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# The Relation between Self-Efficacy Beliefs towards Science Teaching and Learning Strategies of Primary School Teacher Candidates

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**Abstract**

In this research, the relation between primary school teacher candidates' self-efficacy beliefs towards science teaching and learning strategies was investigated. The research group consisted of 314 primary school teacher candidates who are studying in the faculty of education in a public university. "The Science Teaching Efficacy Belief Instrument" was used to determine the self-efficacy of primary school teacher candidates for science teaching; and in order to determine their learning strategies, part of the Learning Strategies Scale (LSS) was used. The data were analyzed with canonical correlation analysis using CANCORR syntax in PASW 21 software. According to the results of the analysis, it was determined that there was a significant relation between the personal self-efficacy belief in science teaching variable in self-efficacy belief in science teaching data set and elaboration strategy (ES), metacognitive self-regulation (MC), effort regulation (ER) and time and study environment management (TSEM) variables in the learning strategies data set.

## Introduction

Science and its teaching is an important key to understanding science and nature, to follow technology, to develop and to help keep up with the changing and developing world. In order to adapt to the developing and changing world, it is obvious that there is a need for qualified programs and their implementers. Therefore, the content of the curriculum has been restructured in Turkey, with programs that started in 2004 and changed in 2013 and 2017. The main purpose of the construction of this program is to train individuals as science literate (Ministry of National Education, 2004, 2013, 2017). Teachers who are the implementers of changing programs, and primary school teacher candidates who are candidates to become implementers, have important duties. Many researchers emphasized the necessity of taking into account the beliefs of teachers in the organization and planning of the curriculum. The reason for the emphasis is that teachers are the practitioners of the program in the classroom and they are the main factor in the success of the program (De Jong, Veal, & Van Driel, 2002; Dogan, 2010; Minor, Onwuegbuzie, Witcher, & James, 2002). The fact that teachers have an idea about their knowledge, opinions, attitudes and beliefs while implementing the program helps them identify and correct the deficiencies they have. Primary school teacher candidates, on the other hand, develop beliefs and attitudes such as opinions, tendencies and philosophy about learning and teaching during their education, with help from their past experiences (Czemiak, Lumpe, & Haney, 1999). At that, the quality and quantity of pre-service teachers' self-efficacy and beliefs come to the fore as an important factor affecting the quality of the teacher.

## Self-efficacy towards Science Teaching

Bandura (1986) states that there is a system that includes cognitive and affective structures in individuals, and regulates and controls individuals' thoughts, feelings and actions. These structures include the ability to symbolize their abilities, learning from others, planning alternative strategies, organizing their own behaviours and self-reflection. This control system perceives, organizes and evaluates behaviour with interaction between the self-system and external environmental impact sources, and plays a role in the provision of reference mechanisms (Pajares, 1996). It also affects the choice, continuity and efforts of individuals' activities (Pintrich & Schunk, 2002).

According to the social learning theory, the environment, behaviour and personal characteristics (cognitive, affective, genetic elements) of the individual are in constant interaction. Therefore, the individual's response to a situation they face, their capacity to cope with difficulties, and the degree of injury varies in the circumstances of the situation (Bandura, 2001). At this point, Bandura (2004) emphasized that this could be caused by the differences in beliefs about the individual's existing abilities. Bandura (1997) has indicated the reasons for these beliefs as why people make certain decisions and how they behave in certain situations throughout their lives. Brophy (1988) emphasized that according to this system, the teacher is important in increasing the effectiveness of the education in the classroom outside the social areas and also pointed out that teachers should understand their beliefs in their abilities, so that the decisions made and practices carried out in the classroom could be better. If self-efficacy, which is one of the cornerstones of social and cognitive theory, is to be defined, it is necessary to mention two basic concepts. The first is the self-efficacy belief and the second is the outcome expectancy. Self-efficacy belief is the belief that an individual can successfully demonstrate the behaviours necessary to create the desired result in a situation, namely his/her own judgment regarding his/her ability for regulating and conducting his/her own performance. The outcome expectancy includes individual's making approximate estimates of how his/her behaviour will have consequences (Bandura, 1977, Smolleck & Mongan, 2011). When evaluated in general, Bandura (1997) has emphasized that self-efficacy beliefs are generally insufficient in predicting the behaviour of the individual, and should be specific to a particular task in order to do this On the basis of the explanation proposed by Bandura, we coma across the concept of teacher self-efficacy, which affects the quality of teaching. This task of organizing and employing skills can significantly affect the teacher’s performance and behaviour. Therefore, self-efficacy for science teaching is a concept that is specific to the field and the task (Riggs, Diaz, Riggs et al., 1994). In addition, it has been stated in many studies that individuals with higher academic self-efficacy set their targets higher, they can easily overcome difficult tasks in achieving these goals, they are more determined and persistent, and that they develop problem-solving strategies (Askar & Umay, 2001; Jerusalem, 2002; Pajares, 1996, Schunk & Pajares, 2001; Yilmaz, Gurcay, & Ekici, 2007). Given that science concepts are difficult to understand and that science is a field in which many misconceptions can develop, importance of science teaching becomes evident. Therefore, while teaching science concepts, teachers should have strong self-confidence in terms of regulating and managing their own performance and should be knowledgeable about what the outcomes of their behaviours can be and make the necessary organizations accordingly; thus, course objectives can be achieved.

## Learning Strategies

Bandura (1991) conceptualized self-regulation within the social cognitive learning theory and defined it as the individual’s directing his/her own learning according to the context around and his/her motivational, cognitive and metacognitive competence. Zimmerman (1990, 2000, 2001) has defined this as the level of metacognitive, motivational and behavioural attendance of the students in the learning process in which the students use the interaction of individual, behavioural and environmental factors to reach their goals. Self-regulatory learning strategies include metacognitive activities, like students' planning, monitoring and organizing their cognitive status (Zimmerman & Martinez-Pons, 1988), the control and management of students' own efforts to accomplish their academic tasks (Pintrich & De Groot, 1990), and students' cognitive strategies, like repetition, elaboration and regulation, which make learning meaningful and memorable (Zimmerman & Martinez-Pons, 1988).

In the self-regulation model in learning developed by Pintrich, Smith, Garcia and McKeachie (1993), there are two sub-dimensions. These are motivation strategies and learning strategies. Learning strategies are based on general cognitive learning and information processing models (Weinstein & Mayer, 1986), and consist of elements that facilitate the self-learning of the individual and aim at permanent learning. Weinstein and Mayer (1986) have stated that this is made up of behaviours and thoughts which shape the learner to choose and organize new knowledge to be taught and to integrate the old knowledge and new knowledge. In the self-regulation model developed by Pintrich, Smith, Garcia and McKeachie (1991), there are two sub-dimensions: motivation strategies and learning strategies. According to their classification:

- ✓ Cognitive strategies are divided into basic and complex cognitive processes in the process of processing the lessons and the information on the subject (Pintrich et al., 1993). Basic cognitive processes are repetitions such as students' repeating the words they used or helping recall information (Pintrich et al., 1993; Weinstein & Mayer, 1986). Complex cognitive strategies are also divided into two sub-categories. These are elaboration strategies (e.g. summarizing, paraphrasing, explaining how existing information is associated with new information), and organization strategies (e.g. determining the outline of a situation or topic) (Pintrich et al., 1993; Weinstein & Mayer, 1986). Additionally, critical thinking sub-dimension was added. Critical thinking is a process involving the application of pre-experience, knowledge, logic and intuition in the new situation in the face of the difficulties faced by the individual, and the universal evaluation of ideas (Pintrich et al., 1993; Tasci, 2005). This process starts with analysis, continues with interpretation, self-regulation, inference and elaboration and ends with evaluation (Craft, 2003; Rudd, 2007).

- ✓ Here, metacognitive strategies are concerned with the use of strategies that help an individual to regulate and control his or her own cognitive structures (Pintrich et al., 1993). Flavell (1979) has divided metacognition primarily into two sub-categories, namely, monitoring and self-regulation, and metacognitive knowledge. Metacognitive knowledge is divided into three: Procedural knowledge refers to knowledge about how to accomplish a task and how to do it. For instance, the person's knowing how to calculate the area of a square. Declarative knowledge refers to one's knowledge about whether he/she can deal with a given task; that is, about his/her competences. For example, the person's knowing whether he/she can calculate the area of a square in the above-given example. Conditional knowledge refers to one's knowing which knowledge to use in the face of a given case; that is, his/her knowing what to do, so it requires both procedural and declarative knowledge. The vast majority of a person's metacognitive knowledge is indeed related to their interaction in two or three of these categories in different ways.
- ✓ When looking at resource management, it includes regulatory strategies that enable students to control other resources as well as their cognition. It is divided into four subgroups. These include time and study environment management (e.g., make use of the time well and the organization of a favourable working environment), effort regulation (e.g., being persistent against a boring or difficult situation), peer learning (using peer groups to help learning) and help seeking (take request for help from teachers or peers when needed) (Pintrich et al., 1993).

Considering the explanations above, it is essential for the student to use basic and complex strategies in order for the concepts in a lesson to be structured in their minds. Given that success in concept teaching affects success in class, it has been shown in various studies that students with low academic achievement do not use learning strategies effectively and their motivation towards the course is low (Paterson, 1996; Pintrich & De Groot, 1990; Sungur, 2004; Wolters & Rosental, 2000). Moreover, some studies have found that students with self-regulating skills are generally more successful in academic terms (Woltes, Yu, & Pintrich, 1996; Zimmerman & Martinez-Pons, 1988). Self-regulation is of particular importance for science teaching. Science subjects are generally found to be frightening, challenging and difficult to understand by students. Therefore, teachers are expected to turn these negative affective factors (attitude, motivation etc.) into positive. To do so, teachers should be able to use methods and techniques including metacognitive methods in the teaching of science subjects. As such, they need to have developed self-regulation skills.

Given all these definitions and explanations, it is substantial for students to use these learning strategies based on their self-efficacy perceptions in the direction of academic objectives in order for their learning to be considered as self-regulatory, and to achieve constructive, meaningful and lasting learning (Zimmerman, 1989). In addition, Zimmerman (1989) stated that high level of self-efficacy of the students would allow them to demonstrate more qualified learning strategies. The development of self-efficacy and learning strategies in terms of quality is related to the extent to which teachers and pre-service teachers who will be future teachers use self-efficacy and learning strategies.

## Methodology

### Research Model

In the current study, the relational survey model, one of the survey models, was used. In the relational (correlational) design, it is aimed to determine the relationships between two or more variables and to predict the possible outcomes (Fraenkel & Wallen, 2006; Karasar, 1999; Metin, 2014). Also, when there is a relation, this model is for determining the degree of the relationship (Fraenkel & Wallen, 2006; Metin, 2014).

### Study Group

In this research, convenience sampling method, which is one of the purposeful sampling methods, has been used. The research group consists of 314 primary school teacher candidates who receive education in the Department of Primary Education. 226 of the study group (72%) were female and 88 (28%) were male primary school teacher candidates. The year where the data was collected was the 2nd year. Stevens (2012) has stated that the reliability of the findings can be achieved in the canonical correlation analysis by including 20 times as many participants as the total number of variables in each set.

When the scales used in the research are examined: There are a total of 11 variables, which are 2 variables including personal science teaching efficacy belief and science teaching outcome expectancy in science teaching self-efficacy belief data set, and 9 variables including rehearsal, elaboration, organization, metacognitive self-regulation, critical thinking, help seeking, effort regulation, peer learning and time and study environment management in learning strategies data set. For the reliability of the analyzes, there should be up to 20 times as many participants as the total number of variables (Stevens, 2012). According to this, for the reliability of the findings, at least (11X20=220) 220 participants are required. The number of sample group is 314, indicating that there are sufficient number of participants to ensure the reliability of the findings.

## Data Collection Tools

### *The Science Teaching Efficacy Belief Instrument*

"The Science Teaching Efficacy Belief Instrument" Scale which was developed by Enochs and Rings (1990) and adapted to Turkish by Tekkaya, Cakiroglu and Ozkan (2002) was used. This scale was developed to measure the self-efficacy beliefs of primary school teacher candidates towards science teaching. The Science Teaching Efficacy Belief Instrument comprise of two sub-dimensions including personal science teaching efficacy (PSTE) (13 items) and science teaching outcome expectancy (STOE) (10 items). The scale consists of 23 items and 5-point Likert type. The scale has 14 positive and 9 negative items. For the reliability study, the scales were applied to a total of 291 primary school science teacher candidates, and the reliability coefficients were calculated. Sample items belonging to the sub-dimensions of the scale and Cronbach's Alpha reliability coefficients obtained in accordance with the reliability study during the development of the scale and calculated for the study are shown in Table 1.

Table 1. Reliability Coefficients of the Science Teaching Efficacy Belief Instrument Sub-scales with Sample Items

| **Sub-scales** | **Cronbach Alpha (Original Scale)** | **Cronbach Alpha (Reliability coefficients obtained in the research)** | **Sub-Item** |
|---|---|---|---|
| Personal Science Teaching Efficacy Belief (PSTEB (Personal self-efficacy belief in science teaching) | .86 | .86 | I will constantly find better methods to teach the Science course. |
| Science Teaching Outcome Expectancy (STOE) | .79 | .73 | Teacher is not responsible for the low academic achievement of students in Science course. |

### *Motivated Strategies for Learning Questionnaire (MSLQ) Scale*

"Motivated Strategies for Learning Questionnaire Scale" (MSLQ) was developed by Pintrich, Smith, Garcia and McKeachie (1993) and adapted to Turkish by Buyukozturk, Akgun, Ozkahveci and Demirel (2004). MSLQ scale in the research consists of two scales. In the research, "The Learning Strategies Scale (LSS)", which formed part of the main scale, was used. The Learning Strategies Scale (LSS) comprise of 50 items and is in the form of 7-point Likert type. The scale has nine sub-dimensions including rehearsal strategy (4 items), elaboration strategy (6 items), organization strategy (4 items), metacognitive self-regulation (12 items), critical thinking (5 items), help seeking (4 items), effort regulation (4 items), peer learning (3 items), and time and study environment management (8 items).

For the reliability study, the scales were applied to a total of 291 primary school science teacher candidates, and the reliability coefficients were calculated. The overall Cronbach's Alpha reliability value of the scale was .86; in the reliability study, general Cronbach's Alpha reliability value was calculated as .95. The Cronbach's Alpha reliability coefficients calculated for the study and obtained in line with the reliability study during the development of the sub-dimensional sample items and the scale are shown in Table 2.

Table 2. Reliability Coefficients of the Learning Strategies Scale (LSS) Sub-scales with Sample Items

| **Sub-scales** | **Cronbach Alpha (Original Scale)** | **Cronbach Alpha (Reliability coefficients obtained in the research)** | **Sub-Item** |
|---|---|---|---|
| Rehearsal Strategies (RS) | .62 | .65 | When I study Science course, I repeat the important information many times silently to myself. |
| Elaboration Strategies (ES) | .74 | .80 | In Science course, I try to use ideas that I obtain from what I read in various activities such as class discussion. |
| Organization Strategies (OS) | .61 | .68 | I prepare simple graphs, diagrams or tables to organize topics related to the course. |
| Metacognitive Self-Regulation (MC) Strategies | .75 | .84 | I ask myself questions to make sure that I understand the topics covered in Science course. |
| Critical Thinking (CT) Strategies | .74 | .71 | I constantly try to review my ideas that form as a result of what I've learned in Science course. |
| Help Seeking (HS) Strategies | .49 | .58 | I try to specify my friends from whom I can ask for help whenever necessary. |
| Effort Regulation (ER) | .41 | .62 | If a topic is difficult, I either stop working or just study the easy parts. |
| Peer Learning (PL) | .46 | .51 | I often spare time for discussing topics with my classmates when I study Science course. |
| Time and Study Environment Management (TSEM) | .61 | .72 | There is a place (room, etc.) that I use constantly to study. |

## Data Analysis

In this research, the relation between science teaching self-efficacy beliefs and learning strategies of primary school teacher candidates was searched by canonical correlation analysis. Canonical correlation's advantage compared to multiple regressions: In multiple regression analysis, the relation between a single variable (Y) and two or more variables (X1, X2, …Xp) (Cohen, 1968) is investigated, while canonical correlation allows simultaneous investigation of the relation between multiple Y variables and multiple X variables. It also includes structural equation models (Bordens & Abbott, 2011; Henson, 2002; Knapp, 1978). The most important feature of such multivariate analyses is that since the relation between variables in the data set can be demonstrated with a single analysis, it allows to keep the Type 1 error to a minimum, which may be involved in the measurement process, while reducing the possibility of considering relation that are not significant in reality to be considered significant (Strangor, 2010; Thompson, 1991). If the variables can be determined as dependent and independent variables in the canonical analysis, then how much the independent variable set affects the dependent variable set can be determined. Albayrak (2010) has stated that it is not compulsory to make a distinction between dependent and independent variables.

In data set variables used in the research, there are a total of 11 variables which are 2 variables including personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) in science teaching self-efficacy belief data set (set1), and 9 variables including rehearsal strategy (RS), elaboration strategy (ES), organization strategy (OS), metacognitive self-regulation (MC), critical thinking (CT), help seeking (HS), effort regulation (ER), peer learning (PL) and time and study environment management (TSEM) in learning strategies data set (set2). In this research, it is tried to determine the relation between the two data sets without determining the data sets as independent and dependent variables.

Before the canonical correlation analysis was performed, whether the data showed normal distribution was tested. Skewness and Kurtosis values were examined for normality test. As a result of the analysis, the value of Kurtosis ranged between -.602 and +.661, and the Skewness value ranged between -.308 and +.263. Tabachnick and Fidell (2007) have emphasized that the values of Skewness and Kurtosis should be between -1.5 and +1.5 for the normal distribution of the data set. Looking at the results of the analysis, it is seen that the data is normally distributed. Canonical correlation analysis was performed in SPSS 20 software by determining the significance level as 0.05 and writing syntax. General diagram of the canonical correlation analysis to be performed for the existing data sets is shown in Figure 1.

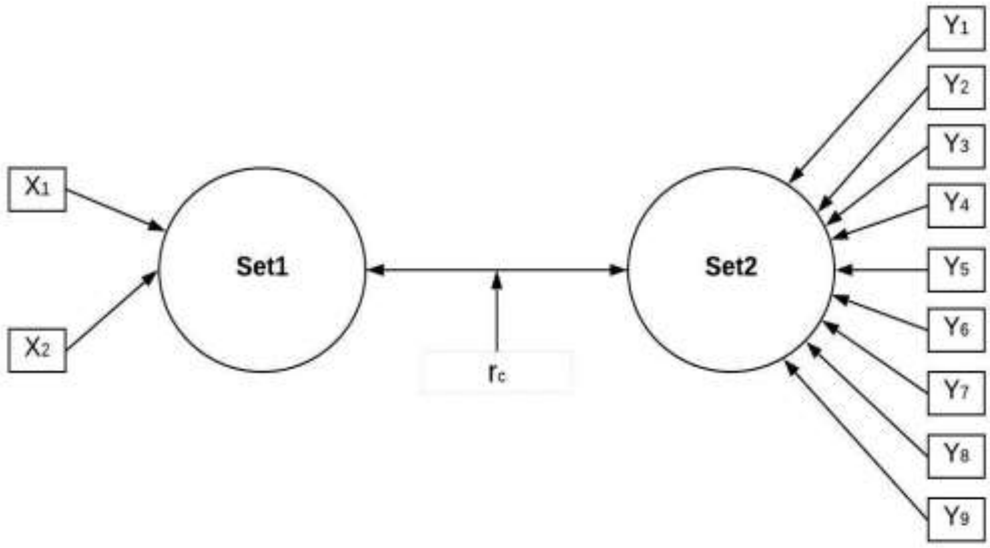


Figure 1**.** General Scheme of Canonical Correlation Analysis

## Results

Descriptive values related to primary school teacher candidates' science teaching self-efficacy beliefs and sub-dimensions in learning strategies data sets, and their correlations are presented in Table 3.

Table 3. Relationships between the Science Teaching Efficacy Belief and the Learning Strategies

| **Variables** | **Mean** | ***SD*** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PSTEB (1) | 41.10 | 3.34 | 1 | | | | | | | | | | |
| STOE(2) | 32.63 | 3.38 | .12 | 1 | | | | | | | | | |
| RS(3) | 18.68 | 3.11 | .12 | .07 | 1 | | | | | | | | |
| ES(4) | 30.60 | 6.31 | .20 | .07 | .51 | 1 | | | | | | | |
| OS(5) | 20.08 | 4.44 | .18 | .12 | .52 | .70 | 1 | | | | | | |
| MC(6) | 59.07 | 10.78 | .26 | .01 | .62 | .81 | .75 | 1 | | | | | |
| CT(7) | 23.69 | 5.56 | .12 | .06 | .49 | .68 | .63 | .71 | 1 | | | | |
| HS(8) | 19.06 | 4.15 | .06 | .05 | .37 | .47 | .37 | .44 | .33 | 1 | | | |
| ER(9) | 18.81 | 4.36 | .21 | .03 | .35 | .50 | .41 | .52 | .39 | .24 | 1 | | |
| PL(10) | 13.29 | 3.30 | .05 | .08 | .32 | .49 | .49 | .43 | .56 | .30 | .22 | 1 | |
| TSEM(11) | 37.84 | 7.26 | .19 | .01 | .44 | .52 | .52 | .67 | .58 | .34 | .55 | .24 | 1 |

Table 3 shows the correlation values between each variable in the data sets. When these values are examined, the correlation coefficient between the personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) variables in the first variable set is determined as 0.16; The correlation coefficients of the relations between the rehearsal strategy (RS), elaboration strategy (ES), organization strategy (OS), metacognitive self-regulation (MC), critical thinking (CT), help seeking (HS), effort regulation (ER), peer learning (PL) and time and study environment management (TSEM) variables in the second set of variables were determined to vary between 0.81 and 0.22, and the correlation coefficients between the first set of variables and the second set of variables ranged from -0.05 to +0.26. In order to determine whether the canonical model was statistically significant in the canonical correlation analysis, firstly, the multivariate significance test was examined. These significance tests consist of four different tests: Pillais, Hotellings, Wilks and Roys. The above-mentioned tests are converted to the F test to help determine the significance of the canonical model resulting from the analysis. The fact that the theoretical basis for each of these four tests is different leads to a difference in the F value calculated for each test. It is performed based on the Wilks λ test because it has more applicability and it is easier to interpret research results (Sherry & Henson, 2005; Stevens, 2012).

Table 4. Multivariate Test of Significance

| | **Value** | **Approx *F*** | **Hypothesis *df*** | **Error *df*** | **Significance of *F*** |
|---|---|---|---|---|---|
| Pillais | .14818 | 2.70282 | 18 | 608 | <.001* |
| Hotellings | .16199 | 2.71785 | 18 | 604 | <.001* |
| Wilks | .85654 | 2.71038 | 18 | 606 | <.001* |
| Roys | .10194 | | | | |

S = 2, M = 3, N = 150 ½, *p<.0001

The findings of the research are presented in Table 4. Table 4 shows that the canonical model created is statistically significant [Wilks's λ =.86, F(18, 606) =2.710, p<.001]. However, the significance of the tests performed does not give any concrete information about the strength of the relationship obtained. In addition, it is also important to evaluate the effect size, apart from the significance of the model established in the analysis. In this evaluation, the opposite effect size, that is, the value of Wilks λ is used. The Wilks λ value expresses the unexplained variances between the canonical variables in the model analyzed. In order to find the variance described here, "1-λ" should be calculated. Thus, the amount of common variance shared by the canonical variables is calculated, and the obtained value is interpreted like the r2 value in the regression analysis. In this case, "1-λ" value was calculated as 0.144 for Wilks' λ value obtained. In other words, it can be said that the common variance shared between data sets of primary school teacher candidates' science teaching self-efficacy beliefs and learning strategies is 14.4%. Then, the significance of each canonical function in the model needs to be examined one by one. While the significance of the canonical model is tested, the operation is performed with the cumulative values of each canonical function. As a result of the analysis, it is not possible for each of the canonical functions to be significant in a canonical model where cumulative values are statistically significant. While it can be significant in one part, the relation between the variables can be insignificant in another part due to the very low level of relation between the variables. Therefore, while interpreting the results of canonical correlation analysis, the significance of each canonical function should be evaluated individually together with the canonical model. While deciding whether the obtained canonical functions are significant, the canonical correlation values and eigenvalues related to the canonical functions are examined. In the research, two canonical functions were obtained as a result of the analysis applied to examine the relation between primary school teacher candidates' science teaching self-efficacy beliefs and learning strategies data sets. Table 5 shows the eigenvalues and canonical correlation values of each function.

Table 5. Canonical Correlation Analysis Results between Renewable Energy Sources Attitude and Critical Thinking Disposition

| **Roods** | **Eigenvalue** | **%** | **Cumulative %** | $r_c$ | $r_c^2$ |
|---|---|---|---|---|---|
| 1 | .11 | 70.07 | 70.07 | .32 | .102 |
| 2 | .05 | 29.93 | 100 | .22 | .046 |

According to the findings in Table 5, the canonical correlation value for the canonical function in the first order was determined as 0.32. According to this, science teaching self-efficacy beliefs and learning strategies data sets of primary school teacher candidates in the first canonical function share a common variance of 10.2%. Finally, after the deduction of the common variance shared by science teaching self-efficacy beliefs and learning strategies data sets of primary school teacher candidates in the first canonical function, the canonical correlation value of the second canonical function was found as 0.22, and the common variance shared by science teaching self-efficacy beliefs and learning strategies data sets of primary school teacher candidates for the second canonical function was found as 4.6%. Investigation of the significance of each canonical function determined individually provides information as to which functions resulting from canonical correlation analysis should be interpreted. Tabachnick and Fidell (2007) has stated that statistically significant of canonical functions determined as a result of analysis should be interpreted. In order to determine which canonical functions should be interpreted, Sherry and Henson (2005) has stated that the canonical value calculated for each function should be squared and the sum of the obtained values should be compared with the value "1-λ". If the value obtained in the comparison is equal to or greater than "1-λ", that many functions must be interpreted. The results of dimension reduction analysis of the relation between science teaching self-efficacy beliefs and learning strategies data sets of primary school teacher candidates are shown in Table 6.

Table 6. Dimension Reduction Analysis

| Roods | Wilks L. | *F* | Hypothesis df | Eror *df* | $r_c$ | $r_c^2$ | Significance of F |
|---|---|---|---|---|---|---|---|
| 1 to 2 | .86 | 2.710 | 28 | 606 | .32 | .102 | <.001* |
| 2 to 2 | .95 | 1.842 | 8 | 304 | .22 | .046 | .069 |

$^{*}p < .0001$

When we look at the Wilk's λ and chi-square values of the two canonical functions obtained as a result of the analysis in Table 6, it is observed that the canonical correlation coefficient calculated between self-efficacy beliefs and learning strategies data sets is statistically significant for the first canonical model (function 1 to 2) [Wilks's λ=.86, F(18, 606)=2.710, p<.001]. The correlation value for the first canonical function is 0.32. Accordingly, the common variance shared between science teaching self-efficacy beliefs and learning strategies data sets was found as 10.2%. The relation between science teaching self-efficacy beliefs and learning strategies data sets was not statistically significant for the weakest second canonical function (function 2 to 2) after the deduction of the first canonical function where the correlation between canonical variables was highest [Wilks's λ =.95, F(8, 304)=1.842, p>.05]. In this function where the relation between canonical variables is the weakest, it is determined that science teaching self-efficacy beliefs and learning strategies data sets share a common variance of only 4.6% ["1-λ"=.046]. In order to determine how much personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) variables in science teaching self-efficacy beliefs data set, and rehearsal strategy (RS), elaboration strategy (ES), organization strategy (OS), metacognitive self-regulation (MC), critical thinking (CT), help seeking (HS), effort regulation (ER), peer learning (PL) and time and study environment management (TSEM) in learning strategies data set contribute to the relation between canonical variables, standardized coefficients and structural coefficients of the first canonical function between the canonical variables are given in Table 7.

In Table 7, standardized coefficients for canonical functions are shown as "Coef" and structural coefficients as "$r_s$". In addition, the common variance shared by the personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) variables in science teaching self-efficacy beliefs data set and rehearsal strategy (RS), elaboration strategy (ES), organization strategy (OS), metacognitive self-regulation (MC), critical thinking (CT), help seeking (HS), effort regulation (ER), peer learning (PL) and time and study environment management (TSEM) variables in learning strategies data set, and the variables mentioned above with the learning strategies data set is shown as "rc2". By adding up the rc2 values in the first canonical function of RS, ES, OS, MC, CT, HS, ER, PL and TSEM variables in learning strategies data set and PSTE and STOE variables in science teaching self-efficacy beliefs data set, the common variance that these variables share with the data set they belong to in the canonical model is determined. In order to determine whether the variance shared by the variables with the data set they belong to is significant, the value of 0.45 is taken as criterion. According to this criterion, if $r_s$ values are 0.45 or greater than 0.45, the contribution of the variable to the data set it belongs to can be said to be significant (Sherry & Henson, 2005). In addition, for each variable to be part of the canonical model, their correlation must be greater than 0.30 (Tabachnick & Fidell, 2007).

Table 7. Canonical Solution for Renewable Energy Sources Attitude and Critical Thinking Disposition for Functions 1

| | Function 1 | | |
|---|---|---|---|
| **Variables** | **Coef.** | **$r_s$** | **$r_s^2$(%)** |
| PSTEB | .97 | <u>.93</u> | .87 |
| STOE | -.37 | -.26 | .07 |
| **$r_c^2$** | | **.102** | |
| RS | -.27 | .28 | .08 |
| ES | -.09 | <u>.54</u> | .29 |
| OS | -.25 | .40 | .16 |
| MC | 1.37 | <u>.79</u> | .62 |
| CT | -.45 | .28 | .08 |
| HS | -.07 | .24 | .06 |
| ER | .39 | <u>.68</u> | .46 |
| PL | -.10 | .06 | .003 |
| TSEM | .05 | <u>.58</u> | .34 |

Structure coefficients (rs ) greater than |.45| are underlined. Coef = standardized canonical function coefficient; $r_s$ = structure coefficient; = squared structure coefficient.

Looking at Table 7, in the first canonical function, it was determined that PSTEB's contribution to the science teaching self-efficacy beliefs data set was above 0.45,while the structural coefficient of the STOE variable was below 0.45. According to the explanations and the structural coefficients taken by the variables, it can be said that the contribution of the PSTEB variable to the science teaching self-efficacy beliefs data set is more significant than the STOE variable for the first canonical function. Again, according to Table 7, the contribution of ES, MC, ER and TSEM variables in the first canonical function to the learning strategies data set is over 0.45. In this case, it can be said that the contribution of MC, ER and TSEM variables in the first canonical function to the learning strategies data set is more significant than the RS, OS, CT, HS and PL variables.

As a result of the analysis, the direction of the relation between the variables can be determined depending on whether the variables contributing significantly to the data set (having a structural coefficient of 0.45 or above) are in positive or negative direction in the canonical functions. When the variables of learning strategies data set in first canonical function are examined, it is seen that all the ES, MC, ER and TSEM variables have a positive value, and that they have a correlation in the same direction. In parallel to this, it can be said that there is a positive relation between PSTEB variable and ES, MC, ER and TSEM variables. According to this result, as primary school teacher candidates' personal science teaching efficacy belief (PSTEB) increases, their elaboration strategy (ES), metacognitive self-regulation (MC), effort regulation (ER) and time and study environment management (TSEM) also increase. As a result, the rc2 value for the first canonical function was calculated as 10.2. According to this value, the common variance shared between the science teaching self-efficacy beliefs and learning strategies data sets in the first canonical function was found as 10.2%. In addition, the structural coefficients of the first conical function and the canonical correlation coefficients between science teaching self-efficacy beliefs and learning strategies data sets for this function are shown in Figure 2.

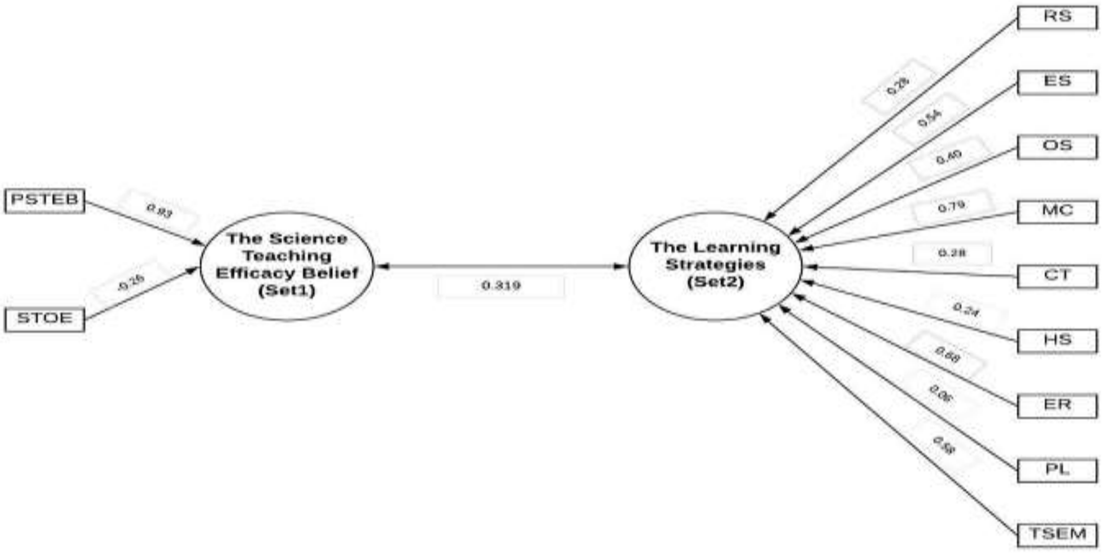


Figure 2. Canonical Correlation Results

When evaluated generally, in line with the data obtained from the primary school teacher candidates, the common variance shared by science teaching self-efficacy beliefs and learning strategies data sets was determined as 14.4%. Figure 3 shows the relationship between science teaching self-efficacy beliefs and learning strategies based on the findings obtained from the analysis.

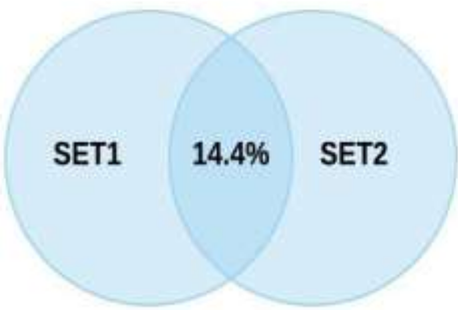


Figure 3. Common Variance Shared by Two Data Sets (14.4%)

## Discussion

The research was conducted to reveal the relation between science teaching self-efficacy beliefs and learning strategies of primary school teacher candidates. Canonical analysis was performed to determine the relation. According to the results of the analysis, two canonical functions associated with the relation between science teaching self-efficacy belief and learning strategies were obtained. Only one of the obtained functions was found to be statistically significant. In the first canonical function, which was calculated to maximize the relation between science teaching self-efficacy and learning strategies data sets, the common variance shared by science teaching self-efficacy and learning strategies data sets was found as 10.2%. In the second canonical function, after the common variance shared by science teaching self-efficacy belief and learning strategies data sets in the first canonical function deducted, the common variance shared by the science teaching self-efficacy belief and learning strategies data sets was found as 4.6%.

In the canonical model, which consists of cumulative values of canonical functions provided as consequence of canonical correlation analysis, the common variance shared by science teaching self-efficacy belief and learning strategies data sets was found as 14.4%. It can be said that these two variables affect each other. Because self-efficacy perception involves the individual's belief in his or her own learning capacity, and the harder the students' self-efficacy, the more they are confident and willing to learn (Bandura, 1986). It can be thought that a student with a high level of confidence in this direction can manage the learning process by organizing his/her self-regulation skills necessary to succeed in his/her own learning. When the consequence of the studies are examined, it is determined that students with high self-efficacy (Eshel & Kohavi, 2003; Suk Hwang & Vrangistinos, 2002) and high self-regulation are more successful in achieving their learning goals (Desoete, 2001; Schunk & Zimmerman, 1998; Suk Hwang & Vrangistinos, 2002). According to the results of the research by Zimmerman, Bandura and Martinez-Pons (1992), these two variables are important in predicting student achievement and are closely related. In addition, when the literature is investigated, it is stated that self-efficacy belief, one of self-regulation skills and the motivational elements, constitutes the basic elements of problem solving processes (Mayer, 1998; Mayer & Wittrock, 1996; O'Neil, 1999). According to O'Neil (1999), self-efficacy perception is an essential element of self-regulation skills, and has an important role in the problem solving process. Reviewing the literature, there are studies showing that there is a positive relation between self-efficacy and self-regulation, which is parallel with this research (Feyzioglu, Feyzioglu & Kucukcingi, 2014; Israel, 2007; Senler & Sungur-Vural, 2013). In fact, primary school teacher candidates' use of learning strategies at a sufficient level while teaching science concepts will increase their self-efficacy beliefs towards the course and their self-confidence (Cheung & Lai, 2013). Thus, their increased confidence in science teaching will enable them to express themselves better as teachers. Moreover, as science subjects are difficult and there are many misconceptions in this field, the instructional methods and techniques to be used should include metacognitive strategies. When the literature is examined, it is seen that metacognitive strategies are important in the elimination of misconceptions (Yangın, 2014; Yürük, Beeth, & Andersen, 2009; Yürük, Selvi, & Yakışan, 2011). Metacognitive strategies are part of self-regulation strategies and therefore a teacher having high self-efficacy is thought to invest greater effort to deal with challenging tasks, to be more persistent, to manage his/her concerns and to use self-evaluation and self-monitoring strategies more frequently. In the literature, it was determined that teachers with high self-efficacy are more enthusiastic to do their job (Allinder, 1994; Walters & Ginns, 1995) and more committed to their job (Coladarci, 1992).

In addition, reference to the results of the first canonical function, it was determined that there was a positive relation between the personal self-efficacy belief in science teaching variable in self-efficacy belief in science teaching data set and elaboration strategy (ES), metacognitive self-regulation (MC), effort regulation (ER) and time and study environment management (TSEM) variables in the learning strategies data set. Metacognitive strategies involve the student's self-evaluation, setting up targets, searching for, recording and reviewing the relevant information, and determining deficiencies (Zimmerman & Pons, 1988). Here, the student decides and applies which learning strategies he/she should use based on his/her own personal metacognitive experiences through his/her metacognitive knowledge. The student's only knowing the strategies to be used is not important; the important thing is that they believe in these strategies and want to use them (Pintrich, 1988). This supports Bandura's (1993) explanation that perceived competence affects the cognitive processes. When some studies in the literature are examined, it is defined that there is a significant relation between metacognitive strategies and self-efficacy, and these results support the research (Alci, Erden & Baykal, 2010; Baykara, 2011; Clause, Debridge, Scmidt, Chan & Jennings, 2001; Coleen Lindsay, 2010; Tunca & Alkın Sahin, 2014).

Elaboration strategies are included in cognitive strategies and include skills required for learning in cognitive strategies. Because of students to be successful in their learning, they must use their cognitive strategies competently. According to Pajares (2002), the success of the students and the ability to use their cognitive processes well depends on the development of their self-efficacy belief. There is no research investigating the relation between time and study environment management and effort regulation, which are other sub-factors of self-regulation, and self-efficacy. However, when we look at the explanations of these concepts, in order for students to insist on working in difficult tasks and subjects in effort regulation, to make a study plan in time and study environment management and to make an appropriate time management for this, it is important that they have high self-efficacy belief about themselves in the first place.

## Conclusion and Implications

The results of the current study have revealed that for pre-service teachers to be able to train science literate individuals who can solve problems in their daily lives, they need to have information about their self-efficacy; that is, their belief in their own capacity. This will allow pre-service teachers to better organize the learning of their students since it will enable them to be more willing to teach. This task of organizing can be performed better with the development of pre-service teachers' self-regulation skills. Therefore, pre-service teachers need to have knowledge about their own self-regulation and self-efficacy in order to train academically successful students. In order for them to develop in this regard, they should be provided with opportunities to be engaged in metacognitive teaching activities in their classes. The main goal of a curriculum is not only to train academically successful individuals. For students to improve their motivation, attitude and psycho-motor skills related to science, teachers should organize their instruction well and to enhance the learning environment. To do so, pre-service teachers who will be the practitioners of science education should be aware of their knowledge, beliefs, attitudes and thoughts, determine their shortcomings and organize their instruction accordingly. In this regard, the current study investigating self-efficacy and learning strategies in pre-service teachers is important. In future research, it may be suggested to use different data collection tools such as observation and interview in order to conduct a more in-depth analysis of the factors that guide the development of pre-service teachers' self-efficacy and learning strategies. In this way, more detailed information can be obtained about the relationship between self-efficacy and learning strategies. One of the limitations of the current study is that it did not investigate whether the variables used in the study vary significantly depending on gender and grade level. Another study having a larger sample can investigate whether the variables vary significantly depending on gender and grade level.

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