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Effectiveness of case-based learning instruction on pre-service teachers' chemistry motivation and attitudes toward chemistry

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ABSTRACT

Background: The development of primary pre-service teachers' chemistry motivation and attitudes toward chemistry were examined in order to develop their science literacy using case-based learning. Students' ideas were emphasized, real-life situations were discussed, and students could share their ideas and knowledge with peers; as a result, students were active in the learning process.

Purpose: The purpose of the study was to investigate the effectiveness of using case-based learning instruction to increase pre-service primary teachers' chemistry motivation and improve their attitudes toward chemistry as a school subject.

Sample: The subjects of this study consisted of 51 (20 female, 31 male) freshman primary pre-service teachers from an urban university in Turkey. The mean age of the primary pre-service teachers was 21.

Design and methods: One group pre-test and post-test design was used. A chemistry motivation questionnaire and chemistry attitude scale were used for data collection. For the data analysis, two-way repeated measures of ANOVA and repeated measures MANOVA were conducted.

Results: The results indicated that the mean of the attitude score after the treatment was significantly greater than the mean of the attitude before the treatment. The results also demonstrated that there is no significant difference between females and males. According to the results of the study, there is no significant difference between primary pre-service teachers' chemistry motivation. However, some chemistry motivation constructs mean scores are greater after the treatment.

Conclusions: In sum, it could be stated that case-based learning is helpful for the development of students' chemistry motivation and attitudes toward chemistry.

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KEYWORDS
Case-based learning; chemistry motivation; attitudes toward chemistry; gender

The main objective of science education is to make students scientifically literate. The American Association for the Advancement of Science (AAAS) (1993) and the Ministry of Turkish Education's reform documents stated that the main aim of science education is the

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development of scientific literacy. Chin (2005) stated that it is important to develop pre-service teachers' scientific literacy in educational programs. Thus, in the present study, the development of primary pre-service teachers' chemistry motivation and attitudes toward chemistry were examined in order to develop their scientific literacy using case-based learning.

Lederman and Niess (1998) defined scientific literacy as understanding science content and science processes (such as observation, data organization, hypotheses generation, hypothesis testing, data interpretation, and conclusions and inferences from data) and using such content and processes to solve personal and societal problems. Dalgety, Coll, and Jones (2003) proposed that one of the ways to develop science literacy is to develop students' motivation. Also, Devetak and Glazar (2001) stated that the reason of pre-service teachers' lower motivation for learning science and chemistry is unsuitable teaching methods used in educational programs. Scientifically, literate teachers had higher motivation (Poluakan 2012); however, Juriševič et al. (2008) investigated primary pre-service teachers and found that they had the least motivation to study symbolic concepts and the highest motivation to study concrete macro-level concepts in chemistry. Thus, they suggested that chemistry education should be designed in order to promote intrinsic motivation for learning. They also proposed that there should be more research in order to discover the factors influencing the development of chemistry motivation. Therefore, in the present study, the development of primary pre-service teachers' motivation will be examined in order to help both these teachers and their students become scientifically literate.

Pre-service teachers' general motivation for learning and their motivation for learning chemistry, physics, and mathematics are not the same (Juriševič et al. 2008). Thus, in the present study, in order to identify pre-service teachers' chemistry motivation, a chemistry motivation questionnaire (CMQ), which is a subject-specific questionnaire, was used. This questionnaire was adapted from the science motivation questionnaire (SMQ), which was developed by Glynn, Taasoobshirazi, and Brickman (2009). They suggested that SMQ could be used in physics, biology, and chemistry by replacing the word 'science' with 'physics,' 'biology,' or 'chemistry.' For example, some researchers (Taasoobshirazi and Sinatra 2011; Taasoobshirazi and Farley 2013) used a physics motivation questionnaire in order to determine undergraduate students' physics motivation. Other researchers (Çiğdemoğlu 2012; Obrentz 2012) used a CMQ in order to determine college chemistry students' and 11th-grade students' chemistry motivation, respectively. Yet so far, there has been little research examining pre-service teachers' chemistry motivation. Therefore, in this study, pre-service teachers' chemistry motivation was examined by CMQ.

CMQ covers the following five important motivational constructs: intrinsic and extrinsic motivation, goal orientation, self-determination, self-efficacy, and assessment anxiety (Bandura 2001; Glynn, Taasoobshirazi, and Brickman 2007). Intrinsic motivation is defined as engaging in an activity for its own sake. Extrinsic motivation, on the other hand, means engaging in an activity in order to gain external rewards such as money, titles, honors, and other outcomes. There are two types of goal orientations: mastery and performance goals. Mastery goal orientations are concerned with learning in which a task is mastered by self-set standards or self-improvement. Performance goal orientations concern competence and ability demonstration such that the ability judgment is assessed relative to others. Self-determination is described as deciding how to act on the environment based on the highest level of reflection and with a full sense of choice. Self-efficacy is defined as the belief that a particular action is possible and that the individual can accomplish that action. Assessment

anxiety is defined as experiencing fear, nervousness, and distress before or during an exam (Pintrich and Schunk 2002).

There are some studies (Meece and Jones 1996; Adamson et al. 1998) showing that male students' science motivation is higher than females students. Juriševič et al. (2008) found that male primary pre-service teachers have higher science motivation. On the other hand, Cebesoy (2013) and Yükselturk and Bulut (2009) did not find significant differences between female and male pre-service science teachers' motivation. Eymur and Geban (2011) and Spittle, Jackson, and Casey (2009) demonstrated that female pre-service chemistry teachers had higher motivation than males. Thus, there is no consensus related to science motivation in terms of gender. To my knowledge, there is not much study on pre-service teachers' chemistry motivation. Therefore, in the present study, pre-service teachers' chemistry motivation was investigated.

In addition to motivation, attitudes toward science also have an effect on scientific literacy. Students have attitudes, abilities, and experiences before coming to class, and students' learning is affected by these factors while conducting instruction (Ausubel 1968). In line with this view, the AAAS (1993) stated that beyond scientific knowledge, the other components of scientific literacy are an understanding of the scientific process and the orientation of attitudes during the learning process. The AAAS mentioned that the way people perceive science can be considered an attitude. The Ministry of Turkish Education also mentioned that attitudes toward science are one of the most important dimensions of scientific literacy. Both the AAAS (1993) and the Ministry of Turkish Education's description of scientific literacy suggests the importance of the students' attitudes toward science.

Attitudes toward science can be defined as the feelings, beliefs, and values held about an object which may affect the enterprise of science, school science, the impact of science on society, or scientists themselves (Osborne, Simon, and Collins 2003, p. 1053). In previous studies, students had different attitudes toward different domains of science, such as chemistry, biology, and physics (Osborne and Collins 2001; Cheung 2009). Although there is much research on attitudes toward science, there are few research studies on attitudes toward specific disciplines, such as biology, physics, and chemistry (Salta and Tzougraki 2004). For example, there are few studies that investigated the attitudes toward chemistry (Menis 1983; Salta and Tzougraki 2004; Kaya and Geban 2011). Attitudes toward chemistry are defined as whether a person likes or dislikes chemistry (Nieswandt 2007). This is important because students' attitudes are related to their achievement; furthermore, attitudes predict behavior (Cheung 2009). Thus, in this study pre-service teachers' attitudes toward chemistry are going to be examined with a chemistry attitude scale (CAS).

There are several studies discussing gender differences in attitudes toward science. Most of these studies (Schibeci and Riley 1986; O'Brien and Porter 1994; Francis and Greer 1999; Jones, Howe, and Rua 2000) showed that boys had more positive attitudes toward science than girls. Some studies demonstrated that there were no differences between boys' and girls' attitudes toward science (Greenfield 1996). These results are similar with the results of studies regarding attitudes toward chemistry. For example, Cheung's (2009) study demonstrated the following: male secondary students' attitudes toward chemistry are higher than female students in theoretical chemistry lessons; female students' attitudes toward chemistry are stable in chemistry laboratory applications; and males' attitudes toward chemistry were lower than female students in chemistry laboratory applications. Salta and Tzougraki (2004) demonstrated that there are no significant differences among female and

male secondary students, but male secondary students' attitudes are higher than female students in terms of the difficulty of chemistry courses. Brandriet et al. (2011) found that male university students' attitudes toward chemistry are higher than females. They also suggested that there should be more research in order to examine female and male students' attitudes toward chemistry. Furthermore, to my knowledge, there is not much research examining pre-service teachers' attitudes toward chemistry in terms of gender. Thus, in the present study, pre-service teachers' gender differences in attitudes toward chemistry were investigated.

Attitude and motivation are important affective variables in science education since they are positively correlated with achievement. In this study, case-based learning (CBL) was used as a teaching method for improving students' attitudes and motivation. In this method, students' ideas were emphasized, real-life situations were discussed, and students could share their ideas and knowledge with peers; students were thus active in the learning process. Case-based learning is consistent with constructivist approaches (Koballa and Tippins 2004) because students participate actively and construct their own knowledge in this method. Cases include fictional stories that have some pedagogical objectives, but they often do not feature adequate intellectual rigor. Cases should include the researcher's specific pedagogical or research objectives, and therefore sufficient material related to the situation and environment should be provided in the case (Naumes and Naumes 1999).

In various efforts to improve the teaching and learning process, case-based learning has been used in the education literature for the past 25 years (Belford and Herreid 2013). Case-based learning has some similarities and differences with problem-based learning and context-based learning. Case-based learning and problem-based learning both utilize an inductive approach; however, case-based learning and problem-based learning are different in terms of the case used. In problem-based learning, the case includes problem situation, whereas in case-based learning, the case is a story with a message. Both case-based learning and problem-based learning use stories in the instruction; however, as Herreid (1997) stated, the case used in case-based learning could be more sophisticated than the case used in problem-based learning. In context-based learning, concepts and theories are instructed within a real-world context by describing real social problems. Campbell et al. (1994) mentioned that at the beginning of the context-based learning course, teacher introduces students some aspects of their lives. Students experience these aspects either on their own or through the media, and the ideas and concepts are introduced to students when it is necessary to do so. Thus, students are active learners during the process of context-based learning. They can relate the topic to daily life in both the case-based learning and context-based learning approaches. However, the case-based learning approach differs from context-based learning because in the case-based learning, the case does not need to be a social problem; instead, the lesson could be instructed using the case stories. From this point on in the present study, the 'case' refers to a story with a message.

Case-based learning was implemented initially at the law and business schools in Harvard University about 100 years ago. Case-based learning was first implemented in science education about 25 years ago (Herreid 2013). The National Center for Case Study Teaching in Science is the most famous case collection center. Herreid (2013) stated that although the center has more than 400 cases and 15,000 faculty members have used this site, most of the users are biologists. He mentioned that ninety percent of the users are biologists and health science instructors, while the percentage of chemists and physical science teachers are only

a small fraction. This study is thus important for implementing case-based learning instruction for chemistry.

Belford and Herreid (2013) stated that although cases have often been used by the Science, Technology, Engineering and Mathematics educators, they have not been used very often by chemistry educators. However, chemistry is an abstract concept and therefore using cases could help make it more concrete. Therefore, in the present study, case-based learning is used and features several formats, one of which is a small group format. In the present study, case-based learning was implemented with a small group format (Herreid 1998) in a chemistry class. The reason for choosing this format is that pre-service teachers work in small groups and their instructor works as a facilitator. As a result, pre-service teachers could interact with each other with the goal of helping them to like the subject. In this study, an acid–base topic is instructed with case-based learning using a small group format. The reason for choosing this topic for the investigation of pre-service teachers' motivation and attitudes toward chemistry is that this topic is difficult to understand and thus students generally do not like this topic. Furthermore, the other reasons for selecting this topic are as follows: acid–base is an abstract topic; it is one of the fundamental concepts in chemistry; and it is interrelated with other topics, including chemical equilibrium, chemical reaction, stoichiometry, and solutions (Demircioğlu, Ayas, and Demircioğlu 2005). Demircioğlu, Ayas, and Demircioğlu (2005) also pointed out that the investigation of acid–base as a topic was mostly conducted among university students and high school students. Therefore, there is arguably not much research related to acid and base topics conducted with pre-service teachers. Therefore, investigating pre-service teachers' motivation and attitudes toward chemistry with respect to the acid–base topic could be helpful for exploring the topics with the previously mentioned properties. The research questions of this study are as follows:

(1) Was there a significant mean difference in primary pre-service teachers' attitudes toward chemistry before and after case-based learning?
(2) Was there a significant mean difference in primary pre-service teachers' motivational constructs before and after case-based learning?
(3) Was there a significant mean difference between girls and boys with respect to their attitudes toward chemistry as a school subject?
(4) Was there a significant mean difference between girls and boys with respect to their chemistry motivation?

Purpose: The purpose of the study is to investigate the effect of case-based learning on primary pre-service teachers' chemistry motivation and attitudes toward chemistry.

Method

Sample

The sample of the study consisted of 51 freshman primary pre-service teachers. In order to be admitted to the educational faculties, they have to get average scores on a verbal test but do not have to complete science and mathematics questions. Although they do not take science and mathematics courses in their secondary school, in the primary pre-service education programs they take mathematics, chemistry, biology, and physics courses. Thus, most of the primary pre-service teachers in this study stated that they do not like science

and mathematics courses very much. Case-based learning was used in order to improve their chemistry motivation and attitudes toward chemistry. In Turkey, after these primary pre-service teachers graduate they will become primary teachers. They will teach both general science and social science courses to first- through fourth-grade primary students. The age range of their students was 7–10. Therefore, primary pre-service teachers take both social and science courses in educational faculties. This study was conducted with students from a General Chemistry course. The mean age of the primary pre-service teachers was 21.

Instrumentation

All pre-service teachers were administered a CMQ and CAS at the beginning and the end of the treatment. In order to control the testing effect, pretests were administered at the beginning of the course.

Chemistry motivation questionnaire

The original instrument is called 'SMQ' and was developed by Glynn, Taasoobshirazi, and Brickman (2009). It was adapted and translated into Turkish by İlhan, Yıldırım, and Sadi Yılmaz (2012) as a 'CMQ.' Items are rated on a five-point Likert type scale (1 = never, 5 = always). The scale has 22 items. The dimensions of the adapted instrument are as follows: *intrinsic motivation and personal relevance*, *assessment anxiety*, *self-determination and self-efficiency*, and *external motivation*. The items of the assessment anxiety dimensions were reversed and thus higher scores represent higher motivation for each dimension. The internal reliability of the instrument is 0.80. Some of the items of the instrument are included in Table 1.

Chemistry attitude scale

The CAS was developed by Geban, Ertepınar, Yılmaz, Altın and Şahbaz (1994) for measuring pre-service teachers' attitudes toward chemistry as a school subject. This scale has 15 items with a five-point Likert-type scale (1 = fully disagree, 5 = fully agree). The internal reliability of the instrument is 0.82. The instrument is provided in Table 2.

Treatment

The study lasted for six weeks. The General Chemistry course covers the common properties of matter, the structure of atoms, the periodical table, solutions, chemical bonding, the mole concept, and acid-base topics. Pre-service teachers were instructed with traditional instruction for all of the topics with the exception of the acid-base topic. For this topic, the instructor can either write the topic on the board or use a PowerPoint presentation to present the

Table 1. Some items at CMQ.

	Never	Seldom	Sometimes	Usually	Always
I enjoy learning the chemistry					
The chemistry I learn relates to my personal goals					
I think about how the chemistry I learn will be helpful to me					
I am nervous about how I will do on the chemistry tests					
……..					

Table 2. Some items at CAS.

	Never	Seldom	Sometimes	Usually	Always
I like reading books related to science					
Science is not important in our daily life					
I get bored when I study science					
I like solving chemistry problems					
……..					

information. In order to examine pre-service teachers' development in terms of chemistry motivation and attitudes toward chemistry by case-based learning, the acid-base topic was instructed using case-based learning. The acid-base topic covers the definition of acid and bases, the properties of acid and bases, and the concept of pH and pOH. The intervention was designed in order to ensure that each of these topics was covered.

In this study, all pre-service teachers were instructed by case-based learning utilizing a small group format, which was presented in Herreid (1998). Pre-service teachers worked in small groups of four or five. First, pre-service teachers were given a case related to the acid-base topic. Then, they analyzed the case using books and the Internet. When they came to the class, they exchanged their ideas with their group members and then they shared their ideas with other groups. Case-based learning is a form of student-centered instruction, and thus the instructor's role was to plan each day's work and guide the pre-service teachers. One of the cases discussed in the study is provided below. The English translations of some cases were given in Supplemental file.

Olive oil

Ali wants to plant an olive tree in his garden. He already planted an olive tree in his garden. Even if he watered and gave enough care to the plant, he could not grow it. His neighbors stated that olive oil cannot grow in this region. Instead, they suggested that he plant blueberries. The neighboring gardens usually grow blueberries. However, Ali decided to set up a research team in order to grow an olive tree.

Ali decided to make this class a research group. In order to do this, everyone will work in groups of four or five, and all groups' responses related to the issue will be discussed with the entire class.

Background information

Soils could be acidic, basic, and neutral. Different plant species grow in the rainy and arid regions. Olive plants grow best in soils with pH 8.5, whereas blueberries grow best in soils with pH 3.5. However, the acidity of the soil could be changed by various soil fertilization methods. For example, if the soil is very acidic for a certain product, slaked lime ($Ca(OH)_2$) could be added in order to increase the pH value of the soil. In order to lower the pH of the soil, gypsum ($CaSO_4$) or organic substances are used.

Questions

(1) Is Ali's garden's soil acidic, basic, or neutral? Explain the reason and provide justification
(2) Suggest one method for determining the pH of the soil
(3) What is the climate of the region inhabited by Ali?

(4) Could Ali grow an olive tree in the existing soil in his garden?
(5) If Ali cannot grow an olive tree in his garden's soil, what should he do in order to be able to do so?

Like other cases, the above case was given to pre-service teachers one week before the class in order to read and analyze it. After analyzing the case using the Internet and the library, pre-service teachers discussed the issue in the class with their group members and other groups. At the beginning of the class, instructor asked all pre-service teachers the following question: 'What is the issue of the case?' Some of the pre-service teachers' responses were as follows: 'Ali could not plant olive tree in his garden'; 'Ali really wants to grow an olive tree in his garden'; 'Ali has an acidity problem in his garden.' Then, in order to answer the questions of the case, the case was discussed in each group again. The entire class then responded to the questions together. The teacher asked the pre-service teachers questions such as 'Which group will answer the first question?' All groups provided responses to each question and the instructor guided the pre-service teachers in order to find the common responses to the question. For example, in the first question, some of the groups' responses included the following: 'Ali's garden's soil is acidic because he could grow blueberries and they could grow in acidic soil' and 'the pH of Ali's garden's soil is 3.5, and that shows that the soil is acidic because pH < 7.' 'Ali garden's soil is acidic and he could grow blueberries.' After all the groups answered the question, the instructor then guided the class to reach a consensus on the question. Thus, all questions were responded to in the same way. At the end of the class, the instructor asked the pre-service teachers to summarize the issue. All of the pre-service teachers stated that the soil could be acidic, basic, or neutral; that the acidity of the soil could be changed by adding some chemicals; and that pH is important for planting.

The pre-service teachers were presented with six cases in this study. These were related to the stomach, the calcification of a teapot, an experiment, acid rain, and teeth decay. The acid rain and teeth decay questions were adapted from PISA questions. These cases were prepared by researchers by examining the related literature, books, journals, and magazines.

Results

Two-way repeated measures ANOVA was conducted in order to determine whether there was a difference in pre-service teachers' attitudes toward chemistry before and after instruction. The repeated measures MANOVA was used in order to determine whether there was a difference in pre-service teachers' motivational constructs before and after instruction.

Contribution of the treatment to attitudes toward chemistry

The 2 × 2 mixed design ANOVA was conducted with gender as a between subjects factor and time as a within-subject factor. The within-subject factor has two levels (before the treatment and after the treatment), and gender also has two levels (females and males). The results indicated that the mean of the attitude score after the treatment ($M = 5.17$, SD = 2.20) was significantly greater than the mean of the attitude before the treatment ($M = 4.23$, SD = 1.84), $F(1, 49) = 12.188$, $p = 0.001$. However, there is no significant interaction between gender and time $F(1, 49) = 0.391$, $p = 0.534$. In other words, pre-service teachers

Table 3. ANOVA results of pre-service teachers' attitudes toward chemistry.

	ANOVA summary table				
Source	*df*	SS	MS	*F*	*p*
Between group					
Gender	1	0.167	0.167	0.064	0.801
Error	49	126.815	2.588		
Within group					
Time	1	24.535	24.535	12.188	0.001*
Time x gender	1	0.788	0.788	0.391	0.534
Error	49	98.637	2.013		

*p is significant.

Table 4. Descriptive statistics for girls and boys before and after the treatment.

	Gender	*M*	SD
Before treatment	Girls	3.45	0.74
	Boys	3.55	0.96
After treatment	Girls	4.70	2.03
	Boys	4.42	1.89

demonstrated more positive attitudes toward chemistry after the treatment, whereas their attitudes toward chemistry did not differ by their gender. ANOVA results are provided in Table 3.

The results demonstrated that there is no significant difference between females and males, F (1, 49) = 0.064, p = 0.801. However, it was found that attitudes toward chemistry scores of females were generally higher at the end of the treatment. The results are given in Table 4.

Observed power was 0.928, which is high. In this study, differences between before treatment and after treatment scores explain 19.8% of the attitude variance.

Contribution of the treatment to chemistry motivation

Repeated-measures MANOVA test was conducted and the within-group independent factor was time (before treatment, after treatment), the between group factor was gender, and the dependent variables were motivational constructs (intrinsic motivation and personal relevance, assessment anxiety, self-determination and self-efficiency, and external motivation). Pre-service teachers' motivational constructs were measured for males and females two times: prior to the treatment and after the treatment.

The results demonstrated that there is no significant multivariate effect for between subjects (for each motivational construct) across gender (regardless if it was at the beginning of the treatment or at the end of the treatment), F (6, 36) = 0.817, p = 0.564. Furthermore, there was no significant multivariate effect across within-subjects time (regardless of gender), F (6, 36) = 1.500, p = 0.206. There is no significant multivariate effect across interaction between gender and time, F (6, 36) = 1.418, p = 0.235.

However, when we looked at the univariate outcome of the study, intrinsic scores are higher for females than males, F (1, 41) = 1.172, p = 0.285; extrinsic scores are higher for females than males, F (1, 41) = 3.080, p = 0.087; goal orientation scores are higher for females

than males, $F(1, 41) = 0.719$, $p = 0.401$; self-determination scores are higher for females than males, $F(1, 41) = 3.399$, $p = 0.072$; self-efficacy scores are higher for females than males, $F(1, 41) = 3.230$, $p = 0.080$; and assessment anxiety scores are higher for females than males, $F(1, 41) = 0.068$, $p = 0.796$. Although there is no significant multivariate effect for between-subjects (of each motivational construct) across gender, females' scores are higher in each motivational construct.

Intrinsic scores are higher at the end of the treatment than at the beginning of the treatment, suggesting an improvement, $F(1, 41) = 0.262$, $p = 0.612$; extrinsic scores are higher at the end of the treatment than at the beginning of the treatment, $F(1, 41) = 0.006$, $p = 0.939$; goal orientation scores are higher at the end of the treatment than at the beginning of the treatment, $F(1, 41) = 0.534$, $p = 0.469$; self-determination scores are higher at the end of the treatment than at the beginning of the treatment, $F(1, 41) = 0.177$, $p = 0.676$; self-efficacy scores are higher at the end of the treatment than at the beginning of the treatment, $F(1, 41) = 1.661$, $p = 0.205$; however, assessment anxiety scores are significantly higher at the end of the treatment than at the beginning of the treatment, $F(1, 41) = 6.722$, $p = 0.013$. Although there is an improvement in each motivational construct after the treatment, there is not a significant effect across time in all motivational constructs, with the exception of anxiety scores. Table 5 shows the descriptive statistics for motivational constructs.

There was a significant interaction between time and gender for intrinsic scores, $F(1, 41) = 5.436$, $p = 0.025$, and between time and gender for assessment of anxiety scores, $F(1, 41) = 4.404$, $p = 0.042$. However, there was no significant interaction between time and gender for extrinsic scores, $F(1, 41) = 1.361$, $p = 0.25$; for goal orientation scores, $F(1, 41) = 1.980$, $p = 0.167$; for self-determination scores, $F(1, 41) = 3.758$, $p = 0.059$; or for self-efficacy scores, $F(1, 41) = 0.664$, $p = 0.420$. Thus, there was no interaction between time and gender for each motivational construct, with the exception of intrinsic and assessment anxiety scores. Table 6 includes a summary of repeated measures MANOVA.

Table 5. Descriptive statistics for motivational construct.

	Pre treatment		Post treatment		Girls		Boys	
Dependent measure	*M*	SD	*M*	SD	*M*	SD	*M*	SD
Intrinsic motivation	2.646	0.167	2.767	0.152	2.823	0.123	2.589	0.178
External motivation	3.338	0.167	3.357	0.159	3.540	0.125	3.155	0.180
Goal orientation	2.488	0.150	2.650	0.135	2.646	0.103	2.493	0.148
Self-determination	2.416	0.170	2.521	0.166	2.675	0.128	2.262	0.184
Self-efficiency	2.226	0.165	2.550	0.178	2.598	0.133	2.179	0.192
Assessment anxiety	2.219	0.180	2.762	0.162	2.526	0.154	2.455	0.222

Table 6. Summary of repeated measures multivariate analysis of variance.

		ANOVA *F* (1, 41)					
Factor	MANOVA *F* (6, 36)	Intr.	Ext.	Goal	S-dete	S-eff	Ass. Anx
Between subjects gender	0.817	1.172	3.080	0.719	3.399	3.230	0.068
Within subjects time	1.500	0.262	0.006	0.534	0.177	1.981	6.722*
Gender x time	1.418	5.436*	1.361	1.980	3.758	0.664	4.404*

*Significant at $p < 0.05$.

Discussion

The result of the study could suggest that CBL was effective for enhancing pre-service teachers' attitudes toward chemistry. After the six-week CBL instruction period, pre-service teachers' attitudes toward chemistry scores improved. The reason for this could be that pre-service teachers were actively involved in the instruction; they were able to discuss real-life stories and could do research both individually and with group members. Similarly, Şenocak, Taşkesenligil, and Sözbilir (2007) found that problem-based learning activities have a positive effect on pre-service teachers' attitudes toward chemistry. The other reason for the improvement could be that CBL includes cases focusing on daily life examples of acids and bases, and thus pre-service teachers had an opportunity to learn daily life connections with the concepts. When they were asked in an informal setting, they stated that they like stories. Furthermore, in the class discussion pre-service teachers had a chance to freely share their ideas.

The other result of the study suggested that pre-service teachers' attitude scores did not differ among females and males before or after the treatment. Çam and Geban (2011) and Eymur and Geban (2011) studies on high school students had similar results. Although there is a nonsignificant difference between females and males in terms of pre-service teachers' attitudes toward chemistry, females' attitudes toward chemistry score were higher than males. However, Adesoji and Raimi (2004) found that males' attitudes toward chemistry scores were higher than girls' when students were exposed to the laboratory method in a chemistry course. Perkins (2011) found that female college students had higher attitude scores in context-based instruction. However, she could not find a significant result. The results above and the present study suggest that girls may like stories more and males may prefer doing something, i.e. experimenting. Thus, females' and males' instruction preferences should be investigated by designing an experimental method with two treatment groups, i.e. laboratory and case-based learning instruction.

Although case-based learning developed pre-service teachers' attitudes toward chemistry in the present study, it did not significantly develop pre-service teachers' motivations in each dimension. According to the result of the study, case-based learning did not have a significant multivariate effect on motivational constructs and gender. The reason for this result could be that the scores of females and males are relatively high at the beginning of the treatment. Thus, this makes it more difficult to improve pre-service teachers' motivations in each construct. Furthermore, the treatment may have been too short to change pre-service teachers' motivations. Similarly, Çiğdemoğlu (2012) and Yükselturk and Bulut (2009) found that high school students' motivation did not change in terms of gender while administering context-based learning and online learning, respectively. Although there is no significant difference between gender and motivational constructs, females' mean scores in each motivational construct is higher than males.

Although there is an improvement in each motivational construct after the treatment, there is not a significant effect across time in all motivational constructs, with the exception of anxiety scores. Thus, there was no interaction between time and gender for each motivational construct except for intrinsic and assessment anxiety scores. The reason for this result could be that at the beginning of the treatment pre-service teachers' mean values in each dimension was at a moderate level, and thus the treatment was not effective for changing motivations. Therefore, it could be stated that pre-service teachers' motivations could

be developed during a long treatment duration when their initial motivational levels are high. The other reason for the nonsignificant result could be that case-based learning should be implemented gradually in order to enhance pre-service teachers' motivation (Baeten, Dochy, and Struyven 2013).

There are some limitations of the present study, one of which is that the case-based learning instruction is limited to acid-base topic. However, this topic covers abstract concepts and integrates other concepts, such as chemical equilibrium, chemical reaction, stoichiometry, and solutions. Therefore, one could argue that chemistry topics with these properties could lead to the same results. The other limitation of the study is the absence of the control group; however, many research findings demonstrated that case-based learning is an effective teaching method compared to more traditional methods.

In sum, the present study demonstrated that while case-based learning is effective for improving pre-service teachers' attitudes toward chemistry, it is not effective for improving their chemistry motivations. Glynn and Koballa (2006) stated that attitudes influence motivation, and therefore in the present study pre-service teachers' attitudes toward chemistry were developed. The next goal of the study was the development of pre-service teachers' chemistry motivation; however, their motivation was not developed during the short six-week intervention.

Disclosure statement

No potential conflict of interest was reported by the authors.

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