training that others have a better understanding of concepts. I had to start from scratch whereas other people have done science. I did not like chemicals and had a fear of the unknown. I was very apprehensive. Originally, I felt apprehension towards the course but I am looking forward to teaching science if I can understand it. I believe that all children can learn science but whether they identify with it or not, that is understand, is another thing.
Intervention group was enjoyable. I think that the more mature students got more out of the group, because they related better to each other. Younger students stopped attending sessions, because weren't prepared to share thoughts as readily.
Getting together and talking was useful as it helped us to cope with the course work. The workshop was particularly good.

The analysis of the quantitative data supported the view that this subject had developed a strong liking for classroom practical activities. Adrienne has also developed stronger academic leadership aspirations and beliefs about the caring nature of teachers. Comments recorded in field notes by the interviewer also reinforced the perception that her self esteem had dramatically improved. A strong feature emerging from her experiences is the concern about being disadvantaged in regard to her knowledge and skills. The opportunity to discuss both in the workshop situation and in the intervention group would have allowed her to realise that these concerns were probably unfounded and that most students in her situation held similar concerns.

Lesley had the largest gain in personal science teaching self-efficacy. She was in A's group and attended the Self Concept Development intervention groups.

It is about 20 years since I have studied any science and that was only to grade 8 level. Then it was expected that boys did science and girls became secretaries. My parents reinforced this attitude by guiding me away from science. I was never really discouraged but never encouraged either. I was generally directed towards secretarial studies. However, after school I went on to do secondary teaching in home economics but found it very scientific and so had to drop out. I had no understanding of the science involved in the course. The experience caused me to fear science greater. I also feel inadequate about science as I can't answer my own children's questions. I have this fear but I want to get over it. I want to be inquisitive but do not want to look a fool. My lack of confidence is due to a lack of knowledge and belief that mature age student is at a disadvantage due to not being up to date as students straight from school. I believe that children can learn science because all children have basic curiosity and so it's the

> way they are directed. They need to be encouraged to go further and have an understanding of the child. My reaction to science is a mixture between fear and a desire to overcome that fear. I want to ask questions but not feel foolish. What the hell just ask the question there is probably 9 out of 10 who want to ask the question. Its about confidence mature age students although they are here because they want to be we know less in a lot of things. We have a desire to find out. I can't learn things by rote I must understand. I would rather do an assignment.

Lesley expresses a feeling of inadequacy in science because of a lack of knowledge and a perception that she was disadvantaged. These feelings are consistent with a low PSTE. Her pretest levels of DOSC Aspiration and Anxiety scales and TOSRA Adoption of Scentific Attitudes are high. But those scales associated with interest and enjoyment were low. Her drive to discover answers for herself is consistent with the TOSRA data.

> On reflection, I was initially very tense and apprehensive and was not looking forward to the semester. Indeed I found lectures very daunting, it was a different language. That feeling has changed particularly because tutes have changed my attitudes. Journal writings in C's group helped mor than the intervention group. I wanted to talk about science which we did in tutes. It is important that teaching staff need to break it down into simpler language. B is overwhelming. He gives you the impression that you don't belong here. Quite in contrast to my tutor's approach. The intervention groups, I don't know if they really did help me. I suppose it was useful in my circumstances because I'm sort of out of step so that I got to know other people. So in that way it was useful. But apart from that not really. I had problems adjusting to the groups. Like we'd sort of do group discussions of on each person. We made up the charts and like you'd be discussing one point and then he would sort of say something, then we, he'd just sort of, it was as if he was going off thinking about something, and just left it quite. Like when you were the person that you were talking about it got very intimidating I think, more than anything else. You just wanted to get it over and done with. I think that the sessions were not very useful for helping us learn science.
>
> I don't know what you could in the future with these type of interventions, I don't really know because I got more out of the, the actual tutes. Like if they run it like A's tute I think people would have a lot better understanding of what's really going on. I don't know that they would really, those sessions would really help you, unless you actually sat down about your actual feelings about science, and spoke about that, because we never really even brought up science. And sort of honing in on that rather then everything broad, I don't know.

The changes in TOSRA scales are substantial for Enjoyment of Science, Leisure Interest in Science and Career Interest. DOSC anxiety levels dropped and large increases in Academic Interest and Satisfaction and Identification and Alienation were observed which put her in the upper range of all subjects. The workshop experience has clearly been the substantial factor impacting on this student.

Harriot was in A's workshop group and attended the intervention group that focused on Self Concept Development. She is unusual in that she is one of the few students to have done and liked physics at grade 12 level. However, her personal science self-efficacy and science teaching outcome expectancies dropped during the semester.

> I left school last year. I did physics in years 11 and 12 which I liked and was good at. I tried to do a lot of science because I wanted to do architecture. Most of my teachers were good because they were helpful and explained things well. I hated chemistry because it was hard and my teacher was very bad. I like science but I get nervous through my own insecurity. In my younger years the family went out on astronomy nights but we did little science in primary school. I think that all children can learn science and I am looking forward to this course.

Harriot's background may have instilled a high degree of confidence resulting in a higher measure of personal science teaching efficacy. She was relaxed and assertive during her interview and seemed to present a picture of one who because she had done it before knew it all.

> Early weeks of the semester I had no feelings but was worried about doing the science course. My fear lessened because lectures were good and enjoyable. concerned about others. Not sure how teaching staff could help more other than being more available. We could be more involved in practical work. I did not attend intervention group because I did a similar course at high school which involved relaxation techniques and relaxing for exams and to make the most of studying habits and things like that. So I didn't feel that it was necessary to do another.

Her confidence in her ability to deal with science would seem to have influenced her decision not to attend the intervention groups. Indeed, she misinterpreted the strategies being used in the intervention group associating it with relaxation therapy rather than self concept development. Given her statement about her insecurity she may have benefited from the planned concept development strategies. Besides her large (7) drop in personal science teaching self efficacy falls in TOSRA scales concerning Adoption of Scientific Inquiry, Enjoyment in Science and Interest in Science dropped. Her dimensions of self concept also fell with large decreases in Academic Aspirations and beliefs about her teachers concern for student welfare and a concomitant increase in anxiety.

Meleta is representative of three students whose personal science teaching self-efficacy fell. She had grown up on a farm where she and commented that science was not overtly a point of focus in the family. She was placed in A's workshop and was assigned to the relaxation therapy group.

> I did biology in year 12 five years ago. I had no strong feelings about it but I didn't like the teacher, a typical science person. That turned me off a bit. If you enjoy the teacher's way of teaching and the teacher your bound to learn more. He was very intelligent and spoke at a level that nobody understood. In year 12 biology was just boring. I mainly disliked dissecting toads. Genes and characteristics I liked. However, my parents encouraged me to do biology because it was good for me. I had mixed feelings about doing science at university. I am probably looking forward to it but I believe that teachers need to explain science at the student's level and explain thoroughly then the students will take an interest in it. There is also a need to relate to real life. The amount of work worries me about science foundations.

Like Harriot, Meleta recorded an above average score on the pretest of PSTE. Her recollections of the semester focussed almost entirely on the group intervention session.

> I found that at university the lectures were a big influx of information and there was so much to do. As time went on the lectures made more sense and got interesting. In our treatment group we did relaxation which was all right. Well, the first time I really enjoyed it because I relaxed, but the two subsequent times that I went I sort of I couldn't, I don't know why. I clearly understood that the objectives of the intervention groups was just to try and get a better perspective on yourself and science so that you would feel positive about science and about teaching it and could convey that to the kids. However, I could not relax . It did help and the group made an impact. I could see myself doing well in exam and this helped with exam confidence because I felt all right about doing the mid-semester exam. However, the sessions did not help on competence. They also helped to meet other students but we didn't talk about science.

Descriptions of Meleta by her tutor were very positive. She was seen as a "front row" student who provided a lot of input into discussions and made every effort to reflect on and clarify issues raised in lectures. She gave the impression that she enjoyed the workshops. This was confirmed by the TOSRA scores in which enjoyment of science, interest in science and orientations towards scientific inquiry increased. On the DOSC scales level of enjoyment in classroom activities increased but anxiety and aspirations to be a better student also increased. This increased level of aspiration coupled with anxiety may be a consequence of a more conscienious effort towards science and recognition that she was struggling with the concepts. Such concerns may have impacted on Meleta's self-efficacy. Her creditable results in the final grade bore out the results of sustained effort.

Dimsi was placed in B's workshop group and the relaxation therapy group that met in the afternoons. She recorded a moderate rise in personal science teaching self-efficacy but a large decrease in science teaching outcome expectancy. This pattern was an extreme case of the trend observed across all students.

> I did science from year 8 to 11 and in year 12 I did biology. I finished last year. I really enjoyed biology although I was more history oriented and I chose biology because of lining problems. The teacher was good and we did hands on things like dissection other things that I could relate to every day life. Some of my junior science was learnt off just for exams and I could not relate it to anything. I can't even remember what they were, I think that we did things on the solar system. My teachers had a impact, I thought, because if they really liked what they were doing then they motivated us and worked to be interesting so I think the attitude of the teacher is important. Family and friends didn't talk about science and I can't remember much science in primary school so I don't have any strong feelings about science.
>
> I suppose I am looking forward to teaching science. I want to motivate the children. I think that one's first experience with science determines if you will learn science.

Dimsi started with a moderately positive self-efficacy score and a strong belief in children's capability of learning science. The need to make science interesting and relevant and for the teacher to model interest are clear features of her discussion. She seemed somewhat ambliviant to the future at that stage of her course but her attitudes became more clear during the post interview.

> I felt at first pretty scared about the course and others said this as well. However, things got better because the tutors were helpful. The lecturers were good and B explained concepts thoroughly. I Did not go to groups because we went home and we came back for the Maths lecture at night because otherwise we'd have four hours in between. Too much time involved in intervention groups although others who went said relaxation made them feel good.

Dimsi's performance on the TOSRA and DOSC scales are contradictory. Although her self-efficacy improved her anxiety also increased along with a decreased level of academic aspiration. Her attitudes to science, interest in science and confidence in the concern of teachers also fell. Coupled with a poor performance overall on the course her PSTE score is enigmatic.

Bunny was allocated to B's workshop group and self concept development intervention group. Also a mature age student her increase in personal science teaching self efficacy was extreme. Unlike Lesley, she exhibited a large drop in outcome expectancy from a moderate starting level.

> It has been 18 years since I studied science in Year 8. Initially, I enjoyed it because a lot of it was interesting and some of it difficult. My science teacher was horrible because she just yelled at us a lot. We felt we were not perfect and everything had to be precise for her. I was never going to be that perfect and so I did not like science. Furthermore, at the end of Grade 8 the teacher said to my Mum don't let her do academic subjects.

I have got three little kids and I do lots of this like looking in the garden and pouring liquids. My husband likes to do thing with the kids.

Science is interesting and scary because I am not precise enough. It is just because of the experimental nature of science. Everything has to be just right. Different aspects such as biology is interesting, particularly biology. Physics in particular is scary because I don't understand much about it. Really bright people do physics.

The man I married was very good at science and his father was a scientist and has encouraged me and I want to help kids discover things. I think all kids can learn science because it is all around them.

Bunny, like her mature age colleagues has had very negative experiences in relation to science. Her PSTE score was one of the lowest overall and science presents itself as a situation that she expects to have difficulty coping with. Her feelings are expressed again in the post interview:

I found the subject very frightening and I was worried that I did not know enough. We were all scared of B who I thought expected a really high standard and he does.

The intervention group just didn't meet often enough. I was embarrassed, having to talk about ourselves. I did not really find out what the group was all about until the last meeting and the coordinator didn't go into it very much at all, we sort of left still not really knowing. Thus I don't think the group had any major difference in terms of my sense of competency in dealing with the course or how I felt really. There was only three in our group, and I guess the three of us didn't have many other tutes or anything in common, so that was the only time we ever really saw each other. We talked about our feelings about our own, I suppose, potential for success, and strengths that we could bring to the course. I think, it made me think about what strengths I had, but it was very difficult, you had to talk about your personal life and your deep feelings about things, so it was a little bit hard.

This student's quantitative scores are also enigmatic. Her scores on all scales except anxiety and enjoyment of science fell by in most cases by more than one standard deviation. Perhaps setting a lower level of aspiration did generate a degree of security but at the expense of maintaining a leadership role and positive attitudes to science. Support through her friendship group would help to maintain self esteem. Despite these changes, she had developed a good understanding of the content of the subject as her grade performance was outstanding.

Victoria attended A's workshops and the self concept development intervention groups. She recorded falls in both dimensions of self-efficacy particularly in science teaching outcome expectancy although from a very efficacious level.

> I studied multi strand science and biology last year. I chose to do science, particularly biology and multistrand, because I liked science except for physics and chemistry which were more about numbers and I did not like that much. My cousin used to help me with assignments in which I had to build things.
>
> I think that teaching science should be fun - experiments and that. All children can learn if they are encouraged.

Her reflections on previous science experience are positive but not indicative of any outstanding success or interest. Her post interview revealed some interesting concerns that were expressed by several other students.

> I basically thought that the lectures has nothing to do with the workshops and I found that difficult. If I did not understand something in the lecture it was not explained in the workshop. We were A's group and had to write up reflections which I was not used to doing. I did not like the informality of A's group. In school we used to write proper structured experiments rather than trying to write up feelings. I went to only one of the intervention sessions. It was not useful because it was too demanding of time and had nothing to do with the lectures.

The perception apparent here is that Victoria was used to a formal structured approach. While many students complained about the information and facts presented in lectures, Victoria was accepting of this but wanted explanation. She considered that time was important and that self-help strategies would not be of benefit for her. Analysis of her quantitative data revealed substantial decreases in measures of academic interest and satisfaction, aspirations, confidence in teaching staff's concerns about their students, interest in classroom work, leadership and in scientific attitudes. Despite these negative changes her overall grade performance was creditable.

Conclusions

The aims of this study had been to explore factors that contribute to low personal science teaching self-efficacy and to use these factors in an intervention program that utilised counselling techniques to increase self concept, provide skills to reduce anxiety or to rationalise and confront negative prior experiences. Resources, timetabling curricula and non-curricular pressures on students challenged these aims.

Although the proportion of students studying science in high school has improved over earlier times (Ginns, Jeays, Muller-Stamp, Spooner, & Watters, 1989) this belies the nature of their experiences. Twenty five percent of the students interviewed expressed outright dislike of science and most of the remaining related specific negative incidences mostly concerning secondary high school teaching of science. Clearly, attitudes towards the teaching of science continue to be a major concern. Negative attitudes to the learning of science are also apparent and fear, anxiety and apprehension expressed by nearly all students needs to be addressed.

Of the three interventions designed to meet this challenge, Rational Emotive Therapy appeared to be rejected by almost all those who attempted to participate. The common concern related to a lack of perceived connection between the strategy and their apprehensions about science. By the third session that intervention program had ceased to function. Relaxation therapy implemented in the systematic desensitisation intervention provided a number of students with skills that they appreciated and applied in their mid-semester exam. But as Melita, Cameron and others stated the technique appeared to achieve its immediate aims within the first two weeks and its relevance there after was limited. However, those who did attend that workshop were clear on the aims of the intervention and saw its direct relevance to science. Furthermore, many spoke in the final interview of the desire to continue these interventions but coupled with traditional tutorial content. Among those who did not attend this session after the initial contact were some who believed that they had done a similar program in high school and did not need this intervention. The third group which involved Self concept Development as a strategy presented an interesting contrast. Those who participated had difficulty in reconciling the activity with science. This is not surprising as the strategy was designed to address more global personality traits. However, the group did persevere as it appeared to catalyse the formation of cooperative work and friendship associations particularly among the more mature students who were more willing to discuss their concerns and experiences than the younger students. This shared experience may have decreased anxiety levels by reducing the isolation felt by mature age students. This collegial atmosphere may have been reinforced given that these students were in A's workshop group which was conducted along a more open cooperative style of teaching.

A further characteristic consistent with self-efficacy theory is that the changes in general self concept are not necessarily reflected in changes to personal science teaching self-efficacy or science teaching outcome expectancy. Several of the discussed students, for example Dimsi and Bunny, showed increased PSTE scores despite negative changes in DOSC scales. Self-efficacy is a domain specific characteristic. The results described here give us some confidence that curriculum initiatives can reduce anxiety and enhance personal confidence in students' perception of their ability to cope with teaching science.

The negative change in STOE was expected as the students have not experienced observing children successfully learning science. It is clear that self-efficacy is a characteristic that changes during the preservice training of teachers and will reflect their most powerful and recent experiences. The implications for preservice teacher educators is that domain specific attitudes can be monitored and curricula and teaching strategies can be modulated to meet the affective needs of students. Self-efficacy theory provides a reliable theory for framing these developments.

References

Ajzen, I. (1985). From intentions to actions: A theory of planned behaviour. In J. Kuhl & J. Beckmann (Eds.), *Springer Series in Social Psychology. Action Control: From Cognition to Behaviour* (pp. 11-39). Berlin: Springer-Verlag.

Anderson, G. A., & Clawson, K. (1992). Science anxiety in our colleges: Origins, Implications, and cures. Annual Meeting of Mid-South Educational Research Association.

Armor, D. J., Conry-Oseguera, P., Cox, M. A., King, N., McDonnell, L. M., Pascal, A. H., Pauly, E., Zellman, G., Summer, G. C., & Thompson, V. M. (1976). *Analysis of the School Preferred Reading Program in selected Los Angeles minority schools.* (Report No. R-2007-LAUSD). Santa Monica: Rand.

Ashton, P. T., Webb, R. B., & Doda, N. (1983). *A study of teachers' sense of efficacy. Final report, executive summary.* Gainsville, University of Florida.

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement.* New York: Longmans.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review, 84,* 191-215.

Bandura, A. (1981). Self-referent thought: A developmental analysis of self-efficacy. In J. H. Flavell & L. Ross (Eds.) *Social cognitive development frontiers and possible futures.* (Pp. 200-239). Cambridge, UK: Cambridge University Press].

Barfield, V., & Burlingham, M. (1974). The pupil control ideology of teachers in selected schools. *Journal of Experimental Education, 42,* 6-11.

Berman, P., McLaughlin, M., Bass, G., Pauly, E., & Zellman, G. (1977, April). *Federal programs supporting educational change; Vol. VII: Factors affecting implementation and continuation* (R-1589/7-HEW). Santa Monica, CA: Rand.

Brookover, W. B., Schweitzer, J. H., Schneider, J. M., Beady, C. H., Flood, P. K., & Wisenbaker, J. M. (1978). Elementary school social climate and school achievement. *American Educational Research Journal, 15*(2), 301-318.

Czerniak, C. M. (1992). A qualitative comparison between preservice elementary teachers identified as having high and low levels of personal science teaching self-efficacy. Conference paper Annual Meeting of the National Association for Research in Science Teaching, Boston.

Dembo, M. H., & Gibson, S. (1985). Teachers' sense of efficacy: An important factor in school improvement. *The Elementary School Journal, 86*(2), 173-184.

Duschl, R.A. (1980). The elementary level science methods course: Breeding ground for an apprehension toward science? A case study. *Journal of Research in Science Teaching, 20*(8), 745-754.

Ellis, A. (1962). *Reason and emotion in psychotherapy.* New York: Lyle Stuart

Ellis, A. (1993). Reflections on Rational-Emotive Therapy. *Journal of Consulting and Clinical Psychology, 61,* 199-201.

Enochs, L. G., & Riggs, I. M. (1990). Further development of an elementary science teaching efficacy belief instrument: a preservice elementary scale. *School Science & Mathematics*}, *90*(8), 694-706.

Enochs, L. G., Scharmann, L. C., & Riggs, I. M. (1993). The Relationship of Pupil Control to Science Teacher Self-Efficacy and Outcome Expectancy. Paper in preparation.

Fraser, B. (1981). TOSRA: *Test of Science-Related Attitudes*. Hawthorn, Victoria: Australian Coucil for Educational Research.

Fullan, M. (1993). The complexity of the change process. In *Change Forces: Probing the Depths of Educational Reform* (pp. 19-41). London: The Falmer Press.

Gibson, S., & Dembo, M. H. (1984). Teacher efficacy: a construct validation. *Journal of Educational Psychology*, *76*, 569-582.

Ginns, I., Jeays, D., Muller-Stamp, E., Spooner, A. & Watters, J.J. (1989). *Survey of science teaching in Queensland Primary Schools*. A report to the Board of Teacher Education. Brisbane: BCAE.

Gorrell, J., & Capron, E. W. (1988). Effects of instructional type and feedback on prospective teachers self-efficacy beliefs. *Journal of Experimental Education*, *56*, 120-123.

Gorrell, J., & Capron, E. (1990). Cognitive modeling and self-efficacy: Effects on preservice teachers' learning of teaching strategies. *Journal of Teacher Education*, *41*, 15-22.

Greenburg, S. L., & Mallow, J. V. (1982). Treating science anxiety in a university counselling center. *The Personnel and Guidance Journal*, *61*, 48-50.

Greenwood, G. E., Olejnik, S. F., & Parkay, F. W. (1990). Relationships between four teacher efficacy belief patterns and selected teacher characteristics. *Journal of Research and Development in Education*, *23*, 102-106.

Hewson, P., W, & Hewson, M. G. A'B. (1989). Analysis and use of a task for identifying conceptions of teaching science. *Journal of Education for Teaching*, *15*, 191-209.

Hoover-Dempsey, K. V., Bassler, O. C., & Brissie, J. S. (1987). Parent involvement: Contributions of teacher efficacy, school socioeconomic status, and other school characteristics. *American Educational Research Journal*, *24*(3), 417-435.

Hoy, W. K., & Woolfolk, A. E. (1990). Socialization of student teachers. *American Educational Research Journal*, *27*, 279-300.

Lucas, K. B., & Dooley, J. H. (1982). Student teacher attitudes toward science and science teaching. *Journal of Research in Science Teaching*, *19*(9), 805-809.

Markle, G. C. (1978). Assessing the validity and reliability of the subject preference inventory with preservice elementary teachers. *Journal of Research in Science Teaching*, *15*, 519-522.

Marsh, H. W., & Shavelson, R. (1985). Self-concept: its multifaceted, hierarchical structure. *Educational Psychologist*, *20*, 107-123.

Michael, W. B. & Smith, R. A. (1976). The development and preliminary validation of 3 forms of a self-concept measure emphasizing school-related activities. *Educational and Psychological Measurement*, *36*, 521-528.

Michael, W. B., Denny, B., Knapp-Lee, L., & Michael, J. J. (1984). The development and validation of a preliminary research form of an academic self-concept measure for college students. *Educational and Psychological Measurement*, *44*, 373-381.

Morrisey, J. T. (1981). An analysis of studies on changing the attitude of elementary student teachers toward science and science teaching. *Science Education*, *65*, 157-177.

Norušis, M. J. (1993). *SPSS for Windows: Base system user's guide, Release 6.0*. Chicago: SPSS Inc.

Prawat, R., S. (1985). Affective versus cognitive goal orientations in elementary teachers. *American Educational Research Journal*, *22*, 587-604.

Riggs, I. M., & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education*, *74*, 625-637.

Rotter, J. B. (1975). Some problems and misconceptions related to the construct of internal versus external control of reinforcement. *Journal of Consulting and Clinical Psychology*, *43*, 56-67.

Schriver, M. (1993 April). A comparison of middle and junior high science teachers' levels of efficacy, and knowledge of developmentally appropriate curriculum and instruction. Paper presented at the annual meeting of the National Association of Research in Science Teaching, Atlanta, GA.

Shrigley, R. L., Koballa, T. R., & Simpson, R. D. (1988). Defining attitude for science educators. *Journal of Research in Science Teaching*, *25*, 659-678.

Stefanich, G. P., & Kelsey, K. W. (1989). Improving Science attitudes of preservice elementary teachers. *Science Education*, *73*, 187-194.

Taylor, P. C. S., Fraser, B. J., & White, L. R. (1994). CLES: An instrument for monitoring the development of constructivist learning environments. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, April 1994.

Trice, A. D. (1985). An academic locus of control scale for college students. *Perceptual and Motor Skills*, *61*, 1043-1046.

Wolpe, J. (1958). *Psychotherapy by reciprocal inhibition.* Stanford, CA: Stanford University Press.

Woolfolk, A. E., & Hoy, W. K. (1990). Prospective teacher's sense of efficacy and beliefs about control. *Journal of Educational Psychology*, *82*, 81-91.