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Salient beliefs of pre-service primary school teachers underlying an attitude "liking or disliking physics"

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ABSTRACT: The aim of this study was to determine the salient beliefs of pre-service primary school teachers (PPSTs) about why they like or dislike physics and to explore whether these beliefs predict their teaching beliefs about physics. A total of 267 PPSTs (Male=137, Female=130) participated in the study. Qualitative data analyses were used and the data were collected through an open-ended questionnaire, the interview and classroom discussion. The results revealed that the majority of the PPSTs did not like physics. Fundamental salient beliefs of the PPSTs about why they disliked physics were their unsuccessfulness in solving physics problems and their previous teachers' teaching based on more memorization of physics formulas and rules. Moreover, the majority of the PPSTs indicated that they would use the teaching strategies that make students more active in learning in their professional teaching. In this regard, the salient beliefs particularly related to the PPSTs' past learning experiences based on more memorization of physics formulas and rules could enable them to believe in students' active involvement in learning.

KEY WORDS: attitude towards physics, liking or disliking physics, pre-service primary school teachers, salient beliefs, teaching beliefs

INTRODUCTION

Attitude is an important construct due to its close relationship with individuals' behavioral intentions and behaviors (Ajzen, 1988; Fishbein & Ajzen, 1975). Due to this, researchers have studied this construct for more than a century (Koballa & Glynn, 2007). Attitude refers to "a predisposition to respond positively or negatively to things, people, places, events or ideas" (Simpson, Koballa, Oliver & Crawley, 1994, p. 212). Belief is another important construct influencing individuals' behaviors (Ajzen, 1988; Fishbein & Ajzen, 1975; Nespor, 1987; Pajares, 1992) particularly in science educational settings (Olafson & Schraw, 2006; Porlán & Martín, 2004; Tsai, 2002). Belief refers to "a person's subjective probability judgments concerning some discriminable aspects of his world" (Fishbein & Ajzen, 1975, p. 131).

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Some researchers (e.g., Osborne & Colins, 2000; Timur, 2012) tried to find the source of students' and teachers' negative or positive attitudes towards science, and some (e.g., Gibson & Chase, 2002; Palmer, 2002) tried to change negative attitudes of students towards science. However, studies do not focus on the relationship between pre-service primary school teachers' teaching beliefs about science, particularly about physics, and their salient beliefs underlying the negative or positive attitudes towards science. Determining the relationship among these two important constructs - salient beliefs underlying attitudes and teaching beliefs - can help individuals better understand how the different types of beliefs relate to each other. Revealing this relationship may offer more permanent solutions to overcoming the problem that the majority of teachers and student teachers hold traditional teaching beliefs (see Porlán & Martín, 2004; Tsai, 2002).

Furthermore, according to Osborne, Simon and Tytler (2009), the development and emergence of interest in science begin at the age of 10 to 14 where it is important for students to gain an enthusiasm for science (Pell & Jarvis, 2003). With this in mind, pre-service primary school teachers (PPSTs) need to take a critical responsibility in helping students attain positive attitudes towards science. As Johnston and Ahtee (2006) indicate, physics is the most disliked subject by the PPSTs among other subjects related to science. Therefore, determining the salient beliefs about why the PPSTs do not like physics in particular, can contribute the development of educational programs that aim to change such negative attitudes.

In addition, this study is based on the theoretical underpinning focusing on the relationships between salient beliefs, attitudes and teaching beliefs. The belief is that by discussing the results considering theoretical backgrounds, this study can present more valid results.

The aim of this study is to determine the salient beliefs underlying why PPSTs like or dislike physics and to explore whether these beliefs can predict their teaching beliefs about physics. In the light of the above discussions, the research questions for this study are;

1. What are the salient beliefs underlying why the PPSTs like or dislike physics?
2. What are the teaching beliefs of the PPSTs about physics?
3. Do the PPSTs' salient beliefs underlying why they like or dislike physics predict their teaching beliefs about physics?

LITERATURE REVIEW

Attitude towards Science

A great number of studies have focused on learners' attitudes towards science over the last two decades (Palmer, 2002). These studies showed that students generally developed their attitudes towards science at an early age due to their previous learning experiences in science classrooms (Palmer, 2002) and their previous teachers' pedagogical content knowledge (Johnston & Ahtee, 2006). Therefore, teachers who teach science to young students are expected to play a critical role in helping them attain positive attitudes towards science (Osborne et al., 2009). Particularly, researchers interested in physics education (e.g., Redish & Steinberg, 1999; Redish, Saul & Steinberg, 1998) claimed that students developed negative attitudes after experiencing more traditional physics activities, compared with hands-on physics activities. Many students did not like the science topics, especially related to physics, and due to a lack of experiencing student centered learning activities (Johnston & Ahtee, 2006; Semela, 2010; Willson, Ackerman & Malave, 2000). In other words, activities based on performing physics experiments, were more popular among students. Students tended to use the physics activities that make them active in learning (Owen, Dickson, Stanisstreet & Boyes, 2008; Semela, 2010). Another reason why students did not like science related subjects was their difficulty (Jenkins & Nelson, 2005; Nilsson & van Driel, 2010; Oliveira & Oliveira, 2013; Ornek, Robinson & Haugan, 2007; Osborne, Simon & Collins, 2003; Timur, 2012). An emphasis on memorization from instruction in science related subjects (Osborne & Colins, 2000; Palmer, 2002; Redish & Steinberg, 1999), and failing in science courses (Osborne et al., 2003) also negatively influenced students' attitudes towards science.

Moreover, other research indicate the popularity of science related subjects among students when choosing courses (Owen et al., 2008). This led some scholars (e.g., Gibson & Chase, 2002; Palmer, 2002; Rukavina, Zuvic-Butorac, Ledic, Milotic & Jurdana-Sepic, 2012) to determine some ways to effect change in teachers' or students' negative attitudes towards science. For example, Palmer (2002) investigated pre-service elementary teachers' change of attitude after participation in an elementary science education course. Some features of the course which including specific teaching strategies and external validation enabled students to change their attitudes from being negative to positive. Additionally, Gibson and Chase (2002) asserted that students in inquiry-based science programs developed more positive attitudes towards science. Rukavina et al. (2012) also concluded that students expressed positive attitudes towards science after experiencing science demonstrations and hands-on science activities.

Researchers, such as Johnston & Ahtee, 2006; Pell & Jarvis, 2003; Timur, 2012, focused on pre-service or in-service primary school teachers' attitudes towards science teaching considering that the attitude formation of students develop during early primary school. Johnston and Ahtee (2006) reported that pre-service primary school teachers viewed teaching of science, mathematics, and mother tongue as more interesting and easier than the teaching of physics. Pell and Jarvis (2003) found that in-service primary school teachers lacked more confidence in teaching of science related topics than teaching of English language. Timur (2012) also showed that pre-service primary school teachers had more positive attitudes towards the teaching of science when including experimentation.

Beliefs about Science Teaching and Learning

Individuals' beliefs shape their behavior, perception, and organization of knowledge and information (Pajares, 1992). In educational settings, teachers' beliefs are one of the most fundamental factors affecting their behavior in the classroom (Nespor, 1987; Pajares, 1992). According to Nespor (1987), teachers' beliefs are independent of knowledge and they are more powerful than their knowledge in influencing their actions in the classroom. Due to its serious effect on behavior, the construct belief increasingly gain the attention of researchers (Pajares, 1992).

According to Ajzen (1988), people hold many beliefs. One type of belief suggested by him, salient beliefs, referring to "immediate determinants of a person's attitude" (Ajzen, 1988, p. 33), closely relates to an individual's attitude. These beliefs are subject to change and can be strengthened or weakened; they can even be replaced by other salient beliefs (Fishbein & Ajzen, 1975). The Theory of Planned Behavior proposed by Ajzen (1985) tries to explain individual behaviors, linking them with their salient beliefs and attitudes. He claims that these salient beliefs influence attitudes and then these attitudes affect behavioral intentions. These intentions also play a critical role in the determination of behavior (Ajzen, 1985).

Furthermore, Rokeach (1968) one of the widely known theorists, asserts that beliefs are part of a system, which includes countless beliefs about physical and social reality. These beliefs are different from each other according to their strengths (Rokeach, 1968). In the center, core beliefs exist and they affect peripheral beliefs. Core beliefs include existential and often non-conscious beliefs concerning the trustworthiness of individuals' senses (Brownlee, Boulton-Lewis & Purdue, 2002). Changing core beliefs is a difficult process; they are based on beliefs about nature of knowledge and nature of knowing (Hofer & Pintrich, 1997). On the other hand, peripheral beliefs, such as learning and teaching beliefs, exist on the surface and are more prone to change (Brownlee et al., 2002).

Belief is an important construct due to its serious impact on behavior (Pajares, 1992). Particularly in science education, studies concerning learners' and instructors' beliefs about teaching and learning have increased, because these beliefs are seen to play a crucial role in determining the instructional strategies that teachers use in their teaching (Tsai, 2002). The results of a study conducted by Tsai (2002) show that many Taiwanese science teachers hold a traditional or transmission teaching belief about the nature of science, learning science and teaching science. For example, teachers holding traditional or transmission teaching beliefs believe in the transmission of knowledge in teaching of science (Tsai, 2002). Another study conducted by Porlán and Martín (2004) with in-service and pre-service teachers point out that in-service teachers mostly hold a traditional, and pre-service teachers a technical, view of teaching. The traditional view of teaching is the same as the traditional teaching belief proposed by Tsai (2002). On the other hand, a technical view of teaching includes an organization of content that refers to stating the objectives before starting the lesson, organizing objectives from simple to difficult and evaluating the students according to these objectives (Porlán & Martín, 2004). Like the researchers (e.g., Porlán & Martín, 2004; Tsai, 2002), Olafson and Schraw (2006) attempt to classify teachers' teaching beliefs. Their classification includes 'realist' 'contextualist' and 'relativist.' In their study, many participants exhibit a contextualist position, which includes performing hands-on activities, carrying out collaborative group work and considering the teacher as a facilitator.

Moreover, beliefs are highly personal and affected by individual experiences (Nespor, 1987; Pajares, 1992). These experiences are held in the episodic memory of individuals (Nespor, 1987). Therefore, these can seriously influence teachers' judgments in the classroom (Pajares, 1992). Some researchers (e.g., Briscoe, 1991; Bryan & Abell, 1999; Eick & Reed, 2002) claim that teachers' previous learning experiences influence their teaching beliefs. In the study by Briscoe (1991), a participating teacher is not able to accomplish organizing cooperative learning activities, because he believes that students need to be rewarded after being successful or working hard. Bryan and Abell (1999) findings show that participating pre-service teacher's beliefs about how children learn science and how to teach science are influenced by both positive and negative learning experiences. Although having prior experiences of hands-on activities in early school years and not believing in the effectiveness of text book driven courses in science learning, instructional practices include teacher centered approaches. Eick and Reed (2002) claim that pre-service teachers' negative learning experiences enable them to consider using more student centered approaches, such as using hands-on activities in the classroom.

METHODOLOGY

Sample

The sample for the study included 137 male and 130 female PPSTs from the department of elementary education in one universities in Turkey. All had received a compulsory physics course in Grade 9 when at high school. In addition, they undertook a course on General Physics in their second year at university.

Data Collection

In the study, data were collected from all PPSTs in each grade in the university so whether their liking or disliking of physics had changed during their four-year education in the university was explored. Qualitative data collection tools, an open-ended questionnaire, the interview and classroom discussion, were used in this study.

The major data source was an open-ended questionnaire asking PPSTs whether they liked physics and, their reasons why they liked or disliked physics so as to elicit their salient beliefs. In addition, the questionnaire sought responses on how the PPSTs would want to teach physics in their professional life and the reasons for their responses so as to identify their teaching beliefs and the relationships of these teaching beliefs with salient beliefs.

The interviews and classroom discussions were conducted based on findings obtained from the open-ended questionnaires. In collecting the data, the open-ended questionnaire was distributed to all PPSTs. After completion of the open-ended questionnaire, eight PPSTs were chosen purposefully for interview. In the selection process for the interview, voluntariness of the PPSTs was considered. Five of them disliked physics while three liked it. As a final source of data, classroom discussions were conducted in two classes.

The same questions were asked to the PPSTs in an open-ended questionnaire, the interviews and classroom discussions. However, the interviews, and classroom discussions were conducted in a semi-structured manner, as suggested by Fraenkel and Wallen (2005). Additional questions, such as “why do you think so?”, and “could you give me more details about your response?” were sometimes asked to participants according to their responses.

Data Analysis

According to Miles and Huberman (1994), qualitative data analysis consists of three components:

1. Data reduction,

2. Data display, and
3. Conclusion drawing and verification.

In the data analyses, data obtained from the open-ended questionnaire was first analyzed. Then, categories and codes according to the responses of the PPSTs to questions were constructed, for example, searching the data based on the regularities and patterns, as well as the topics the data covered. After that, words and phrases were constructed to represent the patterns and topics and coded (Bogdan & Biklen, 1998) so as to try to find the related patterns to the research questions. In the next stage, phrases such as "previous physics teachers", "successfulness in physics", "performing hands-on activities" were recorded. These codes were matched with the main categories of this study. The occurrence frequencies of each code were calculated and written in the parentheses next to the codes. In addition, the data obtained from the interviews and classroom discussions were transcribed into documents after they were audio-taped. These findings were checked against the findings in the open-ended questionnaire.

For the validity, the findings obtained from an open-ended questionnaire, the interviews and classroom discussions were triangulated with each other (Merriam, 1998). In addition, a second person, holding a PhD degree, checked the reliability of the results obtained from the open-ended questionnaire to confirm the categories and codes were appropriate. After discussion of the results, names and numbers of the codes and categories were agreed by consensus.

RESULTS

The first question in the open-ended questionnaire asked whether the PPSTs like physics. The results pointed out that more PPSTs disliked physics. Figure 1 presents the distribution of the PPSTs liking or disliking physics in relation to grade level and gender.

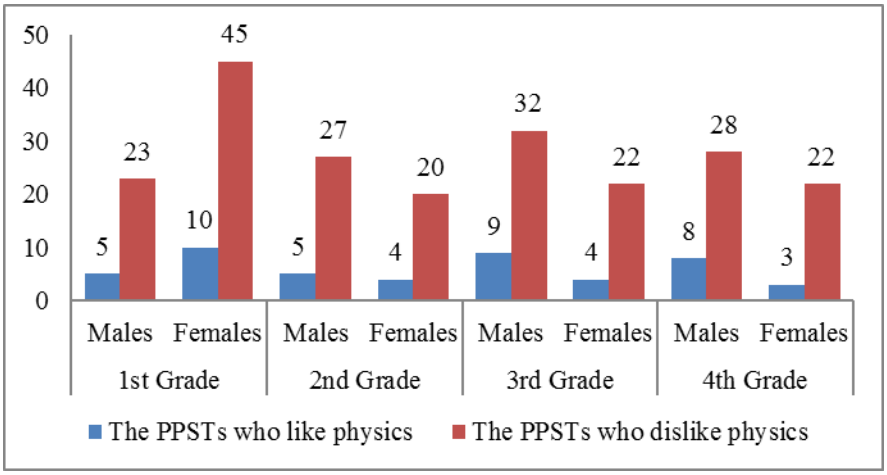

Figure 1. Distribution of the PPSTs who like or dislike physics in terms of grade level and gender.

Figure 2 shows the similar percentage values of male and female PPSTs who like or dislike physics in their own groups and the percentage values of the PPSTs who like or dislike physics in each grade.

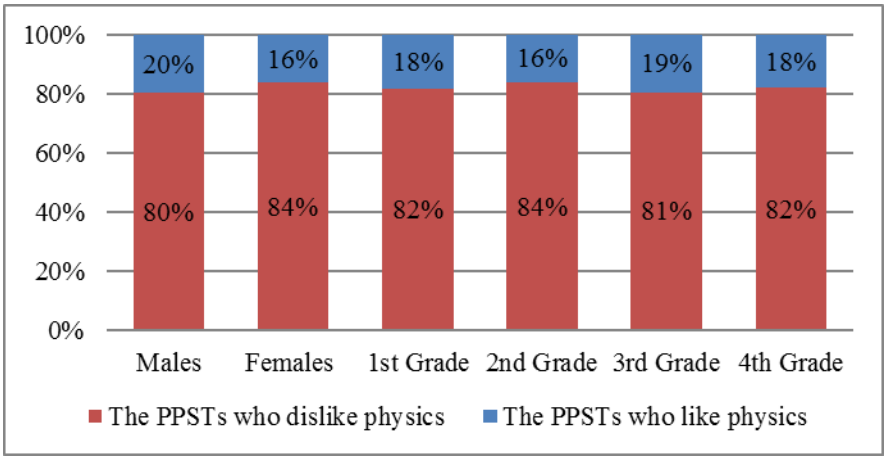

Figure 2. The percentage values of male and female PPSTs who like or dislike physics in their own groups and the percentage values of the PPSTs who like or dislike physics in each grade of the PPSTs.

The results indicate that the percentiles of the PPSTs who dislike physics to the total number of the PPSTs in each grade are almost equal to each other.

Salient Beliefs about Liking or Disliking Physics

The following four codes representing the PPSTs' salient beliefs have emerged from the content analyses of the open-ended questionnaires. The numbers in parentheses after each code indicates the occurrence frequencies of each code for the responses of the PPSTs who like physics and dislike physics respectively, i.e. the first number representing like physics, and the second, dislike physics.

Deep understanding of mathematics or not (N_1 = 44, N_2 = 32)

The PPSTs who liked physics considered that they liked it due to its close connection with mathematics. They viewed physics and mathematics as very similar to each other because both included calculations. Their claim could be based on the belief that successfulness in mathematics lead to successfulness in physics. The following excerpts are given from the various data sources to illustrate the relationship between liking physics and indicating a deep understanding of mathematics;

> *I like physics because I like mathematics. If someone is successful in mathematics, he or she can also be successful in physics. (Open-ended questionnaire)*

> *I always like the courses including mathematical calculations. Although I am not very successful in physics, I like it because it relates to mathematics… (Open-ended questionnaire)*

> *I like all the courses including mathematical calculations. If there are some calculations and problems which can be solved, I like physics. However, I like quantitative aspect of physics more than experimental problem solving. That helps me learn better. I like physics because it more resembles mathematics. (Interview)*

> *I like physics because it is based on mathematics and logic. In physics, you can understand the calculations, it is like a puzzle… I have not been successful in courses encouraging memorization. (Interview)*

When the PPSTs responses from those who disliked physics were examined, it was related to their poor knowledge in mathematics. According to them, this negatively affected their ability to solve physics problems. Some perceived mathematics as an indispensable part of

physics and believed that students could not learn physics without knowing mathematics. Because they were not successful in mathematics, they had an idea that they would also be unsuccessful in physics. Thus, they began to dislike physics. The following two excerpts illustrate why they disliked physics;

> *My knowledge of mathematics was very bad. I could not solve the problems. I am still unsuccessful in mathematics. In addition to this, we try to learn physics. How can we be successful? (Open-ended questionnaire)*

> *If someone does not know mathematics, he/she cannot be successful in physics. We cannot solve physics problems without mathematics. For example, I have not been successful in physics due to mathematics… (Classroom discussion)*

Being interested in physics or not (N_1 = 21, N_2 = 41)

Among the PPSTs who liked physics, some liked it because they were interested in it. According to them, the relationship of physics to daily life and physics related discoveries changing the world attracted their attention. Therefore, they began to be more interested in physical phenomena and curious about them. They thought that physics made their life easier and technological developments existed due to physics. Additionally, some of them claimed that all the events changing the world began with physics. All the reasons mentioned above helped them like physics. Some excerpts to illustrate the salient belief are presented;

> *Physics is always with us. We can see its applications everywhere in daily life. It makes our life easier… (Open-ended questionnaire)*

> *Physics is used everywhere. It is not possible to disregard its contributions to our lives. Many technological tools are working according to the principles of physics. (Open-ended questionnaire)*

> *All the events changing the world exist due to physics. In terms of technological developments, we cannot regard the contribution of physics… For example, I like Einstein, Newton because they invented many terrific things… Some events such as the birth of quantum physics changed the worldview of individuals. (Classroom discussion)*

Some PPSTs who disliked physics also believed that they did not use physics knowledge in their daily life, and therefore; considered physics as unnecessary. According to them, the topics in physics were meaningless. Some excerpts, pointing out their responses to why they disliked physics, are given below;

> *I think that learning physics topics is unnecessary. Where do we use them in our life? Nowhere! (Open-ended questionnaire)*

> *The topics of physics are meaningless according to me. There are not any applications of it in daily life. Therefore, I do not like it. (Open-ended questionnaire)*

> *In short, we dislike physics because we are not interested in it. It is not related to daily life. We cannot see the applications of physics in daily life as in mathematics and the Turkish language. Therefore, we have not been interested in physics. (Classroom discussion)*

Active involvement in learning physics or not (N_1 = 9, N_2 = 93)

The PPSTs' previous physics teachers' teaching approaches used in the classroom also affected their liking or disliking of physics, both positively and negatively. Some PPSTs who liked physics believed that if teachers used activities making students more active in learning and discussed daily life examples related to physics, students would like physics. The following excerpts illustrate the influence of these teaching approaches on the PPSTs who liked physics;

> *Our teacher spent much time in the laboratory. We performed many experiments. Due to these experiments and my teacher, I liked physics. (Open-ended questionnaire)*

> *Students have to learn physics by relating it to their life. If you want to teach physics to students, you have to give concrete examples in the lesson… For example, our teachers in high school were very good at teaching. We went out in our Geography course and our teacher asked questions. Similarly, in the physics course, we undertook hands-on activities in the lesson. If physics teachers performed some activities, everybody could like physics. (Classroom discussion)*

On the other hand, the PPSTs who disliked physics indicated that teachers who did not give concrete examples from daily life, make students active in learning and mention the importance of learning physics, negatively affected their liking of physics. According to them, teachers played a key role in helping students to like physics. Some excerpts are given to explain the PPSTs' ideas;

> *Physics includes many abstract subjects. For example, there are many physics problems in the test books; however, those have not been related to life. Teachers solve them. How do these problems help us learn real physics? Teachers do not make abstract subjects concrete… (Open-ended questionnaire)*
>
> *Our teacher has always solved physics problems and we could not understand them… (Open-ended questionnaire)*
>
> *Our high school physics teacher did not teach us anything. He/she always solved physics problems and we could not solve them in the exams. (Open-ended questionnaire)*
>
> *We did not like physics because our teacher did not help us like it! He/she could not make physics concrete. For example, he/she did not perform any activities and we never went to the laboratory. (Interview)*

Successfulness in physics or not (N_1 = 6, N_2 = 176)

A few PPSTs liked physics due to their successfulness in physics. However, they viewed successfulness in physics as being successful in solving physics problems. They believed that if learners reached a correct solution while solving physics problems they could like physics. According to them, their liking of physics was highly related to successfulness in problem solving. Below excerpts illustrate the ideas of the PPSTs;

> *I like it because I can solve the physic problems. If you know the formulas, you can be successful. (Open-ended questionnaire)*
>
> *I am sure that my friends get angry with me now because I like physics. However, if they feel the happiness after*

> *reaching a correct solution in solving physics problems, they can like it. (Classroom discussion)*

The majority of the PPSTs who disliked physics believed that their disliking physics was based on their inability to solve physics problems. They also had a preconception that physics was difficult. They related this difficulty with their unsuccessfulness in solving physics problems in the classroom discussions and interviews. The reason behind this preconception could be their unsuccessfulness, as they indicated. They also probably viewed physics as mainly problem solving. According to them, when they were not successful in solving physics problems, they were discouraged. As a result, they began to dislike physics, even hated it. The following excerpts show these ideas;

> *Physics problems are very difficult. I cannot solve them. (Open-ended questionnaire)*

> *I remember that I have never solved physics problems. (Open-ended questionnaire)*

> *As I could not solve the problems, I began to dislike physics. If you are not successful, you begin to hate physics… (Interview)*

Furthermore, some PPSTs believed in the necessity of memorization of formulas, understanding the physics problems, use of logical skills and sufficient prior knowledge to solve physics problems. However, they thought that they did not have these skills and knowledge. Therefore, they disliked physics. The following excerpts illustrate these ideas;

> *I dislike physics because I cannot use my logical thinking skills enough. Even if I interpret the problems, I reach wrong answers. There are many rules in physics. It is impossible to memorize all the rules. (Open-ended questionnaire)*

> *Physics includes many formulas. It is very confusing. I do not know how to use formulas. Although, I like mathematics, I cannot solve the physics problems. (Classroom discussion)*

> *We could not learn many topics in physics in the elementary and high school. It is very difficult to learn physics without knowing previous topics. They are all*

> *related with each other. We cannot solve the problems without knowing. (Classroom discussion)*

Teaching Beliefs about Physics and the Relationships with Salient Beliefs

To reveal PPSTs' teaching beliefs about physics, they were asked how they would teach physics in future in the open-ended questionnaire. Following content analyses of their responses, five codes emerged. The occurrence frequencies of each code is written in parentheses next to the codes. Moreover, in presenting the results, some excerpts from the data sources were given to point out the relationships between teaching beliefs about physics and the salient beliefs presented in previous sections. The codes representing the teaching beliefs about physics are as follows;

Giving examples related to physics from daily life (N = 118)

The majority of the PPSTs believed in the necessity of relating physics to daily life by giving examples from daily life in the lesson. They thought that students could learn better by this way and become more interested in physics. According to them, teaching physics by relating it to daily life would also help students like physics, because they perceived physics as a part of their lives. However, PPSTs' previous teachers' behaviors had a serious impact on their construction of teaching beliefs. Their positive and negative previous learning experiences influenced their teaching beliefs. Some excerpts from data sources to illustrate the relationships between salient beliefs and the teaching belief (giving examples related to physics from daily life) are presented as follows;

> *I will try to relate physics to daily life by giving examples. For example, I could not learn anything from my previous teacher. He/she always solved questions. (Open-ended questionnaire)*

> *I think that physics is in life. However, we did not see this. We always solved problems. I think physics has to be taught to students by relating it to daily life. (Classroom discussion)*

Using visual materials to make physics concepts concrete (N = 97)

Some PPSTs considered the necessity of using visual materials in the lessons. In this regard, students could learn better according to them because they could see more concrete examples. Those ideas were also influenced by their previous learning experiences, as illustrated in the following excerpts;

> *The first reason why I dislike physics is my previous physics teacher's teaching approach. I will try to be different from my previous physics teacher. I will try to attract students' attention in the course. For this, I will use some visuals to make physics concepts concrete… (Open-ended questionnaire)*

> *For example, my previous physics teacher always used formulas and rules. He always solved physics problems. He did not talk about any examples related to daily life or carry out any activities. Therefore, we hated physics… I want to perform some activities by using visual materials. If students learn by doing, they can learn better. It is necessary to make physics concrete. (Classroom discussion)*

Carrying out hands-on activities related to physics (N = 83)

Performing some hands-on or laboratory activities was important according to many PPSTs. They believed that students might not forget what they have learned and gain a deep understanding of physics by doing the activities. The following excerpts illustrate the relationships between their salient beliefs and their teaching belief (carrying out hands-on activities related to physics);

> *Instead of teaching too many formulas to students, I prefer to perform some activities with students in the laboratory or classroom. Because they will be active in doing activities, they can understand better. (Open-ended questionnaire)*

> *According to me, if students engage in laboratory and classroom activities, they can learn better because they see the applications of physics. In other words, they forget. For example, I have never forgotten what I have learned in the laboratory. (Interview)*

> *I have remembered that I spent most of my time in the laboratory with my friends. We performed lots of activities with our teacher. I want to behave as my teacher. I understood physics when I was in the laboratory… (Classroom discussion)*

Solving a great number of physics problems (N = 17)

A small number of the PPSTs believed that practicing lots of physics problems could help students learn physics better. According to them, students could be successful in the exams by this way and they could like physics. They related students' liking physics to their successfulness in physics. Some excerpts to show their claims are presented as follows;

> *I solve lots of physics problems. However, these problems are in the order from easy to difficult. Therefore, students can like physics because they are successful. (Open-ended questionnaire)*
>
> *By solving physics problems, students can understand physics better. (Open-ended questionnaire)*
>
> *To be successful in physics, there is a need to solve many problems. (Open-ended questionnaire)*
>
> *I solve lots of physics problems. If students practice more physics problems, they can learn better. (Classroom discussion)*

Teaching physics making connections between subject matter and rules or formulas (N = 13)

Making connections between concepts and teaching the details in physics were necessary according to some PPSTs. The PPSTs holding a superficial understanding about the link between formulas and subjects had difficulty in understanding physics in their previous school years. Therefore, they believed that students should be aware of what they learn by linking their learning with rules or formulas. Below, some excerpts illustrate these ideas;

> *By explaining the connections among formulas and subjects. If it is not done, students can have a superficial understanding about subjects. (Open-ended questionnaire)*
>
> *I will try to teach by explaining the subject in detail. I will explain the connections between the physical phenomena and the rules or formulas. Then I will try to solve many physics problems to help students understand them… (Open-ended questionnaire)*

> *I think that giving the details in teaching of physics related topics can be helpful for students to understand better… For example, our teachers only gave us formulas. We put the values in the formulas without thinking. When we encounter different types of questions, we cannot solve them. (Interview)*

DISCUSSION

Liking Physics

The first important finding of this study was that the majority of the PPSTs (approximately 82% of the participants) indicated that they did not like physics. The attitude "liking or disliking physics" and the salient beliefs underlying it were formed at an early age. When the salient beliefs about liking or disliking physics, found in this study, were examined, it was realized that they were mostly related to the PPSTs' previous learning experiences. This finding was consistent with the claims of Osborne et al. (2009). According to them, attitudes towards science were formed at an early age. For example, the results showed that the PPSTs' previous physics teachers played a key role in influencing their liking or disliking physics. Their previous teachers' teaching strategies (e.g., solving a great number of physics problems, not performing hands-on activities) enabled some of the PPSTs to dislike physics.

Solving Physics Problems

Many of the PPSTs also indicated that they were not successful in solving the physics problems. Their previous teachers' emphasis on memorization of formulas and rules in teaching of physics enabled them to become unsuccessful in solving physics problems. Therefore, this result can imply that this emphasis is one of the obstacles in front of the PPSTs to like physics. Some researchers (e.g., Osborne & Collins, 2000; Redish & Steinberg, 1999) also reported this finding in their studies. Although the PPSTs' previous physics courses have been conducted by giving emphasis on memorization until now, and therefore they have disliked physics, this teaching approach should be changed particularly in university education. Knowledgeable physics instructors about teaching methods promoting active involvement of the PPSTs in learning should conduct physics courses in the universities.

Influence of Mathematics Knowledge

The PPSTs' knowledge about mathematics also influenced their liking or disliking of physics. Some PPSTs who were successful in mathematics liked physics but some who were not successful disliked physics. Close relationship of physics with mathematics influenced the PPSTs' liking or disliking physics. This result was similar to findings by Ornek et al. (2007) and Semela (2010). Semela (2010) found that the number of students who choose physics courses was low due to their poor knowledge in mathematics. In addition, Ornek et al. (2007) indicated that poor knowledge about mathematics was one of the reasons to view physics as difficult. The belief that learning physics is difficult without knowing mathematics could force students to hold such ideas. Therefore, the amount of mathematics used in physics courses should be diminished to be able to prevent students holding this belief.

Perception of Physics as a Difficult Subject

Another important result in this study was that many of the PPSTs perceived physics as a difficult subject. This result was also consistent with the findings of Johnston and Ahtee (2006), as well as Nilsson and van Driel (2010). The PPSTs' salient belief "being not able to solve physics problems" could enable them to perceive physics as difficult subject. Perceiving physics as a difficult subject could affect the PPSTs' liking physics negatively. Such a perception may also influence their teaching of the topics related to physics in their professional life and therefore, it is probable that they may skip some topics related to physics, or teach them superficially. The Theory of Planned Behavior proposed by Ajzen (1985) also emphasized the influence of attitude on behavioral intentions. Therefore, instead of solving lots of physics problems in the physics courses in the universities, the PPSTs should develop skills, such as science process and psychomotor related to physics, to help them like physics. This claim was also supported by Redish et al., (1998) and Redish & Steinberg (1999). According to them, use of hands-on activities related to physics could help students to have positive attitudes towards physics. Gibson and Chase (2002) also suggested that inquiry based activities had an impact on changing negative attitudes of students towards physics.

Unable to Solve Numerical Problems in Physics

Moreover, the results of this study showed that one of the most important salient beliefs of the PPSTs about why they disliked physics was their unsuccessfulness in solving physics problems. Therefore, the PPSTs' problem solving skills enabling them to solve physics problems should be

developed to promote liking physics. Another alternative suggestion, perhaps the most effective suggestion to overcome this problem, should be teaching PPSTs to recognize that physics is not only composed of numerical problem solving. They should be encouraged to acquire a conception of physics tied to explaining nature and natural phenomena considering cause and effect relationships.

Teaching Physics by Considering Active Involvement

The results of this study also pointed out that many PPSTs believed that giving examples from daily life, performing hands-on activities and using visual materials in teaching were necessary for students to learn better. This result was also consistent with the results of Olafson and Schraw (2006). They found that some participating teachers in their study stated their position as contextualist. This position included performing hands-on activities, carrying out collaborative group work and considering the teacher as a facilitator In addition, according to results of this study, previous learning experiences of the PPSTs had a serious influence on their teaching beliefs. These experiences affected their teaching beliefs both positively and negatively, but mostly negatively. These results were also consistent with the results of Bryan & Abell (1999) and Eick & Reed (2002). According to Eick and Reed (2002), teachers' negative learning experiences influenced their teaching beliefs in a positive manner. They used more student centered approaches that differed from their previous own experiences. The results of this study could also imply that the previous learning experiences of PPSTs, based on more teacher centered learning approaches, enabled them to prefer to use more student centered learning approaches. However, observing the PPSTs after their graduation from the university should be necessary to confirm that their stated beliefs are consistent with their teaching. In this regard, researchers could learn how much the PPSTs need in-service training courses in their professional life to make their students more active in learning of physics related topics.

CONCLUSION

The majority of the PPSTs did not like physics due to their unsuccessfulness in physics. They could not solve physics problems and faced difficulty in understanding physics due to their poor knowledge about physics formulas and rules. Viewing physics as only sum of physics problems and formulas was the major factor influencing their disliking physics. Moreover, the PPSTs' knowledge about mathematics influenced their liking or disliking physics. If they were successful in solving mathematics problems, they had more positive attitudes towards physics.

In contrast, the PPSTs who were not successful in mathematics also did not like physics. The PPSTs' interest in physics also affected their liking or disliking physics. According to them, if the physics topics were learned by relating them to more daily life examples and technological developments in the lessons, they could like physics. Furthermore, the PPSTs' insufficient experiences in hands-on activities and their past teachers' teaching based on more students' memorizations of physics facts, rules, and formulas negatively affected their liking physics.

Finally, according to the PPSTs, their previous learning experiences also influenced their teaching beliefs about physics. Their previous teachers' teaching that was encouraging passive learning in the classroom enabled them to believe the strategies that make students active in learning. They believed in the necessity of giving examples from daily life, performing hands-on activities and experiments, using visual materials, solving physics problems and making connections among subject matter and physics rules or formulas in teaching of physics topics.

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