



International Journal of Educational Methodology

Volume 8, Issue 4, 853 - 864.

ISSN: 2469-9632

<https://www.ijem.com/>

Examining the Primary School Teacher Candidates' Science Learning Skills in Terms of Their Attitudes Towards Science and Their Science Teaching Self-Efficacy Beliefs

Meryem Nur Aydede* 
Nigde Omer Halisdemir University,
TURKEY

Received: August 9, 2022 ▪ Revised: October 13, 2022 ▪ Accepted: November 23, 2022

Abstract: This study aims to investigate the relationship between the science learning skills of primary school teacher candidates and various variables. A correlational survey design was used in the study as a research methodology. With the correlational survey design, the relationships between the science learning skills of the primary school teacher candidates and some variables were examined and their effectiveness in predicting their science learning skills was determined. This study was conducted on 160 teacher candidates in the spring term of the 2019-2020 academic year. As a result of the study, a high level of correlation was found between the science learning skills of the primary school teacher candidates and their self-efficacy belief in science education. In addition, it was found that 38% of science learning skills were explained by attitudes and beliefs. In other words, it was seen that the affective characteristics of pre-service teachers about science significantly affected their science learning skills. In the light of these results, it is recommended to carry out studies in the education process to develop the necessary skills before considering the cognitive competencies of primary school teachers about science. They should also develop positive feelings towards science and gain the understanding that science is not a field of memorization, but a fun field necessary to make sense of the world.

Keywords: Attitudes towards science, science learning skills, self-efficacy belief, teacher candidates.

To cite this article: Aydede, M. N. (2022). Examining the primary school teacher candidates' science learning skills in terms of their attitudes towards science and their science teaching self-efficacy beliefs. *International Journal of Educational Methodology*, 8(4), 853-864. <https://doi.org/10.12973/ijem.8.4.853>

Introduction

It is necessary that a learner has certain skills to perceive specific information in science, to structure it, to transfer it in the form of meaningful structures to everyday life, and to put it into practice. On the other hand, a learner's attempting such an endeavor depends first of all on his interest and needs in that area, his ability to develop positive feelings and his being ready. In this case, it can be said that affective characteristics have positive effects in all types of learning in general, and in the science learning process in particular. For example, Suyatman et al. (2021) found that research-based learning method increased students' critical thinking skills. As all educators know, students who practice research-based learning should have scientific process skills and certain scientific attitudes and values. It can be said that all these skills, attitudes and values have positive effects on students' critical thinking skills by creating the necessary infrastructure. Similarly, in the study conducted by Aynas and Aslan (2021), it was determined that authentic learning practices significantly improved the problem-solving skills of the experimental group students and that authentic learning practices had a positive effect on students' attitudes towards science. It can be said that the authentic learning method, which is a teaching method that encourages students to research and question, creates opportunities for social discourse and provides students with sufficient resources to solve their problems, is important in terms of enabling students to acquire important skills on learning methods.

The three factors necessary for anything learned to cause a behavioral and mental change are cognitive elements, psycho-motor and mental skills, and affective characteristics. These factors are gathered under two headings in Bloom's complete learning model, shaped by Carroll's model of learning at school. These are cognitive entry behaviors and affective entry characteristics (Arseven, 1986).

* Correspondence:

Meryem Nur Aydede, Nigde Omer Halisdemir University, Faculty of Education, Nigde, Turkey. ✉ mnaydede@hotmail.com



Cognitive entry behaviors are the preliminary knowledge and skills necessary for learning to take place in a series of learning processes. On the other hand, effective entry characteristics refer to self-efficacy, which is characterized by attitudes and especially by academic self-confidence or academic self-representation (Senemoğlu, 2009). Although cognitive entry behaviors are more effective in efficient, meaningful and persistent learning, it is very important that effective entry characteristics act in a way to strengthen cognitive entry behaviors. To put it simply, these two structures support and complement each other.

The concept of self-efficacy is encompassed by the concept of self in terms of meaning. The concept of self is a sum of an individual's perceptions (Schunk, 2000), and is a form of perception of the person's own essence. In other words, it expresses the positive or negative perceptions that the individual has developed for his or her abilities and other personality traits. In this respect, it can be said that the concept of self-comprises components such as self-efficacy, self-esteem, and self-confidence. Self-efficacy sprouts from the concept of self-comprises a person's beliefs and judgments about how well he can plan, organize, manage and accomplish probable situations that he may face. The greatest feature of these beliefs is that it can be improved over time with the increasing experience gained about the situation (Lee, 2005).

Self-efficacy belief is based on Bandura's social learning theory, called the social cognitive theory. Bandura (1989) has defined self-efficacy as "opinions of people about their ability to control the events that affect their own lives." In other words, self-efficacy is a person's belief that "he is able to organize the actions necessary to manage probable situations and to perform these actions" (Bandura, 1997).

Individuals with strong self-efficacy beliefs do not try to escape from situations that are newly encountered and that have to be fought; and they exhibit a very decisive stance to successfully complete the actions they plan (Bandura, 1997). According to Bandura, self-efficacy beliefs have four fundamental sources: fundamental experiences, indirect experiences, verbal persuasion and the physiological/psychological state of an individual. Let us discuss these resources briefly (Bandura, 1982, 1989, 1994).

- Fundamental experiences: An achievement of an individual in a task is an indication that he will succeed in similar tasks.
- Indirect experiences: Observing the performance and success of other individuals in a task will give the individual the expectation of success in similar tasks.
- Verbal persuasion: Incentives for completing a task successfully will encourage the individual to do that task and cause positive changes in his self-efficacy.
- Physiological/psychological state: When an individual is about to act on a situation, if he feels well physically and emotionally, the likelihood of his taking that action will increase.

The most effective of the self-efficacy resources described above are fundamental experiences, as in the processes of learning by doing and by experiencing and acquiring first-hand experience (Bandura, 1994). The self-efficacy that an individual has about a situation influences his goals, his efforts to achieve the goals, his patience with the difficulties he faces, and his reactions to a possible future negative situation (Aşkar & Umay, 2001).

One of these specific areas is science education self-efficacy belief, and it has been defined as a judgment of teachers about their own ability to teach science effectively and efficiently and improve student success (Akbaş & Çelikkaleli, 2006). In the study conducted by Kılınc et al. (2021), it was found that teacher self-efficacy predicted teacher professional learning positively and significantly. This will also affect the teacher's belief that they can teach science effectively and efficiently and that they can improve student success.

Another effective entry characteristic, like self-efficacy, is attitudes. Attitude is a positive or negative emotional tendency developed by an individual for objects, people, places, events and ideas (Papanastasiou, 2002). The tendency of an individual to take a position at a point ranging from positive to negative towards a good, object, person or event, and to accept or reject a situation is called attitude (Fidan, 1985). Because the beliefs of individuals play an important role in the formation of their attitudes, they are also closely related to behaviors (Bandura, 1982). In other words, the trilateral interaction between attitudes, behavior and beliefs leads to the result that a change in attitudes will also result in a change in beliefs and behaviors. This conclusion emphasizes that any study of self-efficacy has to be associated with the subject of attitudes. This situation is supported by Lewitt (2002) who has claimed that "teachers' beliefs about teaching and learning enable them to develop an attitude"

The focus of this study is the concept of skills. Although skills differ in general as psychomotor and mental skills, the ones that are covered by cognitive entry behaviors are mental skills. Another component in cognitive entry behaviors is the preliminary learning that is specific to subjects or units (Senemoğlu, 2009). Skills are traits obtained through education or experience, and they are often both learned and developed. Skills are needed because they are necessary to access information and to question the information being accessed. In other words, scientific knowledge is structured in ways that constitute a skill domain and are required for accessing and questioning information. In this case, domains of knowledge and skills can be said to affect each other mutually and positively. Skills in science appear

to be the types of skills that are for information retrieval and problem-solving, such as scientific process skills. They also appear to be skills of inquiry and suggesting solutions, such as argument skills (Aydođdu, 2014).

When the elements expressed above are examined from a scientific perspective, scientific knowledge and pre-learning in science, science-related skills, and science-related attitudes and self-efficacy can be argued to be prominent. These concepts, which are prominent, are in fact also among the key components of science literacy. Science literacy is expressed in the form of knowledge of scientific concepts and theories, and scientific research methods; understanding the science-technology-community relationship; the ability to use what is learned theoretically in school in problem-solving and decision making in daily life; the ability to write, read and think over science-related articles, journals and books; the ability to participate in scientific discussions and explain one's own ideas; the ability to interpret the rhetoric of others; the ability to think neutrally, critically and creatively; and having the knowledge and skills needed (Çepni et al., 2003).

Science literacy means to be able to produce solutions to problems in science, in particular, by using scientific methods, and beyond that, it means that the individual is responsible to himself and society (Terzi, 2008). Simply put, cognitive, affective and skill-based dimensions are included in science literacy, which is the ultimate goal of science education (Kaptan, 1999). In this way, an individual who becomes a science literate can easily access the information in this field and produce solutions by questioning; he develops positive attitudes and self-efficacy by displaying a desire, needs and interest in order to make an effort in this field; he also transforms scientific knowledge into a meaningful whole in his mind and makes it permanent by transferring it to life (Scholes et al., 2021).

From this viewpoint, science learning skills that constitute the basis of this study involve skills such as accessing information in science, questioning it, suggesting solutions to the problems encountered, informing and persuading other people about it, and developing new insights into their own life. In terms of the significance of the study, it is necessary to emphasize that in this study, it was determined at what level and how much science learning skills - which are so important in knowledge in science - were influenced by affective characteristics such as attitudes and self-efficacy.

The general purpose of the study expressed in the light of this significance was "to reveal the relationship between the science learning skills of pre-service elementary school teachers and their self-efficacy beliefs and attitudes towards science education." In line with this purpose, answers to the following questions were sought:

1. What are the levels of pre-service teachers' science learning skills, attitudes towards science, and science education self-efficacy beliefs?
2. Is there a significant relationship between pre-service teachers' science learning skills, attitudes towards science and science education self-efficacy beliefs?
3. Are pre-service teachers' attitudes towards science and science education self-efficacy beliefs a significant predictor of their science learning skills?

Methodology

Research Design

The study was structured as a correlational survey design, which is one of the general survey designs of quantitative approaches. Survey designs describe a current or past situation how it is. On the other hand, in the correlational survey design, which is one of the general survey designs, it is intended to determine the presence and/or degree of concomitant change among two or more variables (Karasar, 2000).

Participants

The participant group of the study consisted of a total of 160 freshmen, sophomore, junior, and senior students who were studying at the 4-year elementary education department of a state university in Turkey in the 2019-2020 academic year. Table 1 presents the distributions of the participants constituting the sample, based on their gender and grade levels.

Table 1. Distribution of Participants According to Their Gender and Grade Levels

		1st Grades	2nd Grades	3rd Grades	4th Grades	N
Female	f	24	27	29	26	106
	%	22.64	25.47	27.36	24.53	66.25
Male	f	16	13	11	14	54
	%	29.63	24.07	20.37	25.93	33.75
N	f	40	40	40	40	160
	%	25	25	25	25	100

According to the results in Table 1, 66.25% of the pre-service elementary school teachers were female, 33.75% were male. On the other hand, there were 25% of the participants at each grade level.

Data Collection Instruments

Three different data collection instruments were used in this study. These were the "Science Learning Skills Scale (SLSS)," the "Science Education Self-Efficacy Belief Scale (SESEBS)," and the "Science Attitudes Scale (SAS)." The permissions for the use of these scales were received by e-mail. The validity and reliability studies were redone. The results are listed below.

Science Learning Skills Scale

SLSS was developed by Chang et al. (2011) as a scale consisting of 29 items and 2 sub-scales. It was adapted to Turkish; validity and reliability studies were carried out by Şenler (2014). As a result of these studies, the scale again consisted of 29 items and 2 sub-scales. Then, the researcher redid the validity of the reliability studies by administering SLSS to 80 pre-service elementary school teachers who were not included in the sample. The results are given below.

The KMO and Bartlett test results were investigated to determine if SLSS was suitable for factor analysis required for validity studies. For the implementation of factor analysis on a scale, the result of the KMO test measurement should be .50 and above, and the result of the Bartlett test of sphericity should show a significance of $p < .01$ (Jeong, 2004). In this study, the KMO test measurement result for SLSS was found to be .723, and the result of the Bartlett test of sphericity showed significance ($p < .01$). These results show that factor analysis can be performed on the scale. In factor analysis, the lower limit of each item was accepted as .30. As a result, all 29 items of the scale remained in the scale. The factor communality values of the scale were between .523 and .768. After this phase, the factor load values were calculated by using the varimax rotation technique in the factor analysis. In the end, it was determined that the SLSS was again composed of 2 sub-scales, as in the original scale. The first sub-scale (scientific inquiry) consists of 14 items and explains 35.627% of the total variance of the scale. The second sub-scale (communication) consists of 15 items and explains 28.229% of the total variance of the scale. All sub-scales in the scale describe 63.856% of the total variance of the scale. The factor loads of the 29 items in the scale range from .395 to .849. Kline (1994, as cited in Ekici, 2002) has defined factor loadings between .3 and .6 as "medium," and factor loadings above .6 as "high" as a criterion, and indicated 41% as a reference rate for total variance explained in a scale. Based on the amount of total variance explained and item factor loading values, it can be concluded that the 29 items in the scale can remain in the scale.

During the reliability studies of the scale, the Cronbach's alpha coefficient was checked, and this coefficient was calculated as .893 for the overall scale, and .821 for the first sub-scale, and .825 for the second sub-scale. Tezbaşaran (1997) has indicated that a reliability coefficient on a Likert-type scale that can be considered sufficient should be as close to 1 as possible. These results show that SLSS can measure the science learning skills of pre-service elementary school teachers in a consistent and reliable way within the specified factor structure.

Science Education Self-Efficacy Belief Scale

SESEBS was developed as a scale consisting of 23 items and 2 dimensions by Enochs and Riggs (1990). This scale was adapted to Turkish by Bıkmaz (2002), tested for validity and reliability, and reduced to 21 items in 2 dimensions, after the exclusion of 2 items. Then, the researcher redid the validity of the reliability studies by administering SESEBS to 80 pre-service elementary school teachers who were not included in the sample. The results are given below.

The result of the KMO test measurement of SESEBS was found to be .723, the result of the Bartlett test of sphericity was significant ($p < .01$), and the scale was determined to be suitable for factor analysis. On the other hand, the lower limit of each item was again accepted as .30. As a result of statistical analyses, 3 of the 21 items on the scale were removed from the scale, and the scale was reduced to 18 items. Moreover, the factor communality values of the scale were between .145 and .703. The factor loading values calculated as a result of the Varimax rotation technique revealed that SESEBS was again composed of 2 dimensions, as in the original scale. Accordingly, the first factor (self-efficacy belief) consists of 12 items and explains 28.147% of the total variance of the scale, while the second factor (outcome expectation) consists of 6 items and explains 12.942% of the total variance of the scale. All the factors in the scale constitute 41.089% of the total variance of the scale. The factor loads of the 18 items remaining in the scale range from .318 to .814. This indicates that the 18 items in the scale are suitable for staying in the scale.

Cronbach's alpha coefficient indicating the reliability of the scale was calculated as .768 overall for the scale, as .856 for the first dimension and .722 for the second dimension. All these results show that SESEBS can measure self-efficacy beliefs developed by pre-service elementary school teachers towards science education in a consistent and reliable way within the specified factor structure.

Science Attitudes Scale

SAS was developed by Gürdal (1997) as a scale consisting of 23 items. The researcher redid the validity of the reliability studies by administering SAS to 80 pre-service elementary school teachers who were not included in the sample.

Accordingly, the result of the KMO test measurement of SAS was found to be .837, the result of the Bartlett test of sphericity was significant ($p < .01$), and the scale was found to be suitable for factor analysis. Moreover, the lower limit of each item was again accepted as .30, and 8 of the 23 items in the scale were decided to be excluded from the scale. On the other hand, the factor communalities values of the scale were between .348 and .695. The Varimax rotation technique applied later on showed that SAS consisted of 3 dimensions, and the first factor with 6 items (love), the second factor with 5 items (interest), and the third factor with 4 items (significance) explained 21.389%, 17.1%, and 13.725% of the variance, respectively. All factors explain 52.214% of the total variance. The factor loads of the 15 items remaining in the scale range from .425 to .8. This result reveals that the 15 items in the scale are suitable for staying in the scale.

Cronbach's alpha coefficient calculated for the scale was .856 overall for the scale, .826 for the first dimension, .705 for the second dimension, and .617 for the third dimension. All analyses carried out for SAS reveal that the scale can measure the attitudes developed by the pre-service elementary school teachers towards science in a consistent and reliable way within the specified factor structure.

Procedures and Data Analysis

The research data were obtained by the researcher, by concurrently administering the three different measurement instruments mentioned above to the participants in the spring semester of the 2019–2020 academic year. Moreover, the explanations necessary for participation were made to the teachers who participated in the applications on a voluntary basis before the applications.

The data obtained from the measurement instruments were recorded with the SPSS-24 statistical program, and the required analyses were carried out. First of all, the Kolmogorov-Smirnov test was carried out in order to test the normality of the data distributions. It was found that the variables were normally distributed with 95% confidence. Table 2 shows the results.

Table 2. Data Skewness, Kurtosis and Normality Values

Scales	Skewness		Kurtosis		Kolmogorov-Smirnov		
	Statistic	Std. Error	Statistic	Std. Error	Statistic	df	p
SLSS	-0.187	0.192	0.746	0.381	0.058	160	0.200
SAS	-0.277	0.192	-0.047	0.381	0.055	160	0.200
SESEBS	-0.335	0.192	0.655	0.381	0.066	160	0.084

According to Table 2, the skewness and kurtosis values were calculated as -0.97 and 1.96 for SLSS ($p > .05$), -1.74 and 1.72 for SESEBS ($p > .05$), and -1.44 and -0.12 for SAS, respectively. In the light of these results, it was decided to use parametric tests. Thus, frequencies and percentages were used during the analysis of the first sub-problem, correlations during the analysis of the second sub-problem, and regressions during the analysis of the third sub-problem.

In addition, Harman single factor analysis was used to determine the common method bias of the scales used in the research. In the analysis made for the Science Learning Skills Scale, the common method bias value was found as .42, for the Science Education Self-Efficacy Belief Scale it was found as .36, and for the Science Attitude Scale it was found as .32. Since these values were below .50, it was decided that there was no problem of common method bias in the data obtained, and the analyzes were continued (Podsakoff et al., 2003).

Results

The study was conducted through three sub-problems, and the analysis results of the data on the sub-problems were expressed in the following order.

Findings on the first sub-problem

Table 3 presents the findings based on the analysis of the data of the first sub-problem in the study.

Table 3. Results of Descriptive Statistics on the SLSS, SAS and SESEBS Scores

Scales	N	Min.	Max.	M	SD
SLSS	160	68	141	109.54	12.29
SAS	160	31	74	54.99	8.04
SESEBS	160	40	81	66.5	6.81

According to Table 3, mean and standard deviation scores of a total of 160 pre-service teachers were determined to be 109.54 and 12.29 for the Science Learning Skills Scale, 54.99 and 8.04 for the Science Attitudes Scale, and 66.5 and 6.81 for the Science Education Self-Efficacy Belief Scale, respectively.

While the highest value can score on the Science Learning Skills Scale is 145, this value is 90 on the Science Education Self-Efficacy Belief Scale and 75 on the Science Attitudes Scale. Considering the overall mean scores of the participants for each scale in Table 3, it can be said that the science learning skills, self-efficacy beliefs and attitudes of the pre-service teachers were quite above the average. When these three scales were assessed together, the highest mean score was on science learning skills. It can also be said that the participants' science learning skills were at a higher level compared to their science education self-sufficiency beliefs and their attitudes towards science.

Findings on the Second Sub-Problem

Table 4 shows the findings arising from the analysis results of the second sub-problem.

Table 4. Correlation Coefficient Results for the Relationship Between the Pre-Service Teachers' Science Learning Skills, Attitudes Towards Science, And Science Education Self-Efficacy Beliefs

Variables	Science Learning Skills	Science Attitudes	Science Education Self-Efficacy Belief
Science Learning Skills	1	.520*	.550*
Science Attitudes	.520*	1	.509*
Science Education Self-Efficacy Belief	.550*	.509*	1

* p < .05

Table 4 shows that there was a moderate positive and significant correlation (R = .55) between the pre-service teachers' science learning skills and science education self-efficacy beliefs. Table 4 also shows a moderate positive correlation (R = .52) between their science learning skills and attitudes towards science. This revealed that as the participants' attitudes towards science got better and their science education self-efficacy beliefs got stronger, their science learning skills got better. In other words, the science learning skills of the pre-service teachers were influenced by the affective characteristics they developed towards the fields of science.

The relationship expressed above was found to be moderate, positive and significant between the beliefs and attitudes of the specified variables of the affective domain (R = .509). This suggests that there is also a relationship between the variables of the affective domain. It also suggests that as beliefs get stronger, attitudes get better.

Findings on the Third Sub-Problem

Table 5 presents the findings based on the analysis of the data of the third sub-problem in the study.

Table 5. Multiple Regression Analysis Results on the Prediction of the Pre-Service Teachers' Science Learning Skills

Variables	B	Std. Error	β	t	p	Zero-Order R	Partial R
Constant	36.085	7.765	-	4.647	.000	-	-
Science Attitudes	.495	.112	.324	4.436	.000	.520	.334
Science Education Self-Efficacy Belief	.695	.132	.385	5.275	.000	.550	.388
R = .617				R ² = .38			
F (2, 157) = 48.154				p = .000			

According to Table 5, the "attitudes towards science" and "science education self-efficacy beliefs" variables together significantly explained science learning skill scores of the pre-service teachers (R = .617, R² = .38, p < .05). The two variables described above together explained about 38% of the total variance in science learning skills.

According to the standardized regression coefficient (β), the variables predicting science learning skills in relative order of importance were self-efficacy belief and attitudes. When the t-test results for the significance of regression coefficients were examined, the belief (t = 5.275) and attitudes (t = 4.436) variables were significant predictors of the science learning skills.

On the other hand, according to the results of regression analysis, the regression equation for predicting science learning skill scores (mathematical model) can be expressed as 'science learning skills = 36.085 + 0.695 science education self-efficacy belief + 0.495 attitudes towards science.'

Discussion

The main goal of this study, the participants of which were chosen as pre-service elementary school teachers, was to determine the relationship between the science learning skills of the pre-service teachers and their self-efficacy beliefs

and attitudes towards science education. For this reason, the results obtained at the end of the research process which was planned and executed according to the correlational survey design can be summarized as follows:

All of the pre-service teachers who were included in the participant group had above the average science learning skills, science education self-efficacy beliefs and attitudes towards science. Moderate, positive and significant correlations were found between the pre-service teachers' science learning skills and science education self-sufficiency beliefs, between their science learning skills and attitudes towards science, and between their science education self-efficacy beliefs and attitudes towards science. On the other hand, the strongest of these relations was between skills and beliefs with $R = .55$.

About 38% of the total variance of the pre-service teachers' science learning skills were explained by their attitudes towards science and science education self-efficacy beliefs. On the other hand, beliefs and attitudes were identified as a significant predictor of science learning skills. Moreover, beliefs emerged to be a more significant predictor of skills than attitudes.

It is known that what is important in science education today is to educate individuals each to become a science-literate person. On the other hand, it is also necessary to mention that the basis of science education curricula in advanced educational systems is the inquiry-based constructivist learning approach, which allows to achieve this goal in the most successful way. This situation mentioned above has gained a foothold in the 2005 elementary science and technology curriculum in Turkey. The changes in science curricula in the subsequent years have witnessed positive developments in terms of making the ultimate goal of science education possible.

In the 2005 science course curriculum, science literacy was defined as "a combination of science-related skills, attitudes, values, understanding and knowledge that are necessary for individuals to develop research/inquiry, critical thinking, problem-solving and decision-making skills, become lifelong learners, and pursue a sense of curiosity about their environment and the world" (MEB, 2005). When this definition is examined, certain affective characteristics and cognitive structures were addressed together, especially in different skill areas. It can also be said that the specified areas are not independent of each other and even complement each other. Martin (1996) has defined the three dimensions of science literacy as scientific content, skills required for the scientific process, and attitudes towards the field of science, supporting this situation.

The main component of this study, science learning skills, in fact contains many dimensions of the skills domain in science literacy. Problem-solving skills, research skills, argumentation skills, and decision-making and communication skills, especially scientific process skills, can be shown as examples of these dimensions. For this reason, science learning skills and scientific process skills and inquiry/argumentation skills are used interchangeably. This use is not wrong in reality in terms of meaning and understanding.

The result that the science learning skills of the pre-service teachers were above average is also supported by certain researchers. Aslan-Efe and Özmen (2018), for example, have stated that students' science learning skills are generally high, and female students' science learning skills are significantly higher than those of male students. Sinan and Uşak (2011) have carried out a study on pre-service teachers and found that scientific process skills of their participants are very high. On the other hand, there are also studies that do not support this result being expressed (Aktaş & Ceylan, 2016; Güden & Timur, 2016; Huyugüzel-Çavaş, 2009).

There are also a number of research findings that have provided a different perspective on the first outcome of this study, which was conducted on pre-service elementary school students. For example, in the study of Terzi (2008) on science teachers and elementary school teachers, the science teachers' science literacy was higher than that of elementary school teachers. In the study of Birinci-Konur and Yıldırım (2016) on pre-service science and elementary school teachers, the science teachers gave a greater number of correct answers on the scientific process skills test compared to the pre-service elementary school teachers. These two results show that teachers and pre-service teachers in science are more qualified than elementary school teachers and pre-service teachers on science learning skills.

There are also a number of research studies related to the result of this study that the pre-service teachers' science education self-efficacy beliefs and their attitudes towards science are above average. In terms of self-efficacy, Küçükyılmaz and Duban (2009) and Seven and Akıllı (2009) have determined that the self-efficacy beliefs of pre-service teachers are adequate, whereas Ültay and Uludüz (2018) have suggested that these beliefs were found to be at a fairly low level in pre-service elementary school teachers. In terms of attitudes, Ürey and Cerrah-Özsevgeç (2015) have pointed out that pre-service elementary school teachers' attitudes towards science are far above average. Although the results of the research presented have similarities with the results of this study related to self-efficacy belief and attitudes, they also show that there are also contradicting results.

Another result that was obtained throughout the research process was that there was a moderate and positive correlation between science learning skills and science education self-efficacy belief. This result is supported by Uyanık's (2016) result that "performance in science learning is related to science education self-efficacy beliefs" and Çalışkan's (2008) result that "students with higher self-efficacy perception show better performance in science.

Another moderate and positive relationship exists between science learning skills and attitudes towards science. There are studies supporting (Akpullukçu & Günay, 2013; Gençtürk & Türkmen, 2007; Saracaloğlu et al., 2013; Tatar, 2006; Ulutaş, 2009), and not supporting (Anagün, 2011; Bybee & McCrae, 2011) the relationship between these two variables. For example, Ulutaş (2009) has determined a positive relationship between pre-service teachers' science literacy levels and attitudes towards science, while Saracaloğlu et al. (2013) have found a moderate, positive and significant correlation between pre-service teachers' science literacy and attitudes towards science. On the other hand, Uyanık-Balat et al. (2018) have determined that there is a positive but weak relationship between pre-service teachers' attitudes towards science education and self-efficacy perceptions, whereas Anagün (2011) has stated that science attitudes have no effect on science literacy.

The last situation, which shows moderate and positive relationship, emerged between the self-efficacy belief and attitudes, of which the effect on science learning skills was investigated. This result is in line with the research results of Yıldız-Duban and Gökçakan (2012). The result of Yıldız-Duban and Gökçakan (2012) - which indicates that there is a positive, moderate and significant relationship between pre-service elementary school teachers' self-efficacy beliefs towards science education and their attitudes towards science ($R = .603$) - supports the correlation coefficient ($R = .509$) between the two variables obtained in the present study. The conformance between these two studies becomes meaningful when Moseley and Utley's (2006) statement is considered: Improving the science self-efficacy beliefs of those who take a new step in the teaching profession is a prerequisite for their positive attitudes towards science.

In addition, there are studies conducted abroad on pre-service teachers' science learning skills. In the study, Dwikoranto et al. (2019) concluded that the project-based learning method is effective on the science process skills of physics teacher candidates (the scientific process skill mentioned above can be attributed as a learning skill). Limatahu et al. (2019), one of them, examined the effect of the condition, construction, development, simulation, and reflection model on the science process skills of physics teacher candidates. As a result of the Limatahu et al. (2019) study, it has been proven that this model is effective in improving the science process skills of physics teacher candidates. Samosir (2022), on the other hand, found that the Process-Oriented Inquiry learning model had an effect on students' understanding of science concepts and their scientific process skills. Syazali et al. (2021), on the other hand, found 7 variables as a result of his study on the learning environment variables that affect the Science Process Skills of Indonesian students. These variables are guided inquiry learning models, inquiry, PBL, PjBL and learning cycles, as well as learning media variables and modules and worksheets. In addition, Aripin et al. (2021) found that learning through inquiry had a moderate effect on students' science learning skills ($p=.63$)

Conclusion

From an integrative perspective to all research results based on the literature given above, it can be said that especially pre-service teachers have different levels of competence in terms of the variables of skills, self-efficacy and attitudes. It can also be said that pre-service science teachers are more qualified than pre-service elementary school teachers especially in terms of science literacy and science learning skills, which is the most important pillar of science literacy. For the reasons specified above, in this study carried out on pre-service elementary school teachers, one of the results was that the science learning skills, self-efficacy and attitudes of the pre-service teachers were above the average, and this contributes to other research results.

When the results in the literature examining the relationship between skills and affective characteristics on the basis of science literacy are examined together, it is seen that pre-service teachers with an adequate level of science education self-efficacy beliefs demonstrate superior success in activities carried out based on skills specific to science and performances exhibited. The highest correlation coefficient was achieved between science learning skills and science education self-sufficiency beliefs also in this study, which can be defined as a result that is supported by the literature and contributes to the relevant field. Therefore, in the process of developing science literacy, studies to improve self-efficacy belief, which is one of the affective characteristics of pre-service teachers, will contribute positively to their skills necessary for them to learn science more meaningfully and persistently.

A situation similar to the one that arises between skills and beliefs is experienced between skills and attitudes. However, there are different literature results regarding the contribution of science attitudes towards pre-service teachers' science learning skills and science literacy. In other words, the relationship between skills and attitudes is becoming a more controversial subject than the relationship between skills and self-efficacy. In this study, in terms of a correlational relationship, attitude comes after self-efficacy, which is in line with literature-based research results.

In conclusion, science learning skills, which are an important component in the process of improving pre-service teachers' science literacy, are influenced by the positive self-sufficiency belief and attitudes that they have developed for this field, which cannot be ignored as a result. In other words, it is necessary to address affective characteristics together with skills in the process of developing science literacy. In fact, it is necessary to prioritize studies that will positively affect affective characteristics. On the other hand, the characteristics of the affective domain also affect each other in their own right, which is confirmed by the relationship between beliefs and attitudes emerging from this study as well as the results of studies on this subject in the literature.

The most important outcome of the present study is that the pre-service teachers' science teaching self-efficacy beliefs and attitudes towards science together have a 38% effect on their science learning skills. Although there are no studies on the prediction of science learning skills by different variables in the relevant literature, it can be argued that the results of the research conducted based on the relationship between skills, beliefs and attitudes support this result.

The 38% level of prediction mentioned above clearly points out that in the process of educating an elementary school teacher, the characteristics of the affective domain have to be handled first in order for pre-service teachers to be science literates. This is because positive affective characteristics will increase interest in science; the increased interest will stimulate all types of skills that make one more dominant in this field; and ultimately characteristics of the affective domain and dimensions of the skills domain will join field-specific scientific information structures and will lead to the formation of science literate pre-service teachers who are researchers, inquirers and critics. Moreover, it will become easier for pre-service elementary school teachers with this background to make their students - whom they will train throughout their professional lives - science literate individuals. Thus, the change will start at the bottom; and students will be educated in the current educational system, who are more successful and more skillful in the field and subjects of science, and, most importantly, who consider this field as indispensable and have positive feelings about this field in order to become a citizen of the world.

Recommendations

In light of all the results obtained from the present study, it can be said that important implications have emerged for teaching staff working in higher education institutions who educate elementary school teachers of the future. That is to say, it is necessary that especially the teaching staff who teach the Basic Science in Elementary School, the Science Laboratory Practices, the Science Education, and even the Teaching Practice courses - related to the fields of science in the elementary school teacher education curriculum that was renewed in 2018 in Turkey - should guide pre-service teachers in order for them to have positive attitudes towards the field of science and show interest in this field. By giving them the skills to access information and to test the information they access, it is also important that the teaching staff educate themselves to become guides in the process of accessing information.

In other words, it can be brought as a suggestion to relevant academicians to become modern instructors who adopt the essence of constructivist understanding and science literacy, equip pre-service teachers with the dimensions of affective domain and skills domain in science, and make it easier for them to access information - instead of being a classic teaching staff who transfers information and questions the information transferred.

Another suggestion that is similar to the one given above is for elementary school teachers who currently work as a teacher. The adoption of the instructional approach - described above for university teaching staff - by elementary school teachers will ensure that students show interest in the fields of science from elementary school on, and success will come along. This attitude assumed by elementary school teachers should also be maintained by science teachers at upper educational levels.

It should be remembered that a student who adopts the thinking and working principles of a scientist from elementary school on will become a small scientist. Thus, individuals will make significant contributions to science and the development of the country in their adulthood.

In the light of the findings obtained as a result of this research, future researchers can investigate the effects of different affective domain characteristics on students' learning skills (motivation, career perception, self-perception, etc.). In addition, science learning skills of science, biology, chemistry and physics teacher candidates are other areas that should be investigated by the future researched.

Limitations

This study was carried out in the 2019-2020 academic year. As the study group, it is limited to 160 classroom teacher candidates studying in the 1st, 2nd, 3rd and 4th grades. In terms of data collection tool, the study is limited to Science Learning Skills Scale, Science Education Self-Efficacy Belief Scale and Science Attitude Scale.

References

- Akbaş, A., & Çelikkaleli, Ö. (2006). Sınıf öğretmeni adaylarının fen öğretimi özyeterlik inançlarının cinsiyet, öğrenim türü ve üniversitelerine göre incelenmesi [The examination of elementary pre-service teachers' self-efficacy beliefs in science teaching in terms of gender education type and universities]. *Mersin University Journal of the Faculty of Education/Mersin Üniversitesi Eğitim Fakültesi Dergisi*, 2(1), 98-110. <https://cutt.ly/ZM86mdo>
- Akpullukçu, S., & Günay, Y. (2013). Fen ve Teknoloji dersinde araştırmaya dayalı öğrenme ortamının öğrencilerin akademik başarı, hatırd tutma düzeyi ve tutumlarına etkisi [The effect of inquiry based learning environment in science and technology course on the students' academic achievements, attitudes and retention level]. *Ege Journal of Education/Ege Eğitim Dergisi*, 14(1), 67-89. <https://cutt.ly/kM86Tnk>

- Aktaş, İ., & Ceylan, E. (2016). Fen bilgisi öğretmen adaylarının bilimsel süreç beceri düzeylerinin belirlenmesi ve akademik başarıyla ilişki düzeyinin incelenmesi [Determination of pre-service science teachers' science process skills and investigating of relationship with general academic achievement]. *Mustafa Kemal University Journal of Social Sciences Institute*, 13(33), 123-136. <https://cutt.ly/ZM8616h>
- Anagün, Ş. S. (2011). PISA 2006 sonuçlarına göre öğretme-öğrenme süreci değişkenlerinin öğrencilerin fen okuryazarlıklarına etkisi [The impact of teaching-learning process variables to the students' scientific literacy levels based on PISA 2006 results]. *Education and Science/Eğitim ve Bilim*, 36(162), 84-102. <https://bit.ly/anagun2006>
- Aripin, I., Hidayat, T., Rustaman, N., & Riandi, R. (2021). The effectiveness of science learning research skills: A meta-analysis study. *Scientiae Educatia: Jurnal Pendidikan Sains*, 10(1), 40-47 <https://doi.org/jm9q>
- Arseven, A. D. (1986). Benlik tasarımı [The self-design]. *Hacettepe University Journal of Education/Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 1, 15-26. <https://bit.ly/arseven>
- Aşkar, P., & Umay, A. (2001). İlköğretim matematik öğretmenliği öğrencilerinin bilgisayarla ilgili öz-yeterlik algısı [Perceived computer self-efficacy of the students in the elementary mathematics teaching programme]. *Hacettepe University Journal of Education/Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 21, 1-8. <http://bit.ly/3ESDrli>
- Aslan-Efe, H., & Özmen, S. (2018). Examining secondary school students' competencies for learning science. *Journal of Computer and Education Research*, 6(11), 88-105. <https://doi.org/10.18009/jcer.376953>
- Aydoğdu, B. (2014). Science process skills. In Ş. S. Anagün & N. Duban (Eds.), *Science Teaching* (pp. 87-113). Anı Publishing.
- Aynas, N., & Aslan, M. (2021). The effects of authentic learning practices on problem-solving skills and attitude towards science courses. *Journal of Learning for Development*, 8(1), 146-161. <https://doi.org/10.56059/jl4d.v8i1.482>
- Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, 37(2), 122-147. <https://doi.org/10.1037/0003-066X.37.2.122>
- Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, 44(9), 1175-1184. <https://doi.org/10.1037/0003-066x.44.9.1175>
- Bandura, A. (1994). Self-efficacy. In V. S. Ramachandran (Ed.), *Encyclopedia of Human Behavior* (pp. 71-81). Academic Press.
- Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. Freeman.
- Bıkmaz, F. H. (2002). Self-efficacy belief instrument in science teaching. *Educational Sciences and Practice*, 1(2), 197-210. <https://cutt.ly/FM86Fu1>
- Birinci-Konur, K., & Yıldırım, N. (2016). Pre-service science and primary school teachers' identification of scientific process skills. *Universal Journal of Educational Research*, 4(6), 1273-1281. <https://doi.org/10.13189/ujer.2016.040604>
- Bybee, R., & McCrae, B. (2011). Scientific literacy and student attitudes: Perspectives from PISA 2006 science. *International Journal of Science Education*, 33(1), 7-26. <https://doi.org/10.1080/09500693.2010.518644>
- Chang, H. P., Chen, C. C., Guo, G. J., Cheng, Y. J., Lin, C. Y., & Jen, T. H. (2011). The development of a competence scale for learning science: Inquiry and communication. *International Journal of Science and Mathematics Education*, 9(5), 1213-1233. <https://cutt.ly/YM86Ve2>
- Çalışkan, H. (2008). *İlköğretim 7. sınıf Sosyal Bilgiler dersinde araştırmaya dayalı öğrenme yaklaşımının derse yönelik tutuma, akademik başarıya ve kalıcılık düzeyine etkisi* [The effect of inquiry-based learning approaches in 7th grade social studies course in primary school on attitude towards course, academic achievement and the degrees of retention] [Doctoral dissertation, University of Gazi]. Turkish Council of Higher Education National Thesis Center. <https://bit.ly/dissertation-caliskan>
- Çepni, S., Bacanak, A., & Küçük, M. (2003). Fen eğitiminin amaçlarında değişen değerler: Fen - teknoloji - toplum [Changing values in the goals of science education: Science-technology-society]. *Journal of Values Education/Değerler Eğitimi Dergisi*, 1(4), 7-29. <https://cutt.ly/QM86KHP>
- Dwikoranto, D., Madlazim, M., & Erman, E. (2019). Project based laboratory learning as an alternative learning model to improve sciences process skills and creativity of physics teacher candidate. *Journal of Physics: Conference Series*, 1387, 012074. <https://doi.org/jm9r>
- Ekici, G. (2002). Biyoloji Öğretmenlerinin Laboratuvar Dersine Yönelik Tutum Ölçeği (BÖLDYTÖ) [Biology Teachers' Attitude Scale Toward Laboratory Lessons]. *Hacettepe University Journal of Education/Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 22, 62-66. <https://cutt.ly/kM4qwQP>

- Enochs, L. G., & Riggs, I. M. (1990). Further development of an elementary science teaching efficacy belief instrument: A pre-service elementary scale. *School Science and Mathematics*, 90(8), 694-706. <https://doi.org/d84rp5>
- Fidan, N. (1985). *Okulda öğrenme ve öğretme* [Learning and teaching at the school]. Alkım Publishing.
- Gençtürk, H. A., & Türkmen, L. (2007). İlköğretim 4. Sınıf Fen Bilgisi dersinde sorgulama yöntemi ve etkinliği üzerine bir çalışma [A study of effectiveness and application of inquiry method in a 4th grade science course]. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi*, 27(1), 277-292. <https://cutt.ly/TM4qu53>
- Güden, C., & Timur, B. (2016). Ortaokul öğrencilerinin bilimsel süreç becerilerinin incelenmesi (Çanakkale örneği) [Examining secondary school students' cognitive process skills (Çanakkale sample)]. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, 16(1), 163-182. <https://bit.ly/guden-timur>
- Gürdal, A. (1997). Sınıf öğretmenliği öğrencilerinin fene karşı tutumları ve fen öğretiminde entegrasyonun önemi [Primary school students' attitudes toward science and importance of integration in science teaching]. *Marmara University Atatürk Education Faculty Journal of Educational Sciences*, 9, 237-253. <https://cutt.ly/nM4qsOe>
- Huyugüzel-Çavaş, P. (2009). *Sınıf öğretmenlerinin fen ve teknoloji okuryazarlıkları ile öğretim yeterliklerinin belirlenmesi* [The investigation of elementary teachers' Science and technology literacy and their competence in science teaching] [Doctoral dissertation, University of Dokuz Eylül]. Dokuz Eylül Üniversitesi Kurumsal Akademik Açık Arşivi. <http://hdl.handle.net/20.500.12397/6832>
- Jeong, J. (2004). *Analysis of the factors and the roles of hrd in organizational learning styles as identified by key informants at selected corporations in the republic of Korea* [Master's thesis, University of Texas A&M]. Texas A&M University Libraries. <https://bit.ly/thesis-jeong>
- Kaptan, F. (1999). *Fen öğretimi* [Science teaching] (3rd ed.). Milli Eğitim Basımevi.
- Karasar, N. (2000). *Bilimsel araştırma yöntemi* [Scientific research method]. Nobel Publishing and Distribution.
- Kılınç, Ç. A., Polatcan, M., Atmaca, T., & Koşar, M. (2021). Öğretmen mesleki öğrenmesinin yordayıcıları olarak öğretmen öz yeterliği ve bireysel akademik iyimserlik: Bir yapısal eşitlik modellemesi [Teacher self-efficacy and individual academic optimism as predictors of teacher professional learning: A structural equation modeling]. *Education and Science*, 46(205), 373-394. <https://doi.org/10.15390/EB.2020.8966>
- Küçükyılmaz, E. A., & Duban, N. (2009). Primary teacher candidates' science teaching self-efficacy beliefs and their opinions regarding to the effective factors of self-efficacy beliefs. *E-Journal of New World Sciences Academy*, 4(1), 71-83. <https://cutt.ly/ZM4qjFp>
- Lee, S. W. (2005). *Encyclopedia of school psychology*. Sage Publication.
- Lewitt, K. E. (2002). An analysis of elementary teachers' beliefs regarding the teaching and learning of science. *Science Education*, 86(1), 1-22. <https://doi.org/10.1002/sc.1042>
- Limatahu, I., Sutoyo, S., Wasis, W., Prahani, B. K., & Alfin, J. (2019). Improving science process skills learning ability of physics teacher candidates through the implementation of CCDSR learning model. *Journal of Physics: Conference Series*, 1171, Article 012005. <https://doi.org/jm9h>
- Martin, D. J. (1996). *Elementary science methods: A constructivist approach*. Delmar Publishes.
- Milli Eğitim Bakanlığı (MEB) [Ministry of National Education]. (2005). *Primary School Science Course Curriculum*. The Board of Education within the Republic of Turkey. www.meb.gov.tr
- Moseley, C., & Utley, J. (2006). The effect of an integrated science and mathematics content-based course on science and mathematics teaching efficacy of pre-service elementary teaching. *Journal of Elementary Science Education*, 18(2), 1-12. <https://doi.org/10.1007/BF03174684>
- Papanastasiou, C. (2002). School, teaching and family influence on student attitudes toward science: Based on TIMSS data for Cyprus. *Studies in Educational Evaluation*, 28(1), 71-86. <https://doi.org/cjb437>
- Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879-903. <https://doi.org/10.1037/0021-9010.88.5.879>
- Samosir, B. (2022). Implementation of process oriented guided inquiry learning model learning (POGIL) on understanding of science concepts, skills science process and student's critical thinking ability. *International Journal of Multidisciplinary: Applied Business and Education Research*, 3(9), 1673-1682. <https://doi.org/10.11594/ijmaber.03.09.08>
- Saracaloğlu, A. S., Yenice, N., & Özden, B. (2013). Relationship between self-efficacy perceptions towards science and technology literacy with attitudes towards science of science teachers'. *International Journal of New Trends in Arts, Sports & Science Education*, 2(1), 58-69.

- Scholes, L., Stahl, G. D., Comber, B., McDonald, S., & Brownlee, J. L. (2021). 'We don't read in science': Student perceptions of literacy and learning science in middle school. *Cambridge Journal of Education*, 51, 451 - 466. <https://doi.org/10.1080/0305764X.2020.1860192>
- Schunk, D. H. (2000). *Learning theories: An educational perspective*. Prentice hall.
- Senemoğlu, N. (2009). *Gelisim ogrenme ve ogretme* [Development learning and teaching]. Pegem Academy.
- Seven, S., & Akıllı, M. (2009). İlköğretim fen bilgisi öğretmen adaylarının bazı değişkenlere göre fen öğretimi öz yeterlik inanç düzeylerinin incelenmesi [The investigation of prospective science teachers' self-efficacy beliefs of their science teaching with respect to some variables]. *Bayburt University Journal of Education Faculty*, 4(1), 61-71. <https://cutt.ly/0M4qWTM>
- Sinan, O., & Uşak, M. (2011). Biyoloji öğretmen adaylarının bilimsel süreç becerilerinin değerlendirilmesi [Evaluating of prospective biology teachers' scientific process skills]. *Mustafa Kemal University Journal of Social Sciences Institute/Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 8(15), 333-348. <https://cutt.ly/1M4qUqr>
- Suyatman, S., Saputro, S., Sunarno, W., & Sukarmin, S. (2021). The implementation of research-based learning model in the basic science concepts course in improving analytical thinking skills. *European Journal of Educational Research*, 10(3), 1051-1062. <https://doi.org/10.12973/eu-jer.10.3.1051>
- Syazali, M., Erfan, M., & Khair, B. (2021). Learning facilities that can develop science process skills in indonesia: Review of experimental studies. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, 7(4), 910-923. <https://doi.org/10.33394/jk.v7i4.4414>
- Şenler, B. (2014). Turkish adaptation of the competence scale for learning science: Validity and reliability study. *Journal of Theory and Practice in Education*, 10(2), 393-407. <https://cutt.ly/TM4qSgg>
- Tatar, N. (2006). *İlköğretim fen eğitiminde araştırmaya dayalı öğrenme yaklaşımının bilimsel süreç becerilerine, akademik başarıya ve tutuma etkisi* [The effect of inquiry-based learning approaches in the education of science in primary school on the science process skills, academic achievement and attitude] [Doctoral dissertation, University of Gazi]. Turkish Council of Higher Education National Thesis Center. <https://bit.ly/YOK-TEZ-TATAR>
- Terzi, C., I. (2008). *İlköğretim I. kademedeki fen ve teknoloji dersini yürüten sınıf öğretmenleri ile II. kademedeki fen ve teknoloji dersini yürüten fen bilgisi (fen ve teknoloji) öğretmenlerinin fen okuryazarlık düzeylerinin belirlenmesi ve sonuçların karşılaştırılması* [Defining the science literacy level of the primary school teachers who conduct science technology lesson in primary grades as well as the science technology teachers who conduct science technology lesson in secondary grades and comparison of the results] [Master's thesis, University of Muğla]. Turkish Council of Higher Education National Thesis Center. <https://bit.ly/thesis-terzi>
- Tezbaşaran, A. (1997). *Likert tipi ölçek hazırlama klavuzu* [Likert-type scale development guide]. Turkish Psychological Association Publication.
- Ulutaş, Ö. (2009). *An investigation of pre-service elementary science teachers' scientific literacy level and their attitudes towards science* [Master's thesis, University of Middle East Technical]. Turkish Council of Higher Education National Thesis Center. <https://bit.ly/thesis-ulutas>
- Uyanık, G. (2016). Öğrenme döngüsü yaklaşımına dayalı fen öğretiminin sınıf öğretmeni adaylarının fen öğretimine yönelik öz-yeterlik inançlarına etkisi [Effect of the science teaching based on learning cycle approach to self-efficacy beliefs towards science teaching of elementary teacher candidates]. *Karaelmas Journal of Educational Sciences/Karaelmas Eğitim Bilimleri Dergisi*, 4, 25-37. <https://cutt.ly/EM4qLnW>
- Uyanık-Balat, G., Akman, B., & Günşen, G. (2018). Fen eğitimine karşı tutum, öz yeterlilik algısı ve bilişsel harita bulguları [Attitude against science education, self-efficacy perception and cognitive map findings]. *Mersin University Journal of the Faculty of Education*, 14(2), 756-777. <https://doi.org/10.17860/mersinefd.355520>
- Ültay, E., & Uludüz, Ş. M. (2018). Sınıf öğretmeni adaylarının fen öğretimi öz yeterlik inançları üzerine yapılan çalışmaların incelenmesi [Examination of the studies on primary teacher candidate's self-efficacy belief in teaching science]. *Ondokuz Mayıs University Journal of Education Faculty*, 37(1), 129-143. <https://doi.org/10.7822/omuefd.341242>
- Ürey, M., & Cerrah-Özsevgeç, L. (2015). Sınıf öğretmen adaylarının fen bilgilerini günlük yaşamla ilişkilendirebilme düzeyleri ile fen tutum ve okuryazarlıkları arasındaki ilişki [The relation between the pre-service elementary teachers' levels of relating science knowledge to daily life and their attitude and scientific literacy]. *Journal of Theoretical Educational Science*, 8(3), 397-420. <https://doi.org/10.5578/keg.9627>
- Yıldız-Duban, N., & Gökçakan, N. (2012). Sınıf öğretmeni adaylarının fen öğretimi öz-yeterlik inançları ve fen öğretimine yönelik tutumları [Class teacher candidates' self-efficacy beliefs in science teaching and attitudes to science teaching]. *Journal of Çukurova University Institute of Social Sciences/Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 21(1), 267-280. <https://cutt.ly/EM4qVL2>