Prospective High School Physics Teachers' Beliefs about Teaching Practices: From Traditionalist to Constructivist

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The main aim of this study was to determine the teaching practices of prospective high school physics teachers with respect to their preference for teaching as a traditionalist or as a constructivist. To study the beliefs of prospective high school physics teachers on this subject, firstly, the Teacher Belief Survey was administered to 135 prospective high school physics teachers; and then semi-structured interviews were conducted with eleven prospective high school physics teachers. Analyzing of the survey and interviews showed that most prospective high school teachers had intermediate (traditionalist to constructivist) beliefs about teaching physics.

Keywords: Prospective high school physics teachers, beliefs about teaching practices, constructivist and traditionalist perspective of teaching

INTRODUCTION

The research in physics education has revealed that when prospective physics teachers start attending a university, they hold with them many ideas about learning and/or teaching that generally they come from interacting with their real world environments. As a consequence, those kinds of beliefs influence their further learning (Briscoe, 1991; Duit & Rhöneck, 1997; Gunstone, Slattery, Bair, & Northfield, 1993; Hake, 1998; Hestenes, Wells & Swackhammer, 1992; Hrepic, Zollman, & Rebello, 2007; Mazur, 1997; McDermott, 1997; Palmer & Flanagan, 1997; Poon, 1993; Redish, Saul, & Steinberg, 1997; Thornton and Sokoloff, 1990; Tsai, 2002; Van Heuvelen, 1991; Wallace & Louden, 1992). Interfering with students' learning, these prospective teachers' existing beliefs should be taken into consideration in teacher education programs. Also, Nespor and Barylske (1991) noted that beliefs about the

subject matter are vital to determining the practice of teachers and their beliefs about shaping their interpretations and expectations of future events. And those kinds of beliefs can be very resistant to change. Additionally, the development of prospective teachers' beliefs about teaching and learning science during the university education with experienced some classroom practices influence and affect their further teaching practices too. Therefore, it is very essential to find out the prospective teachers' beliefs about teaching and learning and to support them to reflect these ideas to reach better teacher education program (Mellado, 1998; Southerland, & Gess-Newsome, 1999).

Theoretical Background

According to Shrigley, Koballa, and Simpson (1988), beliefs can be descriptive, informational or inferential. Reviewing the literature, Pajares (1992) stated that beliefs are "the best indicators of the decisions individuals make throughout their lives" (p. 307). When teachers' decision-making about curriculum and instructional tasks, their belief formations play a most important role (Nespor, 1987; Pajares, 1992; Richardson, 1996).

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State of the literature

- Determining prospective physics teachers' belief about their teaching practices is a very important issue in high school physics courses.
- Prospective physics teachers need to have developed the knowledge and skills to choose appropriate teaching strategies/methods/techniques before the instruction. Nevertheless, there is a lack of research on prospective physics teachers' beliefs about their teaching practices.
- One of the most important goals of professional development is to foster constructivist beliefs and enhance activities by emphasizing comprehensive teaching practices.

Contribution of this paper to the literature

- It can be concluded from this study (indicated by the interviewees) that the experiences of prospective physics teachers influence on their beliefs about teaching physics. And this result in accordance with some other studies.
- Teachers' beliefs about developing some concepts in physics are might be related to their viewpoint about how to teach physics and how students learn it.
- Some prospective physics teachers pointed out to the importance of learning and understanding some daily physical phenomena in the context of teaching physics without taking into account the development of scientific skills. Therefore, teacher education programs might play essential roles in developing scientific skills. In this case prospective physics teachers might become aware of this and try to improve their students' scientific skills when they become a physics teacher.

When students entered into teacher education programs, they held some beliefs about learning and teaching. In order to discover and explain teachers' beliefs, many studies (e.g., Kane, Sandretto, & Heath, 2002) have been carried out related to science and also teaching science (see for examples, Aguirre, Haggerty, & Linder, 1990; Hashweh, 1996; Pomeroy, 1993; Porlán & Martín del Pozo, 2004; Smith & Neale, 1991; Spear, 1984; Tsai, 2002). For instance, in reviewing of research on teacher attitudes and beliefs, Richardson (1996) mentioned three sources of teachers' beliefs: "a) personal life experiences that shape a teacher's world view, b) experiences as a student with schooling and instruction, and c) formal knowledge including pedagogical content knowledge" (pp.105-106). On the other hand, Wallace and Kang (2004) argued that teachers' belief system related to teaching represents

their beliefs about students' learning, the nature of science, epistemology, and the role of teachers. However, in terms of their teaching practices, these studies did not investigate the effect of teachers' beliefs about teaching and learning science. Moreover, categorizing teachers' beliefs about science teaching, Porlán and Martín del Pozo (2004) noted tree models as being traditional, technical, and alternative (similar categorizations are given in Pomeroy, 1993; Smith & Neale, 1991; Tsai, 2002).

A number of studies have pointed out that there is a relationship between beliefs and teaching practices (Cronin-Jones, 1991; Anderson, & Mitchener 1994; Dillon, O'Brien, Moje, & Stewart, 1994; Tobin & Espinet, 1989). Another study by Dillon et al. (1994) showed a consistency between the teachers' philosophies of teaching science and their beliefs about explaining subject matters and/or using textbooks (or the other written materials) and their classroom performances. Furthermore, some activities in teacher education programs such as school experiences, laboratory exercises, and so on could also influence teachers' beliefs about teaching (Tsai, 2002). Finding a relationship between prospective teachers' beliefs about learning/teaching science, and the nature of science, the author also noted that most teachers have traditional beliefs about learning/teaching science, and the nature of science. According to some sentences like "the best way of teaching science is transferring knowledge from teachers to students", "learning science is acquiring knowledge from reliable sources" and "science gives the correct answers", it can be drawn a conclusion that most teachers' beliefs about teaching/learning science or nature of science are the traditionalist view.

In general, altering prospective teacher's beliefs during their education program is very difficult. Mayer-Smith and Mitchell (1991) reported some reasonings about these difficulties as follows: conflicts with the short period of classes and curriculum interferences, problems with the critical timing of field and university-based practices, inconsistencies with pedagogical perspectives of universities and schools, and differences with prospective teachers' disciplinary backgrounds and the school culture.

Constructivism vs. Behaviorism Approach

Among many kinds of learning theories, constructivism and behaviorism hold different beliefs about learning. Because of dominating behaviorist-learning theories in the American educational system, most teachers after finishing their teacher education program go into K-12 schools based on the behaviorist learning theories for a long time (Brooks & Brooks, 1993), as well as many countries including Turkey. However, the later on in learning model started altering

from behaviorism to constructivism (Kang & Keys 2000). The constructivist learning theories are a different from the traditional teaching/learning methodology in terms of evaluating and supporting a different teaching approach. Because of addressing some criticism of present practices and promising to deliver higher levels of learning, self-confidence, collaboration, problem-solving skills, etc., the constructivism has found demand as an alternative to traditional methods (Brooks & Brooks 1999; Iran-Nejad, 1995; Larochelle, Bednarz, & Garrison 1998; Sprague & Dede, 1999; Windschitl, 1999). Contrary to constructivists, behaviorists believe that knowledge exists separately from learners and learning occurs when learners' behavioral patterns are changed through "repetition, reinforcement, and consequences" (Russell, 2002). To get the desired behavior from the learner, a behaviorist approach made learning/teaching questionable. In contrast to a cognitive approach, behaviorism highlights the mental explanation that the learner carries out rather than the detailed features of learning/teaching process. (Bruning, 1983). The underlying principle and assumption of constructivism are that knowledge exists in learners' previous living and learning experience. The tenants of constructivism include the idea that learning occurs when learners, on the basis of their prior knowledge, actively interact with others in situated learning environments (Wheatley, 1991). A constructivist teacher exhibits a number of apparent qualities that are evidently distinct from a traditional classroom. A constructivist instructor knows how to flexibly and productively integrate continuing experiences in the classroom into the cooperation and structure of instruction with individuals and/or small groups. In this democratic classroom environment, the instructor acts as a facilitator or advisor and all kinds of activities are student-centered and interactive.

Current direction in science education has highlighted the constructivist view of teaching and the way this view is learnt and implemented relies on beliefs of teachers. Accordingly, instructors have to study the link between beliefs of prospective physics teachers about instruction and their actions. Thus, the current study attempts to describe the beliefs about traditionalist and constructivist teaching practices of prospective physics teachers about teaching physics in high schools. Understanding the beliefs of prospective science teachers is important (Saad and BouJaoude, 2012) for designing curriculum that will help them develop more sophisticated beliefs about learning and/or teaching.

Purpose

The main aim of this study was to determine prospective high school physics teachers' beliefs about traditional and constructivist aspects of their teaching behavior. The research questions of this study are:

1. What are the beliefs of prospective high school physics teachers about teaching physics in high schools in terms of being a traditionalist (behaviorist) or constructivist teaching practice?
2. What are the basic aspects preeminent of these beliefs?

METHODOLOGY

The study employed the mixed research design (Johnson, & Christensen, 2007). In this research model, quantitative and qualitative approaches are mixed within or across the stages of the research process.

Participants

In order to investigate given research questions, quantitative data were obtained from 135 prospective high school physics teachers (61 males (45%) and 74 females (55%)) who attend in the Necatibey Faculty of Education at Balıkesir University. Balıkesir is a mid-side of the city where situated in the northwest of Turkey. Furthermore, semi-structured interviews were taken with eleven prospective high school physics teachers (six females; and five males) with a volunteer basis to obtain qualitative data. Their ages varied from 20 to 24 and they were either in the fourth or fifth year of their educational program.

To attend a university in Turkey, one must take and pass a national exam Undergraduate Replacement Examination (LYS) governed every year by Student Selection and Placement Center (OSYM) then upon graduation from high school. This multiple-choice questions exam consists of a couple of parts to measure students' verbal and arithmetic abilities along with acquisitions in Turkish language and literature, mathematics, physics, biology, history, and geography. The scores obtain from this exam is the main factor for placing to Turkish universities (YÖK, 2013).

The participants, like all the remaining students at the Necatibey Faculty of Education, have to follow a five-year educational program. To complete this program, for the first seven semesters, students have to get physics classes in the physics department. Completing these classes, students have to attend courses regarding the profession of teaching in the "Secondary Science and Mathematics Education" department for additional of three semesters. Finishing all requirements, the students are entitled to have MSc degrees (without a thesis option). After graduation, physics teachers could employ by The Ministry of Education or private high schools as candidate physics teachers.

Processes of Data Collection

All data were gathered in the fall and spring semesters of 2006–2007 academic year from prospective high school physics teachers by "The Teacher Belief Survey (TBS)," written responses, and a semi-structured interview done by the researcher.

The Teacher Belief Survey

Woolley and Woolley (1999) developed an instrument to measure teachers' beliefs about teaching with regard to the behaviorist (traditional) and constructivist learning theories. Beliefs of prospective high school physics teachers about students' learning shape and determine their further classroom performance and practices (Gunstone &White, 1998). Thus, their beliefs about teaching are thought to be appropriate to assess their future teaching practices. This Likert-type instrument consists of 27 items and was organized into the following four different scales (dimensions): *behaviorist management*, *behaviorist teaching*, *constructivist teaching* and *constructivist parents*. The instrument is believed to be an appropriate tool to measure prospective physics teachers' beliefs quantitatively. Also, the alpha reliability estimated by following Woolley and Woolley's (1999) study was calculated separately for scale ratings for each dimension to be about .70, .82, .71, and .57, respectively, values that are considered to be satisfactory except for the constructivist parent scale. The researcher translated all the items into Turkish. Next, TBS was piloted with 62 prospective physics teachers. Then, evaluating the item validity and comprehensiveness of the statements, all necessary changes were made on TBS. Since our prospective physics teachers are not yet actively involved in teaching at high schools and due to the low alpha reliability of the scale in *constructivist parent* section, I did not use the instrument items pertaining to this section. In this case, the revised final version of the instrument consisted of 23 items. (The alpha reliability of the adapted version of the TBS in this study was calculated separately for each dimension to be about .76, .83 and .79, respectively).

Behaviorist Management Scale includes seven statements about the discipline, the schedule, and the physical and social climate of a classroom. Agreeing with the statements on this scale, a prospective high school physics teacher who believes in is being responsible by directing events, rather than sharing power with students.

Behaviorist Teaching Scale, which contains nine statements, is about planning, guiding and evaluating students' learning. Agreeing with the statements on this scale, a prospective high school physics teacher who believes in is two separate subjects, to follow textbook curricula, to work with having students independently, and to assess students in traditional ways.

Constructivist Teaching Scale, which contains seven statements, is about planning, managing and addressing the students' involvement. Agrees with the statements on this scale, a prospective high school physics teacher who believes in having a student-centered classroom with many constructivist approaches such as creating bulletin boards, doing curricula based on students' interest, integrating subjects, and evaluating students in informal ways.

Written responses and interview

In 45 minutes class session, we asked to participants the following question: "How do you think physics should be taught?" In addition to written responses, also eleven volunteer prospective physics teachers were interviewed by semi-structured technique. While the Teacher Belief Survey was administered during the fall semester, the written responses and interview were done in the spring semester. Furthermore, It is expected from interviews to help recognize the complexities of the prospective physics teachers' teaching experience from their perspective, as recommended by Guyton and McIntyre (1990) and others (Zeichner, 1986; Johnston, 1994; Porlán & Martín del Pozo, 2004; Tsai, 2002; Wallace & Kang, 2004). In the interview section, I asked about the six dimensions of teaching physics (adopted from Boz & Uzuntiryaki, 2006). They include: a) teaching subject matter, b) purpose and importance of laboratory, c) roles of teachers and students in the classroom, d) interactions with teacher-student and student-student, e) the role of technology and computer, and f) assessment preference. Prospective physics teachers were interviewed by the independents. Each interview lasted for about 45 minutes and agreed to be recorded, so each interview was taped.

Analysis

The last version of TBS was executed to the prospective physics teachers by a researcher. In order to identify the general themes within the participants, prospective physics teachers' response patterns were investigated (Bogdan & Biklen, 1998). Then, prospective high school teachers' beliefs were divided into three main categories to describe concerning teaching physics based on as a traditionalist, intermediate and constructivist view of teaching (Levitt, 2001; Tsai, 2002).

RESULTS AND DISCUSSION

This part is composed of three major sections. First, the results pertaining to The Teacher Belief Survey;

second, the results pertaining to the written responses about physics teaching; and third, the results pertaining to the interviews.

Results pertaining to the Teacher Belief Survey

Each item in TBS was analyzed by the frequency distribution for to characterize the viewpoint of participants' beliefs (N=135) about teaching on the basis of behaviorist and constructivist learning approaches (see appendix). The overall mean of the instrument was 3.39 and standard deviation was .95. The lowest mean score was obtained from the item, of *"I am a firm believer in paper and pencil tests,"* and the highest mean score was obtained from the item, of *"I would invite students to create many of my bulletin boards."* The mean of these two items shows that many students' beliefs are closer to constructivist learning theories. However, in general, to reveal prospective high school physics teachers' beliefs about traditionalist or constructivist teaching practice in terms of three different (dimension) scales (as behaviorist management, behaviorist, and constructivist teaching). The calculated mean and standard deviations of each scale are given in Table 1.

If the prospective high school physics teachers' average TBS score for each dimension is equal to 3.0, it means that they are equidistant to each dimension or have neutral opinions about behaviorist or constructivist perspective. On the other hand, an average score of less than 3.0 implies that they have less favorable opinions concerning the scale, while scores higher than 3.0 indicate more favorable opinions. As seen in Table 1, the study found that the mean of the constructivist teaching scale is higher than that of the behaviorist management and teaching scales; however, these scores in general were found to be higher than the neutral score (3.0). Consequently, it can be concluded that most prospective physics teachers believed constructivist idea in some parts but also behaviorist thoughts on the other aspects.

Results pertaining to Written Responses

The responses mainly focused the current curriculum in general, the methods used to explain the subject matter, the importance of lab experiments and computer use in the classroom rather exploring other different characteristics of instruction. Most did not consider in great detail some characteristics of teaching physics, for instance the teachers' role and his/her interaction with the students, certain aspects of assessment methods, and so forth.

It is clear from Table 2 that many prospective physics teachers criticized the current physics curriculum implemented in high schools, claiming that it only forces students to prepare for the National Selection Examination (OSS) (rather than focusing on conceptual learning). Furthermore, most confirmed that physics ought to be taught visually with the assist of experiments and computers by simulations and animations. Similarly, most of them emphasized the necessity of teaching physics relating to our daily lives. Some believe in the necessity to address high school students' complaints and/or beliefs that "physics is a hard/tough subject". Only a few noticed about students' misconceptions or the perceptual perspectives.

Table 1. Mean ($\overline{X}$) and Standard Deviations (s.d) of Prospective High School Physics Teachers' Belief Survey in terms of Three Different Dimensions

Scale	$\overline{X}$	s.d
Behaviorist Management	3.22	1.08
Behaviorist Teaching	3.21	0.94
Constructivist Teaching	3.74	0.83

Table 2. Some Responses to the Question of "How Physics Should be Taught" and Their Percentages

Some responses about "how physics should be taught.	%
Mentioning/Importance of subject matter, lab experiments, media (computer), etc.…	>90
(Blaming the current curriculum), not focusing on the conceptual understanding of the subject matters	86
The importance of making physics relevant to daily life	76
Physics is a hard/tough subject	40
Statement of the importance of "pre/misconception" in physics	15
Importance of affective domain/teaching methods, etc	10
A few prospective teachers wrote about using/mentioning alternative evaluation methods (like portfolio, etc)	.10<

Table 3. Interviewees' beliefs and Excerpts from Interviews Related to *"Teaching Subject Matter"*

Interviewees	Focus	Excerpt from the interview
PT1 (constructivist)	• *Students' previous conceptions or backgrounds ought to be considered throughout teaching* (diagnostic tests-like Force Concept Inventory (FCI) or Concept Survey of Electricity and Magnetism (CSEM)- administering to students those given tests at the beginning of the semester could help physics teachers get deep insight into the students' backgrounds. Then, the teacher can be focused on or directed towards students individually according to their needs in the classroom). • *Importance of sequencing physics content.* The order of topics or concepts may influence students' learning. Also, levels of abstraction, complexity and familiarity to students either previously thought or encounter through their daily life is very important, too. • One of the most important things for students is *learning how to learn* is need to emphasize and teach in physics courses.	*"The electrostatics unit was taught for 30 days. However, very little connection was provided with our everyday lives. For instance, investigating the connection between electrostatics and a photocopy machine would be beneficial (and so on…). I would give an assignment about that to the students. Then I might be discussed this at the beginning the next class. Interpretations that students made are not all that important whether or not they are correct. Because, the important thing is that helping students to learn thinking and interpretation abilities."* *"I prefer my students to learn 'how to learn' in my classes. Thus, even though students have a problem with some physics concepts, eventually, they will learn how to learn "* *"I think first I would attempt to realize the students' backgrounds or priory knowledge about any subject matter. In high school level, they learn some physics concepts, so they might have some knowledge about it. In general, I prefer my students perform experiments, if my school has adequate amenities. Additionally, if there is scientific article related to a subject, I might bring with me to the class to open discussion. I allow students to express his/her views or opinion about that subject. In this way, I suppose my students to move their thinking more advance. Then, I prefer to use simulations in the computer environment and/or demonstration about "right hand rule in magnetism."*
PT2 (intermediate)	• To increase students' interest and to make a connection between physics and daily life, it must be given real life examples in the classroom. • Some physics concepts are abstract. If those concepts were not taught without any detail explanations or making links to concrete examples from the real world, students could not retain that knowledge. • At the present time, the way of teaching physics in physics courses is criticized. • Note: Explanations of PT 2's reflect the constructivist viewpoint of teaching physics because his aim is to recognize and reveal students' prior knowledge and thinking habits. However, he holds some traditional (behaviorist) beliefs or approaches to teaching this subject. Therefore, PT 2 would be located between traditionalist and constructivist views about learning or teaching physics.	*"Physics subjects should be associated with to daily life events. For example, I remember in junior high school that my physics teacher taught us how to make a simple doorbell. Actually, it looks somehow easy, but we were quite interested, and we could use this kind of activities in our physics classroom to explain an inductive current, etc...."* *"Explaining the some physical subjects, many physics teachers at all times use the abstract explanations. For instance, teachers draw some kinematics graphs on a board. However, they do not connect those graphs where and how to use in our daily lives. So that, students do not understand conceptually. Memorization symbols, formulas, and graphs for an examination only don not help them desired level of conceptual understanding of that subject. After the exam has passed, they forget all of them, and the learning never occurs.When they graduated from high school, it is impossible to relate physics to daily lives. I think mainly the textbooks are responsible for this. In our country (Turkey) the textbook of high school physics is chosen by a commission from the Ministry of Education department."*
PT3 (behaviorist)	• in order to justify any topic in physics, he favors of teacher-centered instruction • students' priory knowledge or ideas is not considered and it is assumed that learner is ready to be filled with knowledge.	*R: How do you teach the right hand rule in magnetism?* *PT 3: First, I start by providing students with definitions, explanations about the topic. In order to ensure if they have understood the concept, then I would pose them questions related to subjects. Then I go over the next concept according to their answer.* *R: If students do not understand the topic?* *PT3: I try to go over again and then most probably I try to solve different questions related to that topic.* *R: Just explaining the topic, do you think your student will learn?* *PT3: I think they are supposed to learn. Otherwise, he can get stuck and have a terrible grade in the exam.* *R: Could you explain what is learning?* *PT3: Mmm...Learning is… if you understand the subject or memorize the related knowledge like symbol, formula, etc., to use in the future whenever you need them, like exams, for example. It's meant that you learned.* *R: In your view, how do students learn?* *PT3: As I said, when a student needs to use it, or remember it, it means he/she learned it. For example, students should know how to use right hand rules in given situations.*

| PT3 (behaviorist) | • in order to justify any topic in physics, he favors of teacher-centered instruction
• Students' priory knowledge or ideas is not considered and it is assumed that learner is ready to be filled with knowledge. | *"To teach the "the right hand rule in magnetism", I preferred to begin with a question in order to understand students' priory knowledge about the topic. Then I go forward in the normal sequence of teaching provided by textbooks. The most important thing is I would try to give non-abstract examples, like visualizing that concept with some 3D drawing or could get a help from computer software and/or Internet."*

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PT 3: First, I start by providing students with definitions, explanations about the topic. In order to ensure if they have understood the concept, then I would pose them questions related to subjects. Then I go over the next concept according to their answer.

R: If students do not understand the topic?
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R. Just explaining the topic, do you think your student will learn?
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R: In your view, how do students learn?
PT3: As I said, when a student needs to use it, or remember it, it means he/she learned it. For example, students should know how to use right hand rules in given situations. |

Table 4. Interviewees' beliefs and Excerpts from Interviews Related to *"Role and Importance of Lab"*

Interviewees	Focus	Excerpt from an interview
PT1 (constructivist)	• The importance and necessity of laboratory work • the way of doing experiments in physics classes at high schools and even some courses at university is criticized. • The learning process through laboratory activities involves active engagement by the students, and their importance is emphasized. • Criticizing the "cookbook-type" laboratory manual	*R: What is the role of laboratory in teaching physics?* *PT1: "The most feared subjects are physics, whether high school or university. Therefore, as a teacher first we have to deal with this. We have to attract students to physics. To accomplish this, I think, doing laboratory experiments plays a key element. We did many experiments in the physics courses at high school and even university. Yet, mostly it is given some directions about how to perform the experiments "Do this, do that, calculate the results, etc." Because, it is like following a cookbook recipe, students do not understand the concept of doing that experiment. I think, students should know the reasoning about doing in the experiment and I do not want my students to perform experiments like this."*

R: Ok, actually somehow very specific, think about the "right hand rules". How do you begin with this topic to your students?

PT1: "Well, as I said earlier, I would try to begin by doing an experiment, specially I prefer students to do the experiment by themselves if my school has sufficient facilities. I want my students to discover for themselves rather telling them what it is, what it means... If a school does not have adequate facilities, I try to go through some simple hand-on experiments. Because it is a very specific physics subject, showing the right hand rule in any experiment is not easy but its results would be very useful. Then I would demonstrate 3D to visualize the rule, and this case computer simulation about these rules are the best."

PT2(intermediate)

- Importance of laboratory use in physics teaching

- Experiments should be exciting, related, and relevant to everyday life. They influence learning positively and more benefical.

"I believe that laboratory experiments play a very important role in teaching physics. We did some experiments at high school and and also in university, too. Doing an experiment sometimes seems meaningless to me, because you are given a sheet of paper that indicates the aim of the experiment and some step to do lists. When you follow these steps and do experiments, I think, you do not learn anything from it. I think it is a waste of time. It is needed to change for new approaches doing experiments in a classroom setting, like hands-on experiments that I heard of."

"If I had to do some experiments in the lab, it has to be exciting and attractive or fun and also related to their daily life. Definitely, I am in favor of doing experiments relevant to real life, for example, roller coaster or rotational motion of bicycle tire and so on… these kinds of experiments first come up my mind."

PT3 (behaviorist)

- She did not believe much in the need for laboratories in physics teaching

- Criticized the way of performing experiments and their contribution to students' success in exams.

- Somehow experiments sould assist students to increase their practical thinking abilities. However, she criticized the role of the current lab experiments and their contribution to the national university admission examination.

- Note: PT 3 did not mention anything about doing experiments in the lab usefulness, any procedures, or relation to conceptual awareness, or etc. Therefore, it can be said that this perspective of instruction is all consistent with the traditionalist view of teaching.

"I believe in the importance of lab experiments, they could get some benefit from lab experiments, but I do not think it is necessary to get higher scores in tests. We have a national admission examination for admission by universities. They do not ask any question related to any experiment or their results what so ever. They ask only some certain conceptual questions. I think, our main mission or responsibility is to prepare our students for this exam. Also, doing experiments takes lots of time."

Results pertaining to Interviews

Among the interviewed with the prospective physics teachers, only one showed constructivist beliefs about most viewpoints of teaching physics specified in the previous section. In contrast, three of them retained traditional beliefs in most viewpoints of teaching physics. Seven prospective physics teachers had intermediate beliefs about teaching physics, implication that they held constructivist beliefs on some viewpoints but traditional beliefs on the other aspects. This particular result confirms other results obtained from the Teacher Belief Scale as indicated above. In the following section, six aspects of physics teaching are investigated in terms of the students' beliefs about teaching practices from traditional to constructivist by providing examples only from three prospective teachers since the space is limited: constructivist (Prospective Physics Teacher 1 [PT1]), traditionalist (Prospective Physics Teacher 3 [PT3]) and an intermediate believer (between traditional and constructivist) (Prospective Physics Teacher 2 [PT2]).

Teaching Subject Matter

Considering students' prior knowledge and conceptions are the most remarkable features of the constructivist view of learning. In physics, many research (for example, Hake, 1998; Galili, Bendall, & Goldberg, 1993, Hestenes, Wells & Swackhammer, 1992; Maloney, O'Kuma, Hieggelke, & Heuvelen, 2001) indicated that the students' prior knowledge plays a very important role in understanding different physics concepts in their further learning, such as force and motion, and electricity and magnetism and light. Table 3 presents the responses of and excerpts from the interview with three prospective high school physics teachers interviewed.

From the explanations provided by the three prospective high school physics teachers, one could conclude that there might be a relationship between the prospective physics teachers' beliefs about how to learn physics concepts and how to teach physics.

The Role and Importance of the Laboratory

With experiencing phenomena, laboratory activities in high school physics contribute a starting point to the systematic growth of students' beliefs, and reasoning abilities about prediction. Construct their own understanding of physics; the role of the laboratory in high school physics courses is a very essential for students. Knowledge must be accomplished by students in interacting with the teacher and the environment instead of transmitting only by the teacher. Tobin (1990) states that "Theory and research suggest that meaningful learning is possible in laboratory activities if all students are provided with opportunities to manipulate equipment and materials while working cooperatively with peers in an environment in which they are free to pursue solutions to problems that interest them." When well-integrated laboratory activities are a part of a learning sequence, the meaningful learning could occur. Separating laboratory activities from a physics lecture in high school classes are unnatural and not desirable. Table 4 shows the responses of and excerpts from the interviews with three prospective high school physics teachers.

Teachers' and Students' Role in the Classroom

In the constructivist view of teaching, rather than just transmitting knowledge to learner, the teacher supposed to be providing students with an effective learning environment and act as a mentor for students by supporting the dynamic involvement (Driver & Oldham, 1986; Scott, Dyson, & Gater, 1987). For that reason, the teacher plays very important role as a facilitator. Table 5 shows the responses of and excerpts from the interviews with three prospective high school physics teachers.

Student-Teacher and Student-Student Interactions

In the constructivist view of teaching, the interaction of the students with each other and with teachers and group works are very essential. Discussion with peers can provide pupils with opportunities not only to build on each other's ideas, but also to make their ideas explicit and move their view in advance (Driver, Squires, Rushworth, & Wood-Robinson, 1994). Table 6 shows the responses of and excerpts from the interviews with three prospective high school physics teachers.

The Role of Computer and Technology

One of the main views of constructivism is to give learners control over their own learning. Because of the new technologies, the basic relationship between teachers and students is changing, too. The new technologies provide students with allowing access to all varieties of information, but once only available to and restricted totally by teachers. This alteration has made the convention program and a model of learning or teaching totally out-of-date. In addition, many researchers (McLellan, 1996; Mehlinger, 1996; Nicaise & Barnes, 1996; White, 1996; Wise, 1997) proposed that the use of these new technologies will deeply influence our schools and it does. The new technological environments encourage and engage students to support

Table 5. Interviewees' beliefs and Excerpts from Interviews Related to "Teachers' and Students 'Role in the Classroom'"

Interviewees	Focus	Excerpt from an interview
PT1 (constructivist)	• With guiding to students, the role of the teacher described as researcher and social aspect of the teacher. • Interacting with the other students and the teacher, students have to be active in the classroom.	*R: What role do you think a teacher should play in a classroom?* *PT 1: Teachers should guide their students to encourage to critically think and investigative abilities. At this point, much patience is needed. Also, teachers should master subject matters and follow all the latest developments in their field and pedagogical issues. Nowadays, we have easy access to clusters of knowledge by many media including the Internet. Therefore, a teacher has to follow and seek up-to date information related to their profession. More importantly, new information has to be used in their teaching and learning situations.* *R: What about the role of students in the classroom?* *PT1: Students required to be motivated in the classroom. For instance, students should express their ideas freely when teacher poses a discussion in the class. It has to be assured by a teacher that students will not see class discussion as a waste of time. I would prefer to use different activities in my classes according to topics. I encourage students to participate those kinds of class discussions and activities. When students perceive the teacher as a friend or helper to these kinds of activities, then this might influence students to enroll in these activities.*
PT2 (intermediate)	• The teacher should be guiding students to help them whatever they needed. • The role of the teacher as a guide to help or make students connect the topic to real life situations by using some connector such as analogies. • The belief that students accept everything from what the teacher says. • The belief was presented through explanations arguing that the student's role concerns involving of classroom activities	*PT 2: The role of the teacher? Yes, teachers' role is very important for the way he/she teach. If a student is having difficulties, the first thing is teacher' attitude and/or approach to solve this problem. It depends on the teacher. Some teacher is very sensitive but the other even does not do anything about it. I think, if a student likes his/her teacher, he/she will most probably like physics.* *R: Ok. How should a teacher accomplish this?* *PT2: Teacher has to be passion about teaching and has to love teaching and also give opportunities for students to engage different activities.* *R: What are the roles of students in teaching process?* *PT2: That is not an easy question. In general, the teacher asks questions and the students answer. Furthermore, if I do not understand when a teacher explains something, I could ask a question and participate in classroom activities.* *R: What about a student's role in the classroom?* *PT2: The role of the student is to listen carefully to his teacher, and then ask questions when it is needed. Generally, it can be said that the student's job is to learn by listening to the teacher's explanations or directions about the subject matter and actively participate in the classroom activities.*

| PT3 (behaviorist) | • The teacher's role mainly is to teach and explain the subject matter to the audience.
• The student's role as a learner is paying attention to the teacher's explanations and ask questions to the teacher when is needed. | *R: What are the roles of students in the teaching process in the classroom?*
TP3: Initially, I start explaining the subject matter and then ask students some questions related to given topics.
R: If you explain the topics and ask them related questions, do you think that students are going to learn?
TP3: The role of the student is mainly to listen carefully to the teacher, and try to answer questions whenever he posed, then, solve problems and do their homework. |

Table 6. Interviewees' beliefs and Excerpts from Interviews Related to "Student-teacher and Student-student Interactions"

Interviewees	Focus	Excerpt from interview
PT1(constructivist)	• The group work is very importanant because discourse between student-student and student-teacher produce interactions among the whole class. The importance of interaction between teachers and students is focused. • Individual works and experiences should be shared among the group memebers. • One of the teacher's roles is to carry out the individual work experiences into the group	*"I think it is very beneficial for the students and teacher working together in a group. With helping and sharing many things to each other, they learn many physical concepts, and also they develop critical thinking abilities. Therefore, depending on the subject in general I try to create a discussion environment in my classes. In discussion section, saying interesting things to each other, students force each other to think and share many experience without not knowing it or untentionally. However, I am opposed to cases in which only a single person does the work while the others do not."* *"I think I would prefer a student-centered classroom rather than a teacher-centered. Students could assist each other in the classroom in preparing group works or doing homework or projects. For example, in "method of teaching physics" courses given by my university, we did many group works and some projects, but some members of my group did not do their job even they did not write the report. Because I was doing all work by myself. I think, the teacher has to be carefull and make a good plan to share all work in the group members by equally."* *One benefit of group work or interaction among students is those encourages students and make devolopmet of asking questions to their teachers. Also, students learn to express and talk their opinion and thoughts freely. Such classroom environments make and help students construct their understanding of physics concepts."*
PT2(intermediate)	• She indicated the importance of interaction among students. • To share their views and to learn from each other, the group work should be used in physics classes. • The role group members did not stated • In terms of learning the interactions among students and student-teacher did not mentioned. • To enhance student interest in physics it is said that interaction is useful.	*"It must be certainly interactions among students and also student-teacher in physics classes. For example, I, prefer to learn better when talk with my frends in the class. Also, students need to interact with each other to share their opinions in the group to improve their knowledge. Therefore, group work is very important"* *"I see many teachers in high schools who leave their students idle, so they will not listen to the teacher, while some teachers are strict, or have some rigid rules for students; in these cases students are all quiet and afraid of asking questions to their teacher. Student-student interaction has nothing to do with these examples."*

PT3 (behaviorist)	*Each side must show some respect to each other to build better classroom interactions. Teachers should like physics themselves and also make their students like it. Therefore, students are not just studying to pass the exams. In that case, students' interest in physics would increase"*
	• It cannot be any interaction among students during the lecturing because it couses caotic environment. • When there is an interaction among students in class setting, students are going to out of control. • The only authority in the class is the teacher. Students have to be controlled by their teacher. An interaction between students-student and/or student-teacher might end a result of losing control of teacher's authority.	*"There should be interaction between students. However, this should be controlled by a teacher; otherwise, the class would get out of control and chaos starts. I am not opposed to classroom interactions, but I do not prefer group work. I learn better by myself."* *"If the teacher is too strict, students avoid or are afraid of talking or discussing or even asking questions to their teacher. It should be an interaction between students-student and olso student- teacher. But, much interaction between student-student and/or student-teacher might cause the teacher to lose control in classroom and also it may end up with chaotic environmet. But, some interactions must be established in class, otherwise students could not build any interest in physics subjects.*

learning more interactive (Bransford, Brown, & Cocking, 2002; Hake, 1998; Mazur, 1997; Redish, 2003). For example, using computer simulations in class setting gives the enormous benefits to students in deep understanding of some physical concepts (Bryan, 2006; Perkins et al., 2006). Among the other media (for example video, TV, etc.), the internet can provide students basing and building their own knowledge. For example, after finding information on the internet, students can create and construct this information by designing web sites, and by communicating with friends and by sharing them through the internet. Constructing knowledge through active learning environment via internet, learners can achieve or reach their goals more rapidly using the internet as a learning tool (Jonassen, Peck, & Wilson, 1999). Table 7 shows the responses of and excerpts from the interviews with three prospective high school physics teachers.

Although all participants addressed the importance of using technology in their classroom in many different ways, they did not mention in great detail about the use of computer-laboratory acquisition and analysis tools such as Vernier lab pro interface, Logger Pro software, Pasco interface, etc... This might be because most of them did not use these kinds of tools at high school or university laboratory due to the limited budget or somewhat did not know how to access those kinds of sources in Turkey.

Assessment preferences

One of the most important issues in the constructivist view of teaching is assessment of students. Assessment and learning are closely related to one another and occur generally through teacher observations, student demonstration or presentations, and portfolios. On the contrary, in the view of the traditional teaching, assessment of student is considered as separate from learning/teaching process and occurs just about completely through the testing (Brooks & Brooks, 1993). Assessing the effectiveness of constructivist learning Jonassen, Peck, and Wilson (1999) provided to use rubrics in assessments. An assessment and learning is not separable from each other. Or it can be said that learning and assessment are coterminous. Table 8 shows the responses of and excerpts from the interviews with three prospective high school physics teachers.

CONCLUSION AND IMPLICATIONS

In this study, most prospective physics teachers held intermediate beliefs (between traditionalist and constructivist) about teaching physics. They held constructivist ideas on some viewpoints but behaviorist (traditionalist) beliefs on the other aspects. Also, similar results are reported in Gallagher (1991), Lederman (1992), and Tsai, (2002). This could be because they received an education in a traditionally-oriented environment, or did activities in laboratory exercises, or related activities in teacher educational programs that might be acted as a frontier to prevent the teaching (Roth & Tobin, 2002).

In theory and practice, there is an ongoing discussion about wheher to use behaviorist versus constructivist approaches in school setting especially on student achievement. Cultural differences across the nations and pedagogical traditions recommended the

Table 7. Interviewees' beliefs and Excerpts from Interviews Related to "the Role of Computer and Technology"

Interviewees	Focus	Excerpt from the interview
PT1 (constructivist)	• The necessity of technology uses in the whole teaching process • Using technology and how to access up-to-date information related to their profession. • "Using simulations" in her class to improve students' learning	*R: What is the role of computer and technology in teaching physics?* *PT1: As I said earlier, we have to attract students to physics. To accomplish this idea, it must be used computer and technology in the classroom whenever possible. To teach and/or explore many abstract subjects in physics, for example left hand rule, we can get help from simulations. On the internet, actually most of them are in English and I am not good at it, but many simulations and/or animations can be found free of charge."* *R: If you do not have enough knowledge of English, how will you suggest up-to date links or URLs to your students?* *PT1: "Yes, but I follow some popular and scientific research journals, for example, popular journal "Science and Technology" published by TUBITAK (Turkish acronym for Scientific and Technological Research Council of Turkey); I can find many up-to-date links or developments related to science and technology including physics. Also, in this virtual world anyone could find and write an email to any person related to specific topics, I mean if I had a problem or question about any physics subject, I would try to contact my professors or any person with knowledge about that topic."*
PT2 (intermediate)	• Preferred computer and technology use in physics teaching. But he did not present a great deal of specific information, like how to obtain, how to use, and how to, etc., that technology in his classroom.	*"I believe that using computers and technology plays a very important role in teaching physics. You can explain or teach many abstract subjects in physics very easily. For example, some simulations are very useful to achieve these goals. Instead of doing some experiments in the lab, I prefer to show related simulations."*
PT3 (behaviorist)	• The need for computer and technology use in physics teaching • Did not provide any specific explanations or examples of their contribution to physics teaching • Did not mention about getting conceptual understanding or benefits from using computers or new technology in the class.	*"Computers or any kind of new technology has to be used in the classroom. To visualize and to demonstrate some abstract concepts, I would definitely use the new technology such as the internet in my class as a part of my lecture."*

Table 8. Interviewers' beliefs and Some Excerpts from Interviews Related to "*Assessment Preferences*"

Interviewees	Focus	Excerpt from the interview
PT1 (constructivist)	• in favor of portfolio assessment and students' performances at a particular time	*R: In your view, how should high school physics students be assessed?* *PT1: I am not supportive of classic examinations for assessment. For instance, at high school, if you memorize some facts and formulas, before taking physics examinations, you could get a good grade from that exam, but, probably you do not understand or learn,*

some essential physics concepts. Unfortunately, our educational system relies on only test. In order to be admitted by any university in our country (Turkey) one should take a 3-hour test. Therefore, many students have to prepare themselves for this exam and have to practice. Furthermore, this influences students' performance in the classroom and their motivations. I would use a variety of assessment techniques such as projects, homeworks, tests, and observations as a part of portfolios. I will not rely solely on tests because some students do not perform well on tests.

PT2(intermediate)	• When assessing students' basic physics knowledge/understanding, using both multiple-choice and written essay-type examinations is mentioned. • Related to assessing the progress of a student's conceptual understanding or achievement, did not mention anything about it	*"I favor using both multiple-choice and essay-type examinations together. I could use mixed up two exam types. Because, for example, occasionally in multiple-choice tests a student might know the way to solve the problem in any ways- he can get a clue from the answers or a student can guess the correct answer or he/she makes (calculating) mistakes by giving an answer– then he gets a wrong answer. This is unfair. Therefore, you do not know whether the student really understood or not. On the other hand, the university admission examination consists only of multiple-choice tests. Therefore, students have to practice more for this test. On the other hand, in an essay-type assessment you can tell between students' mistakes and errors by analyzing their exam sheet in great details. Even when there are some calculation mistakes; he can get some marks for the remaining of the written correct answers."*
PT3 (behaviorist)	• Open-ended questions with some homework might assist teachers get additional knowledge about students' ideas • the importance of homework is mentioned but did not give any detailed explanation of how to use homework	*"I think, the best way of assessing students is to use usual written examinations. It is easy to prepare and use it. Also you can see the students' mistakes and class performance. Students should be assessed through these written examinations with some homework. The multiple-choice tests makes dulls the students and therefore, it is not necessary and useful for our educational system."*

two possibility view of differences in the patterns across countries. As explained in OECD reports, teachers in most countries believe that their job is not merely to transmit or present information to their students, but they supposed to sustain students in their active construction of knowledge" (OECD, 2013).

Our findings also support that, Turkish prospective physics teachers' beliefs in general exhibit some aspects of behaviorist viewpoints and some aspects of constructivist beliefs about learning and/or teaching.

An important objective of professional development is to foster constructivist beliefs and enhance activities by emphasizing comprehensive teaching methods, as well as planned instruction and automated learning. In the stages of the learning process, a variety of approaches could be applied to outfit the conditions by

relying on cultural traditions. Starting a lecture with direct teaching and then steadily constructing open learning situations, as working in a more structured way with weaker students is given one of the examples. It is needed to find new ways of increasing the use of strengthening activities for all students, independent of their ability by teacher education professionals (OECD, 2013).

Actually, the findings and applicability of the study are only limited to the given sample or similar one; thus, one might also draw a conclusion from this work that the practices of prospective physics teachers (indicated by the interviewees) in both high school and university were leading in their certain beliefs about physics teaching in accordance with some other studies (for

example, Bybee, referred in Lumpe et al., 2000; Tsai, 2002).

Furthermore, some prospective physics teachers pointed out to the importance of learning and understanding some daily physical phenomena in the context of teaching physics without taking into account the development of scientific skills. Therefore, teacher education programs play key roles in improving scientific abilities in prospective teachers, they should become conscious of the meaning of these situations and try to improve their students' skills when they begin teaching. For that reason, different kinds of teaching strategies for example, an inquiry-based teaching might serve effective (Brown & Melear, 2006).

Participated in the survey, most prospective physics teachers presented differences in their belief systems about teaching physics and only one interviewee in this study held beliefs related to the viewpoints of constructivist teaching. Moreover, some prospective physics teachers favored of the importance of peer works, the use of technology and the internet, and interactions between students and also teachers in their physics classes. They emphasized on the necessity of student-student and student-teacher interactions because they believe that discussion with their peers and/or their teachers could facilitate them to make their thoughts explicit as well as helping them to construct on each other's ideas to advance their thinking abilities. Holding the constructivist beliefs about the interactions between student-student and also student-teacher, most prospective physics teachers complained and criticized about the current state of university or high school settings for being behaviorist or a traditionalist. It could draw a conclusion from these explanations that their beliefs about learning/teaching physics resist shifting from traditionalist to constructivist views on some aspects. Sifting from empiricist and behaviorist views of teaching science towards constructivist perspective is not an easy and complex change as indicated by Flores, Lopez, Gallegos, and Barojas (2000). Also, Hancock and Gallard (2005) stated that "prospective science teachers' beliefs focused on two key dualities: learning through experience and transmission and student-centered and teacher-centered instruction."

It is indicated by some researcher like Aguirre, Haggerty, and Linder (1990), Gustafson and Rowell (1995), and Koballa et al.(2000) that there are some links between science teachers' beliefs about learning and teaching science. On the other hand, due to depending upon and differentiating in many factors, Bryan (2003), Tsai (2002), and Wallace and Kang (2004) argued about the complexity of teachers' belief systems. Teachers' beliefs about learning and teaching science subjects might closely related to how to teach science and/or how students learn it. One reason might be their previous beliefs about learning or teaching. Not

integrating their previous ideas with the pedagogical programs might be another reason for this and that might have resulted in participants' inconsistency responses about their beliefs. At this point, as a teacher educator, we can address ourself about this question: How we make a decision about which beliefs account for and then how to manage teacher education program that takes into account for those beliefs? One way to achieve these goals is to look into several things. First, one might develop realistic theories about how prospective physics teachers' beliefs are likely to go into that situation to influence what and how prospective physics teachers learn or teach. Second, it can be investigated about prospective teachers' own practices to see their teaching performance in particular situations. And so forth, anyway, more research is needed to investigate about these issues and inconsistencies in greater detail.

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Appendix: Participants' beliefs (N=135) about teaching by response frequency (%), mean ($\overline{X}$) and standard deviations (s.d) for each item

Survey Items	SA	A	NS	DA	SD	$\overline{X}$	s.d.
Traditional (Behaviorist) Management							
It is important that I would establish classroom control before I become too friendly with students	26.7	47.8	6.7	14.4	4.4	3.70	1.19
When there is a dispute between students in my classroom, I would try to intervene immediately to resolve the problem	1.1	27.8	27.8	38.9	4.4	2.81	.94
I believe that students learn best when there is a fixed schedule	8.9	47.8	18.9	22.2	2.2	3.43	1.01
I would direct classroom events to prevent chaos	7.8	46.7	23.3	18.9	3.3	3.36	1.00
I would decorate my classroom primarily with posters and pictures, teaching charts, and/or seasonal decoration	3.3	27.8	10.0	47.8	11.1	2.66	1.13
In my classroom, I would take care of the learning materials and set them out for students when they need them	10.0	47.8	7.8	28.9	5.6	3.26	1.16
It is more important for learners to learn to obey class rules than to make their own decisions	11.1	44.4	16.7	21.1	6.7	3.30	1.14
Traditional (Behaviorist) Management Total						3.22	1.08
Traditional (Behaviorist) Teaching							
I feel a responsibility to make curriculum choices for children because they can't know what they need to learn	8.9	52.2	26.7	12.2	0.0	3.57	.86
I would base student grades primarily on homework, quizzes, and tests	14.4	37.8	22.2	20.0	5.6	3.36	1.14
I would teach subjects separately, although I am aware of the overlap	2.2	16.7	20.0	44.4	16.7	2.46	1.02
My students would spend the majority of their seatwork time working individually	25.6	64.4	7.8	2.2	0.0	4.10	.70
For assessment purpose, I am interested in what students can do independently	32.2	46.7	14.4	5.6	1.1	4.03	.89
I would generally use the teacher's guide to lead class discussions of a story or text	1.1	26.7	25.6	40.0	6.7	2.76	.98
I would find that textbooks and other published materials are the best sources for creating my curriculum	3.3	41.1	23.3	26.7	5.6	3.10	1.02
I am a firm believer in paper and pencil tests	1.1	10.0	20.0	53.3	15.6	2.28	.88
Traditional (Behaviorist) Teaching total						3.21	0.94
Constructivist Teaching							
I would prefer to cluster around children's desks or use tables so children can work together	37.8	52.2	6.7	3.3	0.0	4.23	.72
I would invite students to create many of my bulletin boards	52.2	45.6	2.2	0.0	0.0	4.49	.54
To be sure that I would teach students all necessary skills, I would follow a textbook or workbook	1.1	31.1	12.2	47.8	7.8	2.70	1.03
I would involve students in evaluating their own work and setting their own goals	7.8	55.6	23.3	11.1	2.2	3.57	.88
I would make it a priority in my classroom to give student time to work together when I am not directing them	23.3	56.7	11.1	6.7	2.2	3.93	.89
I believe that expanding on students' ideas is an effective way to build my curriculum	23.3	43.3	15.6	17.8	0.0	3.66	1.07
I would prefer to assess students informally through observation and conferences	6.7	41.1	31.1	20.0	1.1	3.31	.95
I would create thematic units based on the students' interests and ideas.	17.8	72.2	7.8	2.2	0.0	4.06	.58
Constructivist Teaching total						3.74	0.83
Overall						3.39	0.95

<u>Note</u>: *SA=strongly agree (5 point); A=agree (4 point); "NS"=not sure (3 point); DA=disagree (2 point); SDA=strongly disagree (1 point).*