

Pre-Service Science Teachers' Teaching Self-Efficacy in Relation to Personality Traits and Academic Self-Regulation

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Abstract. The aim of this study is to examine the relationship among pre-service science teachers' personality traits, academic self-regulation and teaching self-efficacy by proposing and testing a conceptual model. For the specified purpose, 1794 pre-service science teachers participated in the study. The Teachers' Sense of Efficacy Scale, the NEO Five-Factor Inventory, and the Motivated Strategies for Learning Questionnaire were administered to assess pre-service science teachers' teaching self-efficacy, personality, and academic self-regulation respectively. Results showed that agreeableness, neuroticism, performance approach goals, and use of metacognitive strategies are positively linked to different dimensions of teaching self-efficacy, namely self-efficacy for student engagement, instructional strategies, and classroom management. In general, while agreeableness and neuroticism were found to be positively associated with different facets of self-regulation and teaching self-efficacy, openness was found to be negatively linked to these adaptive outcomes.

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Compelling evidence suggests that having both pedagogy knowledge and content knowledge is not sufficient for teachers to be effective. Teachers' beliefs about their abilities to positively influence student learning have been demonstrated to have a strong influence on teaching effectiveness (Knoblauch & Hoy, 2008). Indeed, teachers' self-efficacy -teachers' judgment of their capabilities to organize and carry out strategies necessary for successfully accomplishing a specific teaching task in a particular context- is found to be significantly linked to their classroom behavior and to student outcomes such as achievement (Ashton & Webb, 1986) and motivation (Midgley, Feldlaufer, & Eccles, 1989). In general, teachers with a strong sense of efficacy appear to be eager to try new strategies and methods to better meet students' needs (Cousins & Walker, 2000) and show greater commitment to teaching (Coladarci, 1992). They do not give up easily in the face of difficulties and setbacks. A strong sense of self-efficacy helps teachers deal with a struggling student longer and become less critical of student errors (Ashton & Webb, 1986; Gibson & Dembo, 1984; Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998). On the other hand, teachers with low levels of self-efficacy tend to be less willing to work with students experiencing

difficulties and tend to instruct the class as a whole. They are found to be less optimistic about student learning and to experience lower levels of job-satisfaction (Caprara, Barbaranelli, Steca, & Malone, 2006; Klassen et al., 2009; Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998).

Although there has been considerable research on teacher self-efficacy in other countries (e.g. Anderson, Greene, & Loewen, 1988; Greenwood, Olejnik, & Parkay, 1990; Woolfolk & Hoy, 1990; Pajares, 1997; Goddard, Hoy, & Woolfolk Hoy, 2000; Klassen & Chiu, 2010) and in Turkey (e.g. Cakiroglu, Cakiroglu, & Boone, 2005; Gencer & Cakiroglu, 2007; Isiksal & Cakiroglu, 2005; Koc, 2011), there is limited information in the relevant literature concerning the relationship among teachers' self-efficacy, personality, and academic self-regulation. However, since teachers' sense of efficacy is found to be significantly associated with their instructional practices and with students motivation and achievement, there is a need to investigate the factors influencing the development of teachers' self-efficacy beliefs starting with pre-service years. Indeed, the development of self-efficacy beliefs among pre-service teachers has attracted a great deal of research interest, as once efficacy beliefs are established; they tend to be resistant to change (Hoy & Spero, 2005). A limited number of studies found in the relevant literature demonstrated that how pre-service teachers' approach to their own learning and personality are among the factors closely linked to their sense of

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efficacy. Actually, there are three lines of research in the literature. The first line of related research examines the relationship between teachers' self-regulation and teaching self-efficacy. The second line of research investigates the relationship between teachers' personality and self-regulation. Finally, the third line of the research explores the relationship between personality and teaching self-efficacy. By combining these three lines of research, which are explained in detail in the following sections, the present study aims at examining the relationships among pre-service science teachers' personality, self-regulation, and teaching self-efficacy by proposing and testing a comprehensive conceptual model. Therefore, this study has a potential to make a unique contribution to teaching and teacher education literature since it is the first time a structural model with these variables is investigated. Moreover, the study was conducted specifically with pre-service science teachers in Turkey because, within the science domain, Turkish students are found to have low achievement scores on several international studies (PISA, 2003; TIMMS, 1999; TIMMS, 2007). In addition, science is one of the fundamental core subjects in the Turkish curriculum which has been recently revised. Compared to previous curriculum implemented countrywide, the revised science curriculum gives more emphasis on student centered activities, encouraging students to use various self-regulatory strategies in their learning. Since teaching self-efficacy is found to be significantly linked to teachers' classroom practices, investigation of the factors related to the teaching self-efficacy, such as their own strategy use and personality, can be invaluable to support the recent reform efforts in science education and teacher education. Thus, findings can be

used to improve the current status of science education in Turkey. In addition, the related literature on teacher education is based mainly on the studies conducted in Western countries. Turkey, bridging Asia and Europe, on the other hand, has traditionally been influenced by the East and the West. Thus, it has some unique and interesting characteristics. Since personality and the level of self-regulation and teaching self-efficacy can be influenced by culture (Cakiroglu et al., 2005; McInerney, 2008), the observed relationship between these variables may show differences from culture to culture. Considering the fact that Turkey has some unique characteristics, results obtained from this study can provide better explanations for the findings obtained from other countries with different cultures.

Overall, in an effort to improve science teaching, the current study aims at examining the relationship among Turkish pre-service science teachers' personality, self-regulation, and teaching self-efficacy by examining related variables simultaneously. The consolidated model proposed to investigate possible relationships between pre-service science teachers' self-efficacy, their academic self-regulation, and their personality are displayed in Figure 1. In the model, it was hypothesized that personality variables and academic self-regulation variables are related to the pre-service science teachers' teaching self-efficacy variables. In addition, the model suggested links between personality variables and academic self-regulation variables.

Accordingly, as detailed in the following sections, the model contains three main construct, namely teacher self-efficacy, academic self-regulation, and personality. All three constructs are represented by a number of subcomponents: Teacher self-efficacy is examined in

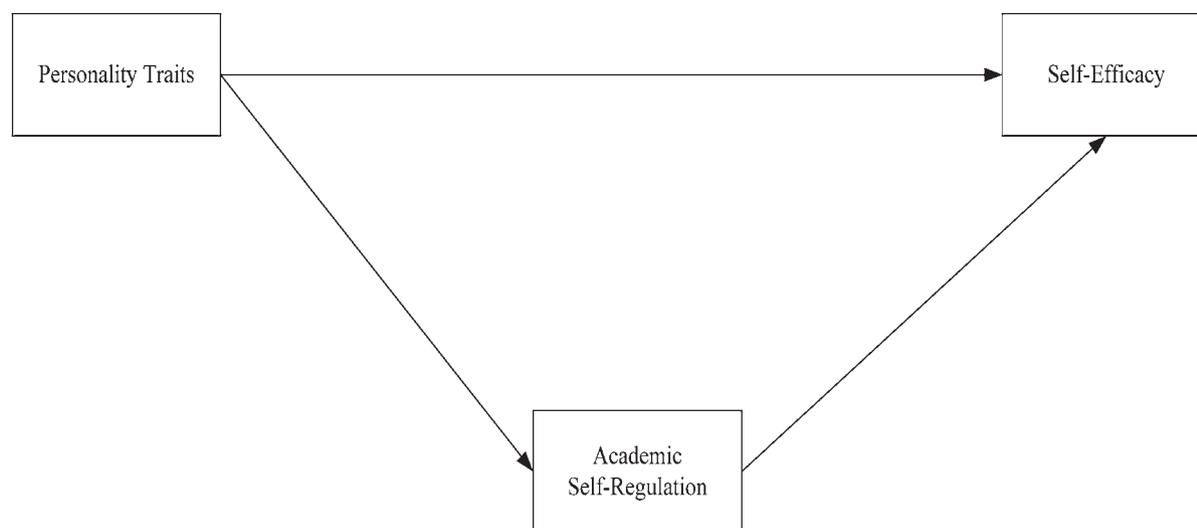


Figure 1. Model of the proposed relationships between self-efficacy, academic self-regulation, and personality traits.

three dimensions namely, self-efficacy for student engagement, self-efficacy for instructional strategies, and self-efficacy for classroom management. Academic self-regulation, on the other hand, encompasses achievement goals, task value, control of learning beliefs, test anxiety, metacognitive self-regulation, effort regulation, and peer learning. Finally, personality includes neuroticism, extraversion, openness, agreeableness, and conscientiousness.

In the proposed model, it was hypothesized that among personality variables, openness, conscientiousness, extroversion, and agreeableness were positively related to all dimensions of teaching self-efficacy. In addition, positive associations were predicted between all dimension of teaching self-efficacy and all components of self-regulation except avoidance goals. Moreover, the model suggested positive relationships between openness, conscientiousness, and agreeableness and approach goals, metacognitive self-regulation, and effort regulation sub-components of academic self-regulation. Additionally, positive relationships were proposed between extroversion and approach goals and between neuroticism and test anxiety. All proposed relationships were derived from relevant literature and theory and detailed in the following sections.

Relationship between Pre-service Teachers' Academic Self-Regulation and Teaching Self-Efficacy

Student self-regulation has generated a great deal of research interest since it has been found to be closely linked to achievement related outcomes such as actual achievement and persistence (Pintrich & Schunk, 2002; Zimmerman, 2000). According to recent models of self-regulated learning inspired by the social-cognitive theory, self-regulation is more than metacognition, it involves motivational and behavioral components as well as cognitive and metacognitive components (Zimmerman, 2000). In other words, recent models of self-regulation based on the social-cognitive theory suggest that use of cognitive and metacognitive strategies are of little value if students cannot motivate themselves to use them. Numerous self-motivational beliefs establish a base for goal setting and strategic planning, which are crucial aspects of student self-regulation. Among these self-motivational beliefs are students' beliefs about their control over the learning process, task value perceptions, and achievement goals. Students' beliefs that they can control their own academic performance are called *control of learning beliefs*. *Task value* perceptions and *achievement goals*, on the other hand, basically involves students' reasons for engaging in a task (Pintrich & DeGroot, 1990; Vanderstoep, Pintrich, & Fagerlin, 1996; Zimmerman, 2000). Recent

research has focused on four *achievement goals*, namely mastery approach goals, mastery avoidance goals, performance approach goals, and performance avoidance goals. While *mastery approach goals* emphasize learning and deep understanding, *mastery avoidance goals* aim at avoiding not learning and misunderstanding. *Performance approach goals* emphasize looking smart and getting the highest grades, whereas *performance avoidance goals* aim at avoiding being inferior and getting the worst grades (Elliot & Church, 1997; Elliot & McGregor, 2001; Elliot & Reis, 2003; Pintrich & Schunk, 2002). Within the motivational component of self-regulation, test anxiety refers to worry and concerns over taking exams.

Research in the field of educational psychology showed that students' beliefs about the importance and utility of academic tasks (i.e. task value) and their sense of control over academic outcomes (i.e. control of learning beliefs) are significantly related to their goals (Eccles & Wigfield, 2002; Hoy, 2004; Pintrich & DeGroot, 1990). More specifically, while these adaptive motivational beliefs are found to be positively associated with approach goals, avoidance goals are often found to be linked to lower levels of task value and maladaptive patterns of attributions leading to the beliefs that academic performance is not controllable (Pintrich & Schunk, 2002). Based on the above-mentioned literature, the conceptual model proposed in the current study predicted positive relationships between task value, control of learning beliefs and approach goals and negative relationships between these two motivational variables and avoidance goals. In other words, it was hypothesized that students who attach value to academic tasks and believe that they can be successful if they put necessary effort forth are likely to study for the reasons of learning, understanding and getting good grades (Valle et al., 2003). However, students with lower levels of positive task value beliefs and control over learning were expected to adopt avoidance goals. In addition, a positive relationship was predicted between avoidance goals and test anxiety since avoidance goals are generally found to be associated with higher levels of anxiety (Pintrich & Schunk, 2002).

Cognitive and metacognitive components of self-regulation involve students' use of various *cognitive and metacognitive strategies* such as planning, monitoring, and regulating strategies that help control and regulate their cognition. Concerning the behavioral component, self-regulated learning involves *effort regulation* (e.g., persisting in the face of a difficult or boring task) and *peer learning* (e.g., working with other students to complete the assignments). Relevant research has also demonstrated that approach goals, task value, and control of learning beliefs are positively related

to use of metacognitive strategies like planning, monitoring, and regulating learning (Ames & Archer, 1988; Meece, Blumenfeld, & Hoyle, 1988; Neber, & Schommer-Aikins, 2002; Pintich & DeGroot, 1990, Sungur, 2007). Therefore, in the present study, the proposed model suggested that approach goals, task value, and control of learning beliefs are positively associated with metacognition. However, negative relations were proposed between avoidance goals and metacognition. Indeed, the study conducted by Vrugt and Oort (2008) revealed a negative relationship of performance avoidance goals and a positive relationship of approach goals with metacognition.

In addition, the research in the field of educational psychology (e.g. Sungur 2007) indicated that students with higher levels of metacognitive strategy use, approach goals, more positive task value beliefs, and control of learning beliefs are likely to put more effort to succeed on a task and persist longer (i.e. effort regulation). Accordingly, in the present study was hypothesized that metacognition, approach goals, task value, control of learning beliefs are positively linked to effort regulation. In addition, it was predicted that negative associations exist between avoidance goals and effort regulation since avoidance goals are generally found to be related to failure to persist and withdrawal of effort (Pintrich & Schunk, 2002).

Relevant research demonstrated that self-regulated learners can initiate learning tasks, determine their own goals, use appropriate strategies to achieve these goals, and then monitor and evaluate their own learning. They are motivated to use the strategies as well as regulate their cognition and effort (Pintrich & DeGroot, 1990; McCoach & Siegle, 2003). Therefore, self-regulated learners are likely to achieve at higher levels than students who are passive in their learning and depend on teachers for performing these same functions (Risemberg & Zimmerman, 1992).

Although there is considerable research on student self-regulation at different grade levels, there has been little research focusing on pre-service or in-service teachers' self-regulatory strategies in their own learning. The studies of pre-service or in-service teachers have demonstrated that they often do not use self-regulatory strategies as effectively as students and it was suggested that if pre-service teachers become self-regulated in their own learning, their experience in self-regulatory processes can help them develop strategies for teaching self-regulation to their students (Gordon, Dembo, & Hocevar, 2007). In addition, it was proposed that pre-service teachers who value self-regulatory skills and teach them to their students are likely to create learning environments supporting student autonomy. In fact, according to Dembo (2001), learning how to teach is not sufficient; rather teachers should learn how to learn

to improve their classroom practices. Furthermore, studies on teachers' effectiveness demonstrated that self-regulatory skills are important determinants of teachers' self-efficacy beliefs which are significantly associated with their behavior and practices in the classroom (Bembenutty, 2006; Dembo, 2001). For example, in a study of 63 secondary education pre-service teachers attending a graduate educational program at a college, Bembenutty (2007) showed that there is a strong correlation between pre-service teachers' self-regulation and their teaching self-efficacy. More specifically, it was found that higher levels of task value, intrinsic interest, time and study environment management and use of metacognitive strategies were associated with higher levels of teaching self-efficacy. Additionally, a positive correlation was found between task value and metacognitive strategy use. Based on the results, the author suggested that teacher education programs should help pre-service teachers learn how to regulate their own learning motivationally, metacognitively, and behaviorally, and use effective strategies during their training in order to improve their sense of teaching self-efficacy beliefs. Therefore, it appears that self-efficacy has a mediating role between teachers' self-regulatory strategies in their learning and their classroom behaviors. In other words, teachers who use self-regulatory strategies in their learning are likely to be self-efficacious in their teaching which is related to the development of strategies supporting student self-regulation and autonomy.

Considering the abovementioned theory and literature, in the proposed model displayed in its consolidated form in Figure 1, significant relationships were hypothesized between different facets of pre-service science teachers' academic self-regulation (i.e. achievement goals, task value, control of learning beliefs, test anxiety, metacognitive strategy use, effort regulation, and peer learning) and three dimensions of teaching self-efficacy (i.e. self-efficacy for student engagement, instructional strategies, and classroom management). More specifically, it was hypothesized that different facets of self-regulation namely, task value, control of learning beliefs, metacognition, effort regulation, peer learning, and approach goals were positively linked to teaching self-efficacy variables. On the other hand, negative relations were proposed between avoidance goals and teaching self-efficacy.

Relationship between Pre-service Teachers' Personality and Academic Self-Regulation

The Five-Factor Model of personality, which suggests that the Big Five traits (Neuroticism, Extraversion, Openness, Conscientiousness, and Agreeableness) display fundamental aspects of personality and greatly

influences human behavior (Costa & McCrae, 1992), has attracted much interest over the past two decades. In the field of education, two of the five traits have been of particular interest: Openness and Conscientiousness. Open individuals are curious, creative and have a wide range of interest. Conscientiousness involves characteristics like being diligent, purposeful, well-organized, and self-disciplined. Therefore, it was predicted that these personality traits may have strong impact on students' motivation, cognition, and behavior in their learning (Costa & McCrae, 1992). Indeed, the study conducted by Blickle (1996) revealed that conscientiousness is highly correlated with students' learning discipline, which includes their effort, metacognition, time and study environment management, peer learning and their rehearsal and organization strategy use. Moreover, it was found that openness is correlated with students' critical thinking, their use of learning strategies leading to deeper understanding of the material such as integrating new knowledge into a network of existing knowledge, and accessing different resources. In sum, the above mentioned study revealed that conscientiousness and openness are significantly linked to cognitive, metacognitive, and behavioral components of self-regulation. Similarly, in their study examining the relationship between personality traits and self-regulation, Bidjerano and Dai (2007) reported that conscientiousness and openness are significantly linked to metacognitive and behavioral components of self-regulation including critical thinking skills, metacognition, effort regulation, time management, and elaboration. Moreover, agreeableness was found to be significantly related to effort regulation and use of surface learning strategies (Slaats, Van der Sanden, & Lodewijks, 1997; Vermetten, Lodewijks, & Vermunt, 2001). Based on the aforementioned literature, the conceptual model proposed in the current study predicted positive relationships between pre-service science teachers' personality traits (i.e. openness, conscientiousness, and agreeableness) and their metacognition and effort regulation. In addition, although the links of extraversion and neuroticism to different components of self-regulation have less theoretical and empirical justification than links of openness, conscientiousness, and agreeableness (Bidjerano & Dai, 2007), in the current study, extraversion and neuroticism are proposed to be negatively associated with metacognition and effort regulation: Bidjerano and Dai (2007) suggested that since extroverts are sociable, impulsive, and distractible, they may less effectively use various strategies and regulate their effort. Moreover, in the literature, the overall relationship of neuroticism with strategy use, motivation, and effort is found to be negative (Matthews & Zeidner, 2004, as cited in Bidjerano & Dai, 2007).

Concerning the relationship between personality traits and the motivational component of self-regulation, Judge and Ilies (2002) demonstrated that extraversion is significantly associated with motivational variables such as goal setting and expectancy beliefs. Supporting this finding, Wang and Erdheim (2007) found that while extraversion is positively related to mastery approach goals and performance approach goals, neuroticism is positively linked to performance avoidance goals. In addition, Komarraju and Karau's (2005) study revealed significant relationships exist between personality traits and motivational factors. Accordingly, in the present study, it was predicted that neuroticism is positively associated with avoidance goals. Additionally, since anxious people are fearful and likely to worry, neuroticism was hypothesized to be positively related to test anxiety. On the other hand, although relationships between remaining personality traits (i.e. openness, conscientiousness, agreeableness, and extroversion) and achievement goals are not well established in the literature, current study proposed positive links between approach goals and these four personality traits. Indeed, the positive link between extroversion and approach goals was empirically demonstrated by Wang and Erdheim's (2007) study. Concerning openness, conscientiousness, and agreeableness, individuals who have intellectual curiosity and willingness to try different activities (i.e. openness), who are tender-minded (i.e. agreeableness), and who work hard and complete tasks in the face of difficulties (i.e. conscientiousness) are likely to study for the reasons of learning and understanding rather than competing and showing their abilities to others.

In sum, the aforementioned literature suggests that there is a significant association between personality traits and different aspects of self-regulation. Therefore, as suggested by Bidjerano and Dai (2007), although the theoretical relationship between personality traits and self-regulation has not been well-justified, several meaningful associations can be proposed and examined based on previous research.

Relationship between Pre-service Teachers' Personality and Teaching Self-Efficacy

Research has demonstrated that teachers' personality traits are associated with their teaching effectiveness. Indeed, Erdle, Murray, and Rushton's (1985) study revealed a significant relationship between personality traits and teaching effectiveness, which was mediated through the teachers' use of a variety of strategies and materials. Supporting this finding, Katz (1992) reported that teachers who are analytical, imaginative, and creative are more likely to utilize various strategies during instruction. Moreover, teachers with tough-minded,

extraverted, and stables personalities were found to be more receptive to new ideas. Related literature revealed that classroom behaviors such as being receptive to the use of alternative strategies and methods to better meet students' needs (Cousins & Walker, 2000) and showing greater commitment to teaching (Coladarci, 1992) are significantly associated with teachers' self-efficacy. In addition, Knoblauch and Hoy (2008) demonstrated that teachers' self-efficacy beliefs have a strong influence on teaching effectiveness, which is found to be associated with personality traits. However, there are a few studies in the relevant literature which have investigated teaching self-efficacy in relation to teachers' personality traits. In one such study, Henson and Chambers (2003) examined the relationship among teachers' personality traits, classroom management and teaching self-efficacy. Results of the study showed that extraverted teachers had higher levels of teaching self-efficacy. Additionally, in their meta-analysis of the big-five personality dimensions and job effectiveness, Barrick and Mount (1991) suggested that conscientiousness and neuroticism are valid predictors of job performance for all occupational groups. According to the researchers, viewing conscientiousness from a positive pole, higher levels of conscientiousness is expected to be associated with better job performance because conscientiousness involves hard work, persistence, and responsibility. On the other hand, viewing neuroticism from a negative pole, higher levels of neuroticism is expected to be related to worse job performance because neuroticism involves nervousness, high-strangeness, and worry. Moreover, Barrick and Mount (1991) predicted that for occupations requiring cooperation or interaction with others, extraversion and agreeableness are valid predictors of job performance. Additionally, it was predicted that openness is a valid predictor of training proficiency because openness involves curiosity, broadmindedness, and intelligence which are characteristics related to positive attitudes toward learning. Results of the meta-analysis, in general, were consistent with the predictions. In line with the aforementioned literature, it was hypothesized in the present study that all personality traits are significantly linked to teaching efficacy, which is closely associated with teaching effectiveness. More specifically, based on relevant theory and literature, the model proposed in the current study suggested that extraverted, agreeable and conscientious pre-service science teachers have higher levels of teaching efficacy. Actually, teaching involves interaction with others such as students, colleagues, and parents and extrovert individuals are friendly, they speak without hesitation and sincerely like people. Moreover, openness is anticipated to be positively related to teaching self-efficacy because

open individuals are curious, open-minded, and has willingness to try different activities and strategies. Conscientious individuals are self-disciplined and they can motivate themselves to get the job done. They do not give up easily (Costa & McCrae, 1991). Such characteristics are expected to have positive impact on teachers' self-efficacy and, in turn, their teaching effectiveness. On the other hand, it is predicted that neuroticism is negatively related to teaching self-efficacy since neuroticism is associated with negative affects and psychological distress, which may interfere with adaptation. In addition, people with higher levels of neuroticism tend to cope more poorly compared to others when faced with stress or difficulties (Costa & McCrae, 1991).

Method

Participants

Participants of the study were 1794 pre-service elementary science teachers (876 males and 905 females) from 27 universities in Turkey. All of the universities involved in the study were public universities that follow the same teacher education program, which had been restructured for all disciplines by the Higher Education Council (YÖK) in 1998 (YÖK, 1998). This restructured program contains courses in different branches of science, namely biology, physics, and chemistry and several courses related to special subject training and pedagogy. The pedagogical domain includes three field experience courses in which pre-service teachers observe teaching environments and teach in actual classes. Pre-service teachers are supposed to teach for at least 24 hours in the last semester of their teacher education program.

During sample selection, universities with departments of elementary science education in seven geographical regions of Turkey were identified. Then, the total number of pre-service science teachers in each region was determined. With the aim of obtaining a sample as large and representative as possible with a reasonable expenditure of time, energy, and money, universities in each region were randomly selected. Finally, data were collected from all volunteer pre-service science teachers attending the selected universities. The participants were informed that their names should not appear anywhere on the data collection instruments to ensure anonymity. Additionally, they were ensured that their responses would be strictly confidential. All data collection instruments were simultaneously administered to the participants.

Instruments

Teachers' Sense of Efficacy Scale (TSES), also known as the Ohio State Teacher Efficacy Scale, was used

to assess pre-service science teachers' teaching self-efficacy. The TSES, a nine-point Likert scale ranging from "1 = nothing" to "9 = a great deal", was originally developed by Tschannen-Moran and Woolfolk-Hoy (2001). It consists of 24 items in three sub-scales, namely efficacy for student engagement (8 items), efficacy for instructional strategies (8 items), and efficacy for classroom management (8 items). More specifically, the TSES assesses teachers' beliefs about their ability to engage all students in learning, to utilize effective instructional strategies and to manage classroom behaviors effectively. The TSES was translated and adapted into Turkish by Çapa, Çakıroğlu, and Sarıkaya (2005). During its validation by Çapa et al., (2005), confirmatory factor analysis was carried out and the results indicated a good fit (TLI = .99, CFI = .99, RMSEA = .065). In order to validate the factor structure of the TSES for the present study, confirmatory factor analysis was conducted. The fit statistics revealed a good data fit (RMSEA = .07, GFI = .90, CFI = .89). Moreover, internal consistencies of the sub-scales were found to be sufficiently high. Table 1 displays Cronbach's alpha coefficients and sample items for each sub-scale.

NEO Five-Factor Inventory (NEO-FFI), a five point likert scale from "5 = strongly agree" to "1 = strongly disagree" was used. Costa and McCrae (1991b) developed this scale as a short form of the NEO Personality

Inventory (NEO-PI). It includes 60 items that provide a comprehensive measure of five domains of personality, namely neuroticism (N), extraversion (E), openness (O), agreeableness (A), and conscientiousness (C). Costa and McCrae (1992) described these five domains as follows: *Neuroticism (N)* refers to the tendency of an individual to experience unpleasant emotional instability and to have corresponding disturbances in thoughts and actions, while *Extraversion (E)* refers to differences in preference for social behavior and lively activity. Characteristics of extraverts include being sociable, gregarious, and outgoing; preferring large groups of people; being active; liking excitement; and being optimistic. *Openness (O)* involves displaying an active imagination, aesthetic sensitivity, consideration of inner feeling, a preference for variety, intellectual curiosity, and independence of judgment. *Agreeableness (A)* is characterized by interpersonal tendencies, including eagerness to help others, altruism, sympathy, and a belief that others will be helpful in return. *Conscientiousness (C)* is an individual's ability to control impulses, plan and organize active processes, carry out tasks, and demonstrate hard-work.

The coefficient alphas for the neuroticism, extraversion, openness, agreeableness, and conscientiousness domains were .86, .77, .73, .68, and .81 respectively.

The NEO-PI were translated and adapted into Turkish by Gulgoz (2002). During its validation for

Table 1. Reliability coefficients of the data collection instruments with sample items*

Instrument	Subscales	Sample item	n of items	Reliability
TSES	Student engagement	How much can you do to get students to believe they can do well in schoolwork?	8	.83
	Instructional strategies	To what extent can you use a variety of assessment strategies?	8	.87
	Classroom management	How much can you do to control disruptive behavior in the classroom?	8	.84
MSLQ	Task Value	It is important for me to learn the course material in the classes.	6	.84
	Control of Learning Beliefs	If I try hard enough, then I will understand the course material	4	.60
	Test Anxiety	When I take a test I think about items on other parts of the test I can't answer.	5	.63
	Metacognition	I try to change the way I study in order to fit the course requirements and instructor's teaching style	12	.77
	Effort Regulation	When course work is difficult, I give up or only study the easy parts.	4	.57
	Peer Learning	I try to work with other students from the class to complete the assignments.	3	.56
AGQ	Mastery Approach	I want to learn as much as possible from the classes.	3	.74
	Performance Approach	My goal in the classes is to get a better grade than most of the other students.	3	.77
	Mastery Avoidance	I worry that I may not learn all that I possibly could in the classes.	3	.73
	Performance Avoidance	My goal in the classes is to avoid performing poorly.	6	.70

*Since The NEO Personality Inventories are copyrighted, no sample item was provided from NEO-FFI.

Turkish sample, Gulgoz conducted exploratory factor analysis and the largest facet loadings were found to be on the same factors as in the original structure. The congruence coefficients, ranging from .88 to 1.00, also indicated that the factor structures obtained from the original sample and Turkish sample were similar. Turkish version of NEO-FFI was also suggested by Gulgoz.

The Motivated Strategies for Learning Questionnaire. All facets of academic self-regulation, except for achievement goals, were assessed by Motivated Strategies for Learning Questionnaire (MSLQ), developed by Pintrich, Smith, Garcia, and McKeachie (1993). It is a self-report questionnaire on a seven-point Likert scale (1 = not at all true of me to 7 = very true of me). The MSLQ consists of two main sections, a motivation section and a learning strategies section. The motivation section includes 31 items in six subscales that assess students' motivational orientations. The learning strategy section, on the other hand, includes 50 items in nine subscales related to students' use of various learning strategies. Among the 15 sub-scales, only the *Task Value* (judgments of how interesting, useful and important the academic task), *Control of Learning Beliefs* (the belief that the effort to learn will lead to positive outcomes), *Test Anxiety* (worry and concern over taking exams), *Effort Regulation* (persisting in the face of difficulties and distracters), *Peer Learning* (using a study group or friends to help learn), and *Metacognitive Self-Regulation* (using the strategies that facilitate the control and regulation of cognition) sub-scales of the MSLQ were utilized for the specified purpose.

The MSLQ was translated and adapted into Turkish by Sungur (2004). During its validation, confirmatory factor analysis was conducted for each section and fit statistics similar to the original instrument were obtained (see Sungur, 2004). In order to validate the factor structure for the present study, Confirmatory Factor Analysis was conducted. The results showed a good model fit (RMSEA = .07, GFI = .94, CFI = .91). The Cronbach's alpha coefficients and sample items for each sub-scale are displayed in Table 1.

The Achievement Goal Questionnaire (AGQ) is a five-point Likert-type instrument developed by Elliot and McGregor (2001). In the present study it was used to assess pre-service science teachers' adoption of mastery approach (3 items), performance approach (3 items), mastery avoidance (3 items), and performance avoidance goals (6 items) in their courses in the teacher education program. While mastery approach goals focus on learning and understanding, performance approach goals emphasize showing abilities to others. Mastery avoidance goals, on the other hand, are characterized by striving to avoid misunderstanding and

making mistakes. Contrary to mastery avoidance goals, performance avoidance goals are characterized by an intention to avoid failure relative to others. The AGQ was translated and adapted into Turkish by Senler and Sungur (2007). During its validation, both exploratory and confirmatory factor analyses were conducted, and the results supported four-factor structure (RMSEA = .06, GFI = .92, CFI = .90, SRMR = .07). Forty-five percent of the variance was explained by the four factors. In order to validate the factor structure for the present study, Confirmatory Factor Analysis was conducted. The results showed a good model fit (RMSEA = .09, GFI = .91, CFI = .90). Table 1 displays Cronbach's alpha coefficients and sample items for each sub-scale.

Data Analysis

In the present study, path analysis was conducted to investigate the relationships among pre-service science teachers' personality, academic self-regulation and teaching self-efficacy. Path analysis, which involves only observed variables, is a special case of structural equation modelling (SEM). The goal of path analysis, and more generally of SEM, is to determine how well a proposed model with a set of specified relationships among variables, explains the observed relationships among these variables. Thus, path analysis (i.e. simultaneous equations) is different from separate regressions approach in that path analysis provides both the path coefficients for the model and a test of the overall model fit (Savalei & Bentler, 2006).

Results

Descriptive Statistics

Descriptive statistics for the subscale scores of Personality Inventory, Teachers' Sense of Self-efficacy Scale, Achievement Goal Questionnaire, and Motivated Strategies for Learning Questionnaire are displayed in Table 2. As shown in the table, pre-service science teachers had high levels of science teaching self-efficacy in comparison to the scale maximum. The highest mean score was obtained on the teaching self-efficacy for instructional strategies ($M = 6.10$, $SD = .89$). This finding implied that pre-service science teachers believed that they can use appropriate instructional strategies effectively in their classes. The high mean score on teaching self-efficacy for classroom management ($M = 6.07$, $SD = .90$) also revealed that their judgment of their ability to manage student conduct and classroom behavior is high. Although the mean score was lowest on the teaching self-efficacy for student engagement ($M = 5.96$, $SD = .87$), it was still above the middle-point of the nine-point scale implying

Table 2. Descriptive statistics

	<i>M</i>	<i>SD</i>
<i>Teaching Self-efficacy</i>		
Student Engagement	5.96	.87
Instructional Strategies	6.10	.89
Classroom Management	6.07	.90
<i>Personality Traits</i>		
Neuroticism	7.86	1.96
Extraversion	6.57	1.89
Openness	6.56	1.73
Agreeableness	6.47	2.08
Conscientiousness	6.23	1.80
<i>Academic Self-Regulation</i>		
Task Value	4.53	.98
Control of Learning Beliefs	3.03	.57
Test Anxiety	3.12	.82
Metacognition	6.47	1.09
Effort Regulation	2.36	.50
Peer Learning	1.28	.39
Mastery Approach Goals	4.10	.76
Performance Approach Goals	3.20	1.00
Mastery Avoidance Goals	2.84	.93
Performance Avoidance Goals	2.55	.98

that pre-service science teachers had also high levels of efficacy in engaging their students in science learning.

With regard to pre-service science teachers' personality, these results suggested that pre-service science teachers tend to demonstrate the characteristics of neuroticism at higher levels compared to the characteristics of the other personality traits. On the other hand, the lowest mean score for conscientiousness may imply that pre-service science teachers demonstrate its relevant behaviors and feelings, such as feeling well-organized and well-prepared to deal with daily life activities, having high levels of aspiration, working hard to realize the goals, and having self-discipline at lower levels than those of the relevant behaviors of other personality traits.

Concerning the different aspects of pre-service science teachers' academic self-regulation, scores on the four subscales- namely control of learning beliefs $M = 3.03$, $SD = .57$, test anxiety $M = 3.12$, $SD = .82$, effort regulation $M = 2.36$, $SD = .50$, and peer learning $M = 1.28$, $SD = -.39$ were below the middle point. On the other hand, the mean score for the task value $M = 4.53$, $SD = .98$ was above the middle point and the score on the metacognitive self-regulation $M = 6.47$, $SD = 1.09$ was at the higher end. These results suggested that, in the courses offered by teacher education program, pre-service science teachers tend to control their own cognition using a variety of strategies such as planning, monitoring, and evaluating, and tend to

have low levels of test anxiety. In addition, they appeared to perceive the tasks that they engage in as interesting, important, and useful. However, pre-service science teachers appeared to have low levels of control of learning beliefs, effort regulation, and peer learning. This finding suggested that pre-service science teachers are less likely to persist longer when they are faced with difficulties and distracters in their learning. Moreover, they tend to believe that they have little control over their learning and they rarely set aside time to work with their peers.

As another facet of pre-service science teachers' academic self-regulation, their achievement goals were assessed through the AGQ. The mean subscale scores on the questionnaire ranged from 2.55 to 4.10 on a five-point scale (see Table 2). The highest mean score was for mastery approach goals $M = 4.10$, $SD = .76$, while the lowest mean score was for performance avoidance goals $M = 2.55$, $SD = .98$. In general, descriptive statistics suggested that pre-service science teachers tend to study for the reasons of mastering tasks, understanding deeply, and getting good grades rather than avoiding misunderstanding, looking stupid, and getting the worst grades.

Zero-order Correlations among Pre-service Science Teachers' Self-Efficacy, Academic Self-Regulation, and Personality

As preliminary analysis, bivariate relationships among pre-service science teachers' self-efficacy, academic self-regulation, and personality correlation analyses were examined. Among the 153 correlations, 128 of them were significant (see Table 3).

The highest positive correlation coefficients were between teacher self-efficacy variables, namely, student engagement and instructional strategies ($r = .76$); instructional strategies and classroom management ($r = .72$); student engagement and classroom management ($r = .70$). The lowest positive correlations among observed variables were found between neuroticism and metacognitive self-regulation ($r = .05$); mastery avoidance and openness ($r = .05$); extraversion and conscientiousness ($r = .05$).

On the other hand, the highest negative correlations were found between conscientiousness and metacognitive self-regulation ($r = -.37$), mastery approach ($r = -.30$), and instructional strategies ($r = -.30$). The lowest negative correlation were determined between mastery approach and test anxiety ($r = -.05$); performance approach and extraversion ($r = -.06$); mastery avoidance and classroom management ($r = -.06$).

Inferential Statistics

In order to examine the relationships among pre-service science teachers' personality, academic self-regulation

Table 3. Zero-order correlations

	N	E	O	A	C	SEST	SEINS	SECM	MA	PA	MV	PV	TV	CLB	TANX	META	ER
N	1																
E	-.11**	1															
O	-.02	.29**	1														
A	-.01	.03	.04	1													
C	.00	.05*	.14**	.22**	1												
SEST	.13**	-.28**	-.31**	-.07**	-.25**	1											
SEINS	.15**	-.22**	-.25**	-.04	-.29**	.76**	1										
SECM	.11**	-.21**	-.21**	-.01	-.24**	.70**	.72**	1									
MA	.02	-.13**	-.18**	-.16**	-.30**	.26**	.28**	.20**	1								
PA	-.14**	-.06*	.06	.06*	-.13**	.06*	.09**	.07**	.21**	1							
MV	-.19**	.04	.05*	-.08**	-.06*	-.01	-.03	-.06*	.26**	.30**	1						
PV	-.16**	.05*	.17**	.12**	.02	-.11**	-.08**	-.08**	-.04	.52**	.33**	1					
TV	.03	-.13**	-.21**	-.13**	-.27**	.29**	.26**	.20**	.49**	.10**	.16**	-.12**	1				
CLB	-.03	-.09**	-.12**	-.09**	-.10**	.21**	.17**	.19**	.20**	.10**	.08**	-.01	.52**	1			
TAX	-.28**	.01	.06*	.03	.05*	-.02	-.08**	-.02	-.05*	.26**	.28**	.30**	.07**	.14**	1		
META	.05*	-.14**	-.26**	-.13**	-.37**	.34**	.30**	.25**	.40**	.10**	.06*	-.13**	.60**	.39**	.04	1	
ER	.08**	-.07**	-.14**	-.11**	-.41**	.22**	.21**	.18**	.36**	.10**	.02	-.15**	.47**	.28**	-.11**	.58**	1
PL	.01	-.18**	-.12**	-.04	-.12**	.20**	.16**	.10**	.21**	.14**	.16**	.04	.35**	.20**	.19**	.36**	.19**

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

and teaching self-efficacy, path analysis was conducted by proposing a conceptual model. In the proposed model, all the variables were identified as observed variables. The model was examined through path analysis utilizing LISREL 8.30 (Jöreskog & Sörbom, 1996). Since the resulting fit indices for the model explained in the introduction section did not indicate a perfect fit (RMSEA = .16, GFI = .91, SRMR = .08, CFI = .78), new paths were specified based on the modification indices. In the revised model, paths were added from self-efficacy for classroom management to self-efficacy for instructional strategies and from self-efficacy for classroom management to student engagement. Moreover, paths were specified from performance approach goals to mastery approach goals and from peer learning to metacognitive self-regulation. Additionally, covariances were set from performance approach goals to performance avoidance goals and from self-efficacy for instructional strategies to self-efficacy for student engagement. The resulting fit indices indicated that the model fits the data well, (RMSEA = .09, GFI = .97, CFI = .95, SRMR = .04). Since the fit indices indicated a theoretically sound model that explained the data well, the standardized path coefficients for direct and indirect effects were analyzed. The conceptual model with significant path coefficients is presented in Figure 2. At this point, it should be noted that in the current study, the notion *effect* does not imply causality; it simply denotes the exerted influence of one variable on another.

Relationships between Personality and Academic Self-Regulation

In the model, the results concerning the relationship between pre-service science teachers' personality and their academic self-regulation and the relationship among different components of academic self-regulation showed that pre-service science teachers' personality and their performance approach goals, task value, and control of learning beliefs explained 53% of the variance in mastery approach goals (see Table 4). In particular, neuroticism ($\beta = .08$), agreeableness ($\beta = .06$), consciousness ($\beta = .05$), and performance approach goals ($\beta = .66$) have significant effect on mastery approach goals. However, openness ($\beta = -.07$) and task value ($\beta = -.07$) were determined to be related negatively to this dimension.

When performance approach goals are examined as one of the components of pre-service science teachers' academic self-regulation, it was found that other components of academic self-regulation (i.e. task value, and control of learning beliefs) and pre-service science teachers' personality accounted for 10% of the variance in this dimension (see Table 5). There were positive relationship between extraversion ($\beta = .09$), agreeableness ($\beta = .20$) and performance approach goals. Similarly to mastery approach goals, negative relationships were found between openness ($\beta = -.07$) and task value ($\beta = -.07$) and this dimension.

Moreover, as shown in Table 6, 10% of the variance of mastery avoidance goals was explained by

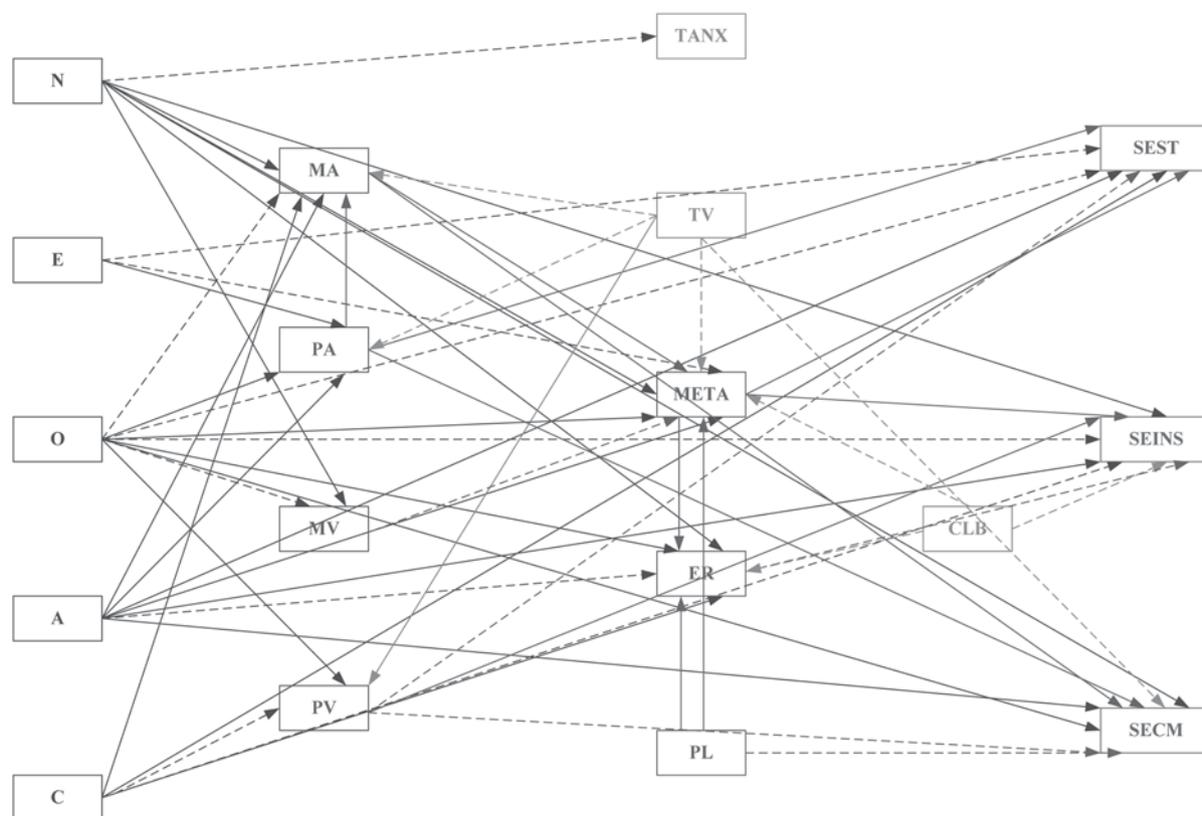


Figure 2. Conceptual model with significant path coefficients.

Table 4. Direct effects on mastery approach goals dimension of academic self-regulation

Effect	Standardized Coefficients	Standard Errors of the Estimates	<i>t</i>	<i>R</i> ²
On Mastery Approach				
of Performance Approach	.66	.02	38.81*	
of Neuroticism	.08	.03	3.85*	
of Extraversion	-.02	.04	-1.29	
of Openness	-.07	.02	-4.36*	.53
of Agreeableness	.06	.02	2.89*	
of Conscientiousness	.05	.14	2.96*	
of Task Value	-.07	.02	-4.17*	
of Control of Learning Beliefs	-.02	.01	-.93	

pre-service science teachers' personality and academic self-regulation implying significant association with neuroticism ($\beta = .07$) and openness ($\beta = -.31$).

With respect to performance avoidance goals, pre-service science teachers' personality and academic self-regulation explained 10% of the variance of this dimension. Openness ($\beta = .05$), conscientiousness ($\beta = -.12$), and task value ($\beta = -.27$) were found to be significantly related to mastery avoidance goals (see Table 7).

In addition, pre-service science teachers' personality and academic self-regulation accounted for 39% of the

variance in metacognitive self-regulation dimension (see Table 8). Specifically, neuroticism ($\beta = .39$), agreeableness ($\beta = .14$), mastery approach goals ($\beta = .15$), and peer learning ($\beta = .24$) predicted metacognitive self-regulation. On the contrary, extraversion ($\beta = -.09$), openness ($\beta = -.12$), mastery avoidance goals ($\beta = -.04$), task value ($\beta = -.07$), and control of learning beliefs ($\beta = -.12$) were found to have significantly effect on metacognitive self-regulation.

Furthermore, 23% of the variance of effort regulation dimension was explained by pre-service science

Table 5. Direct effects on performance approach goals dimension of academic self-regulation

Effect	Standardized Coefficients	Standard Errors of the Estimates	t	R ²
On Performance Approach				
of Neuroticism	-.02	.04	-.80	
of Extraversion	.09	.05	3.40*	
of Openness	-.05	.03	-2.34*	
of Agreeableness	.20	.03	7.09*	.10
of Consciousness	.02	.20	.70	
of Task Value	-.15	.02	-6.30*	
of Control of Learning Beliefs	.02	.02	.91	

Table 6. Direct effects on mastery avoidance goals dimension of academic self-regulation

Effect	Standardized Coefficients	Standard Errors of the Estimates	t	R ²
On Mastery Avoidance				
of Neuroticism	.07	.04	2.35*	
of Extraversion	.00	.07	.07	
of Openness	-.31	.04	-13.41*	
of Agreeableness	.03	.04	.96	.10
of Consciousness	.05	.25	1.86	
of Task Value	.03	.03	1.12	
of Control of Learning Beliefs	.00	.02	.01	

Table 7. Direct effects on performance avoidance goals dimension of academic self-regulation

Effect	Standardized Coefficients	Standard Errors of the Estimates	t	R ²
On Performance Avoidance				
of Neuroticism	.00	.04	-.09	
of Extraversion	-.02	.06	-.77	
of Openness	.05	.04	2.17*	
of Agreeableness	-.01	.04	-.23	.10
of Consciousness	-.12	.24	-4.70*	
of Task Value	.27	.03	11.68*	
of Control of Learning Beliefs	.02	.02	.72	

Table 8. Direct effects on metacognitive self-regulation goals dimension of academic self-regulation

Effect	Standardized Coefficients	Standard Errors of the Estimates	t	R ²
On Metacognitive Self-Regulation				
of Neuroticism	.39	.00	16.10*	
of Extraversion	-.09	.01	-4.29*	
of Openness	-.12	.00	-5.79*	
of Agreeableness	.14	.00	5.88*	
of Consciousness	-.01	.02	-.61	
of Mastery Approach	.15	.00	5.57*	.39
of Performance Approach	.01	.00	.53	
of Mastery Avoidance	-.04	.00	-2.19*	
of Performance Avoidance	-.01	.00	-.25	
of Task Value	-.07	.00	-3.22*	
of Control of Learning Beliefs	-.12	.00	-6.66*	
of Peer Learning	.24	.02	12.38*	

teachers' personality and academic self-regulation (see Table 9). According to the results, neuroticism ($\beta = .07$), openness ($\beta = .24$), conscientiousness ($\beta = .05$), metacognitive self-regulation ($\beta = .27$), and peer learning ($\beta = .20$) were significantly associated with effort regulation. Conversely, negative associations were found between agreeableness ($\beta = -.12$) and control of learning beliefs ($\beta = -.06$) and effort regulation.

Finally, neuroticism ($\beta = -.23$) accounted for 5% of the variance in test anxiety indicating there was negative relationship between neuroticism (i.e. anxiety, angry hostility, depression, self-consciousness, impulsiveness, and vulnerability) and giving value to courses (see Table 8).

Relationships between Academic Self-Regulation and Teacher Self-Efficacy

Concerning the relationship between pre-service science teachers' academic self-regulation and their

self-efficacy, results showed that pre-service science teachers' personality and academic self-regulation accounted for 10 % of variance in self-efficacy for student engagement (see Table 10). Concerning academic self-regulation variables, performance approach goals ($\beta = .09$), and metacognitive self-regulation ($\beta = .14$) were significantly and positively associated with their self-efficacy for student engagement. On the other hand, negative associations were found between performance avoidance goals ($\beta = -.16$) and self-efficacy for student engagement.

Results also showed that personality and academic self-regulation accounted for 23 % of variance in self-efficacy for instructional strategies (see Table 11). With respect to academic self-regulation variables, performance avoidance goals ($\beta = .05$), and metacognitive self-regulation ($\beta = .12$) were found to be significantly related to pre-service science teachers' self-efficacy for instructional strategy. In contrast, control of learning

Table 9. Direct effects on effort regulation and text anxiety goals dimension of academic self-regulation

Effect	Standardized Coefficients	Standard Errors of the Estimates	t	R ²
On Effort Regulation				
of Neuroticism	.07	.00	2.49*	
of Extraversion	-.04	.01	-1.55	
of Openness	.24	.00	10.66*	
of Agreeableness	-.12	.00	-4.63*	
of Conscientiousness	.05	.02	2.31*	.23
of Control of Learning Beliefs	-.06	.00	-2.66*	
of Metacognitive Self-Regulation	.27	.03	10.45*	
of Peer Learning	.20	.02	8.91*	
On Test Anxiety				
of Neuroticism	-.23	.03	-10.07*	.05

Table 10. Direct effects on self-efficacy for student engagement

Effect	Standardized Coefficients	Standard Errors of the Estimates	t	R ²
On Student Engagement				
of Classroom Management	-.04	.01	-.96	
of Neuroticism	.01	.01	.15	
of Extraversion	-.10	.01	-3.63*	
of Openness	-.06	.01	-2.10*	
of Agreeableness	.13	.00	4.53*	
of Conscientiousness	.09	.03	3.49*	
of Mastery Approach	-.07	.01	-1.79	.10
of Performance Approach	.09	.00	2.54*	
of Mastery Avoidance	-.02	.00	-.68	
of Performance Avoidance	-.16	.00	-6.46*	
of Task Value	.03	.00	1.12	
of Control of Learning Beliefs	.03	.00	1.22	
of Metacognitive Self-Regulation	.14	.03	4.87*	
of Effort Regulation	.01	.03	.42	
of Peer Learning	-.03	.03	-1.24	

Table 11. Direct effects on self-efficacy for instructional strategies

Effect	Standardized Coefficients	Standard Errors of the Estimates	t	R ²
On Instructional Strategies				
of Classroom Management	-.05	.02	-1.47	
of Neuroticism	.07	.02	2.29*	
of Extraversion	.00	.02	.06	
of Openness	-.14	.01	-5.88*	
of Agreeableness	.36	.01	13.23*	
of Consciousness	-.06	.08	-2.33*	
of Mastery Approach	-.03	.02	-.77	.23
of Performance Approach	.04	.01	1.22	
of Mastery Avoidance	.03	.01	1.12	
of Performance Avoidance	.05	.01	2.21*	
of Task Value	.00	.01	-.12	
of Control of Learning Beliefs	-.08	.01	-3.85*	
of Metacognitive Self-Regulation	.12	.10	4.52*	
of Effort Regulation	-.07	.08	-3.09*	
of Peer Learning	.00	.08	.01	

beliefs ($\beta = -.08$), and effort regulation ($\beta = -.07$) were significantly linked to teacher self-efficacy for instructional strategies.

Finally, results demonstrated that personality and academic self-regulation accounted for 23 % of variance in self-efficacy for classroom management (see Table 12). Concerning self-regulation variables, it was observed that mastery approach goals ($\beta = .48$) and performance approach goals ($\beta = .29$) were found to have significant effect on pre-service science teachers' self-efficacy for this dimension. On the other hand, results showed that performance avoidance goals ($\beta = -.07$), task value ($\beta = -.07$), and peer learning ($\beta = -.05$) were negatively related to self-efficacy for classroom management.

Relationships between Personality and Teacher Self-Efficacy

Concerning the relationship between pre-service science teachers' personality and their self-efficacy, the results demonstrated that consciousness ($\beta = .09$), agreeableness ($\beta = .13$) were significantly associated with pre-service science teachers' self-efficacy for student engagement (see Table 9). On the other hand, negative associations were found between extraversion ($\beta = -.10$), openness ($\beta = -.06$) and self-efficacy for student engagement.

Concerning the self-efficacy for instructional strategies, neuroticism ($\beta = .07$), agreeableness ($\beta = .36$) predicted this dimension that having higher level of neuroticism (i.e. anxiety, angry hostility, depression, self-consciousness, impulsiveness, and vulnerability) and agreeableness (i.e., trust, straightforwardness,

altruism, compliance, and tender-mindedness) lead to higher teachers' beliefs in their capability to apply many of the instructional strategies (see Table 11). On the contrary, consciousness ($\beta = -.06$), and openness ($\beta = -.14$) were significantly linked to teacher self-efficacy for instructional strategies.

When examining the direct paths to the self-efficacy for classroom management, it was observed that neuroticism ($\beta = .04$), openness ($\beta = .04$), and agreeableness ($\beta = .05$) were found to have significant effect on pre-service science teachers' self-efficacy for this dimension (see Table 12).

Discussion

The Relationship between Personality and Teacher Self-Efficacy

The main purpose of the present study was to examine the relationship among pre-service science teachers' personality, academic self-regulation and teaching self-efficacy. Concerning the relationship between pre-service science teachers' personality and their teaching self-efficacy, it was predicted that extraversion, openness, agreeableness, and conscientiousness were positively linked to pre-service science teachers' sense of efficacy. However, only agreeableness was found to be positively associated with all dimensions of teaching self-efficacy. On the other hand, while conscientiousness was found to be positively related to only self-efficacy for student engagement, openness was found to be positively linked to only self-efficacy for classroom management. These findings suggested that pre-service science teachers scoring high on

Table 12. Direct effects on self-efficacy for classroom management

Effect	Standardized Coefficients	Standard Errors of the Estimates	<i>t</i>	R ²
On Classroom Management				
of Neuroticism	.04	.02	1.97*	
of Extraversion	.02	.03	1.38	
of Openness	.04	.02	2.15*	
of Agreeableness	.05	.02	2.41*	
of Conscientiousness	.02	.12	1.51	
of Mastery Approach	.48	.02	22.62*	.64
of Performance Approach	.29	.02	14.18*	
of Mastery Avoidance	.00	.01	.14	
of Performance Avoidance	-.07	.01	-4.75*	
of Task Value	-.07	.01	-4.46*	
of Control of Learning Beliefs	-.03	.01	-2.00	
of Metacognitive Self-Regulation	.03	.15	1.64	
of Effort Regulation	-.01	.13	-.39	
of Peer Learning	-.05	.12	-3.07*	

conscientiousness (i.e. having high aspiration levels, working hard to realize their goals, persisting in the face of difficulties, and being well-organized) are likely to have higher levels of self-efficacy for improving the understanding of failing students, getting through to the most difficult students, and motivating students with low interest in schoolwork. Moreover, pre-service science teachers with higher levels of active imagination, aesthetic sensitivity, receptivity to inner feelings, preference for variety and novelty, intellectual curiosity, and independence of judgments (i.e. openness) appear to have higher levels of self-efficacy for controlling disruptive behaviors in the classroom and establishing a classroom management system with each group of students. However, contrary to the predictions, openness was found to be negatively associated with self-efficacy for student engagement and self-efficacy for instructional strategies. This finding can be partly explained by Turkish culture. In Turkey, education and thus teachers are highly respected. Teachers are expected to be good models for students with their socially approved behaviors in line with traditional values. Therefore, pre-service science teachers who tend to enjoy novel experiences and consider unconventional ideas may think that, as a teacher, they may not meet the expectations set by society (i.e., families, school administration, and colleagues). For example, one of the items in the self-efficacy for student engagement dimension of the TSES was “to what extent can you assist families in helping their children do well in school?” While 35 % of the pre-service science teachers below the median openness score were found to state “a great deal” (i.e. selected 8 or 9 in the nine-point scale) for this item, only 26 %

of those above the median were found to select these higher ends of the scale. This finding may suggest that if pre-service science teachers believe that they have personalities which may not be compatible with social values and norms, their self-efficacy to cooperate with families to enhance student engagement in learning may be lower compared to closed pre-service science teachers who honor tradition. However, at this point it should be noted that the abovementioned explanations are speculative and should be elaborated through the use of qualitative data collection procedures, such as interviews, to make more valid interpretations of the findings.

Another unexpected relationship was observed between conscientiousness and self-efficacy for instructional strategies. The direction of the relationship between these two variables was found to be negative. This finding could be due to the fact that individuals scoring high on conscientiousness are well-organized and tend to think carefully before acting. However, pre-service science teachers with such traits may think that although they are well-organized and well-prepared for their classes, something unexpected could occur in the classroom that they did not consider beforehand and, therefore, in such a situation, it may be difficult to think and act effectively without a pre-determined plan. Such a thought could lower their self-efficacy, for instance, for responding to difficult questions from their students or providing an alternative example or explanation when students become confused.

Moreover, a negative relationship was unexpectedly determined between extraversion and self-efficacy for student engagement. Since teaching involves interpersonal relations, it was predicted that pre-service

science teachers who are sociable, assertive, talkative, and active have high levels of self-efficacy for student engagement. On the other hand when examining the effect of extraversion on pre-service science teachers' teaching self-efficacy through extraversion's effect on performance approach goals, it was found that there was a positive relationship between extraversion performance approach goals, which was also positively linked to self-efficacy for student engagement and classroom management. Therefore, the indirect effect of extraversion mediated by performance approach goals on teaching self-efficacy appears to be positive.

Results of the path analysis regarding pre-service science teachers' personality and their teaching self-efficacy also unexpectedly revealed that there were positive associations between neuroticism and all dimensions of teaching self-efficacy. However, since negative effects such as embarrassment, guilt, and anger are the core of the neuroticism, it was predicted that neuroticism is negatively linked to teaching self-efficacy. The unexpected result concerning the relationship between neuroticism and pre-service science teachers' sense of efficacy can be also partly explained by the Turkish context. In the present study, descriptive statistics revealed that pre-service science teachers have high levels of neuroticism. These data were obtained from pre-service science teachers who are to graduate at the end of the academic year. In Turkey, people go through very competitive processes to obtain jobs. Graduated teachers must take national exams to potentially obtain opportunities to work in public schools. Teachers are ranked according to their exam scores and those with the highest grades are appointed to a job. Similarly, getting a job in private schools is a difficult task for teachers. They have to demonstrate that they are highly qualified teachers with high a grade point average (GPA) and good interpersonal relations. Most private schools seek experienced teachers. For this reason, newly graduated teachers may not have high hopes finding jobs in those schools. Actually, this competitive culture starts in students' early years of school in Turkey. Starting in 6th grade, students must take national exams in order to attend highly recognized high schools and universities. Since graduating from top schools and universities can help them get better jobs and become more optimistic about their future, students compete with one other to be successful on these exams. In addition, since students' GPA in school contributes to their national exam scores, they must also try to get higher scores compared to others in classroom exams (Sungur & Senler, 2009). Therefore, people experience a competitive life driven by the worry about their future. So, is not unusual that pre-service science teachers feel dependent, hopeless, sad, and worried at high levels. Moreover,

it appears that negative affects experienced in such an environment act as a motive for the individuals: As neuroticism increases, teaching self-efficacy increases. Similarly, neuroticism is found to be positively related to different components of self-regulation, including mastery approach goals, performance approach goals, mastery avoidance goals, metacognition, and effort regulation. Additionally, pre-service science teachers with higher levels of neuroticism were found have lower levels of test anxiety. These findings provide a support to the evidence in the literature that neuroticism can improve effort regulation and motivation, as is in the case of defensive pessimism by which worried people, in expecting failure, put forth efforts to prevent it (Bidjerano & Dai, 2007; Norem & Cantor, 1986).

Relationship between Academic Self-Regulation and Self-Efficacy

Concerning the relationship between pre-service science teachers' academic self-regulation and their teaching self-efficacy, results showed that metacognition and performance approach goals were positive predictors of pre-service science teachers' self-efficacy in all three dimensions, namely self-efficacy for student engagement, self-efficacy for instructional strategies, and self-efficacy for classroom management. Although the relationship between performance approach goals and self-efficacy for instructional strategies and between metacognition and self-efficacy for classroom management were not statistically significant, the direction of the relationship was positive. These findings suggested that pre-service science teachers who use metacognitive skills like planning, monitoring, and evaluating in their own learning and study for the reasons of showing their abilities to others, getting a good grade or looking smart tend to have higher levels of teaching self-efficacy. Similarly, Bembenutty (2007) demonstrated that pre-service teachers who use effectively metacognitive strategies like planning, self-monitoring, and self-evaluating of their own academic progress tend to have a high sense of teaching efficacy.

On the other hand, concerning the motivational component of self-regulation, task value beliefs were found unexpectedly to be negatively related to adaptive outcomes such as self-efficacy for classroom management, mastery approach goals, performance approach goals, and metacognition. These findings are contrary to the findings in the literature (Ablard & Lipschultz, 1998; Neber & Schommer-Aikins, 2002), except for Araz and Sungur's (2007) study in which a negative relationship was found between task value beliefs and the use of learning strategies resulting in deeper processing of information and achievement. Araz and

Sungur (2007) suggested that using the MSLQ to assess task value beliefs can be problematic since the subscale designed to measure this construct includes three sub-components, namely importance value, utility value, and intrinsic interest. Among these sub-components of task value beliefs, utility value is thought to be associated with extrinsic motivation, which is generally found to be negatively linked to adaptive outcomes (Wigfield & Eccles, 2000). For this reason, according to Araz and Sungur (2007), while proposing conceptual models, it may be better to include these sub-components separately rather than combining them with overall task value beliefs

Relationship between Pre-Service Science Teachers' Personality, Academic Self-Regulation and Self-Efficacy

Regarding the relationship between personality and different facets of self-regulation, agreeableness and conscientiousness were found to be mainly associated with adaptive outcomes as well as neuroticism. The observed relationships for conscientiousness and agreeableness were, in general, consistent with the relevant literature (Bidjerano & Dai, 2007; Chamorro-Premuzic & Furnham, 2003; Komarraju & Karau, 2005). On the other hand, the relationship between extraversion and different components of self-regulation was found to be non-significant except for performance approach goals and metacognition. More specifically, while a positive association was found between extraversion and performance approach goals, the link between extraversion and metacognition was negative. The reason for the negative relation found between extraversion and metacognition may be that, as suggested by Bidjerano and Dai (2007), impulsiveness, sociability, and distractibility implied by the construct of extraversion can preclude pre-service science teachers from effectively using metacognitive strategies and regulating their learning.

Concerning the relationship among different components of self-regulation, results showed that mastery approach goals and peer learning were positively associated with metacognition. Moreover, a positive relation was found between metacognition and effort regulation. These results were in congruence with the findings in the literature (Sungur, 2007). However, contrary to the relevant theory and literature, control of learning beliefs were found to be negatively linked to metacognition and effort regulation. These findings implied that pre-service science teachers who think that outcomes rely on one's own effort rather than external factors are less likely to study strategically and persist longer in the face of difficulties. The reason for this finding may be that students in

typical classrooms in Turkey are instructed mainly by lecture and discussion methods. Students depend on the notes and handouts taken in lectures to study for the exams (Gencer & Cakiroglu, 2007). For this reason, pre-service science teachers who have gone through such an educational system may think that effort means memorizing teacher explanations and handouts. Thus, if effort is conceptualized in this way, it is not unusual to find that control of learning beliefs is negatively linked to adaptive outcomes. However, to be able to obtain more valid explanations for these findings concerning control of learning beliefs, it is suggested that future studies examine these beliefs in relation to contextual factors using qualitative data collection procedures.

Implications

The present study showed that self-regulation and teaching self-efficacy have important personality correlates. Given the stability of personality traits, it is suggested that teacher education programs consider the personality disposition each pre-service science teacher brings to the learning environment (Bidjerano & Dai, 2007). In the present study, personality was used as a predictor variable. However, in future studies, the mediating role of personality on pre-service science teachers' self-efficacy and self-regulation can be examined through experimental studies in which they are exposed to treatments designed to improve their teaching self-efficacy and academic self-regulation. Then, using personality variables as mediators, researchers can examine whether certain personality traits promote or hinder the development of self-efficacy beliefs and self-regulatory skills (Bidjerano & Dai, 2007).

In addition, it is suggested that teacher education programs are structured so that pre-service science teachers as learners become aware of their own learning and use effective metacognitive strategies. In order to achieve this end, pre-service science teachers should experience learning environments where they deal with open-ended and challenging tasks (Paris & Paris, 2001). Additionally, instructors can be trained in using and demonstrating self-regulatory strategies to serve as social models for the pre-service science teachers (Dembo, 2001).

Limitations and Recommendations

There are some limitations of the current study that should be considered while interpreting the result. The first limitation is related to the measurement of the constructs. This study relies solely on the self-report data. This can lead to common method bias about verifying consistency and accuracy of the findings. In order to get an in-depth understanding of the

observed relationships and provide better explanations, qualitative approach may be employed in future studies. Such an approach can help determine to what extent the unexpected findings can be explained by culture. In line with this idea, the study can be replicated in different cultures. The second limitation concerns the generalizability of findings. The subject of this study was limited to the senior pre-service science teachers from selected universities in Turkey. Therefore, results may not be generalized to other countries and cultural contexts. Additionally this study may be replicated with a larger sample which includes also freshman, sophomore, and junior pre-service science teachers to be able to determine whether teaching self-efficacy differs across grade levels. Longitudinal studies can help examination of the changes in pre-service science teachers' self-efficacy beliefs during their education. Another limitation is related to the method and data analysis technique utilized in the current study. Since a cross-sectional design is used, observed relationships in the path model do not imply causality. Finally, in the present study, for some variables, the percentage of variance explained was low. In order to improve the proposed model, additional variables, such as those related to sources of teaching self-efficacy (i.e. mastery experience, verbal persuasion, and vicarious experience) and biographical variables, can be integrated to the model.

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