PRESERVICE ELEMENTARY TEACHERS' SCIENCE KNOWLEDGE, ATTITUDE TOWARD SCIENCE TEACHING AND THEIR EFFICACY BELIEFS REGARDING SCIENCE TEACHING

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ABSTRACT

PRESERVICE ELEMENTARY TEACHERS' SCIENCE KNOWLEDGE, ATTITUDE TOWARD SCIENCE TEACHING AND THEIR EFFICACY BELIEFS REGARDING SCIENCE TEACHING

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This study intended to explore preservice elementary teachers' science knowledge level, attitude toward science teaching and their efficacy beliefs regarding science teaching. In addition, the contribution of science knowledge level and attitudes toward science teaching on Turkish preservice elementary teachers' efficacy beliefs was investigated.

The present study was conducted at the end of the spring semester of 2003-2004 academic year with a total number of 750 (n=531 females; n=216 males; and n=3 gender not provided) fourth-year preservice elementary teachers who enrolled at elementary teacher education programs of nine different universities in Turkey. Data were collected utilizing three questionnaires: the Science Teaching Efficacy Belief Instrument (STEBI-B) developed by Riggs and Enochs (1990), Science Achievement Test, and Science Teaching Attitude Scale developed by Thompson and Shrigley (1986).

Data of the present study were analyzed utilizing descriptive and inferential statistics. Analysis of the self-efficacy survey indicated that preservice elementary teachers had moderate sense of self-efficacy beliefs regarding science teaching on both Personal Science Teaching Efficacy and Outcome Expectancy dimensions of the STEBI-B. Also, preservice elementary teachers indicated low level of science knowledge and generally positive attitude toward science teaching. Furthermore, science knowledge level and attitude towards science teaching made a statistically significant contribution to the variation in preservice elementary teachers' personal science teaching efficacy beliefs and outcome expectancy.

Key Words: Science Teaching Efficacy Beliefs, Personal Science Teaching Efficacy, Science Teaching Outcome Expectancy, Attitude toward Science Teaching, Science Knowledge Level

ÖZ

SINIF ÖĞRETMENİ ADAYLARININ BİLGİ DÜZEYLERİ, FEN ÖĞRETİMİNE YÖNELİK TUTUMLARI VE ÖZYETERLİK İNANÇLARI

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Bu araştırma, sınıf öğretmeni adaylarının fen bilgi düzeylerini, fen öğretimine yönelik tutumlarını ve özyeterlik inançlarını belirlemek amacı ile yapılmıştır. Buna ek olarak, sınıf öğretmeni adaylarının fen bilgi düzeylerinin ve fen öğretimine yönelik tutumlarının, fen öğretimine yönelik öz yeterlik inançlarına katkısı incelenmiştir.

Bu çalışma, 2003-2004 bahar döneminde Türkiye'deki dokuz farklı üniversitede ilköğretim sınıf öğretmenliği bölümü son sınıfında okuyan toplam 750 (531 kız, 216 erkek ve 3 cinsiyetini belirtmemiş) sınıf öğretmeni adayıyla yürütülmüştür. Veriler, Enochs ve Riggs'in (1990) "Fen Öğretimi Öz Yeterlik İnanç" ölçeği, Fen Bilgisi Testi ve Thompson ve Shringley'in (1986) "Fen Öğretimi Tutum Ölçeği" ile toplanmıştır.

Araştırmanın sonuçları, sınıf öğretmeni adaylarının, fen öğretimi öz-yeterlik ölçeğinin kişisel öz yeterlik ve sonuç beklentisi alt boyutlarında, inançlarının orta düzeyde olduğunu göstermiştir. Ayrıca analiz sonuçları, sınıf öğretmeni adaylarının fen öğretimine yönelik genellikle pozitif tutum geliştirdiklerini ve fen bilgi düzeylerinin düşük olduğunu göstermiştir. Bunlara ek olarak, fen bilgi düzeyi ve fen öğretimine yönelik tutumun, sınıf öğretmeni adaylarının kişisel öz yeterlik ve sonuç beklentisindeki değişimlerine istatistiksel olarak önemli katkı yaptığı görülmüştür.

Anahtar Kelimeler: Fen Öğretimine Yönelik Öz Yeterlik İnançları, Kişisel Öz Yeterlik, Sonuç Beklentisi, Fen Bilgi Düzeyleri, Fen Öğretimine Yönelik Tutum

To Jale ÇAKIROĞLU

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LIST OF SYMBOLS

SYMBOLS	
TLC	: Teacher Locus of Control
RSA	: Responsibility for Student Achievement
GTE	: General Teaching Efficacy
PTE	: Personal Teaching Efficacy
TES	: Teacher Efficacy Scale
STEBI	: Science Teaching Efficacy Belief Instrument
STEBI-B	: Science Teaching Efficacy Belief Instrument Form B
PSTE	: Personal Science Teaching Efficacy
STOE	: Science Teaching Outcome Expectancy
TSES	: Teachers' Sense of Efficacy Scale
SETAKIST	: Self-Efficacy Teaching and Knowledge Instrument for Science Teachers
LOC	: Locus of Control
CGPA	: Cumulative Grade Point Average

CHAPTER I

INTRODUCTION

1.1. Background of the Study

Improving the preparation of preservice elementary teachers to science teaching have been of great concern over the past two decades. Research made by Victor (1961) and Blosser and Howe (1969) found that elementary teachers possessed a generally low level of knowledge regarding the concepts, facts and skills concerning science. These researchers believe that this low level of background science knowledge, significantly contributed to elementary teachers' hesitancy, and possible inability to provide effective science instruction in their classrooms. These results have been corroborated by Weiss (1978) who found that elementary teachers spent average 90 minutes per day on reading instruction versus on average of 17 minutes per day on science instruction. Why do elementary teachers spend less time teaching science than any other subject?

Similar questions were asked by educational researchers who have continued to be interested in preservice teacher education programs. They suggested that a factor which influence elementary science instruction is science knowledge level of teachers. Wenner (1993) reported that there existed a low level of science knowledge among preservice elementary teachers and he concluded that, "while high school science course work appears adequate, college preparation in science content is inadequate for prospective elementary teachers. This conclusion is supported by the low scores on the science knowledge test ” (p. 465). And also, for USA, Mechling et al. (1982) stated that, “ Inadequate teacher preparation has often been blamed for the sorry state of science at the elementary level. Science for preservice elementary teachers need to be improved” (p. 9). Similarly, for Turkey, the research of Tekkaya, Çakıroğlu and Özkan (2004) found that majority of preservice science teachers did not acquire a satisfactory understanding of basic science concepts. And also, their results revealed that many participants held misconceptions of fundamental science concepts.

The other factors that influence elementary science instruction are: attitudes and beliefs toward science and science teaching. Many studies have indicated that elementary teachers' attitudes towards science teaching is important in determining both the quality and quantity of science taught to children (Schoeneberger & Russell, 1986; Wallace & Louden, 1992) since the attitude towards science teaching translate into effectiveness and time spent on teaching science. Koballa and Crawley (1985) offered the scenario whereby elementary school teachers judged their ability to teach science to be low (belief), resulting in a dislike for science teaching (attitude) that ultimately translated into teachers who avoided teaching science (behavior).

Moreover teachers' beliefs, especially self efficacy beliefs, are indicators of teachers instructional behavior in classroom. Self efficacy was found in social cognitive theory developed by Bandura (1977) who defined self-efficacy as “beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations” (Bandura, 1986 p. 3). Bandura (1997) proposed that efficacy beliefs were powerful predictors of behavior because they were ultimately self-referent in nature and directed toward specific tasks. Due to responsibilities for teaching all subjects in an elementary instruction, a specific measure of science teaching efficacy belief should more accurately predict science teaching behavior.

Studies by Enochs, Scharmann and Riggs (1995) indicate that teachers who do not believe in their ability to teach science (low self-efficacy) are more likely to avoid science instruction whenever possible than teachers with higher self-efficacy.

Some earlier studies have suggested that teacher efficacy is related to student achievement (Armor et.al, 1976), student motivation (Midgley, Feldlaufer & Eccles, 1989), teachers' adoption of innovation (Berman, Mc Laughlin, Bass, Pauly & Zellman, 1977; Guskey, 1988; Smylie, 1988), superintendents' ratings of teacher competence (Trentham, Silvern & Brogdon, 1985) and teachers classroom management strategies (Ashton & Webb, 1986).

Which situations affect a teacher's sense of efficacy have been an important problem for educational researchers over the past two decades. Some of the conclusions of this problem are: elementary level teachers' beliefs (Pajares, 1992); attitudes and anxieties about science (Westerback, 1982; Westerback & Primavera, 1988); personal teaching efficacy and outcome expectancy beliefs (Ashton, 1984; Ashton & Webb, 1986; Ashton et al., 1983; Dembo & Gibson, 1985); teacher preparation (Goodlad, 1990) and professional development (Guskey, 1986; 1988); and teachers as adult learners (Daresh, 1989; Joyce & Showers, 1988; Lieberman & Miller, 1991).

According to the studies above, it seems that following factors are critical to influence elementary science instructions: The science knowledge level of teachers, attitudes toward science teaching and their different efficacy beliefs. The investigation of preservice elementary teacher's self-efficacy belief and their science knowledge are important indicators to gather information about elementary teachers' science knowledge and their efficacy beliefs regarding science teaching.

1.2 Purpose of the Study

The purpose of this study is to investigate preservice elementary teachers' science knowledge level, attitude toward science teaching and their efficacy beliefs regarding science teaching and the contribution of science knowledge level and attitudes toward science teaching on preservice elementary teachers' efficacy beliefs. More specifically, the specific research questions are as follows:

1. What are preservice elementary teachers' efficacy beliefs regarding science teaching?
2. What are preservice elementary teachers' science knowledge level?
3. What are preservice elementary teachers' attitude toward science teaching?
4. Is there a significant contribution of preservice elementary teachers' science knowledge level and their attitude toward science teaching to teachers self -efficacy beliefs regarding science teaching?

Further, this study examines the relationship, if any, between preservice elementary teachers' efficacy beliefs regarding science teaching and their gender, university cumulative grade point average (GPA) and number of university science courses completed.

1.3 Definitions of Important Terms

This section includes some important definitions related to the study.

Science Teaching Efficacy Beliefs: A teacher's belief that she/he has the ability to teach science effectively and can affect student achievement.

Personal Science Teaching Efficacy Beliefs (PSTE): A teacher's belief in his/her ability to perform science teaching.

Science Teaching Outcome Expectancy Beliefs (STOE): A teacher's beliefs in students' ability to learn.

Attitude Toward Science Teaching: Teachers' tendency to react toward science, which define their beliefs, preference, decision, sensitive thoughts.

Science Knowledge Level: Level of success in Science Achievement Test.

1.4. Educational Significance

Teaching characteristics developed during preservice programs will effect a permenant change in teachers' attitudes. Manning et al. (1982) stated, "highly significant relationships exist between teachers' preparation and their practice and attitude toward science" (p. 41). Among these, teacher self-efficacy beliefs influence numerous aspects of behavior, teaching techniques, effort and discipline strategies.

Therefore, teacher educators examine what is done to increase preservice teachers' self-efficacy.

In addition, several studies found low level of science knowledge among preservice elementary teachers (Blosser & Howe, 1969; Leinhardt et al, 1991; Victor, 1961; Wenner, 1992; Stevens & Wenner, 1996). Less studies about self-efficacy exist in Turkey all of which examine preservice science teachers. Therefore, early detection of if any relationship exists between science knowledge and teachers' self efficacy might be valuable in providing specific activities for preservice teachers when planning and implementing science courses.

To sum up, the findings of this study helps researchers, teachers, and teacher educators to understand the preservice elementary teachers' self efficacy beliefs regarding science teaching, and attitudes toward science teaching, their science knowledge level and relationship of them. According to these results, teacher educators can organize their preservice education programs.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter covers the conceptual definition and development of teachers' efficacy beliefs and attitude toward science. The following related review of literature is subtitled as the construct and measurement of teachers' efficacy beliefs, science knowledge and attitudes and beliefs toward science instruction held by preservice elementary teachers.

2.1 The Construct and Measurement of Teachers' Efficacy Beliefs

Self-efficacy belief as a psychological construct is rooted in a social learning theory developed by Bandura (1977, 1981). Self-efficacy beliefs are defined as "judgments of how well are can execute courses of action required to deal with prospective situations" (Bandura, 1982, p.122). He suggested that behavior is based on two factors, firstly, an individual develops a generalized expectancy about action-outcome contingencies based upon life experiences, or outcome expectancy, and secondly he/she develops specific beliefs about his/her own ability to cope, or self-efficacy.

According to Bandura, behavior may be predicted by investigating self-efficacy using both types of expectancy determinants (Bandura, 1982). He hypothesizes that people having both high outcome expectancy and personal efficacy will behave in an assured, decided manner and persist on task. On the other hand, people with both low outcome expectancy and high personal efficacy temporarily intensify their efforts, but eventually have frustration.

Bandura (1997) proposed that there are four sources of efficacy expectations: mastery experiences, physiological and emotional states, vicarious experiences, and social persuasion. Of these, mastery experiences are the most powerful source of efficacy information. The perception that a performance has been successful raises efficacy beliefs, contributing to the expectation that performance will be proficient in the future. The perception that one's performance has been a failure lowers efficacy beliefs, contributing to the expectation that future performance will also be inept (Tschannen-Moran, Hoy & Hoy, 1998). In addition to mastery experiences, vicarious experience which involve the modelling of desired performance influences efficacy beliefs. Self-efficacy is usually increased if one compares well and decreased if one compares less favourable with people in similar situations.

The examination of self-efficacy and outcome expectancy in relation to teaching has been the focus of study by several researchers (e.g., Ashton & Webb, 1986; Enochs & Riggs, 1990; Gibson & Dembo, 1984; Guskey, 1988; Woolfolk & Hoy, 1990). According to Tschannen-Moran et al. (1998), two strands of research can be identified. The first is grounded in Rotter's social learning theory of internal versus external control (Rotter, 1996). Teachers who believe that they are efficient to teach difficult or unmotivated students were considered to have internal control. On the other hand, teachers who believe that the environment has more effect on student learning than their own teaching abilities were considered to have external control.

Rand researchers (Armor et al., 1976; Berman, McLaughlin, Bass, Pauly, & Zellman, 1977) who studied teacher efficacy firstly, developed two items that were based on the locus of control orientation:

Item 1: “When it comes right down to it, a teacher really can not do much because most of a student’s motivation and performance depends on his or her home environment.” A teacher who strongly agrees with this statement indicates that any effort spent by teachers in schools can be overwhelmed by environmental factors. Factors such as the conflict, violence, or substance abuse in the home or community; the value placed on education at home; the social and economic realities concerning class, race, and gender; and the physiological, emotional and cognitive needs of a particular child all have a very real impact on a student’s motivation and performance in school. Teachers’ beliefs about the power of these external factors on students’ learning compared to the influence of teachers and schools have been termed as General Teaching Efficacy (GTE).

Item 2: “If I really try hard, I can get through to even the most difficult or unmotivated students.” Teachers who agree with this statement have confidence in their abilities to overwhelm any factors which make learning difficult for a student. Such teachers are making a statement about their own efficacy in teaching, and reflecting a confidence in the adequacy of their training or experience in developing strategies to overcome any obstacles in student learning. This approach has been termed as Personal Teaching Efficacy (PTE); and it is more specific when compared to General Teaching Efficacy.

Other measures of efficacy in the Rand/Rotter Tradition are the Teacher Locus of Control (TLC) (Rose & Medway, 1981), the Responsibility for Student Achievement (RSA) (Guskey, 1981), and the Webb Efficacy Scale (Ashton, Olejnik, Crocker & McAuliffe, 1982). The TLC consists of 28 forced-choice items that present situations of student success (14 items) and student failure (14 items). The two forced-choice options allow for either an internal (teacher) or external (student) explanation for the student outcome. Similarly, the RSA consists of 30 items also presenting two possible explanations (internal vs external) for student success and failure.

The second strand of research on teacher efficacy is grounded in Bandura's social cognitive theory and his construct of self-efficacy (Bandura, 1977). Several measures grew out of this tradition, including the Teacher Efficacy Scale (Gibson & Dembo, 1984), The Science Teaching Efficacy Belief Instrument (Riggs & Enochs, 1990), the Ashton Vignettes (Ashton, Buhr & Crocker, 1984), and the Teacher Self Efficacy Scale (Bandura, Undated).

Ashton and Webb (1986) were the first researchers in this strand who expanded the Rand methodology by using the two originals items as well as interviews and classroom observation to study efficacy. According to them, responses to the first Rand Item ("When it comes right down to it, a teacher really can not do much because most of a student's motivation and performance depends on his or her home environment.") are the indicator of beliefs about outcome expectations, whereas responses to the second Rand Item ("If I really try hard, I can get through to even the most difficult or unmotivated students.") reflect efficacy expectations. These two items, together, constitute teacher efficacy.

Ashton, Webb and Doda (1983) interpreted teachers' sense of efficacy by proposing a model which consisted of teaching efficacy, personal efficacy, and personal teaching efficacy. Teaching efficacy referred to a teacher's belief about the general relationship between teaching and learning and it appears to be similar to Bandura's outcome expectancy. Personal efficacy referred to a teacher's general sense of his/her own effectiveness not specific to a particular situation. Personal teaching efficacy was considered to be a combination of teaching efficacy and personal efficacy. Ashton et al. (1983) suggested that it was important to keep teaching efficacy and personal teaching efficacy separate conceptually since the intervention strategies planned to produce change may depend on the origin of a teacher's sense of efficacy. Personal Teaching Efficacy is viewed by Ashton et al. (1983) as an accurate predictor of teacher behavior. For example, teachers having high efficacy have been found to be more likely to use inquiry and student-centered teaching strategies, where as teachers who have a low sense of efficacy are more likely to use teacher-directed strategies, such as lecture and reading from the textbook (Czerniak, 1990).

Ashton and Webb (1986) suggested that teachers' self-efficacy would vary according to the subject being taught. For example, a teacher may have low self efficacy in a specific subject area, such as science, and high in another, such as language arts. This may result in spending more time for language arts instruction, as well as more personal interest in participating professional development activities related to this subject area. On the other hand, it may also result in less or no time being devoted to science instruction, the use of didactic teaching strategies and avoidance of professional development activities related to science.

In a study using factor analysis, Gibson and Dembo (1984) identified two teacher efficacy dimensions and developed an expanded, 30-item the Teacher Efficacy Scale (TES) to assess these two dimensions of efficacy. The first dimension which was called "Personal Teaching Efficacy" (PTE) includes teacher beliefs on their knowledge of suitable teaching techniques; ability to help students learn, achieve more, do better than usual and increase retention among other skills (which is equivalent to self efficacy). The second dimension which was called "Teaching Efficacy" (GTE) depends on the belief that the teacher's influence on students is limited by external influences, such as home and family background (which is equivalent to Bandura's factor of outcome expectancy). When the Rand items were included in the factor analysis with the Gibson and Dembo measure, Rand 1 ("When it comes right down to it, a teacher really can not do much because most of a student's motivation and performance depends on his or her home environment.") loaded on the GTE factor and Rand 2 ("If I really try hard, I can get through to even the most difficult or unmotivated students.") loaded on the PTE factor (Coladarci, 1992; Ohmart, 1992; Woolfolk & Hoy, 1990).

Factor analysis of the 30-item instrument (TES) indicated that several items on both factors loaded on both factors and that's why some researchers have used a shorter version of this instrument, selecting only 16 of the items which load uniquely on one factor or the other. Hoy and Woolfolk (1993) have used even a shorter form with just 10 items; five personal and five general teaching efficacy items, and reliabilities they found for each subtests were within the range for the longer versions ($\alpha = .77$ for PTE; $\alpha = .72$ for GTE).

According to Gibson and Dembo, when compared to teachers who had lower expectations of their ability to influence student learning, teachers who have high scores on both teaching efficacy and personal teaching efficacy would be active and assured in their responses to students and these teachers persist longer, provide a greater academic focus in the classroom and exhibit different types of feedback. On the other hand, teachers who have low scores on both teaching and personal efficacy were expected to give up easily if the results they get were not satisfactory.

Teacher efficacy is related to the amount of effort spent by a teacher in class hour and the persistence (Gibson & Dembo, 1984). Teachers with a higher sense of efficacy, having high scores on both the PTE and GTE factors, were likely to criticize a student following an incorrect response and more likely to persist with a student in a failure situation. High efficacy teachers were more likely to divide the class for small group instruction as opposed to instructing the class as a whole.

Researchers found that there was a significant relationship between efficacy and student achievement that emerged from the Gibson and Dembo (1984) instrument (Ross, 1992; Watson, 1991).

Besides student achievement, teacher efficacy also plays a role in shaping students' attitudes toward school, the subject matter being taught, and even the teacher. The stronger the general teaching efficacy of a teacher, the greater a student's interest in school and the more students perceived that what they were learning was important. Students of teachers with a stronger sense of personal efficacy gave more positive evaluations of the teacher (Woolfolk & Rosoff, & Hoy, 1990).

Teacher efficacy has also been linked to the level of professional commitment for both inservice elementary/middle school teachers (Coladarci, 1992) and preservice teachers (Evans & Tribble, 1986).

Other research with Gibson and Dembo (1984) instrument has indicated that teaching efficacy is related to pupil control ideology and to bureaucratic orientation (Woolfolk and Hoy, 1990).

Additionally, Allinder (1994) found that personal teaching efficacy (PTE) was linked to instructional experimentation, including willingness to try a variety of materials and approaches, the desire to find better ways of teaching, and implementation of progressive and innovative methods. The level of organization, planning, and fairness a teacher displayed, as well as clarity and enthusiasm in teaching was also related to personal teaching efficacy. General teaching efficacy (GTE) was related to clarity and enthusiasm in teaching (Tschannen-Moran, Hoy & Hoy, 1998).

To sum up, the researchers who used Gibson and Dembo instrument, have found that teacher efficacy has been related to teachers' classroom behaviors, their openness to new ideas, and their attitudes toward teaching. Also, teacher efficacy influences student achievement, attitude and affective growth. Additionally, school structure and organizational climate appear to play a role in shaping teachers' sense of efficacy.

Other instruments have also been developed to assess teacher efficacy and related constructs. Bandura (1977) emphasized that self-efficacy was most appropriately measured in specific contexts. Thus, Riggs and Enochs (1990) developed a subject matter instrument which was Science Teaching Efficacy Belief

Instrument (STEBI) to measure efficacy for teaching science. The STEBI has two versions; the Science Teaching Efficacy Belief Instrument form A (STEBI-A) for inservice elementary teachers and the Science Teaching Efficacy Belief Instrument form B (STEBI-B) for preservice elementary teachers. This instrument was based on the Gibson's and Dembo's instrument (TES) and also consisted of two largely uncorrelated subscales: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). In most applications, the STEBI consists of 25 items with a 5-point Likert-type scale.

As measured by the STEBI, teachers who have a high sense of personal science teaching efficacy reported spending more time teaching science and developing the science concept being considered (Riggs & Jesunathadas, 1993). Teachers with low personal efficacy (PSTE) spent less time teaching science, used a text-based approach, were rated weak by site observers, made fewer positive changes in their beliefs about how children learn science, and were less likely to choose to teach science (Riggs, 1995). Higher PSTE scores among preservice teachers have been related to their preference to teach science (Lucas, Ginns, Tulip & Watters, 1993) and to a more humanistic orientation toward control in the classroom (Enochs, Scharmann & Riggs, 1995).

Scores on the second factor of the STEBI have also been related to the quality of teaching in science. Teachers with low scores on science teaching outcome expectancy (STOE) were rated as less effective in science teaching, rated themselves as average and were rated as poor in attitude by site observers (Enochs, Scharmann & Riggs, 1995). Teachers who have low scores on STOE used text-based approaches over hands-on, activity-based approaches and used cooperative learning less (Riggs, 1995).

Another work on the Gibson and Dembo instrument (TES) was conducted by Emmer and Hickman (1990). Emmer and Hickman (1990) adapted the Gibson and Dembo instrument yielding a 36-item measure with three efficacy subscales: efficacy for classroom management and discipline, external influences, and personal teaching efficacy. They found that preservice teachers with a higher sense of personal teaching efficacy were more likely to seek outside help in dealing with student discipline problems. Moreover, Coladarci and Breton (1995) used a 30-item instrument, modified from Gibson and Dembo and reworded to apply specifically to special education.

In the light of the perceived weaknesses of the TES, several researchers have recently developed instruments that show promise in furthering the study of teacher efficacy.

Tschannen-Moran and Woolfolk Hoy (2001) sought to develop an efficacy instrument (Teachers' Sense of Efficacy Scale, TSES) that possessed correspondence to the tasks that teachers faced in school. They argued that the TSES could be used for assessment of the three domains of efficacy or to yield a more generalized efficacy score. The TSES employs a 9-point Likert scale and comprises of three factors: Efficacy for Instructional Strategies, Efficacy for Classroom Management, and Efficacy for Student Engagement. Sample items include: “To what extent can you influence the self-discipline of your students?” and “How much can you do to repair student misconceptions?” Because it was a new instrument, further testing and validation issues across different samples have been suggested to examine for future research.

Furthermore, Roberts and Henson (2000) developed a subject matter specific instrument which was Self-Efficacy Teaching and Knowledge Instrument for Science Teachers (SETAKIST). The researchers essentially largely retained the personal teaching efficacy items, with the exception of rewording to reflect science content and elimination of past tense verb uses. Because science education is explicitly involved with the pedagogical conversion of science information into a format meaningful for students, Roberts and Henson (2000) developed a knowledge efficacy construct, which is intended to roughly approximate efficacy for science pedagogical content knowledge. The SETAKIST requires additional validity evidence regarding the knowledge efficacy construct, given its attempt to assess an efficacy dimension formerly ignored in teacher efficacy research. However, the concept of assessing efficacy for pedagogical content knowledge is intriguing and worth further investigation.

Teacher efficacy can be influenced by unique features of inherent cultures. Based on this idea, some researchers modified teacher-efficacy instruments in their countries. For example, Çakıroğlu, Çapa, and Sarıkaya (2004) developed a Turkish version of the Teachers' Sense of Efficacy Scale (TSES). TSES administered 628 preservice teachers from six different universities located in four major cities in Turkey. They found that Turkish version of the Teachers' Sense of Efficacy Scale (TTSES) appears to be a valid and reliable instrument for Turkish prospective teachers. They suggested that TTSES could be a valuable tool for teacher educators working in practical and research settings to assess the efficacy beliefs of prospective teachers. In a similar study, Diken and Ozokcu (2004) examined the Turkish version of Teacher Efficacy Scale (TTES), and investigated factors influencing Turkish teachers' sense of efficacy. Data were collected from TTES and a questionnaire on 82 special education (SE) and 38 regular education (RE) teachers. Consistent with previous teacher efficacy research results (Ashton & Webb, 1986; Gibson & Dembo, 1984; Woolfolk & Hoy, 1990; Guskey & Passaro, 1994), TTES had two reliable subfactors. They also reported that SE teachers showed higher levels of sense of efficacy and the years of experience with students with mental retardation positively correlated with SE teachers' efficacy scores. In another study, Bıkmaz (2002) investigated the validity and reliability of elementary science teaching self-efficacy belief instrument version of preservice elementary teachers developed by Riggs and Enochs (1990) in Turkey conditions. Both original and Turkish forms were administered to 24 preservice science teachers in METU in a period of one week and item equivalency was found as .68. Afterwards, Turkish form was administered to 279 students from three different universities of Turkey who attended elementary school teacher education program. Factor analysis results revealed that the Turkish version had two factors like the original scale, but Turkish version of this scale consisted of 21 items. This study concluded that Turkish version of STEBI-B appears to be a reliable instrument for Turkish prospective teachers. On the other hand, Lin and Gorrell (2000) used a modified version of Gibson and Dembo teacher efficacy scale on a Taiwanese preservice teacher sample. They found a different factor structure compared to the original scale. They concluded that the concept of teacher efficacy may be related to cultural factors and this should be kept in mind when applied to teachers in different countries.

Some researches on self-efficacy were about comparison of teacher efficacy beliefs on different countries. Çakıroğlu and Çakıroğlu (2003) compared preservice elementary teachers' sense of efficacy beliefs in a Turkish university, and in a major Midwest university in USA. The data were collected by Science Teaching Efficacy Belief Instrument (STEBI-B) (Enochs and Riggs, 1990). Students were also asked to indicate how many science courses they had completed to college and high school. In Turkish sample, there were 100 preservice elementary teachers and in American sample there were 75 preservice elementary teachers. The preservice teachers indicated generally positive self-efficacy beliefs regarding science teaching in both countries. Data of this study also suggested that, in both countries, science courses completed in high school and college did not appear to have influence on subjects' self-efficacy beliefs regarding science teaching. The results also indicated that preservice elementary teachers in USA had significantly higher personal science teaching efficacy scores than preservice elementary teachers in Turkey. On the other hand, science teacher outcome expectancy scores of the preservice teachers from the two countries were not significantly different. Similarly, Gorrell et al. (1993) compared American, Swedish, and Sri Lankan preservice teachers with using a modified form of Gibson and Dembo (1984) scale and they found that American preservice teachers had more positive general efficacy of teaching beliefs compared to Swedish and Sri Lankan teachers and also found that Sri Lankan teachers' personal efficacy beliefs were relatively higher than that of American teachers. Furthermore, Campbell (1996) compared teacher efficacy beliefs of preservice and inservice teachers in Scotland and America with using Gibson and Dembo scale. Campbell (1996) concluded that the two countries are equal in fostering teacher efficacy in their preservice and inservice teacher education program. Another study on comparison of self-efficacy construct between countries was recently reported by Ho and Hau (2004). Their research examined and compared Australian and Chinese teachers' personal efficacy in instruction, discipline guidance and beliefs about external influences. Two staged studies were conducted with the participation of 316 Australian teachers and 411 Hong Kong Chinese teachers. A revised Teacher Efficacy Scale was administered. Results of multiple-group confirmatory factor analyses indicated highly comparable factorial structures of teacher efficacy for the two groups, although personal guidance efficacy was more differentiated from personal instruction and discipline efficacy among Australian teachers. All of these comparison studies indicated that despite teachers' self-efficacy had cross-culturally generalizable aspects, there were culture-specific features of the teacher efficacy construct.

In a study to identify factors contributing to preservice teachers' sense of efficacy, Cantrell et al. (2003) examined the efficacy beliefs of a sample of elementary preservice teachers (n=268) at three stages of their program starting with the introductory methods seminar courses, followed by advanced methods course, and finally, at the end of their student teaching. And also Cantrell et al. (2003) explored the relationships between the levels of efficacy beliefs and various factors such as gender, prior science experience, and science teaching time. The Science Teaching Efficacy Belief Instrument Form B (STEBI-B) developed by Enochs and Riggs (1990) was used to assess science teaching efficacy. Their study indicated that the males in their sample were more interested in science in high school. The largest increase in PSTE was for students in the methods group who were able to teach science to children for more than 3 hours across the span of their 3-week practicum. This result suggested that there may be a significant increase in PSTE with the first successful science teaching experiences, which is supported by Bandura's (1997) suggestion that mastery experiences help to increase efficacy beliefs. Only significant effect found for STOE occurred in the student teaching group when students are applying their knowledge and skills to practice of teaching science to children. Another study by Huinker and Madison (1997) investigated the impact of methods courses on preservice elementary teachers' personal efficacy beliefs and outcome expectancy beliefs in science and mathematics teaching. Only 62 preservice elementary teachers were the subjects of this study. A pretest-posttest one-group research design was used each semester to collect quantitative data throughout the use of two teaching efficacy beliefs instruments, one for science (STEBI-B) and one for mathematics (the Mathematics Teaching Efficacy Beliefs Instrument-MTEBI-). A series of individual interviews were conducted with a sample of subjects to gather qualitative data. They found that both science and mathematics methods course consistently had a positive influence on the preservice elementary teachers' beliefs in their ability to teach science and mathematics effectively. Similarly, Marrell and Carroll (2002) examined the impact of science methods courses, student teaching and science content courses an elementary preservice teachers' science teaching self-efficacy. To measure the students' science teaching self-efficacy belief, students completed STEBI-B at the beginning and end of each course included in this study. In this study, it would appear that the methods course positively impacted the elementary preservice teachers' PSTE. The scores on this scale significantly increased over the duration of each methods course. One suggested reason for this finding was that the method course included all of the components identified by Bandura (1986) that contribute to perceptions of self-efficacy. However, while Wingfield and Ramsey (1999), King and Wiseman (2001) found that methods courses did enhance self-efficacy, Cannon (2001) did not find that methods courses taken in conjunction with field experience enhanced self-efficacy.

Ginns et al. (1995) have given attention to investigate changing in preservice teachers' sense of efficacy in teaching science. They used STEBI-B to monitor changes in teachers' sense of science teaching efficacy employing a pretest and repeated posttest, one group research design. The subjects were 72 students enrolled in a 3-year Bachelor of Teaching (Primary) program. The results indicated that, over three semesters of the program, there was significant difference between the pretest and posttest scores on the STOE scale, but no significant difference between pretest/posttest scores on the PSTE scale. They concluded that changing beliefs about personal science teaching efficacy may be more difficult than changing beliefs about the potential for teachers to improve children's learning of science. Also, Hoy (2000) searched out whether there were differences in teachers' sense of efficacy between student teaching and the first year of teaching. The results indicated that efficacy rose during teacher preparation, but fell with actual experience as a teacher.

Some researchers investigated whether there were interactions between teachers' efficacy beliefs and their classroom management beliefs. Woolfolk and Hoy (1990) indicated relationships between efficacy beliefs, as measured by the Teaching Efficacy Scale (Gibson & Dembo, 1984) and those control beliefs. This study included 182 preservice teachers. They found that teachers who scored high in both general teaching efficacy and personal efficacy were more humanistic in their control orientation. On the other hand, only teaching efficacy made a significant independent contribution to beliefs about pupil control ideology. Personal efficacy alone was not significantly correlated with pupil ideology. They also revealed that teaching efficacy was negatively correlated to bureaucratic orientation. In a similar study, regarding student control as measured by the Pupil Control Ideology Form (PCI) (Willower et al., 1967), Enochs, Scharmann, and Riggs (1995) administered the STEBI-B to a sample of 73 preservice elementary teachers. They reported an opposite result of Woolfolk and Hoy's (1990) study that teachers with higher science teaching self-efficacy (PSTE) scores also had more humanistic orientations toward control or management in the classroom, but the relationship between outcome expectancy (STOE) and pupil control ideology was not revealed. One suggested reason for this finding was that the respondent's lack of real classroom experience. In order to further explore the relationships between preservice teachers' sense of efficacy, task analysis and their beliefs about classroom management, Henson (2001) conducted a study among a sample of 127 preservice teachers varied in their education level (elementary, secondary and early childhood). Data were collected by three instruments of the Teacher Efficacy Scale (Hoy & Woolfolk, 1993), the Attitudes and Beliefs on Classroom Control (ABCC) Inventory (Martin, Yin & Baldwin, 1998) and the Means-End Teaching Task Analysis (Henson, Bennett, Sienty, & Chambers, 2000). He reported that the teaching efficacy variables provided different levels of prediction of classroom management beliefs, however, task analysis was found to be unrelated to management beliefs. In a study conducted in Turkey by Savran, Çakıroğlu and Çakıroğlu (2004), Turkish preservice elementary teachers' science teaching efficacy and classroom management beliefs were explored. Specifically, the study explored the interrelationships between teacher efficacy beliefs and classroom management beliefs of participants. Data in this study were collected from a total number of 234 preservice elementary teachers utilizing Science Teaching Efficacy Belief Instrument and the Attitudes and Beliefs on Classroom Control (ABCC) Inventory. Their results indicated that participants expressed positive efficacy beliefs regarding science teaching. In addition, results of the study revealed that participants were interventionist on the Instructional Management subscale, whereas they favored non-interventionist style on the People Management subscale of the ABCC Inventory. Furthermore, no significant correlation between efficacy and classroom management beliefs was found.

To sum up, these studies revealed that teachers' self-efficacy beliefs was related to teacher effectiveness, student achievement, teaching anxiety and instructional strategies. Because of strong relationship between self-efficacy beliefs and teaching behaviors, teacher education programs need to evaluate efficacy beliefs of their education students.

2.2 Science Knowledge and Attitudes and Beliefs toward Science Teaching Held By Preservice Elementary Teachers

Only recently has interest been directed to how attitudes toward science affect learning and science teaching. In an early study, Allport (1935) expressed attitude as the most distinctive and indispensable concept in contemporary social psychology. Attitude toward science should not be confused with scientific attitude, which may be aptly labeled scientific attributes (e.g., suspended judgement and critical thinking). “I like science”, “I hate science” and “Science is horrible!” are considered to be expressions of attitudes toward science because they denote a general positive or negative feeling toward the formal study of science or science as an area of research (Koballa & Crawley, 1985).

The study of attitude change has become an important concept for a number of reasons. First, attitudes toward science are taught to fulfill basic psychological needs, such as the need to know and the need to succeed. Second, attitudes toward science are taught to influence future behaviors, such as interest in working on a science project and scientific activities. Furthermore, results of nationwide assessments of attitude toward science indicate that Turkish students’ attitudes toward science courses substantially decreased from Grade 5 through Grade 11 (Baykul, 1990).

Being aware of teachers’ attitude toward science is one of the major influences on students’ attitude toward science, Shrigley (1972) investigated the status of the attitude of preservice elementary teachers toward science. The variables tested in this study were: (1) the effect of sex difference, (2) the effect of male elementary teachers, (3) the effect of organized and incidental elementary science programs, (4) the effect the number of high school science courses had on the science attitude of preservice teachers. The population for this study was 207 third year elementary education majors at the Pennsylvania State University. The science attitude scale was administered by the investigator during the first week of their enrollment in a science education course. Results of this study indicated that: (1) There is no sex difference in science attitude of preservice teachers, (2) Sex difference would not have a more positive effect on the science attitude of their students, (3) An organized elementary science program affects the science attitude of preservice teachers positively, (4) Either the student who enrolls in four or more high school science courses is the one with a more positive attitude toward science or the enrollment in more science courses affects the attitude positively.

Similarly, Türkmen and Bonnstetter (1999) studied Turkish preservice science teachers' attitudes toward science and science teaching by using a Turkish version of Science Teaching Attitudes Scale (STAS II) developed by Moore and Foy (1997). The sample size of the study was 612 freshman, sophomore, junior and senior science education major students of four different teachers colleges located in different parts of Turkey. Results of this study indicated that preservice Turkish science teachers have positive attitudes toward science and science teaching.

Fishbein and Ajzen (1975) described the relationship between beliefs, attitudes and behaviors (intended or actual). Any attitude change must also deal with belief change and behavior change. If someone's attitude toward science change, this change will be the same as the change in beliefs on science and science related behavior.

In a much broader sense, a person's attitude toward science conveniently summarizes his or her emotional response to basic beliefs about science. In addition to the fact that attitudes toward science serve as convenient summaries of our beliefs about science, they are important for other people for other reasons-they help others predict the kinds of science related behaviors we are likely to engage in more accurately than almost anything else we can tell them (Koballa & Crawley, 1985).

Many teachers state that inadequate background in science and methods is the primary reason for their avoidance of science teaching. But if teachers have strong self-efficacy beliefs as to their ability to teach science, they should find the subject less stressful and will apply more effort in teaching it effectively, perhaps simply because they feel strongly that they can succeed. It appears that low personal self-efficacy may underlie science anxiety, poor attitudes toward science and the resultant reluctancy to spend adequate time and resources teaching science.

In the light of this, Gassert, Shroyen and Staver (1996) have given attention to the factors which influence personal science teaching efficacy and science teaching outcome expectancy in elementary teachers. Data were collected from 23 elementary teachers involved in a project to enhance science, mathematics, and technology education. Data on variables identified as related to science teaching self-efficacy were collected and triangulated from several self-reporting instruments, including the Science Teaching Efficacy Beliefs Instrument, inservice version (STEBI-A) and interview questions. They found that personal science teaching efficacy beliefs was positively correlated with the variables such as attitude toward science, educational degree level, choosing to teach science, and self-rated effectiveness in science teaching. Attitude toward science, choosing to teach science, and self-rated effectiveness all reflect an interest in science and science teaching as well as a familiarity or comfort with science. The connection of PSTE with educational degree level is related with teachers' beliefs that they should continue to learn science in order to instruct children effectively. STOE was positively and significantly correlated with number of college science courses and choosing to teach science. The number of science courses may be related to STOE in that teachers who were comfortable and interested in science took more college science courses.

Further, Manning et al. (1982) stated “Highly significant relationships exist between teachers’ preparation and their practice and attitude toward science” (p.41). This conclusion was based on survey responses from elementary teachers in Florida, which indicated most took relatively few undergraduate science content courses.

Low level of preparation, limited knowledge, negative beliefs regarding personal science teaching competency, and lack of confidence led Shymanski and Green (1982) to conclude that elementary teachers are simply reluctant to teach science. An explanation for this relationship between low science knowledge and a reluctance to teach science was offered by Victor (1961), who found teachers fear a loss of classroom prestige when providing science instruction.

Haury (1984) indicated in his thesis “Many elementary teachers may perceive themselves as having little personal instrumentality or control in a classroom situation involving science instruction” (p.6) which is consistent with Rotter’s (1966) “locus of control” (LOC) construct. The essence of the LOC model is that the power of subjective belief held by an individual exerts greater control on his or her behavior than the objective fact of control. Haury (1984) concluded in his thesis that an internal LOC resulted in positive attitudes toward teaching science. The idea that feelings of competency, based on adequate preparation, would be likely to translate into positive attitudes toward teaching science is supported by previously cited research.

Indeed, Lucas and Pooley (1982) reported that completion of introductory science units (astronomy and physical science) by preservice teachers resulted in “very significant improvement in student teachers’ attitudes toward science teaching” (p.809).

Relative to the previously cited findings, Feistritzer and Boyer's (1983) finding was that no relationships existed between the number of college level science courses completed and teachers' subsequent attitude toward teaching science was somewhat surprising. They also reported an insignificant relationship between the number of college science courses taken and teachers' confidence relating to teach science.

In another study, Wenner (1993) investigated the relationship between attitude held by prospective teachers regarding their ability to affect science learning among elementary students and their level of science knowledge. One hundred sixty-seven undergraduate students of a large North-Eastern state college, who were enrolled in an upper level course that focused on elementary science methodology, served as subjects in this study. He administered instrument that was composed of three parts: (1) survey information regarding high school and college science coursework, (2) general science knowledge as measured by the General Science Test, and (3) beliefs about science instruction measured by a slightly modified version of the Science Teaching Efficacy Belief Instrument (Riggs & Enochs, 1990). This study indicated a relatively low level of science knowledge among preservice elementary teachers consistent with the findings of Victor (1961) and Blosser and Howe (1969), a negative relationship between science knowledge and attitude toward teaching science. In addition, in follow-up study, Wenner (1995) found no increase in science content knowledge but did identify positive changes in efficacy beliefs.

Assessment of both content knowledge and beliefs, were reported by Stevens and Wenner (1996) as an important consideration in restructuring programs designed to enhance teacher competence in mathematics and science education. They examined relationships that might exist between the beliefs held by prospective teachers regarding their ability to affect science and mathematics learning among elementary students and their personal level of science and mathematics knowledge. Sixty-seven undergraduate students in a large North-Eastern state college who were currently enrolled in an upper level course focusing on methods for teaching elementary science and mathematics served as subjects in their study. They utilized three-part instrument. First of the instrument was aimed at securing information regarding general content knowledge in science and mathematics; whereas second part utilized a Likert-type scale to survey students' personal beliefs regarding science and mathematics instruction. Finally, third part consisted of four questions regarding the number of science and mathematics courses taken in high school and college. They found weak knowledge base in science and mathematics among preservice teachers and negative relationship between beliefs and knowledge. They suggested that preservice elementary teachers may well need further background in mathematics and science presented at a level that connects with their current conceptual level and extends this in ways that might be meaningful for them as they enter a career in education.

Furthermore, Tekkaya, Çakıroğlu and Özkan (2002) investigated Turkish preservice science teachers' understanding of science concepts, attitude toward science teaching and their efficacy beliefs regarding science teaching. Data were collected by Science Concept Test, The Science Teaching Efficacy Belief Instrument, The Science Teaching Attitude Scale, Biology/Physics/Chemistry Attitude Scales, and open-ended questions on 85 preservice science teachers. Findings of the study indicated that majority of the participants had misconceptions concerning fundamental science concepts. Results also revealed that they generally had positive attitudes toward science teaching and three different domains of science-biology, physics, chemistry-. In addition, slightly positive self-efficacy beliefs were found among the most of the participants regarding science teaching, although they have misconceptions.

To sum up, the relationship between level of science preparation, beliefs and attitude toward science teaching has been shown to be positive in some studies (Crawley, 1991; Manning et al., 1982; Mechling et al., 1982), while other studies (Stepans & McCormack, 1985; Feistritzer & Boyer, 1983) have shown no relationship or even a negative relationship. According to Gieger (1973) students who have a positive attitude towards science are more likely to promote science and scientific research in a country. Based on this idea, whether or not teachers believe they have the ability to teach elementary science is central to effective science teaching and consequently, student learning.

CHAPTER III

METHOD OF THE STUDY

This chapter includes a brief description of research design and procedure, the statement of the research problem, research questions and related sub-problems, and statistical hypotheses associated with sub-problems. Following these, a brief description of population and sample selection, data collection instruments, analysis of data, and assumptions and limitations are given.

3.1 Research Design and Procedure

This study intends to explore preservice elementary teachers' science teaching efficacy beliefs, science knowledge level and attitude toward science teaching. The present study was conducted at the end of the spring semester of 2003-2004 academic year. The subjects were seniors who were ready to be elementary teachers in elementary schools. In an effort to attain the purpose of the study, data were collected by utilizing the survey research techniques. The subjects filled out the three questionnaires; The Science Teaching Efficacy Belief Instrument for preservice teachers (STEBI-B), The Science Teaching Attitude Scale and the Science Achievement Test.

3.2 The Statement of the Research Problem of the Present Study

In the previous chapters, the conceptual and theoretical framework and a review of related research studies that underline preservice elementary teachers' efficacy beliefs regarding the teaching of science, knowledge level and attitudes were presented. In this section, the main problem, research questions and related sub-problems to be addressed and statistical hypotheses associated with these problems are stated.

The main problem to be addressed in the present study is as follows:

"What are preservice elementary teachers' self-efficacy beliefs regarding science teaching, science knowledge level and attitude towards science teaching?"

3.2.1 Research Questions and Related Sub-problems

Based on the main problem, the specific research questions and related sub-problems are as follows:

1. What are preservice elementary teachers' efficacy beliefs regarding science teaching?
2. What are preservice elementary teachers' science knowledge level?
3. What are preservice elementary teachers' attitude toward science teaching?
4. Is there a significant contribution of science knowledge level and attitude toward science teaching to teachers' self-efficacy beliefs regarding science teaching?

Based on the first research question, the following sub-problems to be addressed in this study are as follows:

Sub-problem 1.1: Is there a significant difference between male and female preservice elementary teachers' self-efficacy beliefs regarding science teaching?

Sub-problem 1.2: Is there a significant relationship between preservice elementary teachers' number of university pedagogical courses completed and their self-efficacy beliefs regarding science teaching?

Sub-problem 1.3: Is there a significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their self-efficacy beliefs regarding science teaching?

Based on the second research question, the following sub-problems to be addressed in this study are as follows:

Sub-problem 2.1: Is there a significant difference between male and female preservice elementary teachers with regard to their science knowledge level?

Sub-problem 2.2: Is there a significant relationship between preservice elementary teachers' number of university science courses completed and their science knowledge level?

Sub-problem 2.3: Is there a significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their science knowledge level ?

Based on the third research question, the following sub-problems to be addressed in this study are as follows:

Sub-problem 3.1: Is there a significant difference between male and female preservice elementary teachers with regard to their attitude toward science teaching?

Sub-problem 3.2: Is there a significant relationship between preservice elementary teachers' number of university science courses completed and their attitude toward science teaching?

Sub-problem 3.3: Is there a significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their attitude toward science teaching?

Based on the fourth research question, the following sub-problems to be addressed in this study are as follows:

Sub-problem 4.1: Is there a significant contribution of science knowledge level and attitude toward science teaching to personal science teaching efficacy beliefs (PSTE)?

Sub-problem 4.2: Is there a significant contribution of science knowledge level and attitude toward science teaching to science teaching outcome expectancy (STOE)?

3.2.2. The Statement of the Statistical Hypotheses Associated with Sub-problems

The following null hypotheses are stated in order to assess the sub-problems. To determine the significance of the sub-problems they are tested at the significance level of .05.

The null hypothesis of the sub-problem 1.1:

► H_0 1.1: There is no statistically significant difference between the mean scores of male and female preservice elementary teachers' self-efficacy beliefs regarding science teaching.

The null hypothesis of the sub-problem 1.2:

► H_0 1.2: There is no statistically significant relationship between preservice elementary teachers' number of university pedagogical courses completed and their self-efficacy beliefs regarding science teaching.

The null hypothesis of the sub-problem 1.3:

► H_0 1.3: There is no statistically significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their self-efficacy beliefs regarding science teaching.

The null hypothesis of the sub-problem 2.1:

► H_0 2.1: There is no statistically significant difference between the mean scores of male and female preservice elementary teachers with regard to their science knowledge level.

The null hypothesis of the sub-problem 2.2:

► H_0 2.2: There is no statistically significant relationship between preservice elementary teachers' number of university science courses completed and their science knowledge level.

The null hypothesis of the sub-problem 2.3:

► H_0 2.3: There is no statistically significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their science knowledge level.

The null hypothesis of the sub-problem 3.1:

► H_0 3.1: There is no statistically significant difference between the mean scores of male and female preservice elementary teachers with regard to their attitude toward science teaching.

The null hypothesis of the sub-problem 3.2:

► H_0 3.2: There is no statistically significant relationship between preservice elementary teachers' number of university science courses completed and their attitude toward science teaching.

The null hypothesis of the sub-problem 3.3:

► H_0 3.3: There is no statistically significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their attitude toward science teaching.

The null hypothesis of the sub-problem 4.1:

► H_0 4.1: There is no significant contribution of science knowledge level and attitude toward science teaching to personal science teaching efficacy beliefs (PSTE).

The null hypothesis of the sub-problem 4.2:

► H_0 4.2: There is no significant contribution of science knowledge level and attitude toward science teaching to science teaching outcome expectancy (STOE).

3.3 Population and Sample Selection

The target population of this study is the fourth year preservice elementary teachers enrolled at elementary teacher education programs of the universities in Turkey. The approximate total number of the fourth year preservice elementary teachers at elementary education programs of forty-four universities in Turkey is 10.395. The required sample size is determined by taking ten percent of the population. According to Gay (1996) for descriptive research, the corresponding general guideline is to sample 10 to 20% of the population. Thus, the desired sample science for this study was estimated as 1000 of the fourth year preservice elementary teachers by taking 10% of the population.

The desired sample size of 1000 was selected from the population through cluster sampling in which groups are randomly selected. Cluster sampling is similar to simple random sampling except that groups of individuals, called clusters, are selected rather than single individuals. All individuals in a cluster are included in the sample; the clusters are preferably selected randomly from the larger population of clusters. The advantages of cluster sampling are that it can be used when it is difficult or impossible to select a random sample of individuals, it is often far easier to implement in schools, and it is frequently less time-consuming (Fraenkel & Wallen, 1996).

The cluster in this study was the university. There were forty-four universities to select the desired sample size of 1000. It was assumed that eleven universities would be sufficient with an average number of 100 preservice elementary teachers per university by estimating losing rate. Since eleven universities could be sufficient to reach the desired number of sample sizes, eleven out of forty-four universities were selected randomly. Then, the desired number of sample size was reached from these randomly selected universities. With the expected losing rate in the returning of the questionnaires, data in this study were collected from a total number of 750 preservice elementary teachers enrolled at elementary teacher education programs of nine of eleven selected universities. The sample included 531 females, 216 males and 3 did not indicate their gender. Table 3.1 displays the distribution of number of preservice elementary teachers by universities.

Table 3.1 Distribution of Preservice Elementary Teachers by the Universities.

University	Number of Participants
Ankara University	48
Gazi University	92
Çukurova University	94
Pamukkale University	168
Afyon Kocatepe University	186
Mustafa Kemal University	128
18 Mart University	13
Ege University	14
Abant İzzet Baysal University	7

In Turkey, elementary teachers are educated through four year undergraduate programs and these programs need to follow very similar coursework that is suggested by the Higher Education Council. Preservice elementary teachers during the typical 4-year course are required to take a number of courses in the different branches of science, and several courses related to teaching profession. The four years of coursework include overall 152 credits hours. The list of science related and pedagogical courses are given in Table 3.2 and Table 3.3 respectively.

Table 3.2 Science Related Courses that Preservice Elementary Teachers Required to Complete in Turkey

Courses	Semester	Total Credit
Life Science	1	3
General Chemistry	2	3
General Physics	3	3
Earth Science	4	2
Science Laboratory	4	2

Table 3.3 Educational Courses that Preservice Elementary Teachers Required to Complete in Turkey

Courses	Semester	Total Credit
Introduction to teaching profession	1	3
School Experience I	2	3
Learning and Development	3	3
Instructional Planning and Evaluation	4	4
Instructional Technology and Material Development	5	3
Teaching Science I	5	3
Teaching Science II	6	3
Classroom Management	6	3
Analysis of science textbooks	7	3
School Experience II	7	3
Practice Teaching	8	5

Note: Pedagogical courses specifically related to teaching of other subjects such as mathematics teaching methods or teaching language are not include in the list.

3.4 Data Collection Instruments

Data were collected through: (1) Science Achievement Test, (2) The Science Teaching Efficacy Belief Instrument Form B (STEBI-B) (Enochs & Riggs, 1990), and (3) The Science Teaching Attitude Scale (Thompson & Shringley, 1986).

3.4.1 The Science Achievement Test

The Science Achievement Test was designed to measure science knowledge level of preservice elementary teachers. It consists of 24 multiple choice questions which is divided into three areas-biology, physics, and chemistry. The questions in the test included one correct answer and four distracters. It was a standardized test by Student Selection and Placement Center (ÖSYM). Appendix A displays the Science Achievement Test.

3.4.2 The Science Teaching Efficacy Belief Instrument Form B (STEBI-B)

The Science Teaching Efficacy Belief Instrument Form B (STEBI-B) (Enochs & Riggs, 1990) was designed to measure self-efficacy beliefs of preservice elementary teachers regarding science teaching. The STEBI-B consists of 23 items in a five-point Likert type scale and response categories were accomplished by assigning a score of 5 to “strongly agree”, 4 to “agree”, 3 to “uncertain”, 2 to "disagree", and 1 to "strongly disagree". Negatively worded items must be reverse scored so that high scores on both subscales are indicative of positive efficacy beliefs towards science teaching. The STEBI-B is comprised of two subdimensions; the Personal Science Teaching Efficacy (PSTE) retained 13 items (Items 2, 3, 4, 6, 7, 12, 16-22) and the Science Teaching Outcome Expectancy (STOE) retained 10 items (Items 1, 5, 8, 9, 10, 11, 13, 14, 15, and 23). Appendix B displays the STEBI-B. Enochs and Riggs (1990) reported that the STEBI-B was a valid and reliable instrument with the alpha reliability coefficients of .90 and .76 for the PSTE, and STOE, respectively.

The STEBI-B was translated and adapted into Turkish by Tekkaya, Çakıroğlu and Özkan (2002). It includes 23 items with a five-point Likert type format. The STEBI consists of two subdimensions as suggested originally; the PSTE (13 items) and the STOE (10 items). They reported that the Turkish version of the STEBI-B was a valid and reliable instrument to be used for similar studies with the alpha reliability coefficients of .86 and .79 for the PSTE, and STOE, respectively.

3.4.3 The Science Teaching Attitude Scale

The Science Teaching Attitude Scale (Thompson & Shringley, 1986), an instrument designed to measure preservice elementary teachers' attitudes towards science teaching consists of 20 items in a five-point Likert scale format. Response categories were accomplished by assigning a score of 5 to "strongly agree", 4 to "agree", 3 to "uncertain", 2 to "disagree", and 1 to "strongly disagree". Out of 20 items, 11 were worded positively and 9 were worded negatively. The Science

Teaching Attitude Scale has been stated to be a reliable, valid instrument useful in determining attitudes toward science teaching (Thompson & Shringley, 1986). Appendix C displays The Science Teaching Attitude Scale.

The science teaching attitude scale was translated and adapted into Turkish by Tekkaya, Çakıroğlu and Özkan (2002). It includes 21 items with a five-point Likert type format. The reliability of the Turkish version of the scale was found to be .83 and the validation of the Turkish attitude scale was examined by a group of panel judges. For the present study, 20 of these items were used and the alpha reliability coefficient was found to be .86.

3.5 Analysis of Data

Data of the present study were analyzed utilizing descriptive and inferential statistics. In order to address the first, second and third research questions, descriptive statistics were utilized. Based on the respondents' scores on the scales of the STEBI-B, the Science Teaching Attitude Scale and Science Achievement Test, individual item means and standard deviations on each subscale as well as mean scores and standard deviations for the subscales were computed.

A series of inferential statistics was performed on the scores of each subscale to evaluate statistical hypotheses of the sub-problems. t-tests were performed whether there was a difference between the mean scores of preservice elementary teachers' self-efficacy beliefs regarding science teaching, science knowledge level and their attitude toward science teaching regarding gender at the .05 level of significance.

In an effort to determine the fourth research question, Multiple Regression Correlation (MRC) Analysis was performed to determine the contributions of science knowledge level and attitude toward science teaching to preservice elementary teachers' self efficacy beliefs regarding science teaching.

Also, Pearson product-moment correlations were computed whether there was a relationship between:

- ► the mean scores of preservice elementary teachers' self-efficacy beliefs regarding science teaching, science achievement and their attitude toward science teaching regarding cumulative grade point average (CGPA);
- ► the mean scores of preservice elementary teachers' self-efficacy beliefs regarding science teaching and the number of university pedagogical courses completed;
- ► the mean scores of preservice elementary teachers' self-efficacy beliefs regarding science teaching and attitude toward science teaching regarding preference to be a teacher;
- ► preservice elementary teachers' science achievement and their attitude toward science teaching regarding number of university science courses completed.

3.6 Assumptions and Limitations

In this section, assumptions and limitations of this study are presented.

3.6.1 The Assumptions of This Study

- ► The sample size represented the population.
- ► The instrument was administered under standard conditions.
- ► Data collectors were not biased during the application of the instrument.
- ► The participants completed the instrument accurately and truthfully.
- ► The participants from the same universities did not interact with each other to affect the results of the study.
- ► The implementation process of the study instrument was the same for all participants.

3.6.2 The Limitations of This Study

- ► Subjects of this study were limited to 750 fourth years preservice elementary students at different universities in Turkey during 2003-2004 spring semester. So, the results of this study can not be generalized to all preservice teachers. The results of the present study can be generalized to subjects having the same characteristics in the similar settings.

CHAPTER IV

RESULTS OF THE STUDY

In the exploring research questions, the results of the study are presented in different subsections. The first subsection includes preservice elementary teachers' efficacy beliefs regarding science teaching and the results of the related sub-problems. The second subsection includes preservice elementary teachers' science knowledge level and the results of the related sub-problems. The third subsection includes preservice elementary teachers' attitude toward science teaching and the results of the related sub-problems. The last subsection comprises the result of the contributions of science knowledge level and attitude toward science teaching to preservice elementary teachers' self-efficacy beliefs and the results of the related sub-problems.

4.1 Preservice Elementary Teachers' Efficacy Beliefs Regarding Science Teaching

The respondents' scores on the STEBI-B were analyzed by utilizing descriptive statistics. Negatively written items that were shown with asterisks in Table 4.1 and Table 4.2 were reversed at their scores at the beginning of the statistical analysis to provide consistent values between negatively and positively worded items. The higher the mean scores on negatively written items indicates also positive teaching efficacy as a consequence of their reversed scores. Because of its two distinct dimensionality subsequent analyses were conducted separately on each subdimensions. Item scores of each subdimensions were summed to create two separate scale scores for each respondent. Consequently, an efficacy score for each subscale was computed by taking the mean of the responses to the items retained each factor. Table 4.1 indicates the means and standard deviations of respondents' scores for each item on the PSTE subscale. In addition, Table 4.2 presents the descriptive statistics for each item on the STOE subscale. For the PSTE subscale the possible minimum score is 13 (least efficacious) and the maximum score is 65 (most efficacious) because it includes 13 items with a five category response scale. For the STOE subscale the possible minimum score is 10 (least efficacious) and the maximum score is 50 (most efficacious) because it includes 10 items with a five category response scale.

In this context, the preservice elementary teachers indicated efficacy beliefs regarding the teaching of science on both dimensions. For the PSTE subscale, raw scores ranged from 17 to 65 with a mean score of 45.22 and a standard deviation of 13.42. Likewise, for the STOE subscale, raw scores range from 15 to 50 with a mean score of 36.34 and a standard deviation of 10.30.

In this study, percentages for each item of responses were categorized into three groups: agreement, neutral, and disagreement. Table 4.1 and 4.2 display percentages of responses to each item that fell into three collapsed categories for Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) scale, respectively.

The preservice elementary teachers' scores on the PSTE scale indicated that they had moderate sense of self-efficacy beliefs in teaching science (M=45.22).

About 77% of the participants asserted that they usually welcome students' science questions and 67% indicated that they would be effective in monitoring science experiments and 63.8% stated that they would generally teach science effectively. In addition, 61.1% of the participants claimed that they would continually find better ways to teach science, 57.8% thought that they knew how to help the student when a student had a difficulty to understand a science concept. Half of the participants (56.4%) believed that with effort they would teach science as well as most subjects. Only 53.1% asserted that they would be able to answer students' science questions. However, slightly less than half of the participants (48.8%) indicated that given a choice, they would invite the principal to evaluate their science teaching. Moreover, 47% asserted that they would be able to explain to students why science experiments work. Approximately 46% claimed that they knew what to do to turn students on to science and they had the necessary skills to teach science effectively. Only 34% and 41% thought that they knew science concepts and the necessary steps to teach science, respectively.

Also, the respondents' scores on the STOE scale indicated that they had moderate sense of outcome expectancy beliefs in teaching science (M=36.34). About 77.6% of the participants believed that the inadequacy of a student's science background could be overcome by good teaching. About the same percentage of the participants (76.8%) believed that students' achievement in science was directly related to their teacher's effectiveness in science teaching. Moreover, 73.8% thought that they could increase students' achievement with effective teaching, 66.7% claimed that extra attention improved low achievers and 66.5% were in agreement that ineffective science teaching resulted in underachieving of students in science.

More than half of the participants (61.6%) believed that the teacher was generally responsible for the low science achievement of some students and some (60.3%) thought that when a student did better than usual in science, it was often because the teacher exerted a little extra effort. Only 55.2% believed that their performance would enhance students' interest in science. However, slightly less than half of the participants (48.2%) indicated that the teacher was generally responsible for the achievement of students in science and 48% asserted that increased effort in science teaching produced change in some students' science achievement.

Table 4.1 Item Means, Standard Deviations and Percentages of Respondents' on the PSTE Subscale of the Science Teaching Efficacy Belief Instrument (STEBI-B).

Item Number	Item Description	Mean	SD	Agree (%)	Neutral (%)	Disagree (%)
2	I will continually find better ways to teach science.	3.62	1.00	61.1	22.1	13.7
* 3	Even if I try very hard, I will not teach science as well as I will most subjects.	3.53	1.18	21.2	19.2	56.4
4	I know the steps necessary to teach science concepts effectively.	3.20	1.00	41	31.9	23.1
* 6	I will not be very effective in monitoring science experiments.	3.78	1.01	11.9	16.3	67
* 7	I will generally teach science ineffectively.	3.71	1.06	14.6	18.8	63.8
12	I understand science concepts well enough to be effective in teaching elementary science.	3.08	.96	34	37.3	25.6
* 16	I will find it difficult to explain to students why science experiments work.	3.32	1.03	23.5	25.1	47
17	I will typically be able to answer students' science questions.	3.47	.91	53.1	27.9	14
* 18	I wonder if I will have the necessary skills to teach science.	3.34	1.03	21.3	27.9	46.2
* 19	Given a choice, I will not invite the principal to evaluate my science teaching.	3.27	1.24	27.9	18.8	48.8
* 20	When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.	3.60	.94	13.5	23.9	57.8
21	When teaching science, I will usually welcome student questions.	4.00	.97	77	8.3	9.6
* 22	I do not know what to do to turn students on to science.	3.30	1.09	23.6	25.7	46.4
	Total Scale (Min 13-Max 65)	45.22	13.42			

* Scoring Reversed For These Items.

Table 4.2 Item Means, Standard Deviations and Percentages of Respondents' Scores on the STOE Subscale of the Science Teaching Efficacy Belief Instrument (STEBI-B).

Item Number	Item Description	Mean	SD	Agree (%)	Neutral (%)	Disagree (%)
1	When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	3.48	1.11	60.3	13.6	23.6
5	When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	3.87	1.05	73.8	10.5	13
8	If students are underachieving in science, it is most likely due to ineffective science teaching.	3.71	1.13	66.5	14.5	16
9	The inadequacy of a student's science background can be overcome by good teaching.	3.99	.97	77.6	8.4	9.9
* 10	The low science achievement of some students cannot generally be blamed on their teachers.	3.64	1.03	15.4	19.5	61.6
11	When a low- achieving child progresses in science, it is usually due to extra attention given by the teacher.	3.68	.93	66.7	18	12.4
* 13	Increased effort in science teaching produces little change in some students' science achievement.	3.23	1.07	29.1	20.3	48
14	The teacher is generally responsible for the achievement of students in science.	3.28	1.05	48.2	22.3	27
15	Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	3.90	.93	76.8	10.3	9.1
23	If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	3.56	1.03	55.2	22.9	16.8
	Total Scale (Min 10-Max 50)	36.34	10.30			

* Scoring Reversed For These Items.

4.1.1 Result of the Hypothesis of the Sub-problem 1.1

The sub-problem 1.1 to be addressed was "Is there a significant difference between male and female preservice elementary teachers' self-efficacy beliefs regarding science teaching?"

The null hypothesis of the sub-problem ($H_0 1.1$) is that: There is no statistically significant difference between the mean scores of male and female preservice elementary teachers' self-efficacy beliefs regarding science teaching.

A series of t-tests was conducted to evaluate the hypothesis $H_0 1.1$ at the significance level .05 (Table 4.3). There was no statistically significant difference between the mean scores of male and female preservice elementary teachers' self-efficacy beliefs regarding science teaching on both the Personal Science Teaching Efficacy (PSTE) and the Science Teaching Outcome Expectancy (STOE) subscales of the Science Teaching Efficacy Belief Instrument (STEBI-B) ($p > .05$).

Table 4.3 Independent t-Test Analysis for Differences in Preservice Elementary Teachers' Science Teaching Efficacy Beliefs with Regard to Gender

Sub-scale	N	Mean	SD	df	t-value
PSTE					
Female	463	45.55	7.16	660	.486
Male	199	45.05	8.59		
STOE					
Female	463	36.44	5.47	660	.510
Male	199	36.12	6.17		

4.1.2 Result of the Hypothesis of the Sub-problem 1.2

The sub-problem 1.2 to be addressed was “Is there a significant relationship between preservice elementary teachers’ number of university pedagogical courses completed and their self-efficacy beliefs regarding science teaching?”.

The null hypothesis of the sub-problem ($H_0 1.2$) is that: There is no statistically significant relationship between preservice elementary teachers’ number of university pedagogical courses completed and their self-efficacy beliefs regarding science teaching.

Pearson Product-Moment Correlations were computed to explore whether a relationship exists between preservice elementary teachers’ number of university pedagogical courses completed and their self-efficacy beliefs regarding science teaching at the significance level .05 (Table 4.4). Analyses revealed that although there was no statistically significant relationship between preservice elementary teachers’ number of university pedagogical courses completed and the Science Teaching Outcome Expectancy (STOE) subscale ($p > .05$; $r = .040$), there was a low positive correlation between preservice elementary teachers’ number of university pedagogical courses completed and the Personal Science Teaching Efficacy (PSTE) beliefs ($p < .05$; $r = +0.140$).

4.1.3 Result of the Hypothesis of the Sub-problem 1.3

The sub-problem 1.3 to be addressed was “Is there a significant relationship between preservice elementary teachers’ cumulative grade point average (CGPA) and their self-efficacy beliefs regarding science teaching?”

The null hypothesis of the sub-problem ($H_0 1.3$) is that: There is no statistically significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their self-efficacy beliefs regarding science teaching.

Pearson Product-Moment Correlations were computed to explore whether a relationship exists between preservice elementary teachers' cumulative grade point average (CGPA) and their self-efficacy beliefs regarding science teaching (Table 4.4). Analyses revealed no statistically significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and both the Personal Science Teaching Efficacy (PSTE) and the Science Teaching Outcome Expectancy (STOE) subscales of the Science Teaching Efficacy Belief Instrument (STEBI-B) ($p > .05$).

Table 4.4 Pearson Product-Moment Correlations of the Two STEBI-B Subscales with the Number of University Pedagogical Courses Completed and CGPA.

Sub-scale	Pedagogical Courses	CGPA
PSTE	r= .140; p= .000	r= .081; p= .059
STOE	r= .040; p= .300	r= .045; p= .280

4.2 Preservice Elementary Teachers' Science Knowledge Level

The respondents' scores on the Science Achievement Test were analyzed by utilizing descriptive statistics. The possible minimum score is 0 (lowest knowledge level) and the maximum score is 24 (highest knowledge level) because it includes 24 questions and one correct answer.

In this study, the preservice elementary teachers indicated low level of science knowledge. Most of the participants responded correctly to less than 50% of the questions. A low mean score of 7.31 over 24 was obtained and the standard deviation was found to be 3.95.

In addition, preservice elementary teachers were asked open-ended questions regarding their confidence in science discipline and their responses revealed more positive confidence toward biology than chemistry and physics.

4.2.1 Result of the Hypothesis of the Sub-problem 2.1

The sub-problem 2.1 to be addressed was "Is there a significant difference between male and female preservice elementary teachers with regard to their science knowledge level?"

The null hypothesis of the sub-problem ($H_0$2.1) is that: There is no statistically significant difference between the mean scores of male and female preservice elementary teachers with regard to their science knowledge level.

A series of t-tests was conducted to evaluate the hypothesis $H_0$2.1 at the significance level .05 (Table 4.5). There was a statistically significant difference between the mean scores of male and female preservice elementary teachers with regard to their science knowledge level. The magnitude of the differences in the means was very small (eta squared = .019).

Table 4.5 Independent t-Test Analysis for Differences in Preservice Elementary Teachers' Science Knowledge with Regard to Gender.

	Gender	N	Mean	SD	df	t-value
Science Knowledge	Female	531	6.97	3.97	745	.000
	Male	216	8.18	3.80		

4.2.2 Results of the Hypothesis of the Sub-problem 2.2

The sub-problem 2.2 to be addressed was "Is there a significant relationship between preservice elementary teachers' number of university science courses completed and their science knowledge level?"

The null hypothesis of the sub-problem ($H_0 2.2$) is that: There is no statistically significant relationship between preservice elementary teachers' number of university science courses completed and their science knowledge level.

Pearson Product-Moment Correlations were computed to find out whether a relationship exists between preservice elementary teachers' number of university science courses completed and their science knowledge level (Table 4.6). Analyses revealed no statistically significant relationship between preservice elementary teachers' number of university science courses completed and their science knowledge level ($p>.05$).

4.2.3 Result of the Hypothesis of the Sub-problem 2.3

The sub-problem 2.3 to be addressed was "Is there a significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their science knowledge level?"

The null hypothesis of the sub-problem ($H_0 2.3$) is that: There is no statistically significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their science knowledge level.

Pearson Product-Moment Correlations were performed to explore whether a relationship exists between preservice elementary teachers' cumulative grade point average (CGPA) and their science knowledge level (Table 4.6). Analyses revealed a negative correlation between preservice elementary teachers' cumulative grade point average (CGPA) and their science knowledge level ($r= -.098$; $p<.05$).

Table 4. 6 Pearson Product-Moment Corelations of the Science Knowledge with the Number of Science Courses Completed and CGPA

	Science Courses	CGPA
Science Knowledge	r= .068; p= .064	r= -.098; p= .013

4.3 Preservice Elementary Teachers' Attitude towards Science Teaching

The respondents' scores on the Science Teaching Attitude Scale were analyzed by utilizing descriptive statistics as shown in Table 4.7. The possible minimum score is 20 (negative attitude) and the maximum score is 100 (positive attitude) because it includes 20 items with a five category response scale; scores approaching the mid-point of 60, indicate neutral.

In this study, for the Science Teaching Attitude Scale mean score was 68.92 with a standard deviation of 20.67. Percentages for each item of responses were categorized into three groups: agreement, neutral, and disagreement. Table 4.7 displays percentages of responses to each item that fell into three collapsed categories for Science Teaching Attitude Scale.

According to the percentages on the Science Teaching Attitude Scale, the respondents indicated positive attitude toward science teaching on most of the items. They were in agreement that the teaching of science process is important in the elementary classroom (86.5%). Similarly, they believed that science is as important as reading-writing and mathematics (77.6%) and they would enjoy the lab/hands on time when they teach science (78.6%). On the contrary, they were low attitude toward science teaching on about science concepts items. For example, most of them afraid that students would ask them questions that they could not answer and they had a difficult time understanding science.

Table 4.7 Descriptive Statistics and Percentages of Respondents' Scores on Science Teaching Attitude Scale

Item	Item Description	Mean	SD	Agree (%)	Neutral (%)	Disagree (%)
* 1	I will feel uncomfortable teaching science.	3.60	1.12	61.2	17.3	18.3
2	The teaching of science process is important in the elementary classroom.	4.27	.95	86.5	3.1	7
* 3	I fear that I will be unable to teach science adequately.	3.30	1.09	47.5	23.9	25.3
4	I will enjoy the lab/hands on time when I teach science.	4.05	.92	78.6	10.1	7.3
* 5	I have a difficult time understanding science.	3.15	1.14	44	19.3	33.1
6	I feel comfortable with the science content in the elementary school curriculum.	3.63	1.03	60.8	18	17
7	I would be interested in working on an experimental science curriculum.	3.88	1.03	73.5	10.8	12.2
* 8	I dread teaching science.	3.44	1.05	52.7	22.8	20.9
* 9	I am not looking forward to teaching science in my elementary classroom.	3.04	1.14	36.8	25.2	34
* 10	I am afraid that students will ask me questions that I can not answer.	3.17	1.16	43.5	19.5	33.1
11	I enjoy manipulating science equipment.	3.70	1.01	65.1	16.5	14.9
* 12	In the classroom, I fear science experiments won't turn out as expected.	2.91	1.12	32.9	22.1	41.2
13	I hope to be able to excite my students about science.	3.70	.89	65.9	21.2	9.5
14	I plan to integrate science into other subject areas.	3.53	.91	53.5	28.1	12
15	Science would be one of my preferred subjects to teach if given a choice.	3.01	1.19	37.1	26.3	32.8
16	Science is as important as reading-writing and mathematics.	4.01	.97	77.6	9.7	9.3
* 17	Teaching science takes too much effort.	2.09	.93	10	8.9	76.8
* 18	Teaching science takes too much time.	2.59	1.02	21.1	21.7	52.8
19	I will enjoy helping students construct science equipment.	3.88	.93	74.8	12.1	9.1

20	I am willing to spend time setting up equipment for a lab.	3.67	1.07	62.5	19.3	14.2
	Total Scale (Min 20-Max 100)	68.92	20.67			

* Scoring Reversed For These Items.

4.3.1 Result of the Hypothesis of the Sub-problem 3.1

The sub-problem 3.1 to be addressed was "Is there a significant difference between male and female preservice elementary teachers with regard to their attitude toward science teaching?"

The null hypothesis of the sub-problem ($H_0$3.1) is that: There is no statistically significant difference between the mean scores of male and female preservice elementary teachers with regard to their attitude toward science teaching.

A series of t-tests was conducted to evaluate the hypothesis $H_0$3.1 at the significance level .05 (Table 4.8). There was no statistically significant difference between the mean scores of male and female preservice elementary teachers with regard to their attitude toward science teaching.

Table 4. 8 Independent T-Test Analysis for Differences in Preservice Elementary Teacher' Attitude Towards Science Teaching with Regard to Gender

	Gender	N	Mean	SD	df	t-value
Attitude Toward Science Teaching	Female	510	64.99	14.26	722	.205
	Male	214	66.45	14.05		

4.3.2 Result of the Hypothesis of the Sub-problem 3.2

The sub-problem 3.2 to be addressed was "Is there a significant relationship between preservice elementary teachers' number of university science courses completed and their attitude toward science teaching?

The null hypothesis of the sub-problem ($H_0$3.2) is that: There is no statistically significant relationship between preservice elementary teachers' number of university science courses completed and their attitude toward science teaching.

Pearson Product-Moment Correlations were performed to explore whether a relationship exists between preservice elementary teachers' number of university science courses completed and their attitude toward science teaching (Table 4.9). Analyses revealed that there was no statistically significant relationship between preservice elementary teachers' number of university science courses completed and their attitude toward science teaching ($p > 0.5$).

4.3.3 Result of the Hypothesis of the Sub-problem 3.3

The sub-problem 3.3 to be addressed was "Is there a significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their attitude toward science teaching?"

The null hypothesis of the sub-problem ($H_0$3.3) is that: There is no statistically significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their attitude toward science teaching.

Pearson Product-Moment Correlations were performed to explore whether a relationship exists between preservice elementary teachers' cumulative grade point average (CGPA) and their attitude toward science teaching (Table 4.9). Analyses revealed that there was no statistically significant relationship between preservice elementary teachers' cumulative grade point average (CGPA) and their attitude toward science teaching ($p>.05$).

Table 4.9 Pearson Product-Moment Correlations of the Attitude toward Science Teaching with the Number of Science Courses Completed and CGPA

	Science Courses	CGPA
Attitude Toward Science Teaching	r= .024; p= .517	r= .037; p= .357

4.4 Relationships Between Science Knowledge Level, Attitude towards Science Teaching and Teachers' Self-efficacy Beliefs

This section includes results of the hypotheses of the sub-problem 4.1, 4.2.

4.4.1 Results of the Hypothesis of the Sub-problem 4.1

The sub-problem 4.1 to be addressed was "Is there a significant contribution of science knowledge level and attitude toward science teaching to personal science teaching efficacy beliefs (PSTE)?"

The null hypothesis of the sub-problem ($H_0$4.1) is that: There is no significant contribution of science knowledge level and attitude toward science teaching to personal science teaching efficacy beliefs (PSTE).

The contributions of science knowledge level and attitude towards science teaching to preservice elementary teachers' personal science teaching efficacy beliefs was determined by using Multiple Regression Correlation (MRC) Analyses (Table 4.10). In this table, beta values are standardized regression coefficients, and B values represent unstandardized regression coefficients.

The results show that the model significantly accounted for 40% of the variation in preservice elementary teachers' personal science teaching efficacy beliefs (F=202,342; p< .05). Also, science knowledge level and attitude towards science teaching each made a statistically significant contribution to the variation in preservice elementary teachers' personal science teaching efficacy beliefs (Table 4.10).

Table 4.10 Independent Contribution of Science Knowledge Level and Attitude Toward Science Teaching to Preservice Elementary Teachers' Personal Science Teaching Efficacy Beliefs

Independent Variables	B	β	t	P
Constant	21.530		17.740	.000
Attitude Toward Science Teaching	.337	.599	18.824	.000
Science Knowledge Level	.215	.111	3.479	.001

4.4.2 Results of the Hypothesis of the Sub-problem 4.2

The sub-problem 4.2 to be addressed was "Is there a significant contribution of science knowledge level and attitude toward science teaching to science teaching outcome expectancy (STOE)?"

The null hypothesis of the sub-problem ($H_0$4.2) is that: There is no significant contribution of science knowledge level and attitude toward science teaching to science teaching outcome expectancy (STOE).

The contributions of science knowledge level and attitude towards science teaching to preservice elementary teachers' science teaching outcome expectancy was determined by using Multiple Regression Correlation (MRC) Analyses (Table 4.11). In this table, beta values are standardized regression coefficients, and B values represent unstandardized regression coefficients.

The results show that the model significantly accounted for 4% of the variation in preservice elementary teachers' science teaching outcome expectancy ($F=12,383$; $p< .05$). Also, science knowledge level and attitude towards science teaching each made a statistically significant contribution to the variation in preservice elementary teachers' science teaching outcome expectancy (Table 4.11).

Table 4.11 Independent Contribution of Science Knowledge Level and Attitude Toward Science Teaching To Preservice Elementary Teachers' Science Teaching Outcome Expectancy

Independent Variables	B	β	t	P
Constant	31.359		28.930	.000
Attitude Toward Science Teaching	.061	.148	3.776	.000
Science Knowledge Level	.133	.093	2.380	.018

4.5 Summary of the Results

- The preservice elementary teachers had moderate sense of personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE);
- The preservice elementary teachers indicated low level of science knowledge;
- The preservice elementary teachers indicated generally positive attitude toward science teaching;
- Science knowledge level and attitude towards science teaching accounted for 40% of the variation in preservice elementary teachers' personal science teaching efficacy beliefs;
- Science knowledge level and attitude toward science teaching accounted for 4% of the variation in preservice elementary teachers' science teaching outcome expectancy;

- ► Although efficacy beliefs and attitude toward science teaching were not related to cumulative GPA, science knowledge level was related to cumulative GPA;
- ► Only PSTE subscale of STEBI-B was related to the number of pedagogical courses completed;
- ► science knowledge level and attitude toward science teaching were not related to the number of university science courses completed.

CHAPTER V

DISCUSSION

The aim of the present study was to investigate preservice elementary teachers' self efficacy beliefs regarding science teaching, science knowledge level and their attitude toward science teaching with some independent variables and in relation with each other. The results of the study were presented in the previous chapter. Thus, in this chapter, the findings are discussed under main headings.

5.1 Preservice Elementary Teacher's Efficacy Beliefs Regarding Science Teaching

The teachers' beliefs (especially self efficacy beliefs) influence their actions; so, many of the educational studies attract attention to self-efficacy. Many of these studies about teachers' self-efficacy beliefs emphasize that teacher efficacy is related to teacher effectiveness and student achievement, attitude and affective growth (Anderson, Greene, & Loewen, 1988; Ashton & Webb, 1986; Ross, 1992; Tschannen-Moran et al., 1998; Woolfolk, Rosoff, & Hoy, 1990). Based on Bandura's idea that self-efficacy is a subject matter specific context, studies in science education also reported that science teaching efficacy is related to positive science teaching behaviors. Czerniak and Lumpe (1996) found that levels of science teaching efficacy were related to science teaching anxiety and the instructional strategies. And also they reported that highly efficacious teachers were more likely to use open-ended, inquiry, student-directed teaching strategies, while teachers with a low sense of efficacy were more likely to use teacher-directed teaching strategies such as lecture and reading from the textbook. Similarly, Riggs and Jesunathadas (1993) found that teachers who exhibit high personal science teaching efficacy (PSTE) are more likely to spend the time needed to thoroughly develop science concepts in their classroom. Furthermore, Enochs and Riggs (1990) revealed that preservice elementary teachers with higher sense of science teaching efficacy were more capable of activity-based science teaching.

Because of strong relationship between science teaching efficacy beliefs and science teaching behaviors, one goal of a teacher education program should be to increase preservice teachers' self-efficacy since teaching characteristics developed during preservice programs will cause a permanent change in teachers' attitudes and beliefs.

According to the result of this study, the preservice elementary teachers indicated moderately positive efficacy beliefs regarding science teaching on personal science teaching efficacy and science teaching outcome expectancy. It means that preservice elementary teachers believe their ability to perform science teaching (personal science teaching efficacy) and their power to overcome the negative effects of non-school factors result in positive student learning outcomes (science teaching outcome expectancy). For the PSTE subscale, most of the participants stated that they would welcome student science questions but they do not feel themselves efficacious enough to answer these questions. They seem to be optimistic and they believe that they will indeed be effective in science teaching in the future. However, most of them expressed concern regarding their background knowledge in science, because low percentage of preservice teachers felt that they understood science concepts well enough to teach science effectively. The possible reason for that is they learn science only at fundamental level in their curriculum in teacher education programs. Results of the science achievement test also confirm this finding.

For the STOE subscale, they generally believed that students' learning can be influenced by effective teaching. They are in agreement that effective science teaching can overcome the inadequacy of a students' science background. If preservice teachers view that effective teaching (active involvement and hands-on science as modeled in their practice course) will cause students to learn science well, they idealistically respond in this manner which is in agreement with Crowther and Cannon (1998).

In this study, additionally, preservice elementary teachers' self-efficacy beliefs regarding science teaching were compared with respect to gender, number of university pedagogical courses completed and cumulative grade point average (CGPA).

t-tests were run on the scores of each subscale to determine differences between male and female preservice elementary teachers' self-efficacy beliefs regarding science teaching. The results revealed no significant differences between efficacy beliefs of preservice elementary teachers in terms of gender. This finding is consistent with Celep's (2001) and Savran and Çakıroğlu's (2001) studies that they did not find a difference between male and female preservice science teachers with regard to their science teaching efficacy beliefs.

Pearson Product-Moment Correlations were computed to explore whether a relationship existed between preservice elementary teachers' number of university pedagogical courses completed and their self-efficacy beliefs regarding science teaching. Elementary teacher education programs include courses related to pedagogical knowledge and pedagogical content knowledge. These programs provide opportunities for preservice elementary teachers to apply their pedagogical content knowledge and pedagogical knowledge with children and to further develop personal teaching instructional competency, skills and abilities. For example, science methods course has provided insights into how children learn science and strategies for teaching science. Shulman (1987) asserted that competent teaching practice requires an integration of such knowledge that of subject matter content knowledge and pedagogical knowledge; therefore, it could be predicted that the sum of the preservice elementary teachers' such experiences during their education programs would impact more on outcome beliefs (STOE) than on personal self-efficacy (PSTE). The relationship between the number of pedagogical courses completed and STOE beliefs has been shown to be positive in some studies (Czerniak & Chiarelott, 1990; Cantrell, Young & Moore, 2003) while other studies (Savran & Çakıroğlu, 2001) have shown no relationship. Contrary to the expectation, data of this study shows that number of pedagogical courses completed at the university are not positively correlated with science teaching outcome expectancy (STOE). On the other hand, number of pedagogical courses completed at the university are positively correlated with personal science teaching efficacy beliefs (PSTE). That is, increase in the number of pedagogical courses completed at the university by the preservice elementary teachers result in increase in their belief to perform science teaching.

Pearson Product-Moment Correlations were computed in exploring possible relationship between the subscales of the STEBI-B and cumulative GPA. However, results revealed no significant relationship between the subscales of the STEBI-B and cumulative GPA.

5.2 Preservice Elementary Teachers' Science Knowledge Level

The preparation of preservice elementary school teachers continues to receive considerable scrutiny. One particular area of concern regards the preparation of prospective teachers to be effective science educators at the elementary school (Tosun, 2000). Inadequate teacher background in science (Franz & Enochs, 1982; Hurd, 1982) have been admitted by elementary teachers as obstacles to effectively teaching science. There is a general agreement that lack of background in science knowledge significantly contributes to hesitancy and possible inability to deliver effective science instruction in classroom settings. Therefore, how much preservice elementary teachers know about science content is an important problem for teacher education program.

In this sense, results of this study showed that preservice elementary teachers had low scores in science achievement test. This test is divided into questions addressing biology, physics, and chemistry which are selected according to elementary school curriculum. However preservice elementary teachers were not successful in any of the three disciplines. Similarly, Tekkaya, Çakıroğlu and Özkan (2004) reported that majority of Turkish preservice science teachers did not acquire a satisfactory understanding of basic science concepts. Moreover, they had misconceptions in most of the science concepts. These results attract attention to investigate teacher education program in Turkey. Preservice elementary teachers in the education program are required to take five science content courses which are Life Science, General Chemistry, General Physics, Earth Science and Science Laboratory. The reason may be the quality of these courses. Lack of science knowledge at a conceptual level is thought to be trouble some for elementary teachers who need to teach fundamental concepts to young students. In other countries, several studies found a similar low level of science knowledge among preservice elementary teachers (Blosser & Howe, 1969; Stein, Baxter & Leinhardt, 1990; Victor, 1962; Wenner, 1996).

t-tests were run on the scores of science achievement test to determine differences between male and female preservice elementary teachers' science knowledge level. The results revealed significant differences between science knowledge levels of preservice elementary teachers in terms of gender. Male mean scores in achievement test are higher than female scores (for female M=6.97 and for male M=8.18). Since number of male participants in this sample was less than half of female participants, differences between science knowledge levels in terms of gender were moderately low.

Pearson Product-Moment Correlations were computed in exploring the possible relationships between science knowledge level, the number of science courses completed and cumulative GPA. It was hypothesized that if the number of science courses increased, science achievement would increase. The results of Wenner (1993) provided evidence which supports this suggestion. Contrary to prediction, this study showed that number of science courses completed was not related to preservice elementary teachers' science knowledge level. Therefore requiring additional content-specific courses as part of preservice elementary teacher preparation may not be the sole solution to preparing competent elementary school teachers. It seems that there is a gap between what science teacher educators perceive as relevant science content and what preservice teachers see as being necessary for teaching science in the elementary school.

In this study, a statistically significant inverse correlation between cumulative grade point average (CGPA) and science knowledge level was found. These data led to the conclusion that high CGPA was not an indication of high science knowledge level. Because in preservice elementary teachers' education program, science courses are only 8% of total number of courses, and high CGPA may be the result of high grades in other courses.

Furthermore, preservice elementary teachers were asked several open-ended questions regarding their confidence of science discipline and their responses revealed more positive confidence toward biology than chemistry and physics (the percentage of preservice elementary teachers who selected biology in this item was 38.5%, chemistry was 14.4% and physics was 12.9%). They asserted that biology was more related to daily life, enjoyable, easier and interesting compared to chemistry and physics. On the other hand, they mentioned that physics was the most difficult discipline to understand and to teach. Positive or negative attitude toward subject matter is highly related to participants' past experiences in high schools and university, especially with their teacher, as understood from their responses to open-ended questions.

5.3 Preservice Elementary Teachers' Attitude toward Science Teaching

A lack of interest in science is one of the barriers to effective elementary science teaching. Stollberg (1969) asserted that teachers with a neutral or negative attitude could either avoid the teaching of science or pass this negative attitude along to young students. Therefore relationship between attitude and behavior must be considered as schools of education that prepare future teachers (Tosun, 2000).

According to the result of this study, the preservice elementary teachers indicated positive attitude toward science teaching on most of the items. Majority of the participants claimed that teaching of science processes was important in the elementary classroom (86.5%). They were in agreement on items which showed the necessity of teaching science and items which were related to laboratory work. On the other hand, participants indicated low attitude toward science teaching on some items which were related to their efficacy in science concepts. This result was consistent with science achievement test result. A low attitude due to low science knowledge was evident.

A series of t-tests was conducted to determine gender differences on attitude toward science teaching. Analysis revealed that there was no significant difference. This finding showed that there is no need for differentiated professional training in science instruction to improve science attitude toward science teaching for the different sexes which is consistent with Tükmen and Bonnstetter's (1999).

Pearson Product-Moment Correlations were computed in exploring the possible relationship between attitude toward science teaching and the number of university science courses completed. The data from this study recorded no significant correlations between attitude toward science teaching and the number of university science courses. In the literature, there are number of studies that consider how the number of university science courses impact on preservice elementary teachers' attitude toward science teaching. For example, Manning et al. (1982) and Lucas and Pooley (1982) found a significant relationship between the number of college courses taken in science and prospective teachers' attitudes toward teaching science. Conversely, Stepans and McCormack (1985) found a negative relationship. Furthermore, Wenner (1993), Feistritzer and Boyer (1983) found nonsignificant correlations between the number of college science courses completed and attitude toward teaching science. The result of present study indicated that increasing the number of science courses do not impact on attitude.

Also, to explore the possible relationship between attitude toward science teaching and cumulative GPA, Pearson Product-Moment Correlations were computed. Analyses revealed that cumulative GPA did not yield a significant correlation with attitude toward science teaching.

5.4 Relationships Between Preservice Elementary Teachers' Self-efficacy Beliefs and Science Knowledge Level and Attitude toward Science Teaching

The contributions of science knowledge level and attitude toward science teaching to preservice elementary teachers' personal science teaching efficacy (PSTE) beliefs and science teaching outcome expectancy (STOE) were determined by using 2 separate Multiple Regression (MRC) Analyses. The results showed that science knowledge level and attitude toward science teaching significantly accounted for 40% and 4% of the variation in PSTE and STOE, respectively. And also, science knowledge level and attitude toward science teaching each made a statistically significant contribution to the variation in PSTE and STOE. This means, preservice teachers with higher science knowledge level and positive attitude toward science teaching scores had more efficacy beliefs on both dimensions of STEBI-B.

Similarly, Haury (1984) concluded that lower knowledge levels lead to decreased efficacy beliefs related to diminution of locus of control. Victor (1961) arrived at a conclusion similar to Haury's. On the other hand, Wenner (1995) found negative relationship between knowledge level and efficacy beliefs toward teaching science in the 1992 study and the follow-up study in 1994 found a non-significant correlation. And also Ginns, Watters, and James (1990) observed no significant correlations between achievement data for science courses and efficacy belief scores.

The literature on teaching performance indicates that content knowledge is part and parcel with (and essentially is a prerequisite for) teaching ability. Ramey-Gassert et al. (1996) examined factors which influence PSTE and STOE in elementary teachers with a qualitative study. In their study, group members in the lower level of PSTE stated that, although they were growing in the area of science teaching, they harbored feelings of inadequacy for many reasons: A primary reason was their perceived lack of background. Whether these teachers had a real or perceived defiency in science content or science methods teacher preparation, it would cause them to hesitate when teaching science.

One logical solution to enhance self-efficacy beliefs is that teacher education programs need to provide more science content and methodology for future elementary teachers. Bandura (1977) identified four sources of efficacy expectations: performance accomplishment, vicarious experience, verbal persuasion, and emotional arousal. The first source of efficacy expectations, performance accomplishment, may be the most significant. It is based upon personal mastery experiences, where by repeated successes increase mastery expectation and failures lower them. Participant modeling is one method of inducing performance accomplishment. These strategies could be integrated in science content courses in the training program to help increase self-efficacy beliefs in science teaching.

Koballa and Crawley (1985) stated that there was an interrelationship among beliefs, attitude and behavior. They offered the scenario whereby elementary school teachers judged their ability to teach science to be low (belief), resulting in a dislike for science teaching (attitude) that ultimately translated into teachers who avoided teaching science (behavior). As expected, preservice elementary teachers' attitude toward science teaching made a significant contribution to the variation in PSTE and STOE in this study. Enhancing self-efficacy beliefs also cause enhancing attitude toward science teaching.

CHAPTER VI

CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

In an effort to inform teacher education practices, this study explored the preservice elementary teachers' self-efficacy beliefs regarding science teaching, their science knowledge level and attitudes toward science teaching. Specifically, the study investigated the relationships between science knowledge level, attitude toward science teaching and self-efficacy beliefs of preservice elementary teachers. In addition, the researcher was interested in determining the difference in preservice elementary teachers' self-efficacy beliefs, science knowledge level and attitude toward science teaching by gender as well as the relation with pedagogical courses, academic achievement and science courses. In this chapter, the research findings are summarized and in the light of these findings some implications for practice and further research on the concern of teachers' efficacy, their science knowledge level and attitude toward science teaching are put forward.

6.1 Conclusions

Analysis of the self-efficacy survey indicated moderately positive self-efficacy beliefs expressed by the most of preservice elementary teachers regarding science teaching. Preservice teachers believe in their own teaching abilities (self-efficacy beliefs) and they believe student learning can be influenced by effective teaching (outcome expectancy beliefs). In addition, analyses of data on the science achievement test revealed low level of science knowledge among preservice elementary teachers. Preservice elementary teachers were not successful in any of the three disciplines. Furthermore, analyses of the science attitude scale indicated generally positive attitude toward science teaching expressed by preservice elementary teachers. Most of preservice elementary teachers believed that science was important in elementary class.

The relationship between science knowledge level, attitude toward science teaching and teachers' self-efficacy beliefs were analyzed by multiple regression analysis. Preservice elementary teachers who had high science knowledge level and positive attitude toward science teaching also tended to have positive self-efficacy beliefs and vice-versa.

A series of statistical analyses revealed that there were no significant differences between male and female preservice teachers' self-efficacy beliefs and attitude toward science teaching.

Pearson product-moment correlations were computed whether there was a relationship between:

- ► the mean scores of preservice elementary teachers' self-efficacy beliefs regarding science teaching, science achievement and their attitude toward science teaching regarding cumulative grade point average (CGPA);
- ► the mean scores of preservice elementary teachers' self-efficacy beliefs regarding science teaching and the number of university pedagogical courses completed;

- preservice elementary teachers' science achievement and their attitude toward science teaching regarding number of university science courses completed.

Analysis indicated that;

- Although efficacy beliefs and attitude toward science teaching were not related to cumulative GPA, science knowledge level was related to cumulative GPA;
- only PSTE subscale of STEBI-B was related to the number of pedagogical courses completed;
- science knowledge level and attitude toward science teaching were not related to the number of university science courses completed.

6.2 Implications

In this section, in the light of the research findings some implications for practice are put forward.

The literature is replete with data supporting the notion that elementary teachers are reluctant to teach science (Cunningham & Blankenchip, 1979; Feistrieter & Boyer, 1983; Sherwood & Westerack, 1983; Wenner, 1993). Other studies (Baker, 1991; Cunningham & Blankenchip, 1979; Riggs & Enochs, 1990; Wolk, 1963) suggest that efficacy is a significant factor contributing to this reluctance. Teacher education programs need to evaluate efficacy level of their teacher education students and begin to find an effective strategy to enhance preservice teachers' sense of science teaching efficacy. This study has the following implications to enhance efficacy beliefs:

► Teacher educators should design existing or any new courses to include experiences to raise preservice elementary teachers' awareness of the efficacy construct and the implications of this construct for their professional growth. Bandura (1981) suggested that self-efficacy can be enhanced through field experiences. This suggestion can be integrated in methods and practice courses in the training program to help preservice elementary teachers increase their self-efficacy beliefs regarding science teaching.

► Since science knowledge level appears to be a factor in teacher efficacy, teachers simply need to know more scientific facts, skills, and concepts. To acquire these requisites preservice teachers should be required to demonstrate proficiency in the fundamental sciences while they are undergraduates. Also in teacher education programs, the number of science courses should be increased and especially quality of science courses should be upgraded.

► Teacher preparation programs must integrate science and methods courses into common units of study. Team planning and teaching involving scientists and educators would be an ideal way to realize this integration goal.

► Since attitude toward science teaching appears to be a factor in teaching efficacy, teacher preparation programs should find ways of changing their preservice elementary teachers' attitudes positively toward science teaching.

6.3 Recommendations

In this section, recommendations for further research are put forward.

► Qualitative and quantitative research techniques should be utilized to construct and measure preservice elementary teachers' self-efficacy more accurately.

► This study should be conducted with in-service elementary teachers.

► The variation of efficacy beliefs should be followed across years.

► Effects of similar variables on science teaching efficacy should be examined.

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APPENDIX A

FEN BİLGİSİ TESTİ

1) Bir ışık ışını, saydam X ortamından, saydam Y ortamına geçerken gelme açısı α, kırılma açısı da β dır. β açısı, aşağıdakilerden hangisine bağlı değildir?

A) α açısı

B) X ortamının kırma indisi

C) Y ortamının kırma indisi

D) Işığın rengi

E) Işığın şiddeti

2) Özellikleri değişebilen durgun bir ortamda yayılan sesin,

I. Şiddeti II. Yüksekliği III. Yayılma hızı

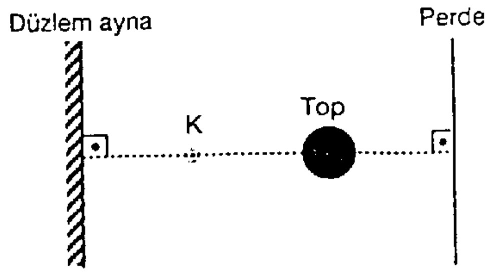
niceliklerinden hangileri değişebilir?

A) Yalnız I B) Yalnız II C) Yalnız III D) I ve II E) I, II ve III

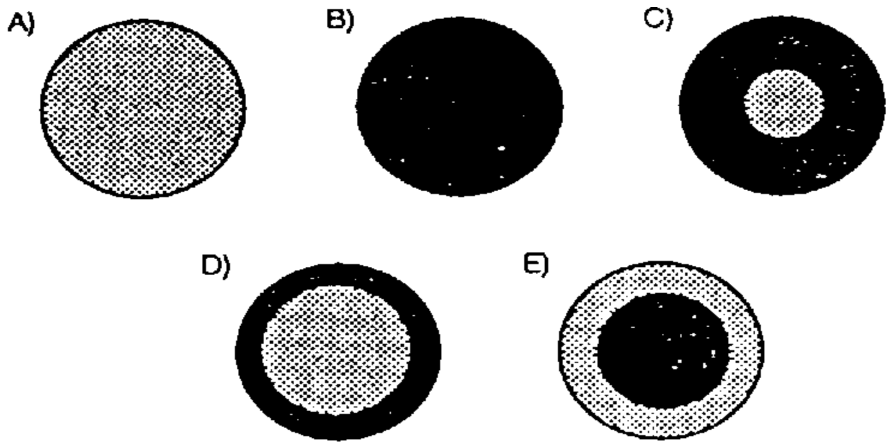
3) Öz ısıları sırasıyla c, 2c kütleleri m, 2m olan X, Y cisimlerinin sıcaklıkları T_1 dir. Bu cisimler t süre ısıtıldığında sıcaklıkları T_2 oluyor. Bu sürede X cisminin aldığı ısı miktarı Q olduğuna göre, Y ninki kaç Q olur?

A) 1/4 B) 1/3 C) 1 D) 2 E) 4

4)



Bir perdenin önüne noktasal K ışık kaynağı, top, düzlem ayna şekildeki gibi yerleştirilmiştir. Perdede oluşan gölge aşağıdakilerden hangisine benzer?



5) Aşağıdaki olaylardan hangisi sesin frekansı ile ilişkilidir?

A) Köpeklerin duyabildikleri bazı seslerin, insanlar tarafından duyulamaması

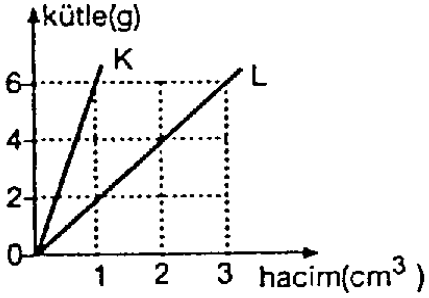
B) Gök gürültüsünün, şimşek çaktıktan ancak bir süre sonra duyulması

C) Havası boşaltılan bir kap içinde çalmakta olan elektrik zilinin sesinin duyulmaması

D) Sesin yüksek engellerden yankılanması

E) Uzaktaki bir kimseye sesin ancak bağrılarak duyurulabilmesi

6)



Kütle-hacim grafikleri şekildeki gibi olan K ve L sıvılarından eşit kütleler karıştırılarak türdeş bir karışım oluşturuluyor. Bu karışımın özkütlesi kaç g/cm^3 tür?

A) 2 B) 3 C) 4 D) 5 E) 6

7) - Vücudu kıllarla kaplı olan

- Yavrularını emziren

- Olgunlaşmış alyuvarları çekirdeksiz olan

hayvanların tümünün toplandığı sınıflandırma basamağı aşağıdakilerden hangisidir?

A) Tür B) Cins C) Familya D) Takım E) Sınıf

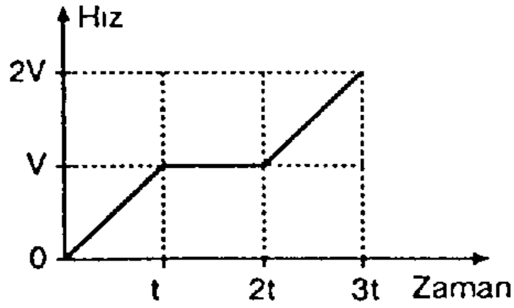
8) Bitkiler, genel olarak, uygun ışık şiddetinde ve ortalama 33^{0}C de yoğun biçimde fotosentez yapıp en fazla miktarda oksijen ve glikoz üretebilmektedirler. Buna göre ılıman bölgede yaşayan ve yaprak döken bitkilerin, aşağıdaki dönemlerin hangisinde dışarıdan aldıkları oksijen miktarları en fazladır ?

A) Kışın, gündüz B) Sonbahar, gündüz

C) Kışın, gece D) Yazın, gece

E) Yazın, gündüz

9)

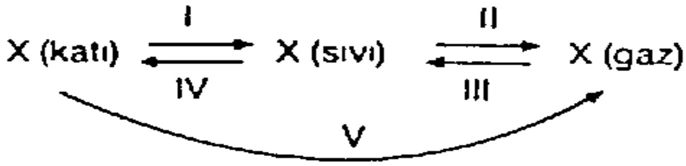


Hız-zaman grafiği şekildeki gibi olan bir cisim KLM yolunu 3t sürede alıyor.

KL=LM olduğuna göre, cisim yolun son yarısı olan LM bölümünü kaç t sürede alır?

A) 0,5 B)1 C) 1,5 D) 2 E) 2,5

10)



X maddesinin farklı hal değişimleri yukarıdaki denklem üzerinde numaralarla gösterilmiştir. Bu hal değişimlerinden hangisi aşağıda yanlış olarak adlandırılmıştır?

A) I: Erime

B) II: Yoğunlaşma

C) III: Sıvılaşma

D) IV: Donma

E) V: Süblimleşme

11) - Proton sayısı aynı, nötron sayısı farklı olan atomlara izotop,

- Nötron sayısı aynı, proton sayısı farklı olan atomlara izoton,

- Nötron ve proton sayıları toplamı aynı olan atomlara izobar denir.

Bu tanımlara göre,

Element	Atom numarası	Kütle numarası	Nötron sayısı
X		35	18
Y	17	37	
Z	18		20

Tablodaki X, Y ve Z elementleri ile ilgili aşağıdaki yargılardan hangisi doğrudur?

A) X ve Y birbirinin izotonudur.

B) X ve Z birbirinin izobarıdır.

C) Y ve Z birbirinin izotonudur.

D) X ve Z birbirinin izotopudur.

E) Y ve Z birbirinin izobarıdır.

12) Canlılar arasındaki beslenme ilişkileri düşünüldüğünde, güneş enerjisinin, aşağıdaki canlılardan hangisinin kullandığı besindeki enerjiye dönüşümü <u>en uzun</u> sürer?

A) Ekmek küf mantarlarının

B) Liken birliğindeki alglerin

C) Bitki virüslerinin

D) Kan parazitlerinin

E) Otoburların

13) Canlılar, akrabalıklarına göre sınıflandırılırken, aralarında sistematik özellikler bakımından en çok benzerlik olandan başlayarak daha az benzerlik olana doğru sıralama yapılır.

Türü	Özellikler									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
K türü	+		+	+		+	+		+	+
G türü		+			+			+	+	
F türü			+	+		+	+		+	+
L türü		+	+		+		+	+		+
M türü	+		+	+		+	+	+	+	

Yukarıdaki tabloda K, G, F, L, M türlerinin, temel 10 sistematik özellikten hangilerini taşıdıkları '+' işareti ile gösterilmiştir. Buna göre, K ye en yakın türler aşağıdakilerin hangisinde birlikte verilmiştir?

A) L, M B) G, L C) F, M D) F, L E)G, F

14) Aynı koşullar altındaki farklı maddelerin, birbirinden ayırt edilmesinde yararlanılan özelliklerine 'ayırt edici' özellik denir. Buna göre,

I. Çözünürlük II. Erime noktası III. Özkütle

özelliklerinden hangileri maddelerin katı, sıvı ve gaz hallerinin hepsinde ayırt edici özelliktir?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) I ve III

15) Bir balık türü, yaşamının,

- I. evresinde bakteriler, su pireleri ve küçük bitkilerle
- II. evresinde eklembacaklılar, salyangozlar ve küçük balıklarla

beslenmektedir.

Bu balık türünün I. ve II. evrelerindeki beslenme biçimlerinin adları aşağıdakilerin hangisinde doğru olarak verilmiştir?

	I	II
A)	Otobur	Karışık
B)	Karışık	Otobur
C)	Otobur	Otobur
D)	Etobur	Etobur
E)	Karışık	Etobur

16) Suda yaşayan bir canlı kolonisinin bazı özellikleri şunlardır:

I. Birer çift kamçı taşıyan 16 hücreden oluşmuştur.
II. Hücrelerin işlevleri birbirlerinin aynıdır.
III. Hücreler, jelatinimsi bir kılıfla bir arada tutulmuştur.
IV. Hücreler, koloniden ayrıldıklarında da bir birey gibi canlılıklarını sürdürebilmektedir.

Yukardaki özelliklerden hangileri, bu koloninin çok hücreli canlı olmadığının kanıtlarıdır?

A) I ve II B) I ve IV C) II ve III

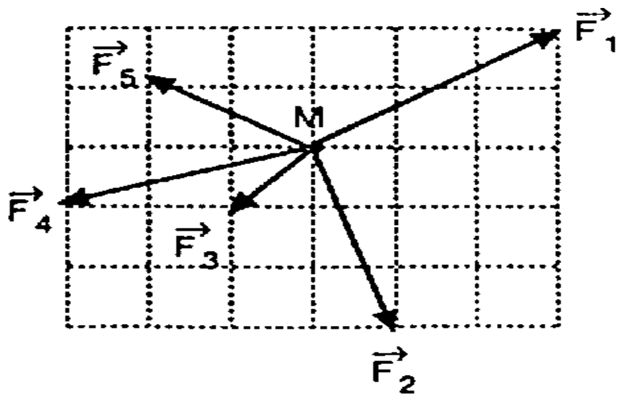
D) II ve IV E) III ve IV

17) Doğrusal bir pistte aynı yerden, aynı anda, aynı yönde koşmaya başlayan X, Y, Z koşucularının hızlarının büyüklüğü sabit ve sırasıyla v_x, v_y, v_z dir. Bir süre sonra X ile Y arasındaki uzaklık, Y ile Z arasındakinden daha büyük oluyor. Buna göre, v_x, v_y, v_z arasındaki ilişki aşağıdakilerden hangisi gibi <u>olamaz</u>?

A) $v_z<v_y<v_x$ B) $v_z<v_x<v_y$ C) $v_y<v_z<v_x$

D) $v_x<v_y<v_z$ E) $v_x<v_z<v_y$

18)

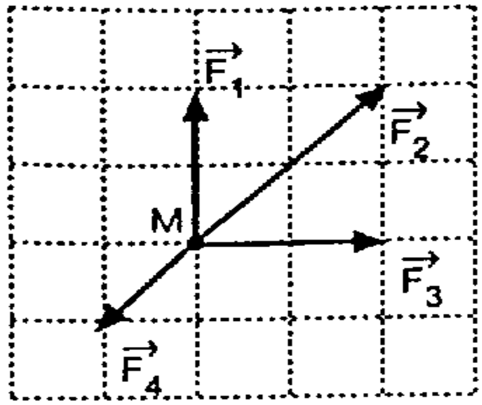


Noktasal M parçacığı, yatay ve sürtünmesiz bir düzlem üzerinde durmaktadır. Bu parçacığa aynı düzlemde F_1, F_2, F_3, F_4 kuvvetleri şekildeki gibi etki ederse, parçacık hangi yönde hareket eder?

A) F_1 yönünde B) F_2 yönünde C) F_3 yönünde

D) F_4 yönünde E) F_5 yönünde

19)



Yatay ve sürtünmesiz bir düzlem üzerinde hareketsiz tutulan M noktasal cismine, aynı düzlemde F_1, F_2, F_3, F_4 kuvvetleri şekildeki gibi etki ediyor. Cismin serbest bırakıldığında da <u>hareketsiz</u> olması için,

I. F_2 kuvvetini yok etme,

II. F_4 kuvvetini yok etme,

III. F_4 kuvvetinin büyüklüğünü iki katına çıkarma

işlemlerinden hangilerini yapmak gerekir?

A) Yalnız I B) Yalnız II C) Yalnız III D) I ve III E) I ve II

20) Isı ve sıcaklık kavramları, aşağıdakilerin hangisinde yanlış kullanılmıştır?

A) Arı suyun normal kaynama sıcaklığı 100^0C tır.

B) Sağlıklı bir kişinin vücut ısısı 36.5^0C tır.

C) Buzdolabının soğutucu bölmesinde sıcaklık yaklaşık 5^0C tır.

D) Odun kömürünün yanma ısısı 8000 kal/g dır.

E) 1 kalori, 1 gram arı suyun sıcaklığını 1^0C yükseltir.

21) Üzerinde r yarıçaplı dairesel delik bulunan türdeş bir metal levha ile yarıçapı r olan türdeş bir metal paranın ilk sıcaklıkları t_1 dir. Bu durumda para delikten ancak geçebilmektedir. Paranın yüzeyce genleşme katsayısı levhanınkinden büyük olduğuna göre:

I. Yalnız paranın II. Yalnız levhanın III. Para ile levhanın birlikte

t_2 sıcaklığına kadar soğutulmaları işlemlerinin hangilerinde para, levhadaki delikten geçebilir?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) I ve III

22) Farklı sıcaklıktaki X ve Y katı cisimleri birbirine değecek biçimde yerleştiriliyor. Cisimler arasında ısı dengesinin kurulması sürecinde, X cisminin;

I. Isı enerjisi değişimi

II. Sıcaklık değişimi

III. Hacim değişimi

niceliklerinden hangileri Y ninkilere kesinlikle eşit olur? (Dış ortamla ısı alışverişi yoktur.)

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) I, II ve III

23) Virüslerin,

I. Yönetici moleküllerinin bir tane olması

II. Yeterli enzim sistemlerinin bulunmaması

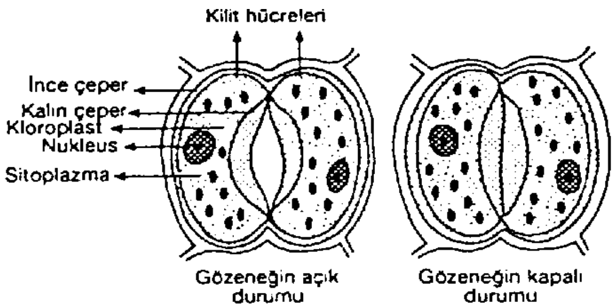
III. Organellerinin bulunmaması

özelliklerinden hangileri, onların, canlılık olaylarını gerçekleştirebilmek için, canlı bir hücre içinde bulunmalarını zorunlu kılar?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

24) Bitkilerin epidermis örtüsünde bulunan stomaların (gözenek) açık ve kapalı şekli aşağıda verilmiştir.



Kilit hücrelerinde su alma ya da verme ile ilgili aşağıdaki olaylardan hangisi, stomanın kapanmasını başlatır?

A) Kilit hücrelerinde turgor basıncının artması

B) Kilit hücrelerinde glikoz miktarının artması

C) Şişen kilit hücrelerinde ince çeperler yönünde kavisin artması

D) Kilit hücrelerinde nişasta miktarının artması

E) Kilit hücrelerinde su miktarının artması

APPENDIX B

SINIF ÖĞRETMENİ ADAYLARININ FEN BİLGİSİ ÖĞRETİMİNE YÖNELİK ÖZ YETERLİK İNANÇLARI

Aşağıda fen bilgisi öğretimine yönelik düşünceler göreceksiniz. Belirtilen ifadelere ne derecede katıldığınızı ya da katılmadığınızı ilgili seçeneği işaretleyerek belirtiniz.

1= Kesinlikle Katılmıyorum	2= Katılmıyorum	3= Kararsızım	4= Katılıyorum	5= Kesinlikle Katılıyorum

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Eğer bir öğrenci fen dersinde her zamankinden daha iyi ise, bunun nedeni çoğunlukla öğretmenin daha fazla çaba harcamasıdır.	1❑	2❑	3❑	4❑	5❑
2. Fen konularını öğretmek için sürekli daha iyi yöntemler bulacağımı düşünüyorum.	1❑	2❑	3❑	4❑	5❑
* 3. Ne kadar çok çaba harcasamda fen dersini diğer dersleri öğrettiğim kadar iyi <u>öğretemeyeceğim.</u>	1❑	2❑	3❑	4❑	5❑

4. Fen bilgisi kavramlarını etkili bir şekilde öğretebilmek için gerekli basamakları biliyorum.	1❑	2❑	3❑	4❑	5❑
5. Öğrencilerin fen bilgisi dersi notlarının iyiye gitmesi genellikle öğretmenin daha etkili bir öğretim yöntemi kullanmasının sonucudur.	1❑	2❑	3❑	4❑	5❑
* 6. Öğrencilerin fen bilgisi dersinde yaptıkları deneyleri takip etmede yeterince etkili <u>olamayacağımı</u> düşünüyorum.	1❑	2❑	3❑	4❑	5❑
* 7. Fen bilgisi dersini genellikle etkili bir şekilde <u>öğretemeyeceğim</u>.	1❑	2❑	3❑	4❑	5❑
8. Öğrencilerin fen bilgisi dersinde başarısız olmasının nedeni büyük bir olasılıkla <u>etkili olmayan</u> fen öğretimidir.	1❑	2❑	3❑	4❑	5❑
9. İyi bir öğretimle, öğrencilerin fen bilgisi dersindeki bilgi yetersizliklerinin üstesinden gelinebilir.	1❑	2❑	3❑	4❑	5❑
* 10. Öğrencilerin fen bilgisi dersindeki başarısının düşük olmasından öğretmen sorumlu <u>tutulamaz</u>.	1❑	2❑	3❑	4❑	5❑
11. Fen bilgisi dersinde başarısız olan bir öğrencinin başarısının artması genellikle öğretmenin daha fazla ilgi göstermesinin sonucudur.	1❑	2❑	3❑	4❑	5❑
12. Etkili bir şekilde öğretecek kadar fen kavramlarından iyi anlıyorum	1❑	2❑	3❑	4❑	5❑

* 13. Fen bilgisi dersini öğretirken öğretmenin daha fazla çaba harcaması, bazı öğrencilerin başarısını <u>çok az</u> oranda değiştirir.	1❑	2❑	3❑	4❑	5❑
14. Öğrencilerin fen bilgisi dersindeki başarısından genellikle öğretmen sorumludur.	1❑	2❑	3❑	4❑	5❑
15. Öğrencinin fen bilgisi dersindeki başarısı, öğretmenin etkili fen öğretimi ile doğrudan ilgilidir.	1❑	2❑	3❑	4❑	5❑
* 16. Fen bilgisi deneyleriyle ilgili soruları açıklamada <u>zorlanırım</u>.	1❑	2❑	3❑	4❑	5❑
17. Öğrencilerin fen bilgisi dersi ile ilgili sorularını genellikle cevaplarım.	1❑	2❑	3❑	4❑	5❑
* 18. Fen dersini öğretmek için gerekli becerilere sahip olacağımdan endişeliyim.	1❑	2❑	3❑	4❑	5❑
* 19. Eğer seçim hakkı verilseydi, okul müdürünü veya müfettişleri beni değerlendirmesi için dersime <u>çağırmazdım.</u>	1❑	2❑	3❑	4❑	5❑
* 20. Fen kavramlarını anlamada zorlanan öğrencilerime nasıl yardımcı olacağımı <u>bilemem</u>.	1❑	2❑	3❑	4❑	5❑
21. Fen bilgisi dersini öğretirken öğrencilerden gelecek soruları her zaman hoş karşılarım.	1❑	2❑	3❑	4❑	5❑

* 22. Öğrencilere fen bilgisi dersini sevdirmek için ne yapmam gerektiğini bilmiyorum.	1❑	2❑	3❑	4❑	5❑
23. Bir veli çocuğunun fen dersine daha fazla ilgi duyduğunu belirtiyorsa, bunun nedeni büyük olasılıkla öğretmenin dersteki performansıdır.	1❑	2❑	3❑	4❑	5❑

* Scoring Reversed for These Items

APPENDIX C

FEN ÖĞRETİMİ TUTUM ÖLÇEĞİ

Aşağıda fen bilgisi öğretimine yönelik düşünceler göreceksiniz. Belirtilen ifadelere ne derecede katıldığınızı yada katılmadığınızı ilgili seçeneği işaretleyerek belirtiniz.

1= Kesinlikle Katılmıyorum	2= Katılmıyorum	3= Kararsızım	4= Katılıyorum	5= Kesinlikle Katılıyorum

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
* 1.Fen dersini öğretirken kendimi rahatsız hissedeceğim.	1❑	2❑	3❑	4❑	5❑
2.Fen dersini öğretirken kendimi rahatsız hissedeceğim.	1❑	2❑	3❑	4❑	5❑
* 3.Fen dersini yeteri kadar öğretemeyeceğimden korkuyorum.	1❑	2❑	3❑	4❑	5❑
4.Fen öğretirken laboratuvar çalışmaları ve basit aktiviteler yapmaktan zevk alacağım.	1❑	2❑	3❑	4❑	5❑
* 5.Fen dersini anlamada zor anlar yaşıyorum.	1❑	2❑	3❑	4❑	5❑
6.İlköğretim fen programında yer alan konularda kendimi rahat hissediyorum.	1❑	2❑	3❑	4❑	5❑

7.Deneye dayalı fen programında çalışmak ilgimi çekiyor.	1❑	2❑	3❑	4❑	5❑
* 8.Fen öğretmek beni endişelendiriyor.	1❑	2❑	3❑	4❑	5❑
* 9.Öğretmen olduğumda, sınıfta fen öğretmek için <u>sabırsızlanmıyorum</u>.	1❑	2❑	3❑	4❑	5❑
* 10.Öğrencilerimin cevaplayamayacağım sorular sormalarından korkuyorum.	1❑	2❑	3❑	4❑	5❑
11.Fen ile ilgili deney düzeneklerini kurmaktan zevk alırım.	1❑	2❑	3❑	4❑	5❑
* 12.Fen deneylerinin beklenen sonucu vermemesinden endişe duyarım.	1❑	2❑	3❑	4❑	5❑
13.Öğrencilerimin fen bilgisine karşı ilgilerini artırabileceğimi umuyorum.	1❑	2❑	3❑	4❑	5❑
14.Feni diğer alanlara entegre etmeyi planlıyorum.	1❑	2❑	3❑	4❑	5❑
15.Eğer seçme hakkı verilseydi fen, öğretmeyi tercih edeceğim derslerden biri olur.	1❑	2❑	3❑	4❑	5❑
16.Fen en az okuma-yazma ve matematik kadar önemlidir.	1❑	2❑	3❑	4❑	5❑
* 17.Fen dersini öğretmek çok çaba gerektirir.	1❑	2❑	3❑	4❑	5❑
* 18.Fen dersini öğretmek çok zaman alır.	1❑	2❑	3❑	4❑	5❑
19.Öğrencilerin fen dersi düzeneklerini kurmalarına yardımcı olmaktan zevk alacağım.	1❑	2❑	3❑	4❑	5❑
20.Fen ile ilgili deney düzeneğini kurmak için zaman harcamaktan zevk alırım.	1❑	2❑	3❑	4❑	5❑

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