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The Effect of Inquiry-Based Learning Activities on Attitudes towards Teaching Profession[1]

Ayşe Sert Çıbık*, *Gazi University, Gazi Faculty of Education, Ankara, Turkey*
Elvan İnce Aka, *Gazi University, Gazi Faculty of Education, Ankara, Turkey*

*Corresponding Author: sertay@gazi.edu.tr

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Abstract

This study aims to examine the effects of inquiry-based learning activities on the attitudes of science teacher candidates toward the teaching profession. In line with this main purpose, the attitudes were examined according to gender, willingness to choose the department, the activities in the course, and the level of influence of the course content on the attitude towards the teaching profession. Furthermore, at the end of the lesson, the candidates' opinions about the activities performed in the lesson were investigated. The sample consists of 28 candidates studying in the Department of Science Education at a state university in Ankara in the spring semester of the 2017-2018 academic year. In the study, where a single group pretest-posttest experimental model was used, the Attitude Scale of Teaching Profession and and open-ended questionnaire were used as data collection tools. As a result, no statistically significant differences were found between the pretest-posttest attitude score averages of the candidates and the pretest-posttest attitude score averages in terms of gender. A statistically significant difference was found between the post-test attitude score averages in terms of willingly choosing the department and the level of effectiveness of the activities performed in the course on the attitude towards the teaching profession. Furthermore, most of the candidates (n=27) responded as the activities in the lesson and the effect of the course content on the attitude towards the teaching profession had "a positive effect." They explained this mostly with reasons like learning how teaching works under the theme of Profession, being ready for the profession, feeling like a teacher, and so on. In the Process theme, the explanation of the effect of the presentations is the majority.

INTRODUCTION

Attitude is described as a learned internal condition that influences one's choices in individual actions in response to events and situations. It is a favorable or unfavorable attitude toward a certain item, circumstance, or event (Türker & Turanlı, 2008). The teacher is the person responsible for educating individuals in line with the needs of the age. Teachers' capacity to perform these tasks and improve educational quality depends on their favorable attitudes toward the profession before and throughout their service, their affective field competencies, and their essential motivation (Karadağ, 2012). The teaching profession is defined in different dimensions, such as role expectations, how and where to be trained, the qualifications to be possessed, and the characteristics of a good teacher (Üstüner, 2006). All these dimensions are like chains that complete each other in the process. For this reason, it is

thought that the attitude towards the profession will have an important role in fulfilling the requirements of the profession more effectively.

The explanations given about the teaching-learning process with the headings of "Teacher-student role" and "Adopted strategies and methods" in the 2018 Science Curriculum in force in Turkiye are similar to the 2017 curriculum. In the 2017 and 2018 Science Curricula, the inquiry-based learning approach is based, and the teacher is in the role of "encouraging and directing individual"; the student, on the other hand, is in the role of "individual who researches, questions, explains, discusses the source of information and turns it into a product." Unlike the previous teaching programs, both curricula emphasize innovative thinking in the sub-field of engineering and design skills within the scope of skill learning. In addition, it is envisaged to use argumentation, problem-based learning, project-based learning and cooperative learning methods in lessons (MEB, 2017; MEB, 2018). In this research, innovative thinking, problem-solving method, project-based learning and 5E lesson plan preparation activities were carried out within the framework of inquiry-based activities.

Teachers, who are practitioners of the curriculum in learning environments, mostly teach their lessons within the framework of the information and activities in the textbook (Newton, Newton, Blake & Brown, 2002; TTKB, 2021). However, it can be claimed that it is not a desired and expected situation in education for teachers to adhere to the textbooks one-to-one. It is important to use different learning methods and techniques envisaged by the curriculum in the conduct of this course, which includes a lot of difficult-to-understand concepts such as science. In this context, it is necessary to ensure that teacher candidates studying at the university gain experience in these subjects by doing different activities and activities before starting their professional life (Ecevit & Kaptan, 2019; Uyanık, 2017). Thus, it will be possible to train candidates who think, research, and offer ideas. At the same time, it will be able to contribute to the positive development of emotional qualities such as beliefs, attitudes, and motivations associated with the teaching profession within the scope of the process's activities. In light of this knowledge, it is reasonable to conclude that attitudes toward the profession have an essential role in the effectiveness of education and achieving desired results.

The training that the teacher candidates have received before the service is related to the quality of the teachers (Beare, Marshall, Torgerson, Tracz & Chiero, 2012). Cochran-Smith and Zeichner (2005) pointed out that the knowledge, skills, and dispositions of the teacher training professionals related to the actual practices in the school. At this point, the importance of the education that teacher candidates receive during their university education becomes evident. It is expected that pre-service teachers will have professional competencies that will facilitate the learning of students with their pre-service training (Ecevit & Kaptan, 2019; Karataş, 2020; Rajić, Hoşgörür & Drvodelić, 2015). In the profession, it is stated that the professional competencies of teachers are to develop student's problem-solving, creativity, and research skills (Şişman, 2002), to plan activities suitable for student levels, to organize individual and group work, and to use appropriate materials (Valli & Renert-Ariev, 2002).

It is stated that teachers who have just started their profession have difficulties in solving problems, and this situation affects them negatively (Haser, 2010). In this regard, it is believed that the fact that they feel competent in terms of serving the demands of today's pupils would favorably improve their attitudes toward the profession. The goal of today's teaching programs is to provide pre-service teachers with various experiences in preparing them for the profession (Tatto, Lerman & Novotta, 2009). Pre-service teachers are required to graduate with certain competencies and equipment in structured learning environments. In this respect, new teachers

need to learn new technologies in their pre-service training and use them actively in their teaching so that they do not experience difficulties in the first years of the profession. Ahmad, Said, Zeb, Sihatullaj and Rehman (2013) concluded in their study that teachers with positive attitudes towards the teaching profession are more successful in teaching and learning processes and participate in academic activities willingly. In this context, the training given to the candidates should lead them to develop positive attitudes toward the teaching profession (Johnson & Howell, 2005).

Within the context of the study's findings, the relevance of the gender factor in changing attitudes about the teaching profession will be assessed. The quantity of survey-type research in this field is abundant in the literature (Akpınar, Yıldız & Ergin, 2006; Chakraborty & Mondal, 2014; Çakır, Kan & Sünbül, 2006; Çapri & Çelikkaleli, 2008; Doğan & Çoban, 2009; Hussain, Ali, Khan, Ramzan & Qadeer, 2011; Terzi & Tezci, 2007). Among these, it was reported that the attitudes of teacher candidates towards the profession did not differ according to the gender factor, or those female teacher candidates had more positive attitudes than males. Furthermore, research in the literature has been conducted to investigate the influence of activities such as reflective thinking and material design on the transformation of teacher candidates' attitudes about the teaching profession during their higher education (Peker, Küçükgençay & Acar, 2018; Tok, 2008). However, no study has been found in the literature on the effect of inquiry-based learning activities foreseen by the pre-service curriculum on the attitudes of teacher candidates toward the profession. As a result, it is hoped that this study, in conjunction with the gender factor, will make significant contributions to the literature by examining whether studies aimed at carrying out learning activities in the classroom environment, which is one of the requirements of the teaching profession, are effective in changing attitudes toward the profession. Furthermore, it is claimed that another component that may influence the attitude toward the profession during the activities is whether or not the department is chosen consciously. Considering that the preference of the department is important in the choice of profession, the effects of the positive or negative attitudes of the candidates towards the profession were investigated.

Because it is established that good attitudes of teacher candidates toward the profession have a favorable impact on their professional life (Johson & Howell, 2005), their education should be geared toward helping them to acquire positive attitudes about their profession. According to these arguments, it is critical to investigate the impact of learning activities conducted with teacher candidates within the scope of a course within the framework of curricular outcomes on their attitudes toward the profession.

The Purpose of Study

The aim of this study aims to examine the effects of inquiry-based learning activities carried out within a course on the attitudes of science teacher candidates toward the teaching profession. In line with this main purpose, the attitudes of the candidates were examined according to their gender, choosing the department willingly, the level of influence of the activities carried out in the course, and course content on the attitude towards the teaching profession. Furthermore, using an open-ended questionnaire at the end of the class, information was gathered concerning the impact of the instructional activities on attitudes about the teaching profession. Thus, using two separate measuring instruments, it is hoped to acquire detailed information regarding the attitude toward the teaching profession. Answers to the following sub-problems were sought in this context.

1. Is there a statistically significant difference between science teacher candidates' attitudes towards the teaching profession before and after the application?
2. Is there a statistically significant difference between the attitudes of science teacher candidates towards the teaching profession before and after the application in terms of gender?
3. Is there a statistically significant difference between science teacher candidates' attitude scores towards the teaching profession after the application, in terms of the level of choosing the department willingly and the effect of the activities carried out in the course on the attitude towards the teaching profession?
4. What are the views of science teacher candidates about the activities performed in the lesson?

METHOD

Study Design

A single-group pre-test/post-test research design was utilized in the quantitative part of this study, which integrated quantitative and qualitative research methodologies, to examine the influence of research inquiry-based learning activities on attitudes toward the teaching profession. The basic assumption of the design is that "post-test scores are higher than pre-test scores, and this is because the applied method is effective" (Karasar, 2004). This design is based on the assumption that the experimental situation of each sample is compared with itself and is more efficient in using the in-group experimental setup. In addition, the case study method was used in the qualitative dimension, in which opinions about the activities carried out in the course were determined.

Study Group

The study's sample includes 28 second-grade teacher candidates (N=28) enrolled in the Science Education Department of a public university in Ankara during the spring term of the 2017-2018 academic year. The convenience sampling approach was used to choose the sample. The descriptive features of the samples are listed below.

Table 1. Gender distribution of science teacher candidates

Gender	f	%
Female	22	78.6
Male	6	21.4

Table 1 shows that 78.6% of the applicants are female and 21.4% are male.

Content and Steps of Teaching Used in the Research

This study was conducted during the second-year spring semester of the Science Education Department's "Science-Technology Program and Planning" course. The content of the course is generally in the form of the science curriculum, planning in science teaching, and planning of teaching activities. It enriches the activities with daily life examples by using appropriate teaching principles, methods, and techniques through planning. In this context, activities based on inquiry-based learning activities were carried out throughout the term to determine the changes in the attitudes of teacher candidates towards the teaching profession. In the first weeks, the theoretical information in the curriculum of the course was given, the candidates were informed about the activities, and groups were formed to work together. Afterward, activities such as innovative thinking, a problem-solving method, project-based learning, 5E lesson plan preparation, presentation preparation, and presentation activities were carried out respectively. Some examples of the activities carried out are presented in Appendix 1. A brief information about the activities determined within the scope of the research is as follows:

1. To write down problem situations and outcomes that will encourage students to think innovatively with examples from daily life for innovative thinking,
2. Preparing an outcome they have chosen from the Science Curriculum (2017) with a scenario taking into account the problem-solving steps (steps followed for problem-solving),
3. To prepare for an outcome they have chosen from the Science Curriculum (2017) following the steps of the project-based learning method,
4. Preparing an outcome they chose from the Science Curriculum (2017) in the form of a daily lesson plan according to the 5E learning model,
5. Presenting the prepared learning activities in the classroom.

Care was taken to plan the activities to include at least two learning areas (Science Process Skill, Science-Technology-Society-Environment, Attitude-Value, Science and Engineering). The aim here is to allow teacher candidates to see the equivalence of learning areas in activities. In addition, during the presentations, each stage of the plan was criticized, and it was evaluated whether it reflected the expected performance from the research investigation strategy. In this context, their performances were evaluated as good and moderately poor with the analytical rubric prepared according to certain criteria regarding the activities carried out. With the scores obtained from the scoring key, it was tried to determine the dominance of the candidates in the learning activities they prepared.

Data Collection Tools

In this study, answers to sub-problems were sought with two data collection tools, quantitative and qualitative data.

1. Quantitative data collection tool: The alteration in attitudes of candidate teachers regarding the teaching profession was measured by using The Attitude towards Teaching Profession Scale. Üstüner (2006) devised a scale of 34 items, 10 of which are negative and 24 of which are positive. The scale was created to assess the attitudes of candidates enrolled in teaching programs about the teaching profession. Options and point equivalents in the expressions in the 5-point Likert-type scale; 5=Strongly Agree, 4=Mostly Agree, 3=Moderately Agree, 2=Partly Agree, and 1=Strongly Disagree. While the highest score that can be obtained from the scale is 170, the lowest score is 34, and the Cronbach Alpha reliability coefficient of the scale is .89. In the reliability analysis made by the researchers, the Cronbach Alpha reliability coefficient of the scale was calculated as .92.

2. Qualitative data collection tool: An open-ended questionnaire consisting of 7 questions about the attitude towards the teaching profession was applied. The researchers have created the questionnaire. Two science educators assessed the questionnaire for consistency of language and meaning in the questions. In accordance with the expert comments, required regulations were made on the survey questions, and the statements were completed. Only one question was included in this study. The question is about the activities done in the lesson and the effect of the course content on the attitude towards the teaching profession.

Validity-Reliability Check

Internal validity is related to the explanation of the changes observed in the dependent variable with the independent variable. Factors that threaten internal validity in quantitative research can be listed as the selection of subjects, maturation of subjects, data collection tool, history of subjects, and subject loss effect (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2014). In this study, some of the factors mentioned were taken under control and internal validity was ensured. Regarding the background factor of the subjects, internal validity was ensured thanks to the willingness of the majority of the candidates to come to this section and to start the research without prejudice. In the study, the same data collection tool was

applied to the participants in all measurements by the researcher herself. To minimize the effect of subject selection and subject loss, the researcher conducted her research in the classroom where she lectured, and attention was paid to ensuring that the study group remained in sufficient numbers.

Accurate data reporting and explanations of how findings are obtained are crucial for validity in qualitative studies (Yıldırım & Şimşek, 2016). Within the scope of this analysis, the conformity of the research findings with the elements addressed during the creation of the interview question was examined. Furthermore, the researchers assessed the consistency and importance of the data on a regular basis. Internal validity (credibility) of the findings was established using direct quotes. The study model, universe and sample, data collection technique, and data analysis were all extensively explored to ensure external validity (transferability).

Clarifying the strategies used during the stages of the study and allowing other researchers to utilize them in comparable ways are some of the actions to be taken in terms of dependability in qualitative investigations (Yıldırım & Şimşek, 2016). Two researchers coded the data acquired for this study at different periods, and the internal reliability (consistency) of the data was attempted to be guaranteed by comparing the codes. The purpose is to get an objective point of view in order to ensure the results' integrity. It has been attempted to contribute to external reliability by presenting the study's stages in full and concisely, as well as keeping raw data for future inspection (repeatability).

Data Analysis

In this study, the data were analyzed both quantitatively and qualitatively.

1. Quantitative analysis of data: The quantitative analysis of the study consists of the examination of the data received from the attitude scale towards the teaching profession using the IBM SPSS Statistic 22 tool. Before making a comparison between the pre-test and post-test scores of the candidates, it was checked whether the data were in a normal distribution. The distribution is considered normal if the skewness and kurtosis values of the data are at specific rates (Taşpınar, 2017). At a 0.05 confidence level, the Z value obtained by dividing the skewness and kurtosis values by their standard errors is within 1.96 limits, specifying that the distribution is normal (Can, 2014; Taşpınar, 2017). In this context, the normal distribution control of the data group compared to the sub-problems of the study was made according to the Z score, and it was determined that the Z scores were within the limits of ±1.96. In this instance, the data were examined using the parametric tests' independent groups' t-Test and dependent groups' t-Test. The significance threshold of 0.05 was used to interpret the findings. The effect size is a statistical metric that may be used to calculate the magnitude of the change between two average scores (Taşpınar, 2017). For variables with a statistically significant difference, the effect size was calculated using Cohen's d.

The formula "sequence width/number of groups to be created" (Tekin, 1993) was used to calculate the interval width of the scale for the analysis of data collected from the scale. In this case, the arithmetic mean weights used to evaluate the study findings are as follows:

1.00-1.80=Strongly Disagree
1.81-2.60=Partly Agree
2.61-3.40=Moderately Agree
3.41-4.20=Mostly Agree
4.21-5.00=Strongly Agree

2. Qualitative analysis of data: The data collected from open-ended question were analyzed qualitatively. The method of content analysis was used to analyze written replies to open-ended question. The purpose of content analysis is to discover concepts and relationships that may be utilized to comprehend the subject matter better. In this setting, similar data are brought together around specific concepts and themes, and they are arranged and expounded in an understandable manner (Yıldırım & Şimşek, 2016).

The content analysis went through the following stages:
1. The codes were produced after the researchers separately reviewed the raw data a couple of times at different times.
2. Researchers collaborated to see whether there were any discrepancies between the codes. A scoreboard was established to ensure that the codes were consistent. The scoreboard used the "Consensus" and "Dissensus" calculation methods. Codes were re-examined in the appropriate data collection where the researchers disagreed, and a consensus was established. Frequency values were assigned based on the frequency of the codes.
3. Miles and Huberman's (1994) percentile compliance reliability was used to compute consensus and dissensus. "Consensus / (Agreement + Disagreement) x 100" = Concordance reliability. The coding percentage was calculated after all of these processes. Reaching a dependability percentage of at least 70%, according to (Yıldırım & Şimşek, 2016), implies that the codes are trustworthy. In the study, the percentage of compliance reliability attained was determined to be 75%. In this instance, the concordance reliability valuation between the encoders is sufficient.
4. Codes having equivalent meaning linkages were grouped together under a certain category once consistency across the codes was confirmed. These linkages were then sought to be articulated under a higher-level theme.

FINDINGS

The results of a comparison of science teacher candidates' attitude scores towards the teaching profession before and after application, as well as the distribution of these scores according to gender, willfully choosing the department, activities performed in the course, and the level of the course content affecting the attitude towards the teaching profession (Yes, No, Partially) are presented below. There are indications about the applicants' views of the influence of the course activities on their attitudes toward the teaching profession.

1. Is there a statistically significant difference between science teacher candidates' attitudes towards the teaching profession before and after the application?

The dependent groups' t-Test was used to compare teacher candidates' pre-test-post-test attitude score averages regarding the teaching profession. Table 2 summarizes the findings.

Table 2. Dependent groups t-Test results regarding pre-test-post-test attitude score averages of teacher candidates towards the teaching profession

Measurement	N	χ	Sd	df	t	p
Pre-test	28	4.03	.737	27	-1.657	.109
Post-test	28	4.16	.623			

Table 2 shows that the pre-test attitude mean score of the pre-test teacher candidates is $\chi_{(pre\text{-}test)}$=4.03, and the post-test attitude mean score is $\chi_{(post\text{-}test)}$=4.16. It was deemed that the applicants' score ranges in both metrics were *mostly agree*. No statistically significant difference was found between the pretest-posttest attitude score averages of the candidates [$t_{(27)}$=-1.657, p>.05]. However, post-test attitude mean scores are higher than pre-test attitude

mean scores. When the results are evaluated in terms of score averages, it can be said that inquiry-based learning activities cause a slight change in the attitudes of the candidates towards the teaching profession.

2. Is there a statistically significant difference between the attitudes of science teacher candidates towards the teaching profession before and after the application in terms of gender?

Independent groups t-Test was used to see if the pre-test-post-test attitude mean scores of teacher candidates for the teaching profession differed by gender. Table 3 displays the results.

Table 3. The independent groups' t-Test results of the pre-test-post-test attitude mean scores of teacher candidates towards the teaching profession in terms of gender

Measurement	Gender	N	χ	Sd	df	t	p
Pre-test	Female	22	3.93	.778	26	-1.283	.211
	Male	6	4.36	.463			
Post-test	Female	22	4.08	.650	26	-1.228	.230
	Male	6	4.43	.456			

When the pre-test attitude means scores of the teacher candidates are analyzed in terms of gender, the scores of the female candidates are $\chi_{(female)}$=3.93, and the scores of the male candidates are $\chi_{(male)}$=4.36. When the post-test attitude score averages are reviewed, it is observed that the female candidates' scores are $\chi_{(female)}$=4.08, while the male candidates' scores are $\chi_{(male)}$=4.43. It was revealed that the candidates' score ranges in both measurements *mostly agree* for females and *strongly agree* for males. In terms of gender, no statistically significant difference was detected between the applicants' pre-test attitude mean scores and their post-test attitude mean scores [$t_{(26)}$=-1.283; $t_{(26)}$=-1.228, p>.05]. The fact that implementations have a comparable influence on gender explains this outcome.

3. Is there a statistically significant difference between science teacher candidates' attitude scores towards the teaching profession after the application, in terms of the level of choosing the department willingly and the effect of the activities carried out in the course on the attitude towards the teaching profession?

The independent group t-Test was used to compare the post-test attitude mean scores of teacher candidates toward the teaching profession in terms of the degree of willingly choosing the department and the activities carried out in the course are noteworthy in terms of their influence on the attitude. The findings are shown in Tables 4 and 5.

Table 4. Independent group's t-Test results regarding post-test attitude point averages of teacher candidates in terms of choosing the department willingly

Choosing the department	N	χ	Sd	df	t	p*	Effect size (d)
Yes	19	4.44	.385	26	4.653	.000	0.21
No	9	3.56	.618				

p<.05

In Table 4, when the post-test attitude means scores of the teacher candidates in terms of choosing the department willingly are examined, it is seen that the scores of the candidates who say yes are $\chi_{(yes)}$=4.44, and the scores of the candidates who say no are $\chi_{(no)}$=3.56. It has been determined that the score ranges of the candidates are at the level of *strongly agree* and *mostly agree*. A statistically significant difference was found between the post-test attitude score averages of the candidates in terms of choosing the department willingly [$t_{(26)}$=4.653, p<.05].

In addition, it was determined that the significant difference between the posttest attitude score averages in terms of choosing the department willingly had a *low level* (d=0.21) effect. According to this result, candidates who answered yes to choosing the department willingly caused a low level of effect on those who answered no. In other words, it can be explained that choosing the department willingly has a lower effect on the change of attitudes of the candidates who say yes to the teaching profession, compared to those who say no.

Table 5. Independent group's t-Test results regarding post-test attitude point averages in terms of teacher candidates' level of influence on the activities carried out in the course

Influence of the activities	N	χ	Sd	df	t	p*	Effect size (d)
Yes	20	4.34	.450	26	2.666	.013	0.97
Partially	8	3.71	.791				

p<.05

When the teacher candidates' post-test attitude mean scores are examined in terms of the level of influence of the course activities, it is seen in Table 5 that the scores of the teacher candidates who say yes are $\chi_{(yes)}$=4.34, and the scores of the teacher candidates who say partially are $\chi_{(partially)}$=3.71. It has been discovered that the candidates' score ranges are between *strongly agree* and *mostly agree*. There was a statistically significant difference in the post-test attitude score averages of the applicants in terms of the effect of the course activities on the candidates' attitude towards the teaching profession [$t_{(26)}$=2.666, p<0.05]. Furthermore, it was discovered that the substantial difference between the post-test attitude score averages on the attitude affect levels of the course activities has *a high level* (d=0.97) influence. According to this study, candidates who replied yes to the influence of course activities on attitudes toward the teaching profession had a high level of effect on those who only partially answered.

4. What are the views of science teacher candidates about the activities performed in the lesson?

The question "Did the activities and course content in this course affect your attitude towards the teaching profession positively or negatively? Explain your answer with reasons.
Affected Positively, Because ….
Affected Negatively, Because ….
It partially affected the …… Direction, Because…"
The distribution of the answers given to the question is given in Table 6.

Table 6. Findings on the effects of the activities and course content in the course

Theme	Category	Codes	f
Profession	Learning	– Learning how teaching works	13
		– Being ready for the profession	7
		– Feeling like a teacher	3
		– Being knowledgeable	3
		– Learning the curriculum	2
		– Learning to plan	2
		– Method learning	2
Process	Activity	– Impact of presentations	6
		– Giving examples from daily life	1
	Behavior	– Being conscious	2
	Negative	– Being boring	1
Affective	Self-confidence	– Confident	1

*Some descriptions have omitted more than one code.

The answers to this question were "Positively affected (n=27)" and "Partially positively affected (n=2)". Table 6 reveals that the responses to the first question are generally grouped under the Profession (f=32) theme. When the codes under the profession theme are reviewed, it is discovered that they are gathered as learning how teaching works, being ready for the profession, feeling like a teacher, being knowledgeable, learning the curriculum, learning to plan, and learning methods. However, the effect of the presentations and the codes of being conscious draw attention to the Process theme. The names of all teacher candidates were kept confidential and codes such as S1, S2…S10 were used. Accordingly, concerning the theme of Profession, S1: "*Learning about the functioning of teaching, what should be done and what should not be done, had a positive effect on me*." While S15: "*We had the opportunity to examine the curriculum and how the lesson is handled, how the topics are explained. While the topics are being explained, we have seen what needs to be paid attention to by doing activities in this lesson.*" expressed an opinion. S18: "*In part, we also practiced teaching, and I learned about this profession more profoundly thanks to assignments and in-class activities. I thought about what kind of teacher I should be. My worries about the future have decreased.*" S16 said: "*While preparing our homework, it made me think that I can use such things in the future when I become a teacher. It taught us methods we could use*." expressed their opinion. S26: "*I felt as a teacher with the homework we did and I had an idea about how I should explain it to my students*." Regarding the Process theme, S3: "*Giving examples from daily life to every subject in the course made the profession more interesting to me. The presentations we made in class helped me to be more ready for the teaching profession*." While S5 expressed an opinion as "*It made me more conscious about the course and more knowledgeable about the profession*.".

DISCUSSION AND SUGGESTIONS

The qualification, character and professional qualifications of the teacher are the cornerstones on which a successful education depends (Emejidio & Gepila, 2020). The qualifications of teachers, who are an important element of the education system, are content knowledge, pedagogical formation knowledge, general culture and talent knowledge (Demirel, 1999). In addition to these competencies, attitude, which is one of the affective domain characteristics, is also important (Oral, 2004). The teaching profession requires candidates with specified competencies and positive attitudes (Srilatha, 2017).

Teacher candidates' attitudes toward the profession should be favorable in order for them to successfully complete the criteria of the teaching profession and be successful in the profession (Ayık & Ataş, 2014). The expression "attitude toward the profession" refers to 'the individual's mood, conduct, and devotion to the profession' (Hussain et al., 2011). According to attitude research, a teacher's productivity and classroom performance are heavily influenced by his attitude toward the profession (Bhargava & Pathy, 2014; Srilatha, 2017). Because, besides conveying information to students, the teacher is a role model that supports their personality development in all aspects (Karataş, 2020). In his study, Mathai (1992) stressed that attitude toward the profession and success in teaching are associated. The disparities in pre-service teachers' attitudes toward the teaching profession can be attributed to variances in learning settings, instructional materials, and tactics used in the teacher training program (Mordi, 1991). Under this context, the diversity of roles expected from the teacher in the current science curriculum and the use of innovative methods and techniques in the learning environment imply that the experiences that pre-service teachers have during their undergraduate education are important and necessary. In their study, Ecevit and Kaptan (2019) state that applications based on argumentation-supported inquiry positively improve the teaching competencies of science teacher candidates. Accordingly, thanks to the practices, the pre-service teachers' ability to design a teaching-learning process improved, some changes and awareness occurred in their

teaching-learning understanding, and their science teaching self-efficacy beliefs increased because they actively experienced the process. This finding supports our explanation.

In this study, inquiry-based learning activities were carried out with science teacher candidates within the framework of the outcomes in the curriculum. The aim here is to gain knowledge and skills about various learning methods and techniques before starting the profession. At the end of the study, no statistically significant difference was found between the pre-test attitude mean scores of the teacher candidates and the post-test attitude mean scores. However, posttest attitude mean scores are higher than pretest attitude mean scores. Attitude has an important role in the effective emergence of knowledge and skills suitable for the teaching profession. In other words, a positive attitude towards the teaching profession becomes meaningful when it develops together with the knowledge and skills related to the profession (Andronache, Bocoş, Bocoş & Macri, 2014). This can happen over time, with long-term interactions with the profession in pre-service training. In this study, pre-service teachers' attitudes towards the profession were evaluated within the framework of the activities carried out during the course, and their attitudes towards the profession did not differ significantly. The reason for this result can be shown as the fact that the applied courses related to the teaching profession are mainly included in the 3rd and 4th grades in the science education undergraduate program and that they have not yet taken these courses. Studies examining teacher candidates' attitudes toward the teaching profession according to grade level support this view. In his study, Uyanık (2017) found that classroom teacher candidates' attitudes towards the teaching profession were at a low level in the first years of their undergraduate education, and there was a significant increase in their attitudes in the third and fourth years. He suggested that for the development of positive attitudes towards the profession, practices in which pre-service teachers are active should be carried out in instructional courses. Terzi and Tezci (2007) state that there is a significant difference between the first and last year candidates of the university teacher training programs in order to interpret the effectiveness of the teaching profession courses on the attitude towards the profession. In their study, Şahin Taşkın and Hacıömeroğlu (2010) stated that most of the pre-service classroom teachers in the last year are useful in terms of teaching methods and techniques of field education courses, and most of the classroom, preschool and science teacher candidates stated that vocational knowledge courses positively affect their professional development.

There are studies in the literature examining the effects of various teaching practices on teacher candidates' attitudes toward the profession. Kartal, Yamak and Kavak (2017) examined the effect of microteaching practices on the professional attitudes of science teacher candidates within the scope of the Special Teaching Methods course. As a result of the study, microteaching had a positive effect on the attitudes of pre-service teachers toward the teaching profession. Similarly, the studies of Tok (2008) and Peker et al. (2018) are in line with these results. In this case, pre-service teachers who have a positive attitude will do their jobs with pleasure and willingly in the future, and as a result, they will make significant contributions to education (Ayık & Ataş, 2014). Their attitudes towards the profession will change as their classroom professional experiences increase (Kartal et al., 2017). There was no statistically significant difference in pretest-posttest attitude mean scores based on gender. Accordingly, the practices carried out in the course had a similar effect on the gender variable. It is possible to see more survey-type studies on this subject. According to Chakraborty and Mondal (2014), and Çakır et al. (2006), there is no substantial gender difference in teacher candidates' attitudes toward the profession. Similarly, Uyanık (2017), in his study with prospective classroom teachers, concluded that there was no difference in terms of gender in the first three grades in the teaching profession attitude scores. Kesen and Polat (2014) reported that there was no

significant difference in the attitudes of teacher candidates towards teaching according to gender. On the other hand, in their study with secondary school teachers, Hussain et al. (2011) found that the attitudes of the majority of teachers towards the profession were not positive, and there were differences in terms of gender. Accordingly, it was determined that female teachers had a more positive attitude. There are findings in favor of female teacher candidates in the literature (Akpınar et al., 2006; Çapri & Çelikkaleli, 2008). Similarly, studies in the literature (Benjamin, Sahayarani & Stanly, 2011; Malsawmi & Renthlei, 2015; Naik & Pathy, 1997) concluded that female teachers have more positive attitudes towards the teaching profession than male teachers. There is an opinion that the teaching profession is more suitable for women in bringing together working and family life conditions in society (Doğan & Çoban, 2009; Terzi & Tezci, 2007). As a general tendency, teacher candidates may have this thought. However, the learning activities carried out in this study can be explained by the fact that many factors such as working with the group, communicating, and sharing what they have learned with each other equate to this tendency. However, it can also be effective for them to gain first-hand experience with the requirements of the teaching profession.

There was a statistically significant difference between the candidates' post-test attitude score averages in terms of the influence of the course activities on their attitude toward the teaching profession [$t_{(26)}=2.666$; $p<0.05$]. Furthermore, it was discovered that the substantial difference between the post-test attitude score averages on the attitude affect levels of the course activities has a high level ($d=0.97$) influence. According to this study, candidates who replied yes to the influence of course activities on attitudes toward the teaching profession had a high degree of effect on those who only partially answered. If positive attitudes are instilled in teacher candidates through learning environments, they will demonstrate more favorable behaviors toward their pupils after they enter the profession (Çeliköz & Çetin, 2004). Because experience, which is one of the factors affecting attitude, makes an important contribution to the formation of attitude (Suja, 2007). Environments should be created to support teacher candidates' positive attitudes toward science teaching. In this context, it is appropriate to design and implement certain courses, strategies, and methods (Kartal et al., 2017). Based on the results of this study, teacher candidates gained various experiences (presentation, homework, etc.), especially professional experience, thanks to the inquiry-based learning activities carried out, and this situation changed their attitudes towards the profession in a positive way. In this context, the learning environments to be presented to the candidates should include the competencies required by the profession and should support the use of the methods and techniques prescribed by the curriculum. The education that teacher candidates receive in professional knowledge and field courses has an important role in the formation of their attitudes towards the profession (Şahin Taşkın & Hacıömeroğlu, 2010).

The teacher who has a positive attitude towards the profession will reflect this in the teaching in the classroom. In such a classroom atmosphere, there will be students who have positive attitudes toward their peers, school, and learning. Therefore, knowing teachers' attitudes toward teaching is an important factor in understanding the learning environment (Rimm-Kaufman & Sawyer, 2004). As a result, teacher candidates need to be aware of the requirements of the profession, its content, their roles, and many other pedagogical and field-specific competencies before starting the profession. Because in this way, he will develop an attitude during his education at the faculty and will perform his profession with this attitude.

Suggestions that can be made in light of the study's findings are as follows:

- Inquiry-based learning activities can be designed to be a project product to be carried out at the next grade level, and their effects on the attitude towards the teaching profession or different variables can be examined.
- In a similar study, the effect of the gender variable can be investigated in depth with one of the mixed-method research designs.
- In new studies, the effect of learning activities that make teacher candidates active on the attitude toward the teaching profession can be examined.
- In future studies, the attitudes of different sample groups (undergraduate groups such as classroom, mathematics, biology, graduate, and teacher) towards the profession can be examined.

CONCLUSION

The quantitative and qualitative findings of the study show that inquiry-based learning activities generally positively affect the attitudes of science teacher candidates toward the teaching profession. Among the qualitative findings, learning how teaching works, being ready for the profession, feeling like a teacher, the effect of the presentations, and so on were observed as common points of view. At the same time, while the activities carried out did not cause a significant difference between the genders, they created a significant difference in favor of those who chose the department willingly and those who thought that the activities carried out in the course affected the attitude towards the teaching profession.

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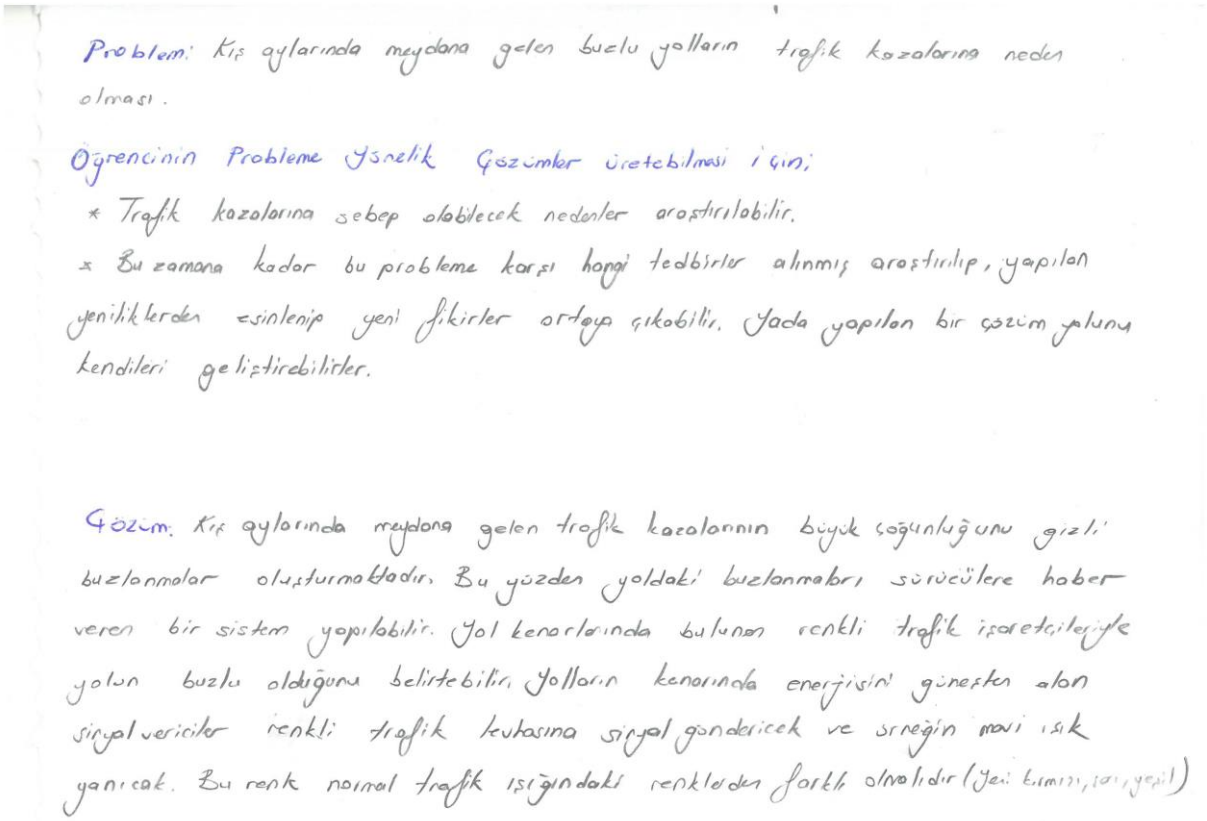
Appendix 1: Some examples of the activities

1. Innovative thinking



Problem: Kış aylarında meydana gelen buzlu yolların trafik kazalarına neden olması.

Öğrencinin Probleme Yönelik Çözümler üretebilmesi için;

* Trafik kazalarına sebep olabilecek nedenler araştırılabilir.
* Bu zamana kadar bu probleme karşı hangi tedbirler alınmış araştırılıp, yapılan yeniliklerden esinlenip yeni fikirler ortaya çıkabilir. Yada yapılan bir çözüm yolunu kendileri geliştirebilirler.

Çözüm: Kış aylarında meydana gelen trafik kazalarının büyük çoğunluğunu gizli buzlanmalar oluşturmaktadır. Bu yüzden yoldaki buzlanmaları sürücülere haber veren bir sistem yapılabilir. Yol kenarlarında bulunan renkli trafik işaretçileriyle yolun buzlu olduğunu belirtebilir. Yolların kenarında enerjisini güneşten alan sinyal vericiler renkli trafik kutusuna sinyal gönderecek ve örneğin mavi ışık yanacak. Bu renk normal trafik ışığındaki renklerden farklı olmalıdır (yani kırmızı, sarı, yeşil)

2. Problem-solving method

5.Sınıf 6.Ünite – İnsan ve Çevre

Konu Kavramları: Çevre kirliliği, çevreyi koruma ve güzelleştirme, insan-çevre etkileşimi
Kazanım: İnsan ve çevre arasındaki etkileşimin önemini ifade eder.
Çevre kirliliğinin insanların sağlığı üzerindeki olumsuz etkilerine değinir.

İlgili Kazanım ve Öğrenme Alanı: FTTG, BSB

Senaryo: Bilgehan ailesiyle birlikte amcasının evine ziyarete gitmişti. Evin yakınlarında mermer fabrikası bulunuyordu. Bilge eve vardıktan bir süre sonra daha zor nefes aldığını farketmişti. Etrafına baktığında ise havanın daha kirli olduğunu görmüştü. Bunun nedenini düşündü;

Problemin Belirlenmesi: Bilge, bu kirliliğin nedenini öğrenmeye karar vermişti. Ayrıca çevresinde gördüğü atıkların fabrikayla alakalı olup olmadığını düşünmeye başladı. Acaba bu kirlilige fabrika mı neden oluyordu?

Problemin Anlaşılması: Bilgehan'ın aklına Fen Bilimleri dersinde öğrendiği çevre kirliliği konusu geldi. Öğretmeni nüfusun artmasıyla çevre kirliliğinin ortaya çıktığını ve canlıların hayatını olumsuz etkilediğini söylemişti. Bilge bunları hatırlayınca fabrika ile hava arasında bir bağlantının olduğunu farketti.

Hipotezlerin Oluşturulması: Bilge başka sebeplerin de olabileceğini düşünmeye başlamıştı. Diğer sebepleri;
- Fabrikanın atıklarını suya ve çevreye bırakması
- Fabrikanın şehir içinde bulunması
- Nüfusun fazla olması sebebiyle çarpık kentleşmenin olması olabileceğini düşündü.

Problemle İlgili Bilgi Toplanması: Konuyu iyice öğrenebilmek için ders kitabında bu konuyla ilgili olan metni okudu. Daha sonra internetten araştırmaya karar verdi. Gerekli bilgileri edindikten sonra Bilgehan bu sorunu çözmek için neler yapılabilir diye düşündü. Aklına fabrikaların yerleşim yerlerine uzak yapılması gerektiği, yerleşim yapılırken planlı ve düzenli yapılması gerektiği, atıkların çevreye değil uygun bir tesise gönderilmesinin gerekli olduğu geldi. Ayrıca fabrikaların kurallara uyup uymadığında denetlenmeli idi.

Hipotezler Arasında En Uygun Olanın Seçilmesi: Bu tesislerin hangi özelliklerinin olması gerektiğini öğrenmek için araştırma yaptı. Tesisin binalardan uzak beton saha üzerine yapılmış olmasını, zararlı gazların kontrollü bir şekilde filtreli baca yardımıyla atmosfere bırakılması gerektiğini öğrendi.

Bilgehan bu araştırmayla atıkların tesislere gönderilmesinin ne kadar önemli olduğunu anladı. Böyle yapıldığında atıklar çevreye bırakılmayacak, doğal dengeyi de bozmayacaktı.

Genel Bir Sonuca Varma: Bilgehan bu konuyla ilgili haberleri okuduğunda yakın mesafede bulunan iki fabrikanın çevresinin çok farklı olduğunu gördü. Çünkü bir fabrika atıklarını toprağa bırakırken diğeri özel tesislere gönderiyordu. Bilge, bu iki doğal çevreyi kıyasladığında en faydalı sonucun atık tesisleri olduğunu anladı.

3. Project-based learning

Konu: 6. Sınıf Dünya ve Evren - Güneş Sistemi ve Tutulmalar

Kazanımlar : * Güneş tutulması esnasında Ay'ın hangi evrede olduğuna değinilir.
* Güneş tutulması çeşitlerine değinilir.
* Güneş tutulmasının her ay olmadığına değinilir.
* Ay tutulmasının nasıl olduğunu tahmin eder
* Ay tutulmasında Ay'ın hangi evrede olduğuna değinilir.
* Ay tutulmasının her ay olmadığına değinilir

Projenin Adı: Güneş ve ay tutulmasının maket modelle gösterimi

Projenin Amacı: Güneş ve ay tutulması kavramlarının benimsetilmesi, yarı gölge tam gölge oluşumunun öğretilmesi

İlgili Öğrenme Alanı: FTTG, BSB

Projede Kullanılacak Malzemeler: Farklı büyüklükte 3 top, el feneri, siyah karton, ayakkabı kutusu.

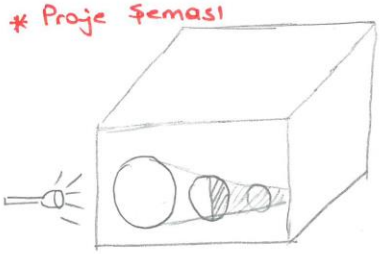
→Proje Aşamaları

* **Konu Seçimi:** Öğrenci güneş ve ay tutulması konusunun sözel bir anlatım ile çok da kavranamadığını, yarı gölge vb. kavramların öğretilemediğini düşündü. Bu yüzden de konu hakkında maket tasarlamaya karar verdi. Bu yüzden 6. sınıf Dünya ve evren ünitesinden, Güneş ve Ay tutulmaları konusunu seçmiştir
* **Bilgi Toplama:** Öğrenci ders kitaplarından, ansiklopedilerden ve çeşitli internet sitelerinden araştırmalar yapmış, bilgi toplamış ve yeterli bilgi birikimine ulaşmıştır.
* **Projeyi tamamlama:** Yeterli bilgiler sonucu, öğrenci 3 farklı boyutta top kullanarak dünya, güneş ve ay modelleri oluşturmuş ve siyah bir ortamda bunların gölge oluşumlarını gözlemlemiştir. Oluşan gölgelerin gerçekten de güneş ve ayın görülmesine engel olduğunu gözleyip, güneş ve ay kavramlarını açıklayabilmiştir
* **Yöntem:** Bu projeyi oluştururken hiç bir bilgi sahibi olmayan öğrenci ilk başta yeterli kaynaklardan bilgi toplayıp bir fikir sahibi olmuş daha sonra bu projeyi tasarlamıştır. Projesinde farklı 3 boyutta top kullanmasının nedeni güneş, dünya ve ayın boyutlarının farklı olmasıdır. Yine aynı şekilde siyah kartonla kaplı bir ortam oluşturmasının nedeni gölge oluşumunun siyah ortamda oluşabildiğini bildiği, bu konu hakkında önceden yeterli bir bilgiye sahip olduğu içindir
* **Takvim:** 1. Hafta → Proje konusu seçimi
2. ve 3 Hafta → Proje hakkında bilgi toplama
4. 5. ve 6. Hafta → Projeyi tamamlama ve ilgili yöntemleri kullanma

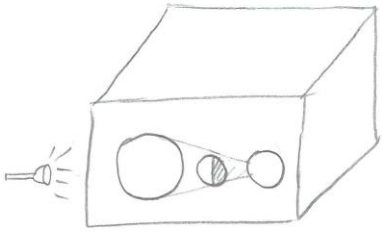
+

Toplam Proje Süresi = 6 Hafta

* Proje Şeması



Ay Tutulması



Güneş Tutulması

* Projenin Faydası Öğrenci anlatılarak soyut olarak çok da kavrayamadığı güneş ve ay tutulması kavramını, yarı gölge, tam gölge kavramını görerek, yani somut olarak daha iyi öğrenecek ve daha iyi aklında kalacaktır

* Projede Kullanılan Kaynaklar

Fen Bilgisi 6. Sınıf ders kitabı
Ansiklopediler
İlgili internet siteleri

* Projenin Sonuçları: * Ay, güneş ve dünya arasına girdiğinde ayın gölgesi dünyanın bir bölümünü kapatır Dünyanın o bölgesi güneşten tam ışık alamaz Buna güneş tutulması denir

* Ay yüzeyine düşecek güneş ışınları, dünyanın ay ve güneş arasına girmesiyle dünya tarafından engellenir Karanlıkta kalan ay kısa bir süre de olsa dünyadan gözlenlenemez. Bu da ay tutulmasıdır

* Işık kaynağından gelen ışık, cisme çarpar ve arkasında bir karartı oluşturursa buna tam gölge denir. Eğer 2 kaynaktan gelen ışık kesişiyor ve burada bir gölge oluşuyorsa bu da yarı gölgedir. Tam gölge yarı gölgeye göre daha karanlıktır. (Kürenin tamamı ışıksız kalan bölgesi tam bölge, kısmen ışık alan bölgesi yarı gölge)

Örnek Gündelik Problemler

→ Televizyonda güneş ve ay tutulmasıyla ilgili haberi gören bir öğrencinin merak edip araştırma yaptığı halde konuyu çok da kavrayamaması

→ Güneş ve ay tutulması kavramlarının öğrencileri tarafından sürekli birbirine karıştırılan bir fen öğretmeninin 2 farklı olayı kavratmak istemesi

[1] A part of this study was presented as an oral presentation at the 14th National Science and Mathematics Education Congress held online between 19-21 May 2021.

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Pre-Service Primary School Teachers' Motivations for Choosing the Teaching Profession and Their Self-Efficacy Beliefs in Science Teaching

Bahattin Deniz Altunoğlu*, *Kastamonu University, Faculty of Education, Kastamonu, Turkey*
Mehmet Altan Kurnaz, *Kastamonu University, Faculty of Education, Kastamonu, Turkey*
Steven S. Sexton, *University of Otago, College of Education, New Zealand*

*Corresponding Author: bdaltunoglu@kastamonu.edu.tr

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Abstract

In the literature, pre-service primary school teachers' low levels of self-efficacy in science and science teaching are frequently expressed. Self-efficacy beliefs of pre-service teachers have a major role in future teaching practices and have a reciprocal interaction with their motivational beliefs. This study researched pre-service teachers' motivation to choose the teaching profession and their science teaching self-efficacy. Participants consisted of 181 pre-service primary teachers at a university in the Western Black Sea Region of Turkey. The 'Science Teaching Efficacy Belief Instrument' (STEBI-B) and the 'Motivation Scale for Profession and Field Selection'(MSTPFC) were used for this research. The study was conducted in the 2013-14 and 2014-15 academic years. The results indicate that intrinsic motivation correlated positively to the student's proficiency perception in their own science teaching. The study has shown how these characteristics positively contribute to the preparation of primary teacher candidates' competencies in terms of self-sufficiency, motivation, self-confidence, interest, need, and belief.

INTRODUCTION

In the scope of science teaching in Turkey, it is now expected that primary teachers create a teaching environment that encourages their students to be more active in their participation in the learning process (MoNE, 2018). Moreover, teachers are also expected to seek alternative and creative ways to improve their students' performance. The newly established Turkish science curriculum for primary school states the teacher's role as:

... the integration of science with mathematics, technology, and engineering is aimed to enable students to look at problems from an interdisciplinary point of view. In this context, the role of teachers is to guide pupils to integrate science, technology, engineering, and mathematics. In this way, it is expected that students achieve high-level thinking, product development, invention, and innovation. (MoNE, 2018, p. 10)

According to the TIMSS-2015 results, Turkish fourth-grade students could not communicate and apply scientific knowledge of life, physical, and earth sciences to their everyday experiences nor could they understand abstract concepts. In addition, these students were insufficient in demonstrating knowledge of scientific inquiry (Yıldırım, et al. 2016). To meet the Ministerial expectations and address students' low achievement in science, qualified

teachers are required with the necessary skills in both science teaching and their own science subject matter knowledge.

In contrast to some higher-income countries, in developing countries such as Turkey, the quality of teachers was found to be one of the most influential factors in the achievement of primary school students (Heyneman & Loxley, 1983; McEwan, 2015). Therefore, the importance of investigating those teacher characteristics that might be influential on the successful fulfilment of their teaching duties has been reported (Klassen & Tze, 2014). The successful fulfilment of a task, duty, or assignment depends on the self-efficacy, motivation, and self-confidence of both the students and teachers. The effects of these factors on achievement, attitude, and professional choice have been examined (Anderson, et al., 1988; Boz & Boz, 2010; Morris, et al., 2017; Özbaş, 2014). Given the positive effect of self-efficacy and motivation on increasing success (Klassen & Tze, 2014; Yazıcı, 2009), teachers should have a high level of self-efficacy and motivation for the successful fulfilment of their tasks. In particular, with their role of facilitating the learning process, one might expect teachers to have high self-efficacy perceptions concerning their teaching knowledge (Bandura, 1997) and high professional motivations (Atav& Altunoğlu 2013).

Research has noted that a strong predictor of behaviors in competent teachers is their self-efficacy (Boz & Boz, 2010; Palmer, et al., 2015). In addition to self-efficacy, a teacher's motives for choosing the teaching profession are important since self-efficacy beliefs and motives have a reciprocal interaction. The motives of an individual are influenced by their beliefs regarding their own capabilities in addition to their interests and aims (Seifert & Sutton, 2010). On the other hand, individuals who are intrinsically motivated to choose the teaching profession have reasons based on their own interests, joy, or inherent contentment (Ryan & Deci, 2000). As such, are intrinsically motivated pre-service teachers more enthusiastic about developing their teaching skills during their teacher education? Is there a measurable relationship between intrinsically or extrinsically motivated teachers with their self-efficacy beliefs in teaching? While Klassen and Tze (2014) argued that there should be studies aimed to uncover links between motivation beliefs and job performance, this current study focused on whether there existed a relationship between student teachers' motives for their career choice and their self-efficacy beliefs. However, as Bandura (2006) stated, there is no all-purpose of measure of self-efficacy beliefs since it limited the explanatory and predictive power of research. He explained this assertion as such:

> *One cannot be all things, which would require mastery of every realm of human life. People differ in the areas in which they cultivate their efficacy and in the levels to which they develop it even within their given pursuits* (Bandura, 2006, p. 307).

From this point of view, researching pre-service primary teachers' beliefs in general teaching self-efficacy could be issued as a limiting factor since they teach their students a variety of contents, such as grammar, mathematics, science, social studies, etc. To escape from this limiting factor, more specifically, primary teachers' self-efficacy beliefs in science teaching should be researched since the studies have reported that many primary teachers have difficulties in science (Bursal, 2010; Koc & Yager, 2016; Martinez Torregrosa, et al., 2018; Palmer et al., 2015; Wang, et al., 2015). For instance, Buss (2010) indicated that pre-service primary teachers' teaching efficacy was lower for science and mathematics than for other curriculum subjects. Similarly, Tosun (2000) reported that some primary teachers had difficulties in teaching science while others were afraid of this subject.

As mentioned above, teacher education is one of the most effective factors in Turkish educational output therefore, recruitment of appropriate individuals for the teaching profession is critical. In Turkey, teachers study at a Faculty of Education. The student selection for universities is administered countrywide by a single central examination system. Primary teacher training programs require a minimum examination score. This score is comprised predominantly of the mathematics, social sciences, and Turkish (literature and grammar) sections of this exam. The contribution from the science component is limited. As a result, most of the students who select primary teacher training focus their preparation on the more dominant sections of the exam. During their teacher training study, however, primary teacher program students have to take science and science education courses.

In contrast to many higher-income western countries, in Turkey, the teacher shortage is less prominent as students continue to prefer teaching as a career (Özdoğan Özbal & Gökçe, 2018). Students are applying to the various teacher-training programs even though there are numerous graduates still waiting for employment by the Minister of National Education (Kılınç, Watt, & Richardson, 2012). One reason for this persistent demand for teacher education might be the job security offered by the teaching profession. In many developing countries, being a teacher has emerged as an option for young people from lower-income families (Mooij, 2008; Stromquist et al., 2013). Kılınç et al. (2012) pointed out that most teacher candidates in Turkey come from middle to low-socioeconomic-status backgrounds. While this career provides a low income, it does provide a high level of job security. Because of this job security, it seems that in Turkey not all the individuals choosing teacher-training programs may have done so for intrinsic reasons. In accordance with this, Özdoğan et al. (2018) stated that the recruitment policies of Turkey reduce the quality of teachers since it affects directly the vocational motivations of teachers. As such, the career choice motives and self-efficacy beliefs of pre-service primary teachers may be questionable.

In this regard, the aim of the present study was to examine the correlation between pre-service primary teachers' motivations for their choosing the teaching profession and their self-efficacy in science teaching.

Self-Efficacy Beliefs and Motivation for Choice of Teaching Profession

Self-efficacy beliefs are based on Bandura's social cognitive theory (Bandura, 1997). According to Bandura, people perceive themselves as either competent or incompetent to be able to achieve a course of action and therefore they hold some beliefs about their own self-abilities. This belief about self-ability is one's own personal efficacy, in addition, the beliefs about one's expectations regarding the desired results are known as outcome expectancy (Bandura, 1997). As a result, an individual's beliefs about their own self-abilities determine their self-efficacy (Bandura, 1977a, 1977b).

In the education domain, self-efficacy can be explained as a teacher's personal belief in their competence to execute teaching tasks at a particular level of quality in a classroom environment (Rouweler, 2016). In the scope of the teaching profession, as a personal trait, self-efficacy has been widely evaluated. In previous studies, both pre-and in-service teachers' commitment to the teaching profession, their students' achievement, the quality of their teacher-student relationship, teacher training, student teachers' academic achievement etc. have been investigated in relation to self-efficacy (Chesnut & Burley, 2015; Klassen & Tze, 2014; Martins, et al., 2015; Zee, et al., 2017; Tomšik, 2019).

It should be noted that not all science courses or research interventions have had a positive influence on self-efficacy beliefs in science teaching (Cakiroglu, et al, 2012). Specifically, Woolfolk Hoy, et al. (2009) asserted that the self-efficacy of teachers was more or less resistant to change because their self-efficacy had already been shaped. Additionally, Bergman and Morphew (2015) have stressed that one should not attribute statistically significant differences between pre-and post-survey science teaching self-efficacy beliefs solely to educational treatment, other lurking variables should be considered, especially, the diversity of participants' backgrounds. In this scope, the motivation regarding the choice of teaching profession would be influential on self-efficacy beliefs, since motivation regarding the choice of teaching profession would shape one's career track. For instance, individuals, who are motivated intrinsically to choose the teaching profession, would be more enthusiastic to develop their abilities and knowledge in subject matter and teaching. Based on their research, Watt and Richardson (2008) found that the motivation to teach, beliefs about the profession, and satisfaction with career choices were closely linked to the pre-service teachers' professional commitment and career development desires. In this context, the studies subjected to investigate the students' motivations, which were relevant to the choice of the teaching profession, are reviewed. For instance, Çermik, et al. (2010) stated that pre-service primary teachers' reasons for teacher training were shaped firstly by mercenary reasons, secondarily extrinsic, thirdly intrinsic, and finally altruistic reasons. Those authors defined the mercenary reasons in the context of economic benefits and working conditions. The reasons for normative characters such as "family demands to choose teaching as a career" or "prestige of teaching profession in society", were grouped by authors under extrinsic reasons. In the same manner, Kiziltepe (2015) analyzed student teachers' responses to the question "what is your primary motivation for choosing teaching as a career?" and reported: altruistic motivations (a worthwhile profession or career, helping children, and positively impacting upon their lives) had a response rate of 37%; extrinsic motivations (stable salary, immediate job, positive work climate) had a response rate of 31%; and, intrinsic motivations (personal satisfaction and improvement, getting a good education) had a response rate of 18%. From these results, it would appear that Turkish teacher candidates are motivated more by altruistic and extrinsic reasons. In contrast to Kiziltepe (2015), One-quarter of Ozturk Akar's (2012) participants in her study on the motivation of pre-service teachers for choosing the teaching profession claimed that if their university entrance exam scores had been higher, they would have chosen a different career. In the Turkish context, the career choice of some individuals appears to be influenced by external factors. Although altruistic reasons are mentioned by studies as one of the reasons for choosing the teaching profession, such motives are valid not only for the teaching profession but also for other Turkish public service related professions. Therefore, this study's focus was only on intrinsic and extrinsic reasons.

In Turkey, there have been studies regarding motivation on choosing primary teacher as a career, but there has been no study that researches teaching career motivation in relation to self-efficacy beliefs in science teaching. It is especially important to remember that many primary school teachers demonstrate low self-efficacy in science teaching (Palmer et al., 2015) and therefore this tendency should be investigated regarding the reasons for these teachers' selection of the teaching profession. Thus, this study aimed to investigate pre-service classroom teachers' self-efficacy in science teaching and their motivation for choosing to become a teacher. The study's research questions were as follows:

1. How do pre-service primary teachers' motivation to choose the teaching profession vary?
2. How do pre-service primary teachers' self-efficacy beliefs in science teaching vary?

3. What is, if any, the relationship between pre-service primary teachers' motivation to choose the teaching profession and their self-efficacy beliefs in science teaching?

METHOD

Study Design

This research was designed on the fact that the motivations for choosing the teaching profession may also have a reciprocal relationship with the teacher's self-efficacy beliefs in science teaching which has been seen as a problematic issue regarding primary teacher candidates. In order to investigate this phenomenon, this study applied a descriptive research model in a quantitative manner.

Study Group

The research involved 181 third-year pre-service teachers studying primary teaching at a university in the Western Black Sea Region of Turkey. Measurement tools were administered at the end of the science teaching courses during both the 2013-14 and 2014-15 academic years. Table 1 presents the demographic characteristics of pre-service classroom teachers participating in the research. For both participating student teacher cohorts, the structure of their training program and the university entrance system was identical. Before conducting the research, the ethical aspect of the study was confirmed by faculty management. All participants were made aware that participation in the study or withdrawal at any time was at their own discretion
Students who successfully completed science courses and science teaching courses were selected for the study: General Biology, General Chemistry and General Physics. Each science course was taught for two hours per week for one semester (14 weeks). The General Biology and General Chemistry courses were offered in the first year of this primary teacher-training program. The General Physics course was offered in the second year. The science-teaching course was delivered over three hours per week for both semesters of the third year. In this programme, the student teachers must complete the science content component of the programme before undertaking the science teaching component. The data collection of the current study was conducted after the student teachers had successfully completed their science teaching course.

Table 1. Demographic characteristics of the study group

Variables	Categories	(%)
Gender	Female	77
	Male	23
Type of high school attended	General High School	54
	Anatolian High School	46
Mother's educational status	Primary School	75
	Lower-secondary School	9
	Upper-secondary School	11
	University	5
Father's educational status	Primary School	40
	Lower-secondary School	13
	Upper-secondary School	24
	University	23

	2.0-2.5	11
GPA	2.6-3.0	44
	3.1-3.5	36
	3.6-4.0	9

It is tought that the demographical characteriscs of the study group appopitrates with the aimns of the research as seen at Table 1.

Data Collection Tools

A three-part measurement tool was used. The first part of the measurement tool gathered demographic and personal information from each pre-service primary teacher to include: gender, type of high school graduation, and their academic average (GPA). The second part of the measurement tool included the 'Motivation Scale on Teaching Profession and Field Choice' (MSTPFC) to identify each pre-service teacher's motivation for choosing the teaching profession. The final part involved the 'Science Teaching Efficacy Belief Instrument' (STEBI) to determine each pre-service teacher's self-efficacy.

Riggs and Enochs (1990) developed the 'Science Teaching Efficacy Belief Instrument' (STEBI-A) in order to measure in-service primary teachers' self-efficacy beliefs in science teaching. This scale was constructed as context-specific and subject matter in accordance with Bandura's theory of self-efficacy and is a 5-point Likert-type scale. Enochs and Riggs (1990) modified the STEBI-A into STEBI-B which was appropriate for primary teacher candidates. The STEBI-B form consists of two subscales: Personal Science Teaching Efficacy Belief Scale and Science Teaching Outcome Expectancy Scale.

The modified STEBI-B was translated into Turkish by Bıkmaz-Hazır (2002). The internal consistency of subscales of the Turkish STEBI-B was calculated at .86 (.71 for the current study) for the Efficacy Belief Scale and .69 (.60 for the current study) for the Outcome Expectancy Scale (Bıkmaz-Hazır, 2002). The 'Motivation Scale on Teaching Profession and Field Choice' (MSTPFC) developed by Mayr (1998) was adapted for the Turkish population by Atav and Altunoğlu (2013). A pilot study of this scale was conducted with two separate groups consisting of 587 teacher candidates. In this pilot study, both explanatory factor analysis (EFA) and confirmatory factor analysis (CFA) were used. According to the results of EFA, it was determined that the scale consists of four subscales: Intrinsic Reasons for Profession Choice (IRPC), Intrinsic Reasons for Field Choice (IRFC), Extrinsic Reasons for Profession Choice (ERPC), and Extrinsic Reasons for Field Choice (ERFC). The structure of the instrument with four subscales was confirmed according to CFA results. Fit index values were found as follows: GFI=.90, AGFI= .87, NNFI= .95, CFI= .96, RMSR= .091, SRMSR= .061, and RMSEA= .064. This scale is a 5-point Likert type.

Data Analysis

Mean and standard deviation values were used in the description of continuous data obtained through the MSTPFC and STEBI. The categorical data for the study group was presented under two different categories: socio-demographic (gender, settlement unit, parental occupation, and income) and academic (type of upper-secondary school and GPA).

The multivariate analysis of variance (MANOVA) was used in the analysis of the dependent variables obtained through the Motivation Scale and STEBI in terms of socio-demographic and academic independent variables. The Pearson correlation coefficient was calculated for the

determination of the correlation between the self-efficacy perception of science teaching and the choice to pursue the teaching profession.

FINDINGS

This study examined pre-service classroom teachers' motivations for choosing the teaching profession and their self-efficacy in science teaching.

Results Regarding the Reasons for the Choice of the Teaching Profession

As seen in Table 2, female pre-service teachers demonstrated the highest proportion in terms of their intrinsic reasons for choosing their profession and field, while male pre-service teachers were more prominent in terms of their extrinsic reasons.

Table 2. Analysis of the subscale scores of the MSTPFC

Variables		Factors							
		IRFC		IRPC		ERPC		ERFC	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Gender	Female	4.12	.76	4.39	.56	2.95	.88	3.64	.88
	Male	3.80	.79	4.00	.88	3.01	.88	3.79	.89
Mother's educational status	Primary school	4.06	.77	4.29	.65	3.71	.86	2.98	.90
	Lower-secondary	3.91	1.01	4.46	.59	3.69	1.05	2.85	.86
	Upper-secondary	3.97	.64	4.30	.63	3.45	.91	2.88	.81
	University	4.17	.65	4.19	.82	3.53	.98	3.13	.76
Father's educational status	Primary school	4.10	.75	4.33	.65	3.67	.94	2.97	.92
	Lower-secondary	3.99	1.04	4.46	.64	3.67	.92	2.82	.94
	Upper-secondary	3.92	.81	4.23	.62	3.83	.85	3.06	.82
	University	4.12	.58	4.23	.69	3.52	.80	2.92	.84
GPA	2.0-2.5	4.05	1.06	4.33	.65	3.56	1.25	2.90	1.12
	2.6-3.0	3.93	.72	4.20	.63	3.62	.86	2.90	.83
	3.1-3.5	4.19	.65	4.40	.54	3.75	.80	3.09	.88
	3.6-4.0	4.02	1.00	4.31	1.03	3.78	.83	2.82	.80
Type of high school attended	General high school	4.16	.67	4.40	.55	3.72	.94	2.94	.96
	Anatolian high school	3.92	.86	4.18	.74	3.61	.81	3.00	.77

MANOVA was used to determine any differences in the motivation for the selection of profession and field according to demographic variables. Box's M test was performed for the variance-covariance equation, and the sample was found to be appropriate for the analysis (Box M = 116.730 p> .05). According to the result of MANOVA, Wilks' λ was λ= 0.905 $F_{(4, 102)}$ =

2.665 p< .05, the partial eta squared = .095 for the variable gender, Wilks' λ= .812 $F_{(12, 270)}$ = 1.846 p < .05, and the partial eta squared = .067 for the variable GPA, and Wilks' λ= .641 $F_{(12, 270)}$ = 4.126 p < .05, with the partial eta squared = .138 for the interaction of the variables gender and GPA. Accordingly, there were statistically significant differences in the pre-service teachers' reasons for selecting their profession and field in terms of gender, GPA, and the interaction of both variables. A follow-up analysis was conducted to determine which subscale/subscales demonstrated differences in profession and field choice according to gender. The analysis results are presented in Table 3.

Table 3. Results of ANOVA concerning the follow-up test

Source	Dependent variables	*df*	KO	*F*	*p*	Partial η^2
Gender	**IRFC**	**1**	**2.670**	**5.432**	**.022**	**.049**
	IRPC	**1**	**2.630**	**10.047**	**.002**	**.087**
	ERFC	1	.080	.097	.756	
	ERPC	1	.055	.076	.783	
GPA	IRFC	3	.429	.873	.458	
	IRPC	**3**	**0.858**	**3.280**	**.024**	**.086**
	ERFC	3	.346	.420	.739	
	ERPC	3	1.665	2.293	.082	
Gender*GPA	IRFC	3	1.311	2.668	.051	
	IRPC	**3**	**2.256**	**8.619**	**.000**	**.198**
	ERFC	3	.792	.962	.414	
	ERPC	**3**	**3.172**	**4.368**	**.006**	**.111**

As seen in Table 3, gender was a source of difference between pre-service teachers in terms of IRFC and IRPC scores. However, given the values of η^2, it is clear that this difference has a low effect value. According to the results of the follow-up test concerning the variable GPA, this independent variable serves as a source of difference in pre-service teachers' IRPC scores, and the effect value of this difference is low. The interaction of the variables of gender and GPA was a source of difference in IRPC and ERPC scores, and the effect size was low based on η^2 values. The statistically significant interaction between the variables of gender and GPA indicated that the effect of GPA varies by gender. Therefore, the variation of IRPC and ERPC scores affected by the interaction of both independent variables was examined through graphs.

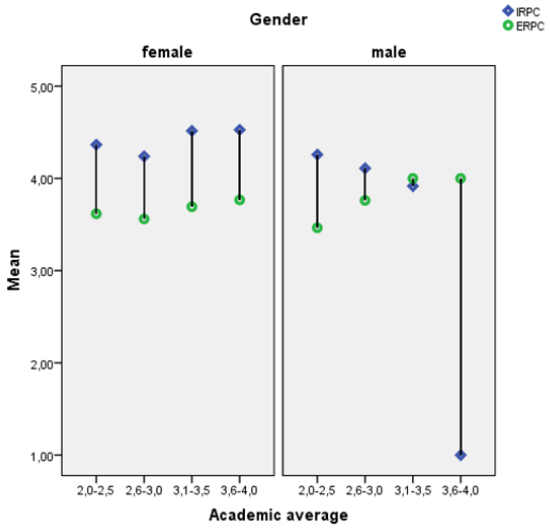

Figure 1. The variation of IRPC and ERPC scores by GPA among female and male pre-service teachers

Figure 1 shows the variation of intrinsic and extrinsic reasons for the profession choice of female and male pre-service teachers according to GPA; as the GPA increased, IRPC scores increased in female pre-service teachers, whereas ERPC scores increased in male pre-service teachers.

Results Regarding Self-Efficacy in Science Teaching

Table 4 shows the variance of pre-service teachers' scores of the STEBI by gender, GPA, and type of high school from which the participant graduated.

As seen in Table 4, the scores of the STEBI subscales vary by gender and GPA. MANOVA was used to determine whether this difference is statistically significant.

Table 4. Results of STEBI according to gender and academic variables

Variables		STEBI Subscales			
		Efficacy Belief		Outcome Expectancy	
		M	*SD*	*M*	*SD*
Gender	Female	3.45	.40	3.68	.46
	Male	3.38	.37	3.68	.37
GPA	2.0-2.5	3.34	.43	3.74	.49
	2.6-3.0	3.42	.40	3.64	.46
	3.1-3.5	3.46	.38	3.69	.42
	3.6-4.0	3.50	.43	3.72	.39
Type of Upper-secondary School	General high school	3.45	.38	3.66	.47
	Anatolian high school	3.42	.41	3.70	.41

According to the results of MANOVA, Wilks' λ was λ= .989 F(2, 165) = .904 p > .05 for the variable gender, λ= .983 F(2, 330) = .466 p > .05 for GPA, and λ= .997 F(2, 165) = .283 p > .05 for the type of upper-secondary school from which the participant graduated. Accordingly,

there was no significant difference in the pre-service teachers' scores from the STEBI subscales with respect to the independent variables.

Results Regarding the Correlation Between MSTPFC and STEBI Scores

The relationship between pre-service teachers' self-efficacy in science teaching and their reasons for their choice of the teaching profession was determined to calculate the coefficients of the correlation between the Subscales of the Motivation Scale and STEBI. The correlation coefficients are presented in Table 5.

Table 5. Correlation Coefficients between the Subscales of the Motivation Scale and STEBI

Correlation Coefficients		
	Efficacy Belief	Outcome Expectancy
IRFC	.367**	.147*
ERFC	.013	.155*
IRPC	.175*	.153*
ERPC	.025	.198**

** Correlation was significant at .01
* Correlation was significant at .05

As presented in Table 5, a positive significant correlation was found between the IRFC and IRPC scores of the Motivation Scale on the one hand and the Efficacy Belief scores of the STEBI on the other.

DISCUSSION

The present study examined the effects of variables on pre-service teachers' motivation for the selection of the teaching profession and their self-efficacy in science teaching. The parents' educational background, one of the independent variables, was evaluated in relation with motivation to choosing the teaching profession, while academically relevant variables such as GPA and type of upper-secondary school were assigned as the independent variables were interpreted with self-efficacy beliefs in science teaching. It also examined the relationship between their reasons for their profession choice and science teaching self-efficacy.

According to the results, a significant difference was found in the selection of the teaching profession and primary teaching as a specific teaching field in terms of gender and GPA and the interaction of the two variables. By examining the subscales of the Motivation Scale with respect to gender, the study revealed a significant difference with a low effect size in the dependent variables of IRFC and IRPC (see Table 3). Considering the mean scores of the Motivation Scale, the female pre-service teachers' intrinsic reasons for their profession and field choice were significant in the selection of primary teaching. These subscales demonstrated that the variable of GPA was a source of significant difference, with a low effect size present only in IRPC scores. The variables of gender and GPA together seem to be a source of significant difference, with a low effect size in both IRPC and ERPC scores (see Table 3). It is suggested that further studies be carried out with wider participant groups because the effect size of the differences discovered in the analysis is small. However, the analysis performed in this study may contribute to future research.

The research results revealed that female participants intentionally selected primary teaching as a future profession and achieved high GPAs in their studies. Among male pre-service teachers, as their GPA increased, their extrinsic reasons for profession choice appeared to become more

evident. This result could be explained by the fact that in Turkey primary teaching is specifically associated with women. Male pre-service teachers who were academically successful may demonstrate hesitation to commit to a career in the field because of social factors such as potential employment and appointment. Female pre-service teachers were more likely to demonstrate high motivation to engage in their profession as a result of the combination of inner satisfaction and academic achievement. However, it seems less likely for male pre-service teachers to engage in their profession with high motivation, even if they attain academic achievement. Previous research has also revealed similar results in that female pre-service teachers choose the teaching profession for altruistic reasons that could be regarded as intrinsic reasons, while male pre-service teachers prefer it for more extrinsic reasons (Yüce, et al., 2013). Therefore, it can be suggested that male pre-service teachers are subjected to orientation training for such situations in the pre-service period. Liu and Onwuegbuzie (2014) have suggested that the selection of teaching profession for intrinsic reasons influences professional satisfaction in both developing and developed countries, and thus the motivation of student teachers and prospective teachers as well as their qualifications should be taken into account. Agbaria (2013) has researched the level of decisiveness the participants demonstrated when choosing their profession and found a low positive relationship between self-determination in choosing a profession and academic motivation. This perspective suggests that career choices are driven by intrinsic motivation and the tendency to make positive contributions both during the pre-service education period and during the in-service period. This positive contribution is likely to manifest itself in people's self-efficacy beliefs, both in their academic and professional careers.

The results concerning the science teaching self-efficacy of the participant pre-service teachers indicate no significant difference with respect to independent variables. Accordingly, there should be no expectation of a difference regarding science teaching in terms of independent variables such as gender, GPA, and type of high school attended, and the training of pre-service teachers should be structured accordingly.

Self-efficacy has an effect both on professional satisfaction in teaching and on professional attendance and continuity during the participants' in-service period (Klassen & Chiu, 2010; Chesnut & Burley, 2015). Thus, the present study examined pre-service classroom teachers' self-efficacy in science teaching and their motivation to choose a teaching profession and considered these factors together. Upon observing the relationship between participants' self-efficacy and reasons for profession choice, significant relationships were found in some of the subscales. A positive but weak relationship was discovered between the intrinsic motivations for the choice of classroom teaching profession and field and science teaching efficacy beliefs (see Table 5). A positive but weak correlation was observed between the participants' intrinsic reasons for their field choice and the science teaching efficacy beliefs as well as a weaker positive relationship between the intrinsic reasons for profession choice and efficacy beliefs (see Table 5). These results point to the assertion that participant pre-service teachers who take into account their intrinsic reasons to select their profession and field perceive themselves as more qualified for their required performance during training. This finding is likely to be reflected in their working life. However, it should also be noted that there was no significant relationship between their extrinsic reasons for their profession and field choice and their efficacy beliefs. Thus, when pre-service teachers prefer the teaching profession for intrinsic reasons, it seems more likely that they will be efficacious in their science teaching practice.

The outcome expectancy subscale of the STEBI showed a positive and statistically significant but weak correlation with both the intrinsic and extrinsic reasons for profession and field choice

on the MSTPFC. Based on these results, it is expected that pre-service teachers who have chosen to become teachers for intrinsic reasons have greater beliefs that they will obtain positive results from science teaching. However, pre-service teachers who take into consideration extrinsic reasons do not demonstrate positive outcome expectations for science teaching. This finding may indicate that those in the latter group, on the one hand, do not perceive themselves as possessing sufficient knowledge of science (no correlation was found between efficacy belief and extrinsic reasons for profession and field choice), while on the other hand, they have positive beliefs that their training and education in science will somehow yield positive results. It may also indicate the pre-service teachers' belief that they have the knowledge of science necessary for primary school-level teaching, although they do not have sufficient knowledge of the field.

In terms of given the results above, summarily, it may highlight that there is a gender difference in their motivation to become a teacher, and also, this difference is not observed in science teaching self-efficacy. However, there is a need for further research on pre-service classroom teachers and their perceptions of the basic concepts of science they will be responsible for teaching.

CONCLUSION AND IMPLICATIONS

The evidence indicates that the career choice motivation of female primary teacher candidates is shaped more intrinsically. These results could be expected due to the social structure of Turkey. Like many other developing countries, in Turkey, more women are oriented in the teaching profession than in many other professions. Other relevant results of the research are related to academic achievement and gender in relation to profession choice motivation. In contrast to female candidates, as the academic achievement gets higher, male teacher candidates' motivation is oriented more extrinsically. Certainly, this gender contrast could be attributed to this study's group of student teachers. Therefore, a further study that seeks to research this gender contrast in academic achievement and profession choice would be suggested. One of the relevant results is the relationship between the career motivation of primary teacher candidates and their self-efficacy belief in science teaching. Considering the issues regarding self-efficacy beliefs in science teaching of primary teacher candidates in the literature, intrinsically motivated teacher candidates are more confident in science teaching efficacy. From this view of point, an interview is suggested during the selection of the students for teacher training recruitment in order to select more intrinsically motivated individuals.

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Performance Scale Development Study for Science-Chemical Laboratory Applications

Özge Göktürk, *Mersin University, Faculty of Education, Department of Mathematics and Science Education, Department of Science Education, Mersin, Turkey*
Nezaket Bilge Uzun, *Mersin University, Faculty of Education, Department of Educational Sciences, Department of Measurement and Evaluation in Education, Mersin, Turkey*
Mehtap Aktaş*, *Kafkas University, Faculty of Education, Department of Educational Sciences, Department of Measurement and Evaluation in Education, Kars, Turkey*

*Corresponding Author: mhtpaktas@gmail.com

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Abstract

This study aimed to develop an analytical rubric that measures performance levels for Science/Chemistry Laboratory Applications and to examine its reliability with generalizability theory. The study group consists of 18 grade 5-6 secondary school students in formal education, taking science or chemistry laboratory courses in a science and art center in the 2020-2021 academic year. In addition, the laboratory performances of students were scored simultaneously by three expert raters, using an analytical rubric. In addition, during the development process of the rubric, the opinions of eight experts were obtained when determining and arranging performance indicators and performance levels. It was determined that the scale developed with the findings obtained from the performance scale development study yielded valid, reliable, and generalizable results in determining the performance of students who attended science/chemistry laboratory practices. In this context, it is thought that the use of this scale, which was developed to evaluate the students' performance in secondary school science/chemistry laboratory practice courses, will provide valid and reliable measurement results and will make the evaluation process more objective.

INTRODUCTION

Science tries to describe and interpret the events taking place in nature to find the facts of nature. In this respect, science can be interpreted as human beings' attempt to understand themselves through nature (Collette, 1989). In the self-recognition process, people tend to do research to describe and interpret events. Novak (1964) defined research as an effort to find logical explanations for events that individuals are curious about. Therefore, doing research is an effort to eliminate curiosity. Laboratories are the environments that provide students with the opportunity to practice this effort by systematizing it. For this reason, laboratory applications have an important place in science education (Lunetta, 1998; Saunders, 1992).

Laboratory practices are practical learning environments where the concepts desired to be learned are transferred to the learners through first-hand or demonstration methods (Tezcan & Aslan, 2007). Since the main purpose of laboratory applications is the realization of meaningful

learning, the active participation of students in the process, their taking responsibility, and the realization of learning by doing (Aksoy & Doymuş, 2011; Nakiboğlu & Meriç, 2000), science educators suggest that frequent laboratory activities will have many benefits on learning (Hofstein & Lunetta, 1982).

The techniques used in science laboratory applications have an important place in learning the target information (Leach, 1998). As a classical approach in science laboratory practices, there are traditional laboratory practices in the "recipe type" where verification-type experiments, that is, high cognitive levels, do not need to be employed (Jackson, 2004). Kaptan (1999) stated that traditional laboratory practices are used to prove the information found in books. However, it was also stated that it did not contribute to the structuring of scientific knowledge in students (Renner, 1986; Aktamış, 2007). On the contrary, it is stated that in applications where alternative laboratory approaches are used, students construct their knowledge by evaluating and constructing the knowledge they have learned through experiments and developing scientific thinking and critical thinking skills (Wyatt, 2005; Rehorek, 2004; Jackson, 2004; Lunetta & Tamir, 1978; Ergin, Şahin-Pekmez, Öngel-Erdal, 2005). Therefore, for permanent and effective learning to take place, using alternative approaches by creating environments where student-focused activities can be designed and implemented becomes of great significance (Lapadat, 2000; Costa, 1985; Birinci, Sezen, & Tekbıyık, 2010). Therefore, effective science education necessitates laboratory practices and environment prepared according to the constructivist approach, in which students can learn the desired learning outcomes through practice and will be responsible for their own learning related to their daily life. In the constructivist learning approach, which is the basis of alternative learning approaches in science education, students are guided to find solutions to problems by interacting with their environment (İlhan, 2013; Geraldo, Jofili, & Watts, 1999). According to this approach, students should be at the center of the learning process, while teachers should guide students on how to construct knowledge (Liang & Gabel, 2005).

As a result of the literature research on laboratory applications in science education, it is seen that various studies have been carried out on the subject. These include evaluation of science laboratory applications (Uluçınar, Cansaran & Karaca, 2004; Ayas, Karamustafaoğlu, Sevim & Karamustafaoğlu, 2002), opinions about the usability of teaching model in science laboratory (Bozdoğan & Altunçekiç, 2007), self-efficacy in laboratory utliziation (Kılıç Mocan, Keleş, & Uzun, 2015; Kaya, Böyük, 2011; Boyuk, Demir, Erol, 2010; Akdemir, 2006; Yurdatapan, 2013), evaluation of science laboratory use (Güneş, Dilek, Topal, & Nesrin, 2013), opinions on the use of science laboratories (Demir, Böyük, Koç, 2011; Kocakülah, Savaş, 2011; Kılıç, Aydın, 2018), difficulties encountered in the chemistry laboratory (Aydoğdu, 1999), competencies in using science laboratory materials (Çoştu, Ayas, Çalık, Ünal, Karataş, 2005; Korkmaz, 2000), views on science laboratory applications (Uluçınar, Doğan, Kaya,2008; Karamustafaoğlu, 2012; Uzal, Erdem, Önen, Gürdal, 2010), attitude towards science experiments (Yıldız, Akpınar, Aydoğdu, & Ergin, 2006; Alkan, Erdem, 2013; Karatay, Doğan, Şahin, 2014; Taşlıdere, Korur, 2012), success in science experiment applications (Alkan, Erdem, 2013; Tezcan & Bilgin, 2004), the effect of science laboratory on academic achievement (Ayvacı & Durmuş, 2016), and the use of V Diagram in science laboratory (Meriç, 2003; Nakiboğlu, Meriç, 2000; Nakiboğlu, Benlikaya, & Karakoç, 2001).

It is seen that there is a tendency towards the use of the traditional evaluation approach in studies conducted for the evaluation of science or laboratory studies, but the adoption of alternative measurement methods is seen as an important method or tool in terms of process evaluation (MEB, 2005). It is argued that traditional assessment measures low-level cognitive knowledge,

whereas performance assessment, which is one of the alternative assessment types, aims to measure high-level cognitive knowledge and competencies (Aydın & Karaçam, 2015).

Performance can be expressed as a service, situation, or idea that is put forward for the realization of a task that is expected or desired to be performed in line with the determined criteria (Pugh, 1991). When examined on the basis of education, performance can also be defined as psychomotor skills such as playing a musical instrument, doing sports, and using a microscope (Turgut & Baykul, 2010; Helvacı 2002). When measuring and evaluating the performance, it is expected that the relevant behavior is done, not explained. In behavioral measurements, in order to reveal the behavior, the measurement is made by observing all the performance steps or the product revealed as a result of the behavior (İşman, 2001). In performance measurement and evaluation processes, checklists revealing whether performance exists, rating scales that reveal the degree as well as the existence of the behavior (Dalkıran, 2006), and holistic and analytical rubrics that allow more objective measurement-evaluation can be used. Rubric is one of the most widely used measurement tools in performance evaluation. It is seen as an important tool in minimizing the biases that may occur during scoring and obtaining more realistic results regarding performance (Parlak & Doğan, 2014). According to Popham (1997), rubric consists of three parts: evaluation criteria, criterion definitions, and scoring strategy. Evaluation criteria are used to distinguish between acceptable and unacceptable answers, criteria definitions are used to identify qualitative differences in students' answers, and a scoring strategy is used to determine the path followed for scoring (analytical or holistic rubrics). Since holistic rubrics focus on the whole process, they are used to make a general judgment about the quality of the performance and are more convenient for evaluating the results (Jonsson & Svingby, 2007). Analytical rubrics, on the other hand, have restrictive performance characteristics when compared to holistic rubrics and can make process evaluation in more detail (Sezer, 2005). Each performance criterion or skill that an individual is expected to demonstrate is evaluated independently within the framework of defined criteria (Çepni, 2011).

Laboratory practices are also activities in which students are active and have to demonstrate performance, as they include stages such as planning, observation, data collection, conclusion, and evaluation. Therefore, it is necessary to evaluate the performance of students. One of the biggest shortcomings when evaluating the performances exhibited in these applications is the use of appropriate measurement tools, and the second one is not using a reliable and valid measurement tool. For example, evaluating laboratory applications through paper and pencil exams prevents students' involvement in scientific research stages. This is because there is a big difference between explaining how to do an experiment in writting and applying it. Evaluation of laboratory applications while practicing is considered important in terms of allowing students to analyze their results (Hilosky, Sutman, Schmuckler, 1998; Goh, Toh, & Chia, 1989). Silberman, Day, Jeffers, Klanderman, Phillips, and Zipp (1987) stated that in order to evaluate the performance of laboratory applications, performance measurement can ensure that the laboratory practitioner is successful in reaching the goal and that the student can achieve permanent learning by improving their higher-order skills in practice. They determined that using a tool for evaluating laboratory practices makes students more willing to actively participate in practices.

Suits (2004) emphasized the importance of performance assessment tools in the assessment of high-level research skills as they provide useful feedback on the quality of laboratory practice exams, and developed an assessment rubric consisting of six components to evaluate laboratory practice. When Panadero and Jonnson's (2013) studies on the use of rubrics are examined, it is

observed that using rubrics eliminates evaluation bias, gives more accurate feedback, reduces assessment anxiety in learners, and helps improved performance.

When the international and national literature on laboratory practices and evaluation is examined, it is seen that various methods are used to make laboratory practices more educative and effective (Arnold, 2003; Exstrom and Mosher 2000; Harle, Leber, Hess, Yoder, 2003; Selco, Roberts, Wacks, 2003; Criswell, 2006) but few of them have been observed to develop and use a performance scale for evaluation (Silberman et al., 1987; Hilosky et al., 1998; Suits, 2004; Arı, 2008). However, it has been determined that these scales are limited to certain applications. It was found that academic achievement tests or V diagrams are often used as an evaluation method (Meriç, 2003; Nakiboğlu, Meriç, 2000; Nakiboğlu, Benlikaya, & Karakoç, 2001), but there was no study on developing a valid and reliable performance scale for measuring laboratory practices in science education that incorporates the whole laboratory practice process into the assessment. Researchers suggest that performance-based assessment and evaluation methods should be used in order to fully evaluate the process (Darling-Hammond, 1994; Shepard, 2008).

Therefore, in this study, which addresses laboratory applications as performance evaluation processes, the development of a "rubric" for laboratory applications may close an important gap in the field. While developing measurement tools used in performance evaluation, such as rubrics, reliability between raters is generally taken as a basis (Atılgan, 2005; Atmaz, 2009; Deliceoğlu, 2009; Güler & Taşdelen Teker, 2015). In this study, the Generalizability Theory (GT), which gives information about both random and systematic sources of error and provides comprehensive reliability analyses in performance evaluation; was employed.

Unlike the classical test theory, GT provides a single reliability value by examining the effects of multiple error sources at the same time. The generalizability theory focuses not on the observed score or a specific measurement result, but on how the measurement results can be generalized to a much larger universe than a specific sample (Güler, 2009). In generalizability theory, it is possible to reach a single reliability value by considering the interaction of many error sources, and error sources within the scope of the study (Brennan, 2001). According to Shavelson and Webb (1991), the GT has four important features. 1) It deals with multiple sources of variance with a single analysis. 2) It determines the size of each variance source 3) It provides the calculation of two different reliability coefficients related to the relative decisions of the individuals (G coefficient) and the absolute decisions about the performance of the individuals (Phi coefficient) 4) It enables decision studies that can offer suggestions for arranging measurements in which the measurement errors are minimized.

GT provides comprehensive analyses by simultaneously evaluating the error from many sources of variability based on the within-group correlation coefficient, which enables the evaluation of reliability in behavioral measurements, the design, and research of reliable observations. GT means that the reliability of an observation depends on the universe from which conclusions are drawn. It deals with how sources of variability reflect the universe. In generalizability theory, the universe is a construct that the researcher considers, but it also provides findings on how well the observed scores represent the universe score. Interpreting how accurately the universe score is estimated from the observed score within the framework of these findings can also be considered as construct validity studies. For this purpose, GT-based analyses, which eliminate the difference between reliability and validity and focus on the generalizability of the measurement tool, were conducted in this study.

There are two basic stages in GT, namely Generalizability study (G-study) and the Decision study (D-study) (Goodwin, 2001). In the G-study, all sources of variability (variance components) and interactions involved in the study are estimated. In the D-study, these estimated variance components are optimized and the conditions for the most appropriate sources of variability are tried to be determined. In addition to the G-studies of this developed measurement tool, S-studies were also conducted to determine the most suitable conditions for the sources of variability.

In light of all these explanations, the aim of this study is to develop a reliable and valid analytical rubric that can enable the evaluation and comparison of application processes and results of students taking the science and chemistry laboratory applications course. In line with the aim, "developing analytical rubric that measures performance levels for Science/Chemistry Laboratory Applications and examining its reliability with generalizability theory and "conducting the decision study by manipulating the number of conditions belonging to the rater variability source", answers were sought to the following questions.

1. What are the variance components estimated for the individual, rater, task, and their interactions for the Science/Chemistry Laboratory Applications analytical rubric?
2. What are the reliability (G and Phi) coefficients of the scores obtained as a result of the analytical rubric evaluation of Science/Chemistry Laboratory Applications?
3. What is the effect of manipulating the number of raters with the D-study on the G and phi coefficients?

METHOD

Working Group

The study group consists of 18 grade 5-6 secondary school students in formal educations, who take science or chemistry laboratory courses in a science and art center in the Southeastern Anatolia Region in the 2020-2021 academic year. In addition, the laboratory performances of students were scored simultaneously by three expert raters using the analytical rubric, which was tried to be developed by the researchers through the process described in detail below.

In addition, during the development process of the rubric, eight experts' opinions were obtained when determinating and arranging performance indicators and performance levels, and these opinions were evaluated by the researchers.

Data Collection Tools

The following steps were carried out on the basis of the steps suggested by Goodrich (2001) and Andrade (1997) in the analytical rubric development process, which was prepared in order to evaluate the process of science and chemistry laboratory applications. The procedures related to this process are detailed below.

1. Literature review was conducted for the evaluation of science and chemistry laboratory process.
2. A review of the literature on performance evaluation was conducted.
3. The following steps have been followed in determining performance indicators and performance levels.

The performance indicators to be used in determining performance, 11 performance indicators were determined for six main tasks for the rubric of science and chemistry laboratory

applications. These tasks are preparation for the experiment, preliminary knowledge of the experiment, preliminary preparation of the experiment, the use of chemicals, the execution of the experiment, and the test result and report. The indicators determined depending on these tasks were determined by considering the behaviors expected from the learner in such laboratory practices. In determining the rubric to be used, it was preferred to use analytical rubrics in the research to be able to conduct the process evaluation in more detail by scoring. In the determination of performance levels, the performance levels were determined as excellent, acceptable, inadequate, and unobserved performance. A score of 3 was given when the performance expected to be observed was fully realized, and 0 was not realized at all.

4. A draft rubric was created.
5. The following steps were followed to receive and evaluate expert opinions and to finalize the draft rubric.

After the analytical rubric was prepared, the opinions of eight experts working at various universities were consulted. One of the experts works in the field of chemistry education (an associate professor), two of them conduct laboratory-based studies in science education and chemistry departments (professor and associate professor), one works in the field of analytical chemistry and teaches analytical chemistry laboratory applications, one works in the field of physical chemistry, teaches the physical chemistry laboratory applications course, one conducts studies in the field of food chemistry, one works in the field of organic chemistry and teaches the organic chemistry laboratory applications course, and one works in the field of measurement and evaluation and has scale development studies. The prepared analytical rubric was evaluated by eight experts in terms of both the tasks and the behavioral indicators of these tasks in terms of suitability and clarity to the target audience. As a result of these evaluations, a consensus was reached and a draft rubric was obtained.

6. Piloting the draft rubric
7. Conducting validity and reliability studies as a result of the pilot application
8. Finalizing the rubric.

Data Collection

The study data were obtained from 5^{th} and 6^{th}-grade students attending chemistry classes in the 2020-2021 academic years in a Science and Art Center located in the Southeastern Anatolia Region of Turkey. The subject of "Solution Preparation", which is among the activities of the students' chemistry laboratory applications, was chosen as a performance determination application. In line with the tasks in the prepared performance evaluation scale, the performance of each student was scored and evaluated independently by three different expert teachers, and the data were collected.

Analysis of Data

In the study, Generalizability Theory was used, which enables the determination of reliability by evaluating all error sources at the same time. Within the scope of GT, a G study was conducted on the main effects of student, task, and rater and the interaction effects depending on these sources of variability, and the variance components were estimated by G studies. In addition, G and Phi coefficients, which are important in making absolute and relative decisions regarding the developed rubric, were calculated. Then, the number of raters was manipulated and the D study was carried out, and suggestions were made for the appropriate number of raters.

Within the scope of the study, the sxtxr (student x task x rater) pattern in which all sources of variability are crossed; is used. In this design, all students (s); are in line with all the tasks (t) included in the rubric; rated by all raters (r). 18 students were evaluated simultaneously by three raters while performing 11 tasks. The G and D studies for the fully crossed "SxTxR" pattern were carried out using the EduG program.

FINDINGS AND DISCUSSION

Examination of the predicted variance components of the individual, rater, task, and their interactions for the analytical rubric of Science/Chemistry Laboratory Applications

In the fully crossed SxRxT pattern, the variance components estimated according to the three raters scoring 18 students in line with 11 tasks in the Science/Chemistry Laboratory Practices analytical rubric are given in Table 1.

Table 1. Components of variance obtained as a result of the G study

Source of Variance	Sum of Squares	df	Mean of Squares	Explained Variance %	Standard Error
S	293.86700	17	17.28629	68.5	0.16995
T	22.38047	10	2.23805	3.7	0.01726
R	0.16498	2	0.08249	0.0	0.00096
ST	44.22559	170	0.26015	4.9	0.01008
SR	1.53199	34	0.04506	0.0	0.00141
TR	11.98316	20	0.59916	3.3	0.01006
STR	50.31987	340	0.14800	19.5	0.01132
Total	424.47306	593		100%	

In Table 1, a total of seven variance components were estimated, namely the main effects of student (S), rater (R), task (T) of the student, rater and task variability sources, the interaction effects of studentxtask (ST), studentxrater (SR) and taskxrater (TR), and residual effects (STR, e). The findings of the variance components obtained from these sources of variability were interpreted as main effects, interaction effects, and residual effects.

Considering the main effects, among all variance percentages, the estimated variance component percentage of students has the highest value (68.5%). The variance estimated for the students reveals the differences between students in terms of performance levels shown during the laboratory applications. In this design, students are the main object of measurement, and it is desirable that all sources of variability, their interactions, and other sources of variability not taken into account in the design, and the percentage estimated for random errors are higher (Güler, 2009). This finding can be interpreted that the main difference in the measurement results related to the performance of science / chemistry laboratory applications is due to students. The high percentage value obtained can be interpreted as heterogeneous in terms of performance among individuals and the measurement tool used was successful in revealing this heterogeneity.

Among the main effects, the second highest (3.7%) component of variance belongs to tasks (T). This shows that the tasks that make up the steps of performance differ in terms of difficulty. It points out that while some tasks are difficult to perform by students as they require complex operations, some tasks are prepared in a way that individuals with basic laboratory knowledge can perform. The variance component (R) related to the source of rater variability gives information about the generosity and rigidity of the raters in terms of scoring. This introduces a systematic error in the existing measurement situation. However, the fact that the percentage of variance for the raters is 0.0% indicates that there is no systematic error originating from

raters. The raters reported very consistent results in their scoring in terms of the feature being measured.

When the percentages of variance components of the interaction effects are examined, it is seen that the highest variance component belongs to the student-task interaction (ST) (4.9%). Students differ in terms of their performance on the basis of tasks. This high variance component may have been caused by confounding variables such as students' being familiar with the laboratory performance in question, their previous interest in laboratory practices, and the difference in difficulty between the steps. In addition, this high variance component in the main effects that make up the interaction, may have caused the variance component of the student-task interaction effect to be high. When the rater and task interaction effect is examined (TR), the main reason for the percentage of variance (3.3%) can be interpreted as the main effect of difficulty and convenience between tasks. The scoring status of the raters varies from item to item. The fact that the variance component of the rater and student interaction (SR) is 0.0% indicates that there is no interaction between the raters and students that may affect the scoring and cause a systematic error.

When the residual variance (SRT) result is examined, it is thought that there are random errors in the measurement and different sources of variability (rater gender, student skill, interest, experience) that are not present in the design also affect the result. However, in this study, contrary to many studies, the fact that the percentage of residual variance was relatively lower than the students, who are the main object of measurement, can be interpreted as the most important sources of variability that can affect this performance are included in the design and the measurement tool used in terms of the feature subject to measurement reveals the differences between students well.

Examining the Reliability (G and Phi) Coefficients of the Scores Obtained as A Result of the Analytical Rubric Evaluation of Science/Chemistry Laboratory Applications

The reliability (G and Phi) coefficients of the scores obtained as a result of the analytical rubric evaluation of Science/Chemistry Laboratory Applications were $G_{relative}$=.99 and $G_{absolute}$=0.98. The coefficients calculated for the G (0.99) relative evaluation and Phi (0.98) absolute evaluation calculated according to the estimated variance components were quite high for this accepted population of observations. Based on these coefficients, it can be interpreted that the performance levels in the measurement tool and the degrees corresponding to the levels defined are correctly determined, the tasks in the rubric are relatively different from each other in terms of difficulty, they distinguish students well in terms of their laboratory performances, and the rater reliability of the raters who carry out the scoring is high.

Examination of G and Phi Coefficients Obtained as A Result of Manipulating the Number of Raters

Based on the variance components examined within the scope of the G study, the results of the decision studies carried out to determine the ideal rater coefficient in a similar measurement situation are given in Table 2. The number of raters was manipulated as 2, 4, 5 and G and Phi coefficients were obtained for each variation.

Table 2. Scoring decision study

	Number of Raters (R)			
	3*	**2**	**4**	**5**
G Coefficient	0.985	0.980	0.987	0.988
Phi Coefficient	0.978	0.974	0.981	0.982

When the results of the G and phi coefficients obtained based on the D studies in Table 2 are examined, it is concluded that there is no significant change in the coefficients when the number of raters is increase or decrease and the measurement situation can be carried out with two raters because of being practical.

CONCLUSION AND RECOMMENDATIONS

It was determined that the scale developed with the findings obtained as a result of the performance scale development study yielded valid, reliable, and generalizable results in determining the performance of the students attending science/chemistry laboratory practices. In this context, it is thought that using this scale, developed to evaluate the students' performance in secondary school science/chemistry laboratory practice courses, will provide valid and reliable measurement results and make the evaluation process more objective.

The variables that make up the main effect in the performance scale were determined as student, task, and rater. While the expected situation in a performance scale is that the effect originating from students is high, the effect from tasks and raters is low (Shavelson & Webb, 1991; Brennan, 2001; Güler, 2009). It can be concluded that the main source of change in the measurement results obtained from the developed performance scale is the students, as the estimated variance value of students has a very high value (Table 1). This indicates that individuals differ considerably from each other in terms of the performance in question and that they are heterogeneous. In other words, individual differences regarding performance were revealed with the measurement tool. This indicates that the reliability and validity of the said measurement tool are high.

As the relative and absolute reliability coefficients ($G_{relative}$=.99 and $G_{absolute}$=0.98) obtained as a result of the analyses for the Science/Chemistry Laboratory Applications analytical rubric are quite high, it can be said that the evaluation results obtained from this tool will give very reliable and valid results. These coefficients show that the tasks that are the subject of performance are defined correctly in the measurement tool and that they distinguish the students well in terms of the feature that is the subject of the measurement because their difficulty levels are different. The Student-Task variance (3.3%) indicates that students may be somewhat related to their experiences on assignments. The task-rater variance (4.9%) suggests that it may have been caused by factors such as the raters' gender, interests, and interactions with the task.

The fact that the variance of the raters is 0.0% (Table 1.) means that there is no error caused by the raters, that is, the raters make objective scoring in terms of the feature being measured and can make consistent evaluations with each other. The low student-rater variance (0.0%) may also mean that the error caused by the raters is low. In other words, it can be said that raters do not exhibit different behaviors from student to student. However, as a result of the D study, it was revealed that the ideal number of raters to be recommended in the performance scale created to measure the performance of science/chemistry laboratory practice is two.

Valid and reliable measurement tools are needed, especially when it comes to evaluating practical and performance-requiring situations (Darling-Hammond, 1994; Shepard, 2008). Therefore, the widespread use of reliable and valid measurement tools for performance evaluation in the literature will increase the accuracy of the evaluation results.

Studies on popularizing the use of Science/Chemistry Laboratory Applications Analytical Rubrics as measurement tools in schools (vocational high schools, science high schools, science

and art centers, secondary schools) affiliated to the National Education, in science and chemistry laboratories in education faculties of universities, in chemistry laboratory practices of pharmacy, science, literature, and engineering faculties can be conducted

In future studies on this subject, it may be recommended to carry out generalizability studies with different sources of variability such as students' gender, whether they have participated in laboratory practices before, and raters' gender.

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