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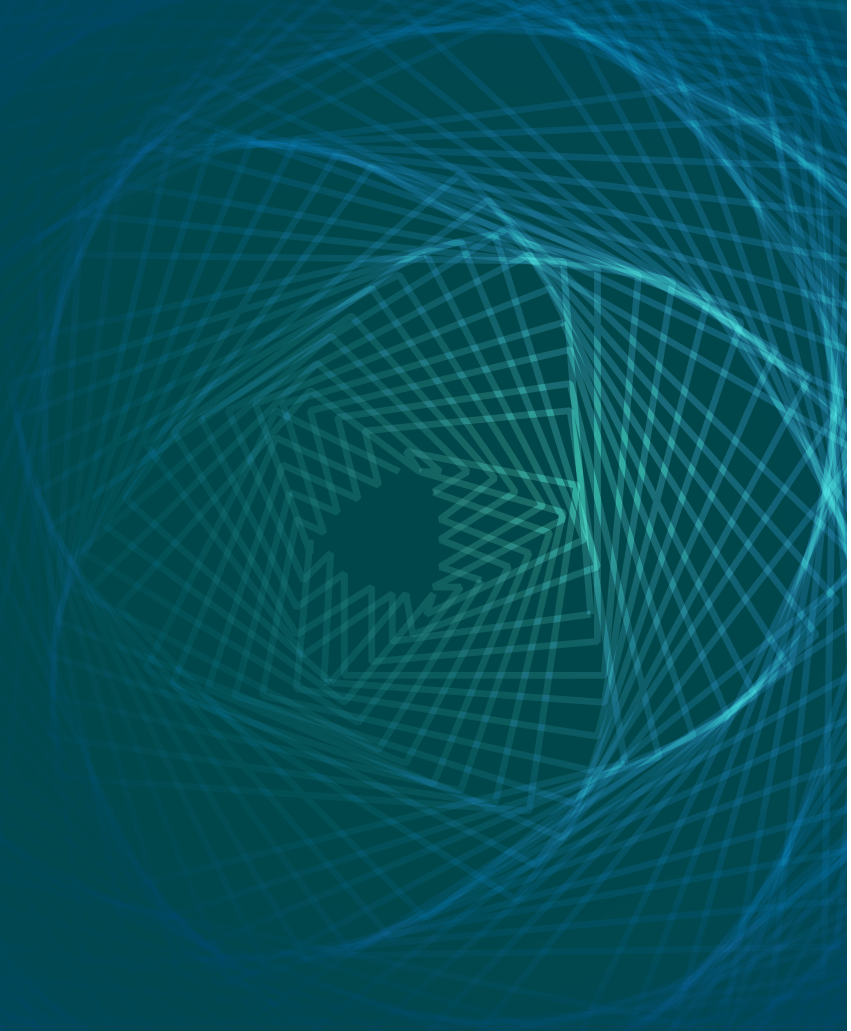

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Prospective Chemistry Teachers' Evaluations About the Instruction of the Graphic Organizers Course

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Abstract

Graphic organizers (GOs) are visual teaching and learning tools that provide an organized expression of knowledge by explaining concepts and events. If the teachers incorporate the GOs into their lessons as instructional material and assessment tools, they can make the teaching period more effective and also help their students' understanding of the chemistry subjects. In this study, the prospective chemistry teachers (PCTs) attended a Graphic Organizers Course, and then their opinions regarding the evaluation of the course were taken. A total of 43 PCTs, 32 female and 11 male, who took the course in four different semesters, participated in this study. In this course, the PCTs were taught about ten types of GOs that stand out most in the literature. At the end of the course, the evaluation of both the instruction of the course and their own learning experiences was collected from PCTs with a course evaluation instrument with 5 open-ended questions. It was concluded that the inclusion of the Graphic Organizers Course in the chemistry teacher education program significantly contributed to the professional development of the PCTs.

Keywords: graphic organizers, prospective chemistry teachers, secondary school chemistry lessons

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Introduction

Ausubel has proposed a pedagogical strategy of using advance organizers to facilitate the incorporation of new knowledge into the cognitive structure in a substantive manner (Novak 1984). Novak (1984) has pointed out advanced organizer is a small part of learning that is more general and more inclusive than the ensuing learning material and perceived by the learner to serve as a cognitive bridge between what he/she already knows and what is to be learned. Therefore, an advance organizer can help students to organize and interpret new incoming information and it is generally presented before the material to be learned. Advance organizers (AOs) can be also constructed graphically and this kind of advance organizers are called graphic organizers (GOs). Culbert et al (1998) have indicated that a graphic form of the advanced organizer, the structured overview, was developed by Barron (1969) and Earle (1970). They stated that the structured overview was designed to illustrate relationships among concepts in a hierarchical organization and the illustration included only key vocabulary terms to eliminate lengthy and difficult text.

Graphic organizers (GOs) are visual teaching and learning tools that provide an organized expression of knowledge by explaining concepts and events. They can visually categorize new

knowledge into a similar category, provide to construct the relationships between pre-existing and new knowledge, help to think of new ways to create a simple structure about knowledge and provide a new understanding by providing the opportunity to review concepts (Nakiboğlu & Çamurcu, 2014; Nakiboğlu & Yıldırım, 2018). GOs are powerful tools that support instruction and also allow students to make sense of complex content by exploring and visually representing linkages and relationships between different components (Amin, 2004). The studies that examined the effectiveness of using GOs during lessons have indicated that using different types of GOs can enhance students' understanding of the content (Kwon et al., 2018; Omondi et al., 2018).

Although sometimes the AOs and GOs are used interchangeably, there are differences between them. AOs are presented at the beginning of the lesson and link between what students already know and what is to be learned. GOs can be used as an advance organizer at the beginning of the lesson, as well as to organize the students' knowledge about the subject taught at any stage of the lesson and to evaluate them at the end of the lesson. Over time, graphic organizers went beyond being just advance organizers and became a visual teaching and learning tool used at every stage of a lesson with different purposes. Even it is seen that some researchers use the GOS as a Teaching Model (Malik & Zaman, 2012).

Literature Review

Researchers have pointed out that the origin of the GO bases on the cognitive theories of learning, and the meaningful learning theory and the information process theory can help us to understand how the GOs contribute to learning. Wills and Ellis (2008) have also indicated that schema theory, dual coding theory, and cognitive load theory provide the basis for explaining the characteristics of GOs. According to Meaningful Learning Theory, learning takes place when the newly learned concepts are connected hierarchically to the learners' mind through the concepts learned in the previous lessons. The GOs can make possible meaningful learning by providing students with a framework for relating existing knowledge to the new information learned (Virk and Wik, 2011). Schema theory is defined as an abstract knowledge structure (Anderson & Pearson, 1984, p.42 cited in An, 2013) which is also related to prior knowledge or background knowledge. It explains how the students use prior knowledge to comprehend and learn from text. According to schema theory, comprehending a text is an interactive process between the reader's background knowledge and the text (An, 2013). Another important factor in learning is student's cognitive processing capacity, which is severely limited (Mayer & Moreno, 2003). According to the cognitive load theory, it suggests that effective teaching material facilitates learning by directing cognitive resources to activities related to learning rather than preparation for learning (Chandler & Sweller, 1991 p. 293). Thus, it can be said that the GOs can affect learning positively by reducing the cognitive load (Kwon et al., 2018; Stull & Mayer 2007).

The studies have shown that students have many problems with learning chemistry concepts and topics while teaching chemistry lessons at all levels of education (Nakhleh, 1992; Nakiboğlu & Tekin, 2006; Nakiboğlu, 2003; Nakiboğlu, 2016; Rahayu et al., 2011; Taber et al., 2012). There are many reasons why secondary students have difficulties and misconceptions regarding chemistry topics and concepts. The first reason is that chemistry concepts are abstract, and chemistry explanations include invisible interactions between invisible entities. Depending on the first reason, a second one relates to the teaching approaches followed during chemistry concept teaching in the lessons since concept acquisition is a crucial facet of knowledge development

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(Fitzgerald et al., 2017). Gil-Garcia and Villegas (2003) have indicated that the use of GOs can help make expository texts which are difficult to understand for learners because of the problematic or abstract nature of the topics more comprehensible for the students. Thus, engaging the GOs in the secondary school chemistry lessons can assist students in better understand abstract chemistry concepts and construct them in a meaningful way in their cognitive structure. Additionally, since concept learning includes internal cognitive processes, it is difficult to measure internal representations of knowledge about concepts learned directly. For this reason, when the GOs are constructed by learners, instructors can also evaluate students' knowledge and their comprehension. For chemistry teachers to use GDs effectively in their lessons, it is extremely important for teachers to know what GOs are, to learn how to benefit from GOs in lessons, and to have experience in what stage of the lesson and how they can use the GOs. To achieve this, teachers should either receive training on this subject during their undergraduate education or should participate in in-service workshops regarding the GOs to improve themselves.

Due to all the aforementioned reasons explained, the chemistry teacher training program in our faculty offers an elective course for the PCTs about what graphic organizers are and how to use them in secondary school chemistry lessons. This study aims to take the opinions of PCTs who attended a Graphic Organizers Course about how they evaluate this type of course in terms of chemistry teacher professional education, and their progress. For this purpose, the research questions of this study attempted to answer are the following:

- How do the PCTs evaluate themselves about their comprehension of how to use GOs in teaching secondary chemistry lessons at the end of the course?
- What are the opinions of the PCTs about the teaching method of the course?
- How do the PCTs evaluate the group work used during the lessons at the end of the GO course?
- What are the opinions of the PCTs about whether there are missing places concerning the teaching methods of the course?

Methods

Sample, data collection, data source, empirical model were presented below in detail.

Sample

A convenient sampling method was used to select the participants. This is a non-probability sampling method that relies on data collection from a group that is conveniently available to participate in the study. It is also known as availability sampling. The participants were drawn from the Chemistry Education Division at the Education Faculty of a Turkish Public University. The program is a 4-year chemistry teacher training program and its purpose is to educate teacher candidates for chemistry teaching in secondary schools. A total of 43 PCTs, 32 female and 11 male, who took the course in four different semesters, participated in this study

Data Collection

At the end of the Graphic Organizers Course, the evaluation of both the instruction of the course and the PCTs' own learning experiences were collected from PCTs with a course evaluation

instrument with 5 open-ended questions. All the PCTs were volunteers to fill the course evaluation form and were informed about the purpose of the study. The researcher guaranteed their anonymity when results were to be presented.

The Graphic Organizers Course is an elective course in the chemistry teacher training program of an education faculty. This course continued for 14 weeks and 3 hours a week. One week was devoted to midterm exams and in the other 13 weeks, instruction was given to PCTs. In the first week, it was explained how the teaching of the course would be carried out, and then, for 12 weeks, the PCTs were introduced to different types of GOs and their applications were carried out. The literature is examined, it is seen that the GOs can be prepared in many different styles and formats and classified in a wide variety of ways. In this course, the PCTs were taught about 12 types of GOs that stand out most in the literature. The GOs taught were concept definition map, semantic feature analysis, comparison-contrast matrix, spider map, persuasion map, positive, negative, and interest diagram, flow diagram, cause-effect diagram, V-diagram, and concept map.

The below route was followed during each week's lessons in the course. At the beginning of the lesson, after introducing the GO to be taught that week and teaching how to use it in the secondary school chemistry lessons, at least 3 examples prepared on different chemistry subjects were shown. This part of the lesson was conducted as a whole class discussion. First, the pre-knowledge of the PCTs about GO was reviewed by asking whether such a GO has been included in their lessons before or whether they have seen it in textbooks or other sources. After the introduction of GO and the presentation of the examples, a discussion was made about how it can be used in the lessons with the whole class discussion. Later, by working in PCTs groups collaboratively, they prepared a GO at the chemistry class level related to GO that they learned that week.

The course was planned to teach graphic organizers, their purposes, and ways of use in secondary chemistry lessons to PCTs by collaborative learning. Both studying in small groups and participating in whole group discussions during their presentations, a suitable learning environment for the collaboration was provided to the PCTs during the course.

All groups prepared their PowerPoint slides to demonstrate their GOs constructed in the groups. Later, they presented these slides to the whole class. While the presentation, they made an explanation about which grade level this GO is prepared for and at what stage of the lesson it will be used. After each presentation, the whole class made a discussion about the GOs presented and explained. After all the presentations were completed, the instructor evaluated the teaching of the GO of that week by asking questions to the PCTs about how to use this GO in secondary chemistry lessons. After a whole group discussion about the GO, if necessary she completed her teaching of that week by making additional explanations about GO.

Data Source

All data were analyzed by using the content analysis method. In content analysis, data is first analyzed and coded by the researcher during the processing of data. While coding, themes, and concepts suitable for the research problem are used (Yıldırım & Şimşek, 2008). In the study, firstly, the collected data were coded as sentences/word groups, and then the sentences were gathered under appropriate themes and brought together in a meaningful way. Finally, due to the quantitative sufficiency of the qualitative data, the data were tabulated and were presented as

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frequency and percentage. In addition, direct quotations from the explanations of the PCTs were made to support to quantitative data. To obtain intra-judge reliability of the analysis, all answers in the sample were analyzed twice by the author of the study (Gay & Airasion, 2000, p. 175).

Empirical Model

This is descriptive research conducted to obtain the opinions of the PCTs. "Survey research involves asking questions of a sample of individuals who are representative of the group or groups being studied. Such investigation may have a variety of purposes such as describing, comparing, and correlating (Koh and Owen, 2000, p. 220).

Findings

In the first research problem, what the PCTs think about the situation of their competence at the end of the course was investigated. For this purpose, one open-ended question was posed to the PCTs. When the PCTs were asked to evaluate themselves on how to use GOs in the teaching of chemistry lessons at the end of the Graphic Organizers Course, it was concluded that all the PCTs said that they learned how to use GOs at which stage of the secondary school chemistry lessons in detail and would include the GOs in their future classless.

Only 4 of the PCTs without making an explanation in detail indicated they learned how to use GOs at which stage of the secondary school chemistry lessons. However, it was detected that other PCTs gave a more detailed answer to this question. Analysis of the detailed answers given is shown in Table 1.

Table 1. Self-Evaluation of Prospective Chemistry Teachers About Their Competence

Explanations of PCTs	**Number of PCT**	***f***	***%***
Understanding how it can be used at every stage of the lesson	PCT1, PCT2, PCT3, PCT5, PCT6*, PCT7*, PCT9, PCT10, PCT11, PCT12*, PCT14, PCT15, PCT16, PCT17, PCT18, PCT19, PCT20, PCT22, PCT23, PCT25, PCT28, PCT29, PCT31, PCT32, PCT33, PCT34, PCT35, PCT36, PCT37, PCT38, PCT39, PCT40, PCT41	33	76.7
Understanding the appropriate GO selection according to the content and type of GO, and subject	PCT6*, PCT7*, PCT8, PCT12*, PCT13, PCT21,	6	14.0
Understanding how GOs help evaluation of students	PCT30	1	2.3
Believing that GOs will contribute to their profession	PCT4	1	2.3
Thinking that GOs should be used for students to understand the subject better and easily	PCT42	1	2.3
There is no extra explanation	PCT24, PCT26, PCT27, PCT43	4	9.3

* Some explanations were included in both groups

It seen that from Table 1, 76.7% of the PCTs explained that they fully understood how to use GOs at every stage of a chemistry lesson, and 14% of the PCTs stated that they understood how to select which GOs were appropriate for the content taught. A quotation from a sample expression stated by PCT1 about understanding how to use GOs at every stage of a chemistry lesson was given below.

> We use GO to remember the previous information at the beginning of the lesson, to reinforce the concepts and the subject during the lesson, and to understand that the information has been learned at the end.

When the other answers are examined, it is understand that one PCT (PCT30) stated that he understand how GOs help evaluation of the students. While one PCT (PCT4) thought that this course would be contributed his professional development, PCT42 stated that GOs should be used for students to understand the subject better and easily.

In the second research problem, how the PCTs evaluate the instruction of the Graphic Organizers Course was investigated. For this purpose, one open-ended question was asked to PCTs. In this question, they were asked to explain what they thought about the teaching method of the course. The findings of this question are presented in Table 2.

When Table 2 is examined, it is seen that most of the responses of the PCTs contain positive evaluations of the teaching method of the Graphic Organizers Course. Their opinions concerning positive evaluations of the PCTs fall under four themes and these themes are positive thinking about the teaching method, cognitive contribution, affective contribution, and improving PCTs' skills. Regarding the theme of positive thinking about the teaching method of the course, 93.0 % of the PCTs thought the course method to be successful and correct method. A quotation from a sample expression stated by PCT15 was given below.

> It was very nice to be given information first, then we prepared the GO, helped while preparing it, and evaluated together in class.

Regarding the theme of cognitive contribution, it was determined that the opinions of PCTs divided into two groups. While some of them expressed that they understood that how to prepare and use GOs in secondary school chemistry lessons, others had some thoughts about their cognitive contribution. They stated that the course helped students understand how they could contribute to their cognitive development. A quotation concerning this theme was given below.

> It enabled us to understand how we should envision the subject in the student's mind and make it permanent.

Regarding the third theme, it was determined that 18.6% of PCTs thought that the method applied increased their interest in the lesson and they enjoyed the lesson. A quotation from PCT34's explanation for this theme is given below.

> I like this method. It was nice that we were able to carry out the lesson in an enjoyable way without boring us and that I could do something myself.

When the expressions in the fourth theme are examined, it is seen that 14% of the PCTs stated that the method used in this course contributed to the development of some of their skills. It is understood that these contributions are gathered in three groups. The expression of PCT4, which states that he/she gained all three of these, is given below.

> The lessons were conducted in a purely practical style. We have improved our use of computers. We have seen how to organize and use information. We improved our presentation skills by making presentations. Everything was perfect.

The last theme is concerning whether the method used in the course has a deficiency. When Table 2 is examined, it is seen that there are four different opinions under this theme. Only three of these opinions are related to the course method. In these opinions, it was determined that the PCTs

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stated that it would be more productive if the presentations were prepared outside of the class hours and to do the work individually instead of group work. Besides, it was seen that they thought that the course hours were not sufficient.

Table 2. PCTs' Evaluation About the Graphic Organizers Course

Themes	PCTs' expression	Number of PCT	*f*		%
Positive thinking about the teaching method	It was very nice to be given information first, then we prepared the GO, helped while preparing it and evaluated together in class.	PCT1, PCT2, PCT6, PCT7, PCT8, PCT11, PCT13, PCT18, PCT28, PCT31, PCT36, PCT39, PCT40, PCT42, PCT43	15	40	93,0
	Efficient/nice method	PCT4, PCT6, PCT19, PCT20, PCT22, PCT25, PCT27, PCT28, PCT29, PCT38, PCT40	11		
	Successful method	PCT2, PCT3, PCT5, PCT7, PCT16, PCT26, PCT8, PCT23	8		
	Correct method	PCT13, PCT30, PCT32, PCT36, PCT37, PCT39	6		
Cognitive contribution	Ensured retention in the mind	PCT20, PCT29, PCT35, PCT39, PCT42, PCT43	6	17	39,5
	It was more beneficial for us to be active	PCT9, PCT10, PCT15, PCT23, PCT27	5		
	Provided to learn how to prepare GOs	PCT21, PCT25,	2		
	Contribution to learning our shortcomings	PCT6, PCT21	2		
	Contribution to learning the subject easily	PCT13	1		
	It enabled us to understand how we should envision the subject in the student's mind and make it permanent.	PCT19	1		
Affective contribution	It was enjoyable	PCT8, PCT34, PCT35	4	8	18,6
	I like the method	PCT11, PCT34	2		
	Increased interest in the lesson	PCT10, PCT29	2		
Improving PCTs' skills	Improved our questioning of knowledge and organizing.	PCT3, PCT4	2	6	14,0
	Improved our presentation skills by making presentations	PCT4, PCt21	2		
	Improved the computer usage skill	PCT4, PCT19	2		
Deficiencies of the method	It would be more productive if the presentations were prepared outside of the class hours.	PCT12, PCT17, PCT37	3	7	16,3
	It could be studied individually	PCT38, PCT41	2		
	It was limited in terms of time and scarcity of our resources created a difficulty.	PCT33	1		
	Not every teacher has both the time and the opportunity to do these all the time.	PCT5	1		

The third research question focused on the evaluation of group working and on the understanding of PCTs' satisfaction with the collaboration in small groups. For this purpose, the PCTs were asked the question "Did you find it useful to use group work during the conduct of this course? Did you want to work alone?" The findings of these questions are presented in Table 3.

Table 3. PCTs' Evaluation About the Group Working

PCTs' opinion	Number of PCT	*f*	%
PCTs who found group work beneficial	PCT1, PCT2, PCT3, PCT4, PCT5, PCT6, PCT7, PCT8, PCT9, PCT10, PCT11, PCT13, PCT14, PCT16, PCT17, PCT18, PCT19, PCT20, PCT21, PCT22, PCT23, PCT24, PCT25, PCT26, PCT27, PCT28, PCT29, PCT30, PCT31, PCT33, PCT34, PCT35, PCT36, PCT37, PCT39, PCT42, PCT43	37	86.0
PCTs who think that working alone will be beneficial	PCT12, PCT41	2	4.7
PCTs whose thoughts are not clear	PCT15, PCT32, PCT38, PCT40	4	9.3

When Table 3 is examined, it is seen that 86% of PCTs find group work beneficial, while 4.7% think that working alone is more beneficial. When the explanations of the pre-service teachers who found group work useful were examined, it was seen that they thought that group work created more useful products, cooperation and exchange of ideas, time saved and they corrected each

other's mistakes. Sample statements of two of the PCTs who thought group work was helpful are given below.

> As a result of group work, we prepared better materials. Good work came out because everyone's opinions were taken (PCT1)

> Group work was increasing success. It was the right method. With group work, we correct each other's mistakes and come up with more creative things with different ideas (PCT2).

As can be seen from Table 3, 4.6% of PCTs found it more beneficial to work alone. A statement of PCT12 who stated that working alone would be more beneficial is given below.

> I think working alone would be more beneficial. One person can do everything (PCT12)

It was seen from Table 3, four of the PCTs' thought were not clear on this issue. Two examples of this are given below.

> Group work is beneficial, but it is not right to do group work in every lesson. While some students work hard and comment, others may pass the course without knowing anything about the subject (PCT15).

> It would be better if we were alone, but the course would be too heavy and the subjects would not be covered (PCT32)

In the fourth research question, the opinions of the PCTs regarding whether there are missing places about teaching methods in the Graphic Organizers Course were examined. It was determined that all PCTs gave the answer that there was no missing place in the teaching method of the course except two PCTs. One of them, PCT15, reported a deficiency as "the issues we saw in high school were not focused much on". PCT26 indicated that "we had a little trouble with the flow chart, but then we completed the deficiencies".

Conclusions

In this study, the opinions of the prospective chemistry teachers who attended a Graphic Organizers Course about the evaluation of both the instruction of the course and the PCTs' own learning experiences were examined. Based on the data obtained, it was revealed that the inclusion of the Graphic Organizers Course in the chemistry teacher education program significantly contributed to the professional development of the PCTs. It was concluded that most of the PCTs fully understood how to use GOs at every stage of a chemistry lesson, how to select which GOs were appropriate according to the content, and how GOs help evaluation of the students. It was also found that the course also improved the several skills of PCTs like presentation skills and computer usage skills. It was revealed that almost all of the PCTs found the collaborative student-centered approach used during the course very useful and thought that nothing was missing during the course.

It was also concluded that most of the PCTs stated that they found working within a small group more useful. Collaborative learning supports learners both to regulate their learning (self-regulation) and to those of their peers (co-regulation) (Strauß & Rummel, 2021). Hutter and Diehl (2011) have expressed that the working teams are often established to bring together different skills

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and aptitudes to build an advanced group product. In this study, it was determined that PCTs stated that they produced better products with group work and that some of their skills were improved.

Besides being effective teaching and learning tools, the use of GOs to evaluate students shows how important it is for the PCTs to have sufficient knowledge on this subject. In addition, since the graphic organizers are included in the textbooks, the pre-service teachers need to have certain knowledge of graphic organizers so that they can include these GOs placed in the textbooks to their lessons correctly. Based on the these reasons, it can be suggested that the courses concerning GOs should be included in the chemistry teacher education programs as compulsory courses to increase their professional development, and also the workshops related to the GOs should organize for chemistry teachers who cannot take such courses in their undergraduate education. Following a student-centered approach and using collaborative learning methods make a significant contribution to students' learning. Therefore, it can be also suggested that collaborative learning methods and student-centered approached can be used in the conduct of such courses.

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