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THE PREDICTORS OF PRE-SERVICE ELEMENTARY TEACHERS' ANXIETY ABOUT TEACHING SCIENCE

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Introduction

Preservice teachers enter into the teacher education programs and teaching profession with different beliefs, motivations, experiential backgrounds and concerns (Olson & Appleton, 2006; Riggs, 1995; Yılmaz-Tuzun, 2008). Their beliefs, backgrounds and concerns may have positive or negative impact on their behaviors and performance in teacher education programs and in their future classrooms (Brookhart & Freeman, 1992; Czerniak, 1989; Enochs & Riggs, 1990; Hollingsworth, 1989). One of these attributes related to their affective state is their anxiety about teaching. Anxiety about teaching is an affective state which is expressed in unpleasant feelings, physical symptoms, and coping behaviors (Sinclair & Nicoll, 1980). Thomas (2006) defined teaching anxiety as the feelings, beliefs, or behaviors that interfere with a person's ability to start, continue, or finish teaching tasks.

Anxiety arises when individuals' feeling of self-adequacy and security are threatened (Sinclair, Heys and Kemmis (1974). If anxiety arises individuals behave in a way to avoid the threat to increase the feeling of control over the situation. A number of studies have showed that anxiety interferes with the direction of attention (Wine, 1971) and with the memory processes, such as remembering and selecting correctly from various related set of information (Seiber, O'Neil & Tobias, 1977). Reduction in anxiety often leads to an enhanced achievement (Zoller & Ben-Chaim, 1988).

Teaching anxiety may have dramatic impacts on teachers' professional effectiveness and in-class behaviors. For example, teaching anxiety may result in the use of authoritative techniques of classroom management or abandoning the planned lessons (Sinclair & Nicoll, 1980). Teaching anxiety may reduce teachers'

Abstract. *The aim of this study was to investigate the nature of the relationship between pre-service elementary teachers' anxiety about teaching science and their self-efficacy beliefs about science teaching, their perceptions of the nature of their past experiences in science teaching, the number of science courses they took in college and their previous grades in these science courses. The data was collected from 82 pre-service elementary teachers enrolled in an M.Ed program. The results indicate that personal science teaching efficacy and number of science courses taken in college are the significant predictors of science teaching anxiety. Pearson correlations among the variables show that their perception of their experiences in science teaching, grade point average of science courses and perception of science background indirectly influence science teaching anxiety. The effect of these variables on science teaching anxiety was mediated by personal science teaching efficacy.*

Key words: *perception of past experiences in science courses, science teaching anxiety, self-efficacy.*

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creativity with lesson plan design and their energy level in the classroom and their intention to integrate new teaching methods into their teaching practice (Thomas, 2006). Teaching anxiety may also influence teachers' performance and persistence in the profession in an undesired way. Koran and Koran's study (1981) demonstrated that highly anxious preservice teachers who did not receive any memory support performed worse at acquisition of teaching skills than those who were provided with protocol models including a set of teacher questions. Anxiety about teaching in teacher candidates was found to be related to their attrition from teaching. In a longitudinal study, Marso and Pigge (1998) reported that teacher candidates with high level of teaching anxiety and less positive attitudes towards teaching did not become certified as teachers. Byrne (1994) reported teaching anxiety as a major component of teacher burnout.

A number of studies suggested that some level of teacher anxiety might become detrimental not only to the teachers' professional well-being but also to their students. Koran and Koran (1981) reported that teacher anxiety was negatively related with students' performance. Doyal and Forsyth (1983) found teachers' anxiety to be positively related to students' anxiety but negatively related to their rapport and acceptance by the students.

A more domain specific dimension of teaching anxiety among preservice elementary teachers is their anxiety about science teaching. Preservice elementary teacher's anxiety about science teaching may result in poor performance in both teacher preparation programs and in their future classrooms, poor acquisition of teaching skills and knowledge about science, avoidance of science teaching and undesired students' outcomes in the future. Westerback and Long (1990) suggested that teachers who were more comfortable with science were likely to devote more time to teaching it, and approached teaching science with more creativity and diversity. Less anxious elementary science teachers are more likely to use open-ended inquiry and students-centered instructional strategies. On the other hand, teachers with higher sense of anxiety relied upon teacher-directed instructional strategies (Czerniak & Schriver, 1994; Czerniak & Haney, 1998).

A number of studies have explored the relationship between science teaching anxiety and self-efficacy beliefs (Czerniak & Chiarelott, 1990; Czerniak & Lumpe, 1996). Among all the beliefs that influence human functioning, self-efficacy belief is critical in explaining and predicting human actions (Bandura, 1997). Self-efficacy belief is defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). As proposed by Bandura (1997), self-efficacy is specific to a particular set of behaviors and comprises two components: efficacy expectations and outcome expectations which are respectively related to the beliefs in personal capacity to affect a behavior and belief that the behavior will result in a particular outcome. In science teaching contexts, self-efficacy is an individual's belief that one has the ability to effectively perform science teaching behaviors (called personal science teaching efficacy) as well as one's belief that his/her students can learn science given factors external to the teacher (called science teaching outcome expectancy), such as gender, ethnicity, etc. (Ramey-Gassert, Shroyer & Staver, 1996).

Purpose and Significance of the Study

The aim of this study was to investigate the predictors of pre-service elementary teachers' science teaching anxiety. In other words, the variables that influence or are related to science teaching anxiety were identified in this study. In doing this, the degree of the simultaneous relationship between pre-service elementary teachers' science teaching anxiety and some variables such as their self-efficacy beliefs about teaching science, their perception of their past experiences in science teaching, the number of science courses they took in college and their previous grades in the science courses they took in college was examined. Pre-service teachers' self-efficacy about teaching science in relation to their science teaching anxiety was examined by considering its two components, namely, personal science teaching efficacy and science teaching outcome expectancy. Although the bivariate relationship between teaching anxiety and self-efficacy beliefs about teaching has been studied by a few researchers the simultaneous contribution of self-efficacy beliefs and the other variables considered in this study has not been investigated in the literature.



Previous studies have shown that teaching anxiety is detrimental to teachers' professional well-being and consequently to their students' performance. For the improvement of elementary science teachers' performance in teacher preparation programs and in their future professional life their anxiety about teaching science should be reduced. In order to reduce this undesired affective state its predictors should be investigated. As the factors that influence science teaching anxiety are identified, the teacher preparation programs can be shaped into less anxiety-arousing environments. It was the purpose of this study to identify the triggers of pre-service elementary teachers' science teaching anxiety.

Methodology of Research

Participants

The participants of the study consisted of preservice elementary science teachers who were enrolled in a M.Ed program in elementary education at a university in Ohio in USA. This M.Ed program is a graduate level program which admits students who have baccalaureate degree in science related areas. The program includes a series of professional courses leading to teacher licensure for teaching science to elementary school students. The data of this study was collected from 82 preservice elementary science teachers who were taking a science teaching methods course. These preservice teachers were selected as the participants because of the group's diversity in terms of their experience in science teaching. Although they had not started student teaching by the time the instruments were administered they had had experience in formal or informal field settings. Among 82 participants, 41 of them had had science teaching experience in settings, such as in formal classrooms, summer camps and museums.

Instruments

The instruments used to collect data in this study are described below.

The Science Teaching Anxiety Scale

The existing and frequently used anxiety scales constructed by other researchers (e.g., Parsons, 1973) already include items measuring teaching self-efficacy (e.g., I feel confident about my ability to improvise in the classroom). In order to prevent this overlapping a 20-item Science Teaching Anxiety Scale constructed by the researcher was used to assess pre-service teachers' anxiety about science teaching. In the items of this scale, situations that are in line with science teaching demands are provided and preservice teachers are asked how they would feel about the given context. The items consist of statements, such as "Imagine that you are conducting an experiment to explain a science concept. How would you feel?" "Imagine that you are in front of the class explaining a science concept? How would you feel?" "Imagine that you need to collaborate with other teachers to prepare lesson plans about science. How would you feel about working with other teachers about planning lesson plans for science?" and "Imagine that a student in your class asks you to explain how a scientific principle works. How would you feel about answering the question?" In this scale participants are required to choose one among the 14 verbal descriptors that best describes their feeling about the given situation. The rating scale includes verbal descriptors, such as wonderful, fine, comfortable, steady, does not bother me, indifferent, timid, unsteady, nervous, worried, unsafe, frightened, panic, and scared stiff. These verbal descriptors were given to 3 professors in the field of educational psychology and 11 graduate students in science education program. They were asked to rank the verbal descriptors from the least to the most anxious affective state. All of them arranged the given verbal descriptors in the above provided order in which the unpleasantness of the feeling increases as we go from the adjective "wonderful" to "scared stiff." The face and content validity of the items were checked by a professor who taught a course about motivation and a professor who taught science teaching courses. Based on the feedbacks of the experts 7 items of the scale were modified. The reliability coefficient (Cronbach Alpha) of this scale was found as 0.92.



Science Teaching Self-Efficacy Belief Instrument

In order to assess pre-service elementary teachers science teaching self-efficacy beliefs Science Teaching Efficacy Beliefs Instrument (STEBI-B, pre-service version) developed by Enochs and Riggs (1990) was administered. This instrument has two subscales one of which aims to measure personal science teaching efficacy (PSTE), which refers to teacher's belief in his/her ability to perform science teaching behavior. The second subscale aims to assess science teaching outcome expectancy (STOE), which reflects a teacher's belief that students' learning can be influenced by his/her teaching. This scale consists of 25 Likert type statements, such as "Even teachers with good science teaching abilities cannot help some kids to learn science" and "I will find it difficult to explain to students why science experiments work." The published Cronbach alpha for the PSTE subscale was found as 0.89 and for STOE it is 0.76.

Past Experience in Science and Science Teaching Questionnaire

In order to assess preservice teachers' grades in previous science courses, their perceptions of their background in science, the number of science courses they took in college and their perception of the nature of their past experiences about science teaching, a questionnaire constructed by the researcher was used. The questionnaire constructed consists of three sections. In the first section of the questionnaire, preservice teachers were asked to self-report the number of science courses they took in college and their grades for science courses pursued in college. The second section of the questionnaire includes 7 Likert type items about preservice teachers' perceptions of their background in science. Examples to the items are "I had done poorly in science content classes" "I did not learn well in science classes" and "I had difficulty in learning science concepts." The reliability coefficient (Cronbach Alpha) of this subscale was found as .89. In the third section of the questionnaire, preservice teachers were asked whether they have had an experience in science teaching. They were requested to briefly explain the nature of their experiences and select one of the negative or positive descriptors that describe best their experience. Examples to these descriptors are scary, stressful, unpleasant, enjoyable, relaxing and comfortable.

Procedure

The self-reporting instruments were administered to the preservice elementary teachers in a M.Ed course. Because of the sensitive nature of anxiety inventories (Westerback & Long's, 1990), the science teaching anxiety scale was administered prior to the other questionnaires. Completion of the surveys by the preservice elementary teachers took about 40 minutes.

Data Analysis

The data collected was analyzed by multiple regression analysis to examine the extent to which (a) the dimensions of science teaching efficacy (PSTE and STOE), (b) grade point averages of science courses taken in college, (c) perception of background in science, (d) number of science classes taken in college and (e) the nature of past experiences in science teaching predict science-teaching anxiety. Pearson correlations among all the variables were computed to get an idea about the nature of correlations among the variables in this study. ANOVA was generated to compare science teaching anxiety of preservice teachers who have no experience, positive experience and negative experience in science teaching.

Data Management

In order to classify preservice elementary teachers with respect to their perception of their past experiences, they were requested to choose one of the six descriptors (i.e., enjoyable, relaxing, comfortable, scary, stressful, and unpleasant) which describe best their experience in science teaching. Participants who chose one of the positive descriptors (enjoyable, relaxing, and comfortable) were categorized as



having positive experience in science teaching. Likewise, participants who chose one of the negative descriptors (scary, stressful, and unpleasant) were classified as having negative experience in science teaching. In terms of the nature of past experience in science teaching, three groups of preservice elementary teachers emerged: (1) preservice elementary teachers with no experience in science teaching ($n=41$); (2) preservice elementary teachers with positive experience in science teaching ($n=26$); and (3) preservice elementary teachers with negative experience in science teaching ($n=15$). For the purpose of multiple regression analysis 2 dummy variables were created to explore the relationship between science teaching anxiety and the nature of preservice teachers past teaching experience. In the first dummy variable, preservice elementary teachers who had had a positive experience were coded as 1 and the others were coded as 0 (pre-service teachers with positive teaching experience: 1; others: 0). In the second dummy variable, preservice teachers with no experience in science teaching were coded as 1 and the rest were coded as 0 (pre-service teachers with no teaching experience: 1; others: 0).

In order to calculate students' grade point average of science courses taken in college, number of credits of each science course was multiplied by the numeric value of the grade received for that course. Then, this value was added up for each course and divided by the number of total credits received for science courses.

Results of Research

Pearson correlations were computed to determine the significant relationships among the variables in this study. The results of Pearson correlations are displayed in Table 1.

Table 1. Inter-correlations for science teaching anxiety and other variables.

Variable	1	2	3	4	5	6	7	8
1. Science Teaching Anxiety	—							
2. Number of Science Courses Taken in College	-0.274*	—						
3. Grade Point Average of Science Courses	-0.286**	0.093	—					
4. Perception of Science Background	-0.465**	0.317**	0.533**	—				
5. Positive Experience vs. No Experience and Negative Experience-Dummy Variable 1	-0.339**	0.170	0.210	0.412**	—			
6. No Experience vs. Positive and Negative Experience- Dummy Variable 2	0.187	-0.208	-0.168	-0.226*	-0.681**	—		
7. Science Teaching Outcome Expectancy (STOE)	-0.151	0.015	0.197	0.072	-0.051	0.017	—	
8. Personal Science Teaching Efficacy (PSTE)	-0.613**	0.143	0.245*	0.644**	0.484**	-0.298**	0.155	—

* $p < 0.05$; ** $p < 0.01$

As Table 1 suggests, science teaching anxiety was found to be significantly correlated with the number of science course taken in college, grade point average of science courses, pre-service teachers' perception of their background in science, positive experience vs. no or negative experience (dummy variable 1), and personal science teaching efficacy. It should be noted that the correlations are all



negative. This means, for example, that the more pre-service teachers had personal science teaching efficacy the less anxious they felt about science teaching. Similarly, the more they perceived to have positive experience rather than negative experience or no experience the less anxious they felt about science teaching. Table 1 also shows that personal science teaching efficacy is highly correlated with the perception of science background and dummy variable 1. That is, the more pre-service teachers perceive that they had a good background in science the more they believed that they had the ability to teach science. Likewise, pre-service teachers who perceived that they have had a positive experience in science teaching had higher personal science teaching efficacy compared to those who had not had experience or had a negative experience in science teaching. The results of Pearson correlations also show that science teaching outcome expectancy was not found to be significantly correlated with either science teaching anxiety or personal science teaching efficacy.

In order to determine the degree to which each variable simultaneously contributes to the science teaching anxiety, multiple regression analysis was generated. Simultaneous entry procedure was used to provide a detailed view of the strengths of the associations between the dependent variable and the predictors. The results of the multiple regression analysis are summarized in Table 2. The results of multiple regression analysis show that the linear combinations of predictor variables and science teaching anxiety significantly explained 44% (adjusted $R^2 = 0.44$) of the total variance in science teaching anxiety ($F(7, 74) = 8.18, p < 0.001$).

As Table 2 suggests, only personal science teaching efficacy and number of science courses taken in college accounted for a significant percent of variance in predicting science teaching anxiety. The values of standardized β s indicate that personal science teaching efficacy was a relatively more significant predictor of science teaching efficacy.

Table 2. Regression analysis summary for predicting science teaching anxiety.

Variables	B	SEB	β
Science Teaching Outcome Expectancy	-2.08	4.96	-0.038
Personal Science Teaching Efficacy	-21.19	4.69	-0.57**
Number of Science Courses Taken in College	-18.21	8.47	-0.20*
Grade Point Average of Science Courses	-63.43	45.09	-0.15
Positive Experience vs. No Experience and Negative Experience	-48.12	67.41	-0.09
No Experience vs. Positive and Negative Experience-	-46.94	57.44	-0.10
Perception of Science Background	2.78	6.02	0.07

Note. $R^2 = .436$ $N = 82$ * $p < .05$. ** $p < .01$

Although the Pearson correlation between the science teaching anxiety and dummy variable 1 (positive experience vs. no experience and negative experience) was significant, this variable did not account for a significant portion of the variance in science teaching anxiety when it was entered with the other variables in the model. This is due to the high correlation between this variable and personal science teaching efficacy. When it was simultaneously entered into the model along with personal science teaching efficacy, the common variance explained by both of these variables was excluded from the common variance explained by science teaching anxiety and dummy variable 1. Thus, the unique variance explained by dummy variable 1 did not account for a significant portion of the variance in science teaching anxiety. Similarly, although Pearson correlations show that grade point average of science course taken in college and perception of science background were found to be significantly correlated with science teaching anxiety, these variables did not account for a significant portion of the variance in science teaching anxiety when they entered with other variables into the regression model. This result emerged also due to their correlation with personal science teaching efficacy.

In order to compare preservice teachers' science teaching anxiety across the levels of the perceived



nature of their experience in science teaching (no experience, positive experience and negative experience) ANOVA was generated. The results of ANOVA are displayed in Table 3.

Table 3. The Summary of ANOVA.

Source	SS	df	MS	F
Between	539883.77	2	269941.89	5.32**
Within	4009888.48	79	50758.08	
Total	4549772.26	81		

Note. Dependent variable: Science teaching anxiety; Independent variable: Nature of Experiences in science teaching. ** $p < 0.01$

As Table 3 indicates, ANOVA was resulted in significant F ($F(2, 81) = 5.32, p < 0.01$). This means that there was a significant mean difference in pre-service teachers' science teaching anxiety across the different levels of the nature of their experiences. The results of Scheffe Test indicate that there was a significant mean difference between pre-service elementary teachers who have had positive experience and negative experience or no experience in science teaching in terms of the science teaching anxiety. On the other hand, there was not found a significant mean difference between pre-service teachers who had no experience and negative experience in science teaching in terms of science teaching anxiety. However, it should be noted that the effects of the nature of science teaching experience on science teaching anxiety was mediated by personal science teaching efficacy.

Discussion

The purpose of this study was to investigate the predictors of preservice elementary teachers' science teaching anxiety. The results of multiple regression analysis show that preservice elementary teachers' personal science teaching efficacy and number of science courses taken in college are the significant predictors of science teaching anxiety. However, the results of Pearson correlations and ANOVA indicate that preservice elementary teachers' perceptions of the nature of their experiences with science teaching, their grade point average of science courses taken in college and their perception of science background indirectly influence science teaching anxiety. The effect of these variables on science teaching anxiety was mediated by personal science teaching efficacy.

It is possible to explain the results of this study from the perspectives of different motivational theories, such as social cognitive theory and drive theory. According to Weiner (1992), Hull and drive theorists contend that pleasure and pain are determined by attainment or nonattainment of a goal. This conception has been called hedonism of the past. Once pain-inducing stimulus-response association is learned through experiences, emotional reactions such as anxiety and fear are instigated whenever threatening situation emerges. In other words, emotional reactions like anxiety depends on the extent to which a person perceives a situation as psychologically threatening which is greatly influenced by individuals past experiences.

In terms of science teaching anxiety, individuals who have had a negative or positive science teaching experience may generalize this past experience to subsequent science teaching experiences. Sarte (1970) defined anxiety as a fear of failure to meet a standard. Preservice teachers, who perceived that they met the demands of science teaching in the past, may be less afraid of failing to teach science effectively and, thus, feel less anxious about science teaching. In this study, it was found that preservice elementary teachers who have had positive experience with science teaching were less anxious than those with negative experiences. However, it should be taken into consideration that the effect of the nature of past experiences was confounded by personal science teaching efficacy. Based on the nature of their experiences preservice teachers may anticipate pessimistic or optimistic scenarios that are in line with their past experiences. Once preservice teachers have had positive experiences with science teaching their perception of their capabilities may be raised. This could lead preservice teachers to preconceive positive images of ability and result in lower anxiety toward science teaching. On the other



hand, individuals with negative or no experiences in science teaching may harbor pessimistic thoughts about their future accomplishments.

In this study preservice teachers' personal science teaching efficacy was found to be the strongest predictor of their anxiety about teaching science. The relationship between science teaching anxiety and self-efficacy beliefs was reported in previous studies (Czerniak & Chiarelott, 1990; Czerniak & Lumpe, 1996). Among the other thoughts that affect human functioning self efficacy beliefs provide a foundation for human motivation and accomplishments. Bandura (1986) believes that stress and anxiety primarily arise when individuals believe that they can't handle the approaching problem. Believing that you are likely to succeed or cope with the problem results in good feelings, such as pleasure, while expecting failure brings about bad feelings, such as anxiety. In the context of science teaching, a preservice teacher who does not believe that he/she can cope with the demands of science teaching will feel uncomfortable with teaching science and produce anxiety.

According to Bandura (1986), individuals form their self-efficacy beliefs by interpreting the information from different sources. The most influential source is the interpreted result of one's previous performance, or personal mastery experience. Having successful experiences lead people to believe that they can succeed while failure in past experiences gives rise to lower self-efficacy. In this study, it was found that higher grade point average of science courses taken in college, better science content background and more positive experiences in science teaching resulted in higher personal science teaching efficacy and, thus, lower science teaching anxiety. The number of science classes taken in college was found to be another significant predictor of science teaching anxiety. Preservice teachers who took higher number science courses in college perceive science teaching less threatening. In a previous study Westerback and Long (1990) documented a similar result. They found that increased content knowledge reduced experienced elementary teachers' anxiety about science teaching.

In this study one of the independent variables entered into the multiple regression model was science teaching outcome expectancy. The results of both Pearson correlations and multiple regression analysis show that science teaching outcome expectancy did not significantly predict preservice teachers' science teaching anxiety. That is preservice teachers' beliefs that a teacher can affect a positive learning outcome in their students was not found to be related to their anxiety levels about science teaching.

Conclusions and Implications

For many teacher education programs, the development of effective teacher is one of the primary goals. The results of this study offer potential implications for the improvement of elementary teacher training programs. Preservice teachers' positive beliefs about their capabilities in science teaching generated less anxiety in science teaching. This result indicates that teacher training programs should focus on raising preservice elementary teachers' teaching efficacy. In order to enhance science teaching efficacy, stronger content background in science should be supported. The role of having a strong science content background in enhancing science teaching self-efficacy beliefs was also emphasized in previous studies (Butts, 1988, Oliver, 1995, Riggs, 1995; Borko & Putnam, 1995). In this study, preservice teachers who reported taking more science content courses reported feeling less anxious about science teaching. Thus, in order to decrease their science teaching anxiety they may be required to take several science courses or participate in science related extracurricular activities which result in a good science content background. Teacher training programs and departments that offer science content courses may work in collaboration to enhance preservice elementary teachers' perception of their science content background.

One way of enhancing science teaching self-efficacy is to provide preservice teachers with positive experiences in science teaching. Preservice teachers are rarely exposed to good role models during field experience because many in-service teachers have also difficulty with science and avoid teaching it (Skamp, 1995). Teacher training programs should assure that field experiences are effective and positive experiences under the supervision of good role models. Microteaching experiences can be provided in which preservice teachers receives constructive feedback on their effectiveness. Techniques, such as modeling, counseling and desensitization, can be used to change preservice teachers' beliefs



about their capabilities. Effective science teaching methods courses that focus on developing preservice teachers' conceptual understanding of core science concepts and their teaching skills should be provided to enhance their beliefs about their capabilities to teach science and thus lower their science teaching anxiety. Finally, preservice teachers' science teaching anxiety levels and efficacy beliefs may be monitored as they progress teacher education program. Early detection of high science teaching anxiety and low science teaching self-efficacy beliefs is critical for teacher education programs to take necessary actions for the prevention of these undesired affective states.

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