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IDENTIFICATION OF THE PHYSICS SUBJECTS THAT ARE LIKED/DISLIKED AND WHY THESE SUBJECTS ARE LIKED/DISLIKED BY STUDENT TEACHERS

(ÖĞRETMEN ADAYLARI TARAFINDAN SEVİLEN YA DA SEVİLMEYEN FİZİK KONULARININ VE BU KONULARININ NEDEN SEVİLDİĞİNİN YA DA SEVİLMEDİĞİNİN BELİRLENMESİ)

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ABSTRACT

In this study, the physics subjects that student teachers liked or disliked and the reasons of why they liked or disliked these subjects were determined. A total of 322 student teachers from different departments participated in the study. To collect the data cross-sectional survey was used. As a main data collection tool, an open-ended questionnaire was delivered to the student teachers. Then interviews were conducted with some student teachers to confirm the results obtained from an open-ended questionnaire. The results revealed that student teachers who liked the physics subjects indicated the subjects such as 'vectors', 'torque' and 'optics I' more. On the other hand, student teachers who disliked the physics subjects indicated the subjects such as 'projectile motion', and 'magnetism II' more. It was found that some of the reasons of why student teachers liked or disliked the physics subjects were closely related to their successfulness in solving some physics problems about the physics subjects, their past learning experiences, and difficulty level of some physics subjects.

Keywords: Attitude, interest, physics education, physics subjects, student teachers

ÖZET

Bu çalışmada öğretmen adaylarının sevdiği ya da sevmediği fizik konuları ve onların bu konuları neden sevip ya da sevmediğinin sebepleri belirlenmiştir. Çalışmaya farklı bölümlerden toplamda 322 öğretmen adayı katılmıştır. Veriler kesitsel tarama araştırması ile toplanmıştır. Ana veri toplama aracı olarak açık uçlu anket öğretmen adaylarına dağıtılmıştır. Sonrasında açık uçlu anketten elde edilen verilerin doğrulanması amacı ile bazı öğretmen adayları ile mülakatlar yapılmıştır. Elde edilen sonuçlar fizik konularını seven öğretmen adaylarının 'vektörler', 'moment' ve 'optik I' gibi konuları daha çok belirttiklerini göstermiştir. Diğer taraftan fizik konularını sevmeyen öğretmen adayları 'atışlar' ve 'manyetizma II' gibi konuları daha fazla belirtmişlerdir. Öğretmen adaylarının fizik konularını neden sevip ya da sevmediğinin bazı sebepleri, onların fizik konuları hakkındaki problemleri çözerken ki başarıları, onların geçmiş öğrenme deneyimleri ve bazı fizik konuların zorluk seviyesi ile yakından ilişkili olduğu bulunmuştur.

Anahtar Sözcükler: Tutum, ilgi, fizik eğitimi, fizik konuları, öğretmen adayları

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INTRODUCTION

Some physics teachers might be exposed to the complaints of students about physics and physics courses. Students could view physics as irrelevant to their life and dislike it (Kapucu, 2014). In fact students might be right to increase their voices. Excessive numbers of physics formulas to be memorized and equations to be solved in physics lessons could have resulted in such complaints (Kapucu, 2014). Seeing physics as a difficult subject (Angell, Guttersrud, Henriksen & Isnes, 2004; Oliveira & Oliveira, 2013), poor mathematics knowledge (Gill, 1999; Kapucu, 2014) and failing in physics tasks (Barmby & Defty, 2006) can also enable students to dislike physics subjects. Interestingly physics has been the most disliked discipline among other science disciplines such as chemistry and biology (Barmby & Defty, 2006). On the other hand, while students' disliking for physics increases, this remains stable for biology. In addition, the ratio of students who like physics is lower than the students who like biology (Williams, Stanisstreet, Spall, Boyes & Dickson, 2003). Consequently, students' interest in particularly physics decline and they begin to view physics as boring (Oon & Subrama-niam, 2011; Reid & Skryabina, 2002). Many students are less interested in physics anymore (Hannover & Kessels, 2004; Willson, Ackerman & Malave, 2000).

Some researchers (Barmby & Defty, 2006; Hannover & Kessels, 2004; Kapucu, 2014) tried to identify whether physics learners like physics and the reasons of why it is liked or disliked. In his study, Kapucu (2014) found that the majority of Turkish pre-service primary school teachers (approximately 82% of the participants) did not like physics. They did not like physics due to their low interest in physics, previous learning experiences based on root memorization, poor mathematics knowledge and unsuccessfulness in physics. Barmby and Defty (2006) also investigated whether the students (ages ranged between 11 and 16) in England liked physics, chemistry and biology. They found that physics was the least liked discipline and its liking ratio 'a little' or 'a lot' was between 60% and 65% during the period 1999 to 2004. In addition, they found that there was a strong positive relationship between the students' expectation of success in physics and their liking for physics. Hannover and Kessels (2004) also tried to determine why students like or dislike physics and mathematics. For example, they found that the students who favor in physics and mathematics were considered to be less physically and socially attractive but to be more intelligent or motivated.

Perceiving physics as a difficult subject (Angell et al., 2004; Oon & Subramaniam, 2011) might also result in physics learners' low interest in physics. Then this low interest might negatively affect students' liking for physics (Kapucu, 2014). Angell et al. (2004) found that the majority of Norwegian students (ages between 16 and 19) viewed physics as a difficult subject. Similarly, Oon and Subramaniam (2011) found that physics teachers in Singapore believed that students' interest in physics was low because the students perceived it as difficult and abstract. Additionally, Angell et al. (2004) mentioned that students perceived some physics subjects such as astrophysics, relativity and electricity more

interesting than electromagnetism and thermophysics. Şahin and Yağbasan (2012) also indicated that Turkish pre-service physics teachers perceived the subjects such as 'electromagnetic waves', 'Gauss' law', 'inductance', and 'Faraday's law' more difficult than the subjects such as 'vectors', 'motion in two dimensions', and 'the laws of motion'. The researchers (Angell et al., 2004; Şahin & Yağbasan, 2012) discussed that the abstractness of the subjects and the way how they are taught could also affect students' choices in determining those subjects' difficulty and interest level. Furthermore, Ornek, Robinson and Haugan (2007) studied with the students in introductory physics course. They asked them that what made physics difficult and what could be done to handle these difficulties. They presented three major factors that made physics difficult for students; student-controlled factors, course-controlled factors, and the factors related to nature of physics. For example, some of the factors such as the lack of interest and motivation in physics, too much work to succeed in physics, and related subjects with each other in physics made physics difficult for the students.

Physics learners' poor mathematics knowledge (Kapucu, 2014), and teacher-dominated lessons with traditional learning activities (Redish & Steinberg, 1999) can also negatively influence physics learners' interest in or attitudes toward physics. The study of Kapucu (2014) revealed that the pre-service primary school teachers who did not like mathematics also did not like physics. In addition, their failure in mathematics negatively influenced their liking for physics. Moreover, teaching methods that teachers have implemented in their physics lessons can also influence the physics learners' liking for physics. For example, Redish and Steinberg (1999) indicated that physics courses supported with laboratory activities that encourage discovery could enable students to have more positive attitudes toward physics. They have actually advised to the teachers to use the learning methods that make students more physically active in learning. Although over twenty-five years have passed after the ideas of Redish and Steinberg (1999), I think that their ideas and claims still remain valid. It can be claimed that the attempts to improve learners' attitudes toward science disciplines such as physics, chemistry, and biology now continue on all over the world. These attitudes are also tested in international exams such as TIMMS (see Martin, Mullis & Foy, 2015). Thus, I believe that the popularity of investigating the physics learners' interest in, attitude toward or liking for physics currently remains high. Investigating them might help the researchers and educators to be always aware of what is changing in physics learners' interest in or attitude toward physics.

Rationale

It is now well known that some physics learners do not like physics (Hannover & Kessels, 2004; Kapucu, 2014), and they have low interest in physics (Williams et al., 2003; Willson et al., 2000). Actually, the reasons of why they have these negative attitudes toward physics have been widely discussed in some studies. However, is generalizing the findings in these studies to all of the subjects in physics correct? The reasons of why they like or dislike different subjects can differ

from each other. Some researchers have implicitly highlighted this point by asking students to indicate the difficult physics subjects (Şahin & Yağbasan, 2012), and choose the interesting physics subjects (Angell et al., 2004); and then, discussing what accounts for these difficulties and interests in their studies. Consequently, asking physics learners to indicate some physics subjects (e.g., 'vectors', 'pressure', and 'electricity') that they like or dislike and the reasons of why they like or dislike these subjects might provide some clues about what should be done in helping physics learners to like such topics. For example, science/physics teachers should be more careful in teaching of the physics subjects that are mostly disliked by physics learners. They should choose more specific learning methods or strategies that should encourage physics learners to like these subjects.

Concentrating also on which factors determine physics learners' liking or disliking for the physics subjects might contribute to development of physics textbooks and curricula. Particularly considering the factors that can negatively influence the learners' liking for some physics subjects some specific learning methods or strategies that might reduce the effect of these negative factors should be advised to the teachers in these curricula or textbooks. Thus, more specific learning methods and activities might be determined for teaching of each physics subject.

Purpose and Research Questions

The purpose of this study is to identify the physics subjects that are liked/ disliked and the reasons of why these subjects are liked/disliked by student teachers. Furthermore, the research questions of this study are as follows;

- What are the physics subjects that are liked and the reasons of why these subjects are liked by student teachers?
- What are the physics subjects that are disliked and the reasons of why these subjects are disliked by student teachers?

METHOD

Sample

A total of 322 student teachers from different departments (see Table 1) participated in this study in Turkey. First and second-year student teachers (pre-service primary school teachers [PPST], pre-service elementary science teachers [PST], and pre-service elementary mathematics teachers [PMT]) were selected purposefully. As the majority of student teachers recently graduated from their high schools and they take compulsory physics courses in the first or second year of their education in the university, they can remember the name of the physics subjects more easily while answering an open-ended question that elicit the subjects liked or disliked. In this regard, more reliable results could be obtained if they remember more subjects when answering this question. Table 1 presents the distribution of student teachers from different departments.

Table 1. Distribution of student teachers from different departments

	# of student teachers			
Departments of student teachers	**1st grade**	**2nd grade**	**Male**	**Female**
Primary school teacher education	64	53	55	62
Elementary science teacher education	23	57	43	37
Elementary mathematics teacher education	71	54	38	87
Total	158	164	136	186

Data Collection

One of the types of survey research that is a cross-sectional survey (Fraenkel & Wallen, 2005) was used in data collection. Main tool to collect data was an open-ended questionnaire. In it, student teachers were firstly required to indicate whether they like the physics subjects. Then they were asked to mention the subjects which they like or dislike. As a final they explained why they like or dislike the subjects that they indicated. After the analyses of data gathered from this, semi-structured interview was performed with six student teachers. Before selecting the participants to be interviewed, each open-ended questionnaire was labeled with representative numbers. Then, six participants were selected randomly. After that, voluntariness of the participants to interviews was asked to selected ones. Only one participant did not want to be interviewed. Therefore, one student was also selected randomly. He accepted to participate in the interview. Same questions in an open-ended questionnaire were asked to those participants. However, they were encouraged to talk more about why they like and dislike the physics subjects that they indicated in an open-ended questionnaire.

Data Analysis

First of all, student teachers' responses to the open-ended questionnaires were analyzed by the researcher. Categories and codes were constructed according to these responses (Miles & Huberman, 1994). While identifying the reasons of why student teachers like the physics subjects some codes such as 'interesting', 'easy', 'daily life' 'technology', and 'entertaining' were identified. However, in presenting the results these codes were presented with meaningful statements. For example, the codes 'interesting' and 'entertaining' were combined and these codes implied the "popularity of the physics subject". In addition, 'technology' and 'daily life' were combined and these codes meant to "relationship of the physics subject with technology and daily life". Then, some of the open-ended questionnaire responses were analyzed by one researcher who has been a master of student in science education. He also identified some codes on randomly selected 20 open-ended questionnaires. They were compared with the codes identified by the researcher. After the discussion of these two analyses, agreed categories and codes were presented. The occurrence frequency of each code was also calculated and presented. These strategies provided more reliable results for this study (Silverman & Marvasti, 2008). For the validity, triangulation method was used. The data results obtained from the open-ended questionnaires were compared with the data results obtained from the interviews for the confirmation of findings (Bogdan & Biklen, 1998; Merriam, 1998). The interviews were audio-taped and transcribed into

documents. Finally, some excerpts from the open-ended questionnaires and interviews were given to present the results. In presenting the source of the excerpt, some encodings were used. For example, an excerpt taken from 3th Participant's open-ended questionnaire response was labeled as OQR3 and 124th Participant's interview response was labeled as IR124. In addition, some original excerpts from the open-ended questionnaires that were scanned after taking permission of the participants were presented in Appendix.

FINDINGS

After the analyses of the student teachers' responses to an open-ended questionnaire, four main categories have emerged. These are "the physics subjects liked", "the physics subjects disliked", "the reasons of why the physics subjects are liked", and "the reasons of why the physics subjects are disliked". First of all, how many student teachers like or dislike the physics subjects is presented.

Liking or Disliking the Physics Subjects

In an open-ended questionnaire, the majority of student teachers mentioned that they did not like the physics subjects. Table 2 depicts the number of student teachers who like or dislike the physics subjects in each department.

Table 2. The number of student teachers who like or dislike the physics subjects

	# of student teachers		
Department of student teachers	**who like the physics subjects**	**who dislike the physics subjects**	**Total**
Primary school teacher education	34	83	117
Elementary science teacher education	32	48	80
Elementary mathematics teacher education	45	80	125
Total	111	211	322

As shown in Table 2, while 111 student teachers like the physics subjects, 211 student teachers dislike the physics subjects. Approximately 65% of student teachers do not like the physics subjects. Over half of the student teachers in each department indicated that they did not like the physics subjects.

The Physics Subjects Liked and the Reasons of Why These Subjects are Liked

Student teachers were asked to indicate the physics subjects that they like and to explain why they like such subjects in an open ended questionnaire. Table 3 presents the physics subjects that are liked by student teachers and a total frequency distribution of each subject mentioned by student teachers.

Table 3. The physics subjects liked by student teachers and a total frequency distribution of each subject

The physics subjects liked	# of occurrence (frequency) for PPST	PST	PMT	Total frequency
Vectors	17	16	19	52
Optics I (reflection and refraction of light, mirrors, lenses, shadows)	5	8	7	20
Torque	3	6	7	16
Properties of matter (density, volume, mass, equal-arm balance)	4	4	6	14
Electricity I (simple circuits, Ohm's Law, charging)	3	5	6	14
All physics subjects	4	6	3	13
Linear motion	4	5	3	12
Astronomy	1	4	5	10
Work, energy and power	3	4	2	9
Projectile motion	3	2	1	6
Modern physics (special relativity, atom, subatomic particles, radioactivity, photoelectric, Compton)	1	2	3	6
Heat and temperature	1	2	2	5
Magnetism II (magnetic fields, electric currents and magnetic fields, alternative current, electromagnetic induction)	-	2	3	5
Curricular motion	-	3	-	3
Momentum	-	1	2	3
Magnetism I (magnetic poles)	2	1	-	3
Pressure	-	2	-	2
Electricity II (electric force, electric fields, electric potential)	-	2	-	2
Optics II (spring waves, water waves, diffraction and interference, Doppler effect, electromagnetic waves)	-	2	-	2
Buoyancy force	-	1	-	1

Note: PPST refers to pre-service primary school teachers, PST refers to pre-service elementary science teachers, and PMT refers to pre-service elementary mathematics teachers

According to Table 3, 'vectors' was the most indicated subject by student teachers. They also frequently indicated 'optics I'. Moreover, some subjects 'torque', 'properties of matter', 'work, energy, power', 'linear motion', 'electricity I', and 'astronomy' were indicated by most of the student teachers. Some of them also indicated that they liked all physics subjects (i.e., they indicated that they liked all physics subjects without giving the names of physics subjects in an open-ended questionnaire). Pre-service elementary science teachers also indicated more various physics subjects than pre-service primary school and elementary mathematics teachers.

Furthermore, in an open-ended questionnaire, student teachers were required to explain why they like the physics subjects that they indicated. In Table 4, the reasons of why student teachers like the physics subjects and occurrence frequency of each reason are shown.

Table 4. The reasons of why student teachers like the physics subjects and occurrence frequency of each reason

The reasons of why the physics subjects are liked	# of occurrence (frequency) for			Total frequency
	PPST	PST	PMT	
Easy physics problems about the physics subject	15	11	17	43
Easy physics subject to learn	9	7	10	26
Relationship of the physics subject with technology and daily life	5	4	6	15
Relationship of the physics subject with mathematics	1	3	9	13
Physics experiments while learning the physics subject	2	5	4	11
Popularity of the physics subject	1	3	2	6

The majority of student teachers who liked the physics subjects indicated that they liked them because they viewed some of them such as 'vectors', and 'optics I' as easy to learn. According to them, these subjects did not force them to think deeply so they easily understood the concepts about these subjects. Some student teachers also thought that being successful in solving physics problems about the physics subjects was an important factor in determining their liking for these subjects. They believed that successfulness was closely related to liking for the physics subjects. When they were able to solve the physics problems related to the subjects, they liked physics more. In addition, being able to solve the physics problems increased their self-esteem to be successful in physics. Having a high self-esteem also encouraged them to solve more physics problems about the subjects. The following excerpts from the open-ended questionnaire and interview responses illustrate student teachers' explanations about why they like some of the physics subjects;

> OQR8: I like the subject of force [force refers to vectors]. There are some arrows that added to each other. Solving them [them refers to problems about vectors] is easy for me.
> IR8: I like vectors because they are easy. I am not bored while solving the questions [questions refer to questions related to vectors]. On the other hand, being able to solve the questions encourages me to solve more questions. I can solve them. Therefore, I feel myself better.
> OQR23: If the subjects are easy and simple, physics is liked. For example, vectors are very easy and entertaining subject.
> OQR35: Buoyancy force of water and equal-arm balance. I realized that when I solved the problems (the problems refer to the questions about the buoyancy force of water and equal-arm balance), I was successful. These were not difficult. In addition, I like them because these subjects are used in social life.

In addition, some student teachers perceived some physics subjects (e.g., 'electricity', and 'optics') as a part of technology and daily life. According to them, some developments in the technology that facilitate people's life were depended on physics rules. That is, no tools and machines could work without physics rules in

the world. Therefore, they were interested in physics. This enabled them to like physics. The following excerpts from the open-ended questionnaire and interview responses illustrate the effect of relationship of physics with daily life and technology on student teachers' liking for some physics subjects;

> OQR96: Electricity. We use it in our houses and factories. Everything in the life is depended on electricity.
> IR96: I like the electricity because the life is depended on it. [the interviewer wanted the student teacher to explain why the life was depended on the electricity] When we think the technological devices that we use, they work by using the electricity.
> OQR227: Matter and classification of matters because these subjects are in our daily life as concrete.

Liking mathematics also influenced student teachers' liking for some physics subjects because they perceived physics as mathematics. According to them, physics included some equations to be solved and calculations as in the mathematics. Learning some subjects particularly related to kinematics by engaging in mathematical calculations and equations enabled them to like physics. The following excerpts from the open-ended questionnaire and interview responses illustrate why student teachers like some physics subjects due to liking mathematics;

> OQR124: Velocity. If you know the formulas, it [it refers to solving questions about linear motion] is only mathematics. I like mathematics so I also like this subject.
> IR124: I can solve the questions related to the velocity problems because it is based on mathematics. When you memorize the formulas, you only put the values on them. Then, you can easily reach the solution.

Some student teachers performed some easy physics experiments related to some physics subjects such as 'electricity' and 'optics' in their elementary and high school years. This previous learning experience played a key role in helping them to better understand these subjects and encouraged them to be interested in them. Hence, they liked these subjects. Their teachers' instructional practices seriously influenced their liking for these subjects. Final reason that encourages student teachers to like some physics subjects was about popularity of these subjects. For example, hearing some popular physics subjects (e.g., 'astronomy', 'modern physics') and some famous physicists (e.g., 'Einstein') from school environments and media enabled student teachers to be interested in some physics subjects. Therefore, they began to like these subjects. The following excerpts from open-ended questionnaire responses illustrate student teachers' such views;

OQR143: I like the electricity and optics. We observed how the light travelled in different mediums in high school. I also light the bulbs using batteries. These enabled me to be interest in these subjects. I wish we performed more experiments.
OQR47: I like almost all physics subjects. However, frankly, I like the subjects that make people's lives better. Law of universal gravitation and quantum physics although I do not know it [it refers to quantum physics] enough, I heard that it could explain almost everything.
OQR314: Einstein is the most popular physicist in the world. For example, while watching a television, his theory about the special relativity attracted my attention toward physics. Then, I bought some books to learn more about it.
OQR91: Astronomy is very interesting subject. Planets, stars and space attract all people's attention.

The Physics Subjects Disliked and the Reasons of Why These Subjects are Disliked

In an open-ended questionnaire, student teachers were also asked to indicate the physics subjects that they disliked. Table 5 shows the physics subjects disliked by student teachers and a total frequency distribution of each subject.

Table 5. The physics subjects disliked by student teachers and a total frequency distribution of each subject

	# of occurrence (frequency) for			Total
The physics subjects disliked	**PPST**	**PST**	**PMT**	**frequency**
All physics subjects	23	5	14	42
Projectile motion	19	9	11	39
Magnetism II (magnetic fields, electric currents and magnetic fields, alternative current, electromagnetic induction)	-	12	23	35
Optics II (spring waves, water waves, diffraction and interference, Doppler effect, electromagnetic waves)	3	9	14	26
Electricity II (electric force, electric fields, electric potential)	1	9	15	25
Optics I (reflection and refraction of light, mirrors, lenses, shadows)	12	5	7	24
Linear motion	11	6	7	24
Electricity I (simple circuits, Ohm's Law, charging)	7	5	9	21
Work, energy and power	7	4	9	20
Buoyancy force	7	5	6	18
Pressure	3	5	6	14
Torque	6	5	3	14
Curricular motion	-	7	4	11
Heat and temperature	2	3	2	7
Vectors	4	2	1	7
Momentum	-	3	2	5
Modern physics (special relativity, atom, subatomic particles, radioactivity, photoelectric, Compton)	-	3	2	5
Properties of matter (density, volume, mass, equal-arm balance)	2	1	-	3
Magnetism I (magnetic poles)	-	-	-	-
Astronomy	-	-	-	-

As can be seen in Table 5, the number of student teachers who disliked all physics subjects is very high. When the physics subjects indicated by student teachers were also examined, the subjects 'projectile motion', 'magnetism II', 'electricity II', and 'optics II' are greatly indicated. Then, the subjects 'linear motion', 'optics I', 'electricity I', 'work, energy, power' and 'buoyancy force' are in a second place within mostly indicated physics subjects disliked. These results can imply that when the level of difficulty of physics subjects increases, the number of students who dislike such subjects also increases. In fact, as expectedly, some subjects such as 'vectors' and 'properties of matter' that are perceived as easy by student teachers presents low occurrence frequency in Table 5. These subjects were also liked by most of the student teachers. In addition, 'magnetism I' and 'astronomy' were not indicated by student teachers as the subjects disliked.

Student teachers also explained why they disliked the physics subjects in an open-ended questionnaire. Table 6 presents the reasons of why they dislike the physics subjects and occurrence frequency of each reason.

Table 6. The reasons of why student teachers dislike the physics subjects and occurrence frequency of each reason

The reasons of why the physics subjects are disliked	# of occurrence (frequency) for			**Total frequency**
	PPST	**PST**	**PMT**	
Difficult physics subject to learn	16	14	44	74
Difficult physics problems about the physics subject	24	16	30	70
Learning the physics subject by memorizing	12	7	10	29
Unrelated physics subject to daily life	9	6	8	23
Unsuccessfulness in mathematics	20	2	-	22

As shown in Table 6, the majority of student teachers indicated that some physics subjects were difficult to learn. They also viewed the physics problems related to them as difficult. The students who held these ideas mostly indicated the subjects such as 'electricity I', 'electricity II', 'optics I', 'optics II', 'magnetism II' and 'projectile motion'. Abstractness and complexity of these subjects were also main reasons for student teachers to view them as difficult subjects. The following excerpts from the open-ended questionnaire and interview responses illustrate how the difficulty of physics subjects and physics problems influences student teachers' liking for physics;

> OQR3: I do not like the optics. Because I have difficulty in understanding it, and this subject is difficult, I do not like.
> OQR56: The subjects including the electric circuits and bulbs. I do not like them because I cannot solve them [them refers to problems related to the electric circuits and bulbs].
> OQR217: Magnetic fields and right-hand rule. I cannot understand it because I confuse how to find direction of the current or magnetic fields.

> IR217: I always have difficulty in understanding the magnetic field. It has been difficult for me. [the interviewer asked her the reason of this difficulty] Physics subjects especially related to the magnetic fields are very abstract. There are not any concrete examples of it.
> OQR301: I have never understood the electricity that was taught in elementary school. The teacher has drawn unusual figures on the blackboard so I was confused.

In addition, some student teachers disliked some physics subjects such as 'pressure', 'linear motion', and 'projectile motion' because of a great number of formulas in them to be memorized. Students were discouraged because they did not know how to use the formulas in given physics problems and choose appropriate formulas while solving the problems. Hence, they began to dislike these physics subjects. The following excerpts from the open-ended questionnaire and interview responses illustrate the influence of learning some physics subjects by memorizing formulas on student teachers' liking for these subjects;

> OQR158: I do not like the projectile motion and circular motion. There are many formulas.
> IR158: I do not like some subjects of the physics for example projectile motion. I cannot memorize all the formulas and I can confuse them. I wish there were fewer formulas. Thus, we can learn better. Physics is very boring.
> OQR286: The subjects that I do not like in physics are the pressure and pressure related subjects most. There are sometimes confusing formulas in them. A person is confused because he/she does not know where and when to use them. Hence, we are confused. In fact, if there is no confusing formulas, people can like physics.

Some student teachers also thought that being not able to frequently relate some physics subjects such as 'magnetism II' and 'modern physics' to their daily life enabled them to dislike the subjects. Their expectation in learning of the physics subjects was based on frequent connection of them with their daily life experiences. The following excerpts from the open-ended questionnaire and interview responses illustrate the reason "unrelated subjects to daily life";

> OQR87: I do not like some subjects of motion such as the uniformly accelerated motion, constant motion and laws of motion because I do not question about them, I do not consider them as useful in daily life and I have difficulty.
> OQR139: I do not like the magnetic fields and photoelectric. These are illogical according to me. We never use them in our daily life.
> IR139: We have learned many subjects in physics course up to now. However, there are very few subjects related to our life. The majority

> of the physics subjects are not related to daily life. We only hear some subjects such as the velocity and acceleration in life. We do not calculate the force on the charge in the magnetic fields in our life.

Final reason indicated mostly by pre-service primary school teachers was about their unsuccessfulness in mathematics. They had a strong belief that it was difficult to learn some physics subjects without knowing mathematics. For example, according to them, it was difficult to solve the problems related some subjects such as 'linear motion' and 'projectile motion' without knowing how to solve mathematical equations. The following excerpt from the open-ended questionnaire response illustrates this belief;

> OQR173: Motion subjects. There are many equations to be solved, but I cannot solve them [them refers to equations in the problems about motion]. My mathematics [mathematics refers to knowledge about mathematics] was poor. In fact, you cannot be successful in physics without knowing mathematics.

DISCUSSION AND CONCLUSIONS

This study showed that the majority of student teachers who liked physics subjects indicated that they liked the subjects that were easy and easy to understand. In other words, they did not like the subjects that were difficult for them. In fact, their successfulness or unsuccessfulness in being able to solve the physics problems about the physics subjects influenced their liking or disliking for these subjects. For example, they mostly liked the subjects 'vectors', and 'optics' because they could solve the questions about them. Similarly, the study of Şahin and Yağbasan (2012) revealed that 'vectors' was one of the least indicated physics subjects as difficult by pre-service physics teachers. When it is assumed that there can be a close relationship between liking the physics subjects and viewing them as easy, this finding confirms the findings of Şahin and Yağbasan (2012). On the other hand, student teachers did not like some abstract and difficult subjects such as 'projectile motion', 'magnetism II', 'electricity II', and 'optics II' in this study. Şahin and Yağbasan (2012) also found that pre-service physics teachers viewed some magnetism and electric subjects as the most difficult ones. Moreover, in this study some subjects such as 'modern physics' and 'astronomy' were liked due to their popularity in physics. Therefore, they have also viewed them as interesting subjects. Angell et al. (2004) also found that these subjects were mostly indicated as interesting by students. When we consider these findings, it can be claimed that there can be close relationships among liking physics subjects, difficulty of them and viewing them as interesting. At this point the question of "what causes this close relationship among these" comes into researchers' mind. Nature of the subject itself as one of the reasons might affect the students choices in indicating the subjects liked. That is, difficult and interesting nature of physics subjects might

affect whether these are liked. Ornek et al. (2007) also discussed that the nature of physics (i.e., abstractness of the physics, and difficulty of the physics) could make physics difficult for students. Therefore, while planning the curricula or textbooks nature of physics should also be considered. The number of the suggested activities in them should be increased and more activities that might increase students' interest in or attitude toward physics should be advised.

Moreover, learning some physics subjects (e.g., optics, electricity) by relating them to daily life and by performing some experiments positively influenced student teachers' liking for some physics subjects during their previous school years. However, student teachers who learned physics by memorizing disliked some physics subjects. This result was consistent with Redish and Steinberg (1999)'s claim that learning physics by memorizing could negatively influence students' attitudes toward physics. Therefore, to have more students who like the majority of physics subjects in future, teachers in elementary and high school levels should choose the learning methods that encourage students' active involvement in learning. For example, students should be encouraged to conduct some projects and perform some hands-on activities.

Another important reason that determines student teachers' liking or disliking physics subjects was their successfulness or unsuccessfulness in mathematics. Some student teachers faced some difficulties in solving some physics problems of some subjects such as kinematics so they began to dislike the subjects. Similarly, Kapucu (2014) found that some pre-service primary school teachers did not like physics due to their poor knowledge about mathematics. Some student teachers might not like some physics subjects because of learning some physics subjects by using excessive mathematical equations in the elementary and high school years. Due to this learning approach, these students might think that they could not be successful in learning some physics subjects with their poor mathematics knowledge. Therefore, teachers in elementary and high schools should diminish the amount of mathematical calculations or equations that they used in their lessons. They should give more importance to nature of physics (e.g., theoretical bases of the physical phenomena or concepts) in their lessons.

Popularity of some physics subjects such as 'atomic particles' and 'relativity' also enabled student teachers to be interested in these subjects. Due to their interest in these subjects, they began to like these subjects. Hearing also some popular physicists' (e.g., Einstein, and Newton) contributions to science from elementary and high school years and media influenced student teachers' liking for these subjects. Therefore, more emphasis should be given to mention physicists' contributions to physics and technology in the lessons to increase the number of physics learners who like the physics subjects. Mentioning the history of physics in the lessons as suggested by Oon and Subramaniam (2011) might also positively contribute to development of physics learners' interest in physics.

As a conclusion, the majority of student teachers did not like the physics subjects. Particularly they did not like the subjects such as 'projectile motion', and 'magnetism II' that appear difficult to them. They also did not like some physics

subjects because they were not able to solve the problems about the physics subjects, and learned them by memorizing. On the other hand, some student teachers liked the subjects such as 'vectors', and 'torque' more because they could solve the questions about these subjects. They also liked some interesting subjects such as 'astronomy', and 'modern physics'. The most important reasons to like or dislike physics subjects were based on the difficulty level and complexity of the subjects according to the student teachers.

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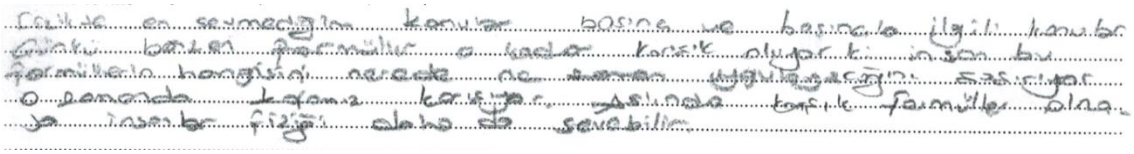
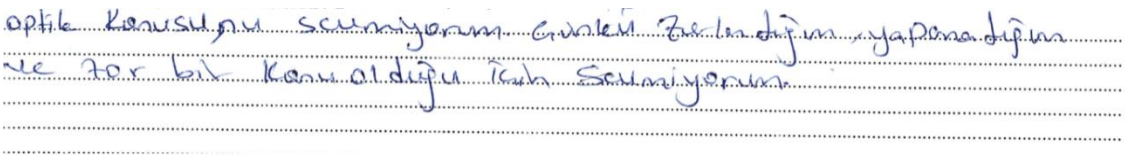
APPENDIX

Some example excerpts taken from students' responses to an open-ended questionnaire are as follows;

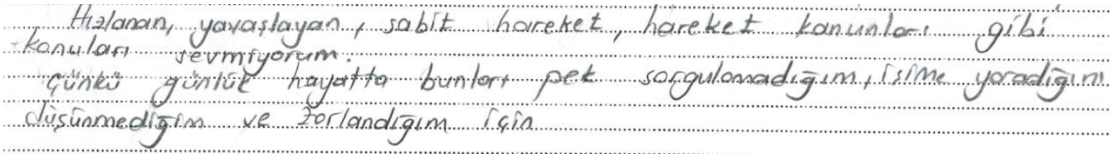
Excerpt taken from 286th participant's response to an open-ended questionnaire;



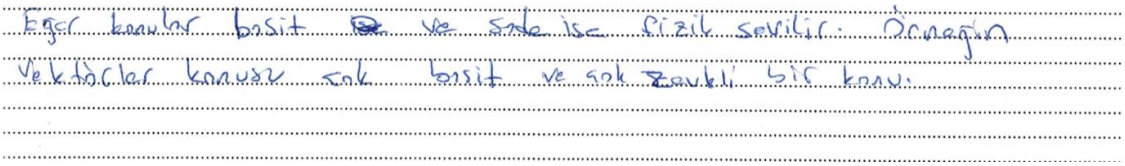
Excerpt taken from 3rd participant's response to an open-ended questionnaire;



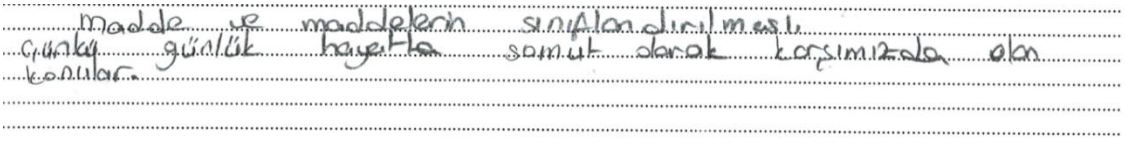
Excerpt taken from 87th participant's response to an open-ended questionnaire;



Excerpt taken from 23rd participant's response to an open-ended questionnaire;



Excerpt taken from 227th participant's response to an open-ended questionnaire;



Excerpt taken from 35th participant's response to an open-ended questionnaire;