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The Effects of Jigsaw Technique Based on Cooperative Learning on Prospective Science Teachers' Science Process Skill[1]

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Abstract
The purpose of this study is to investigate the effects of laboratory approach based on jigsaw method with cooperative learning and confirmatory laboratory approach on university students' cognitive process development in Science teaching laboratory applications, and to determine the opinions of the students on applied laboratory methods. The participating student teachers were identified as the Jigsaw Group (n=25), in which the laboratory approach based on Jigsaw method is applied, and as the Control Group (n=23), in which confirmatory laboratory approach is applied. Scientific Process Skill Test and Student Opinion Scale were used as data collection instruments. As a result of statistical analysis made, it was found that the effect of laboratory approach based on Jigsaw method on the development of student teachers' scientific process skills is higher than those of confirmatory laboratory approach. It was also revelaed that there is no statistically significant difference between the opinions of research groups on applied laboratory approaches.
Keywords: Cooperative learning, Jigsaw technique, scientific process skill

1. Introduction

Effective teaching is fundamental to learning. Knowledge, attitudes and learning outcomes including the skills depend on effective teaching. The effectiveness of teaching and learning process can be facilitated through appropriate strategies adopted in a learning environment (Adesoji, Omilani & Nyinebi, 2015). Classroom environment can be characterized with various thought patterns of learners. These differences stem from the differences in the information processing mechanisms of individuals. Although teachers can do nothing for their learners to expand their mental capacities, teachers can change their teaching strategies to facilitate their learners' understanding of the concepts. Therefore, to encourage effective learning, it is appropriate for science teachers to adopt a strategy that can be adapted to various thought patterns (Mari & Gumel, 2015). It is a serious responsibility to train qualified teachers and involve them in the education system with the aim of improving the education system successfully. The practitioners of teaching science at schools are the science teachers. Thus, teachers are required to gain contemporary knowledge, skills and attitudes. Teachers also need to know about new teaching and learning approaches at science education. These approaches help teachers to understand on their own in a meaningful way and to teach their learners through up-to-date teaching knowledge (Gezer, 2015; Surian & Damini, 2014).

Laboratory approach is one of the leading teaching methods to ensure effective and meaningful learning in science teaching, which is the basis for scientific and technological developments. The laboratory approach, which is based on the active participation of learners in the analysis of true events and data collection procedure, enables learners to understand the core and method of science, to improve their problem-solving skills, to investigate and generalize, to gain scientific knowledge, and to develop positive attitudes. Laboratory approach rests upon experiments. Therefore, it refers to investigating the events, facts and procedures observed in nature through experimental studies (Koray, Köksal, Özdemir & Presley, 2007). Experiments are one of the fundamental methods used to obtain and expand scientific knowledge via research. Hence, science educators have viewed the science for science courses as vital since the 19th century (Emden & Sumfleth, 2016).

Labarotory is at the center of science teaching in terms of serving for scientific purposes. Laboratory practices enable learners to solve problems by using the scientific methods as the scientists do. It is crucial for learners to gain problem solving skills. Laboratory practices provide learners with the opportunities to develop their problem solving skills through learning based on searching. Basic and integrative scientific process skills come into play in the problem solving process through research. Laboratory practices based on this truth are used for developing attitudes towards science, conceptual understanding and technical skills and how to use scientific research methods (Gurses, Gunes, Barin, Eroglu & Cozel, 2015; Kanlı & Yağbasan, 2008). In a laboratory, students can learn the facts and laws of science, confirm their validity and know how to use them practically. Science courses including laboratory practices teach learners to search, investigate, detect the problem and to cooperate with their peers to solve the problem. In this method, learners are more active and can learn by themselves. Learners record the data gathered through observation, make calculations according to these data and come to the conclusions based on these calculations. Thus, science laboratories become the place where all

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the necessary activities can be conducted smoothly and effectively. Most of the success of modern science takes its source from the practices of experimental method. Practising is more important in terms of "learn by doing" fact at schools. Scientific principles and practices get more meaningful in this way (Gezer, 2015; Yadav & Mishra, 2013).

In addition to learning strategies, the importance of cognitive strategies affecting success in science courses is emphasized in science teaching studies for more than a decade. One of the cognitive strategies influencing learning is mental ability. The studies on mental ability focus on the factors such as verbal comprehension, spatial visualization, scientific process skills, the ability to use numbers, word fluency, relational memory and detection rate (Adesoji, Omilani & Nyinebi, 2015). Learners at science courses need to learn how they are required to apply science rather than learning principles, theories and concepts. Therefore, it is crucial for them to learn how to use scientific process skills (Carey et al., 1989). Scientific process skills are the basic skills that make learners active, provide them with research methods and ways, enhance the permanence of learning and facilitate learning (Çepni, Ayas, Johnson & Turgut, 1997). Scientific process skills are also abilities that strengthen learning, support long-term learning and help learning scientific research methods and techniques (Ağgül-Yalçın, 2011). Scientific process skills (SPS) are of great importance for improving scientific ideas and training learners who are independent thinkers. SPS are essential for introducing science to children in a formal way. Process skill is a preparation for being a scientist (Yadav & Mishra, 2013). SPS can be divided into two levels as basic and integrated. Basic SPS consist of observation, classification, measurement, using numbers, using the space and time relation, interpretation, anticipation and communication. Integrated SPS are making inferences by defining the variables, hypothesizing, describing the variables in terms of functions, doing experiments and interpreting the results. All science teachers need to improve these skills in various scientific research contxts, use them and transfer these skills into learners through effective science teaching strategies (Feyzioglu, Demirdag, Akyildiz & Altun, 2012; Kruea-In, Kruea-In & Fakcharoenphol, 2015). Science educators focus on questions such as "How are SPS improved? Which strategy is more effective in improving SPS? What is the role of a teacher in improving SPS? What are the perceptions of learners regarding SPS? Some SPS researchers state that SPS of learners can be developed through constructivist approach, problem-based learning, cooperative learning, project-based learning and research-based learning methods. However, some research findings in the studies of SPS development vary (Yildirim, Çalik & Özmen, 2016). Classroom environments in science courses need to be prepared for learners to conduct experiments and research, and to interpret the findings with the aim of involving learners in science activities and facilitating them. In this way, learners can easily understand and care for science courses thanks to these skills gained. Thus, attitudes of learners towards science courses affect their achievements (Bahadır, 2007). To improve scientific process skills of students at primary school level, science teachers of these students need to gain these skills themselves first (Bağcı-Kılıç, 2003). For this reason, novice teachers in service who are equipped with scientific process skills are an important step for students to improve their scientific process skills. Laboratory practices with the active participation of learners give the opportunity to learners to develop their scientific process skills (Tamir, 1997).

One of the main targets of teachers is to use learning strategies effectively to enhance students' cognitive and affective learning. Traditional learning methods employed widely by teachers are challenged as they are viewed the source of many problems (Tran, 2016). One of two basic reasons of the inefficient use of laboratory practices is "not giving enough time for learners to think about scientific principles and to deeply process knowledge in traditional laboratory practices". The second one is that laboratory practices, which employ deductive or confirmation methods, are designed for improving low level mental abilities such as learning by heart, algorithmic problem solving (Kanlı & Yağbasan, 2008; Wilcox, & Lewandowski, 2016). Teaching science does not just mean transferring knowledge. It is about improving the skills of criticial and analytical observation and problem solving as well as creativity. These skills are less developed through traditional approaches as practice and productive work do not have an important place in traditional approaches (Wambugu, Changeiywo & Ndiritu, 2013; Yadav & Mishra, 2013).

On of the major challenges of educators is to be able to identify the most effective learning strategies for their students. We live in a knowledge-based society. Knowledge creation occurs through collaborative work in a social environment. That means knowledge creation is a social process. In this regard, the question of "How can the most effective learning design be created?" needs to be answered in knowledge creation procedure (Hong, Chai & Tsai, 2015). In order to minimize the challenges learners face while learning science, student-centred active learning strategies are recommended as an alternative to traditional learning methods that center teachers (Adesoji, Omilani & Nyinebi, 2015). Active learning rests upon the hypothesis that learning is an active effort and individuals learn in different ways. While learning actively, learners actively (rather than being passive) participate in the learning procedure by discovering, processing, and practicing knowledge. In a student-centred approach, the responsibility passes on learners who need to attend learning procedure with their teachers and peers (Cherney, 2011). Cooperative learning is one of the most widely used approaches of active pedagogy. Cooperative learning that occurs through an individual's interaction with peers and environment is based on students' learning through social contexts (Gillies, 2014; Slavin, 2014; Tsay & Brady, 2010). The core of cooperative learning is based on the social dependency theory. According to this theory, cooperation is the most effective when learners are aware that they share the similar targets and the targets of individuals are positively linked to the actions of the group. This positive reciprocal dependency is accepted to increase the encouraging interaction. Hence, this encouraging reciprocal interaction is anticipated to increase academic achievement (Herrmann, 2013).

Cooperative learning is a pedagogical practice that provides learners with the cognitive, affective and psychomotor attainments when they have the opportunity to interact with others to achieve common goals (Devi, Musthafa & Gustine, 2015; Gillies & Boyle, 2010). Cooperative learning is formed as a promising teaching innovation to enhance the cognitive, affective and social learning attainments. A great number of cooperative learning techniques and structures exist today. These models differ from one another in terms of some important aspects such as enabling individual learning and intergroup collaboration as well as in-group collaboration and competition. In addition, certain basic elements such as positive dependency, individual accountability and face-to-face interaction are common in these models (Ghaith & Bouzeineddine, 2003; Slavin, 2015; Sharan, 2015). One of the various classroom practices of cooperative learning is Jigsaw technique.

Jigsaw activity is a teaching practice in which learners are responsible for learning the material and teaching it to other learners. Jigsaw activity has been a teaching activity that can be used by teachers of all grades in their classrooms. Many educators have adapted and employed the revised versions of Jigsaw technique in their classes (Colosi & Zales, 1998; Doymus, Karacop & Simsek, 2010; Hedeen, 2003; Zacharia, Xenofontos & Manoli, 2011; Zhan & Georgia, 2011). Jigsaw technique encourages student participation in a classroom where learners have a critical role for success and this success depends on active cooperation and participation. Using Jigsaw technique increases the variety of learning experiences, and teaches learners course content and cooperative social skills (Perkins & Tagle, 2011). In the Jigsaw technique, as the only way for a student to learn the other parts of the content that are not under his/her responsibility is to carefully listen to his/her teammates, these practices encourage learners to support and care about the work of others (Anderson & Palmer, 1988; Huang, Liao, Huang, & Chen, 2014; Mari & Gumel, 2015). Jigsaw technique has been designed to promote cooperation by making individuals dependent on each other. In this technique, each student is responsible for learning a part of a broad topic and teaching it to other learners. That is, each learner is dependent on other group members to learn the main topic (Buhr, Heflin, White, & Pinheiro, 2014; Carroll, 1986; Maden, 2011). As each learner in the cooperative work group is responsible for a small part of the learning material and teaching it to other members, the sense of having a responsible role places them in the center of knowledge creation process (Slavin, 2014; Tran, 2016).

Jigsaw model is an effective approach to develop dependency and cooperation. However, there are some disadvantages of this model that affect learners' participation in group work in a negative way. When students believe that their individual efforts are not related to their group's performance, some negative group procedures such as social evasion and fool effect may occur. In order to use this teaching method effectively, some limitations of the technique need to be considered. When the cooperative tasks given to the group members are not challenging enough to require joint effort, group members can view their individual contributions as unnecessary. Moreover, if the cooperative work does not comprise sufficient tasks for each group member to contribute, students are inclined to social evasion. This instability gives inconvenience to the group members who have to undertake the majority of work. Also, it is important for the main content chosen for the group work to be divided into sub-categories for the equal responsibility of group members (Berger & Hänze, 2015; Devi, Musthafa & Gustine 2015; Karacop & Doymus, 2013; Voyles, Bailey & Durik, 2015).

Kanlı and Yağbasan (2008) found out in their study that laboratory approach based on 7E model is more effective than deductive laboratory approach in developing scientific process skills of first grade tertiary level students taking the course of basic physics laboratory. Gurses et al. (2015) conducted a study to determine the student teachers' levels of using scientific process skills. The findings of the study indicated that the most of the participating student teachers had the prediction ability regarding a problem encountered. Moreoever, it was seen that these student teachers can easily make interpretations when they face a problem. However, this study also highlighted that variable definition skill of these student learners needed to be improved. Yıldırım, Çalık and Özmen (2016) conducted a meta-analysis study on scientific process skills. In this study, they tried to investigate a) the SPS improvements of teachers and students, b) the effects of variables on SPS achievement levels, c) the intregration of SPS into science syllabus, d) determining SPS levels. Also, this meta-analysis study showed that a learning approach based on research is a crucial factor in developing SPS. It was also stated that science course syllabus has an important role in improving students' SPS. Kruea-In, Kruea-In and Fakcharoenphol (2015) carried out some treatments in their study to enhance the performances and perceptions of science teachers regarding pre-service and in-service scientific process skills. In this study, learn by doing activities were designed to promote the scientific process skills development. Based on the findings, it was suggested that lesson preparation for pre-service science teachers needs to include both content and scientific process skills.

When theoretical knowledge and the results of the studies in the field of science teaching are taken into account, it has been deduced that the use of laboratory in science courses is crucial. Furthermore, the use of student-centered learning strategies that will ensure effective learning has been emphasized. It has been understood that activities to promote the development of scientific process skills as well as students' academic performances in science courses need to be carried out. Based on these results, the present study investigates the effects of Jigsaw technique, one of the classroom practices of cooperative learning, through laboratory practices on the students' development of scientific process skills. Moreover, it is aimed to find out the perceptions of students regarding the activities carried out with this technique to determine the effectiveness of the Jigsaw technique and its challenges. The research questions of the study are as follows:

1. Does teaching with cooperative learning-based Jigsaw method and confirmatory laboratory method constitute differences in terms of students' science process skills?
2. What are the students' opinions regarding the cooperative learning-based Jigsaw method and confirmatory laboratory method used in Science teaching laboratory practices?

2. Method

2.1 Research Design

This study was conducted by using the pre-test post-test control group design out of quasi-experimental research designs. While science teaching laboratory practices were performed through Jigsaw method based on cooperative learning for the experimental group, the control group employed confirmatory laboratory method. The data to determine the perceptions of the students on scientific process skills and laboratory techniques were gathered and compared. Thus, the effects of Jigsaw technique on the students' development of scientific process skills were investigated. Moreover, the perceptions of the students regarding activities carried out through the Jigsaw technique and confirmatory laboratory method were examined.

2.2 Sample

48 third-grade student teachers of Science Teaching, taking Science Teaching Laboratory Applications (STLA) course in the second semester of 2014-2015 education year, participated in the study. While the student teachers in the experimental group (n=25) received training through the laboratory approach based on Jigsaw method, the control group (n=23) used the confirmatory laboratory approach.The student teachers in the sample took the courses of basic and advanced physics, chemistry, biology in the first five semesters, and most of them have passed the courses.

2.3 Instruments

The data for this study were collected through Scientific Process Skills Test (SPST) developed by Kanlı (2007). As cited in Kanlı (2007), SPST was originally developed by Burns, Okey and Wise (1985). Turkish translation and adaptation of the test were performed by Özkan, Aşkar and Geban (1992) and cronbach α reliability coefficient was computed as .79. Scientific Process Skills Test (SPST) was used as the data collection instrument in order to test whether scientific process skills of the participating student teachers were developed or not. SPST consists of 36 multiple-choice questions in order to measure skills of identifying variables, operational identification, hypothesizing and identification, interpretation of graphics and data and research designing. SPST was administered to treatment groups as pre- and post-test.

Student Opinion Scale (SOS) consists of 16 items, which are graded from 1 to 5 according to the participation level, to determine the perceptions of the students on applied laboratory approaches, and one open-ended question to discover additional comments of the students. SOS was developed and used by the researchers for the attainments that students need to gain in the laboratory group work activities. Some of the items in SOS are as follows: "The activities conducted in the laboratory enabled discussions with my peers for more sustainable knowledge", "I had the pleasure and excitement of being a part of a group thanks to the applications in the laboratory", "I learnt more about science topics than those in the textbooks thanks to the laboratory applications". Reliability coefficient was calculated as 0,94 for SOS. SOS was administered to the research groups as the post-test after completing the laboratory practices.

2.4 Procedure

Science Teaching Laboratory Applications (STLA) course was conducted through Jigsaw method based on cooperative learning in the experimental group and confirmatory laboratory method in the control group. Throughout the procedure, same experiments chosen from the same source book were performed in both groups. Moreover, topic titles handled in theoretical lessons were the same for both groups. STLA course was performed for 15 weeks according to Physics, Chemistry and Biology contents, and th experiments determined for these fields. The activities for these three fields were carried out in separate weeks. Physics, Biology and Chemistry content were respectively taught via Jigsaw and confirmatory laboratory method.

Laboratory Practices through Jigsaw Method

For Physics, Biology and Chemistry fields of STLA course, five sub-topic titles for each were identified. By taking the number of student teachers in the experimental group (N=25) and the number of sub-topic titles into account, five Jigsaw groups with five people were formed. Same groups had tasks for each application in Physics, Biology and Chemistry fields. These Jigsaw groups were coded through the "JG" symbol and the letters in an alphabetical order, and they are shown in Figure 1. While forming the groups, the student teachers in the experimental group were sorted according to their general academic averages. By taking student teachers' general academic achievements into consideration, in terms of academic echievement, each group was made heteregenous and there was homogeneity among the groups. These groups were given a form that includes their personal information, member codes and a colour to symbolize the group. These forms also involved some information about the course content and the experiments that will be conducted throughout the semester. The student teachers in Jigsaw groups were informed about their tasks and responsibilities during the course, which activities they were supposed to carry out and how Jigsaw technique of cooperative learning was performed. Next, all the groups were asked to find and bring information about the contents of the course from all the possible sources till the next class. In the following class, each group member of each JG took the responsibility of a topic. After sharing the topics in Jigsaw groups, each group member took the related part of the materials that would be prepared by doing research out of the class.

Student teachers taking the same topics in Jigsaw groups came together and formed expert groups. With the same method, five Expert Groups consisting of five members were set up. These Expert Groups were shown in Figure 1 by using the "EXP-G" symbol and number codes. The student teachers in the expert groups were charged for searching their topics in a detailed way, learning the topics and teaching their expertise areas to other group members when they go back to their prior groups formed in the beginning. Expert groups conducted their research and learning activities in and out of class hours. The actions of expert groups were tracked by the professor in class hours, support was given when the groups needed and they were guided. Thus, the student teachers in all the groups became the experts of their own topics. After expert groups completed the theoretical part of their work, each expert group was asked to perform the experiments in the course book that wer related to their expertise area. Expert groups completed their work by preparing reports that included both theoretical information about their expertise topic and the application procedures of the experiments conducted.

When the tasks were fulfilled in the expert groups, each student teacher went back to their Jigsaw group. In this way, Jigsaw groups had expert group members who had both the theoretical knowledge and practice experience for each topic of the course. Each member in Jigsaw groups taught their own expertise topics to other group members in and out of class hours. Moreover, they shared application procedures of the experiments they carried out about their expertise topic with their group members. By going through the same procedure in all the Jigsaw groups, the group members learnt the theoretical knowledge within the context of the course and got ready for the experiments that would be performed. Then, Jigsaw groups conducted the experiments for two hours by turns. The groups prepared experiment reports for each topic by using the observation findings and the data obtained through experiments. The applications conducted in the fields of Pysics, Chemistry and Biology through Jigsaw laboratory approach based on cooperative learning were completed in 5 weeks (20 class hours). In each application, 2 hours of the class hours were allocated for the activities in the first Jigsaw groups, 4 hours for the Expert group activities, 4 hours for the second Jigsaw group activities and 10 hours were spent for experiments.

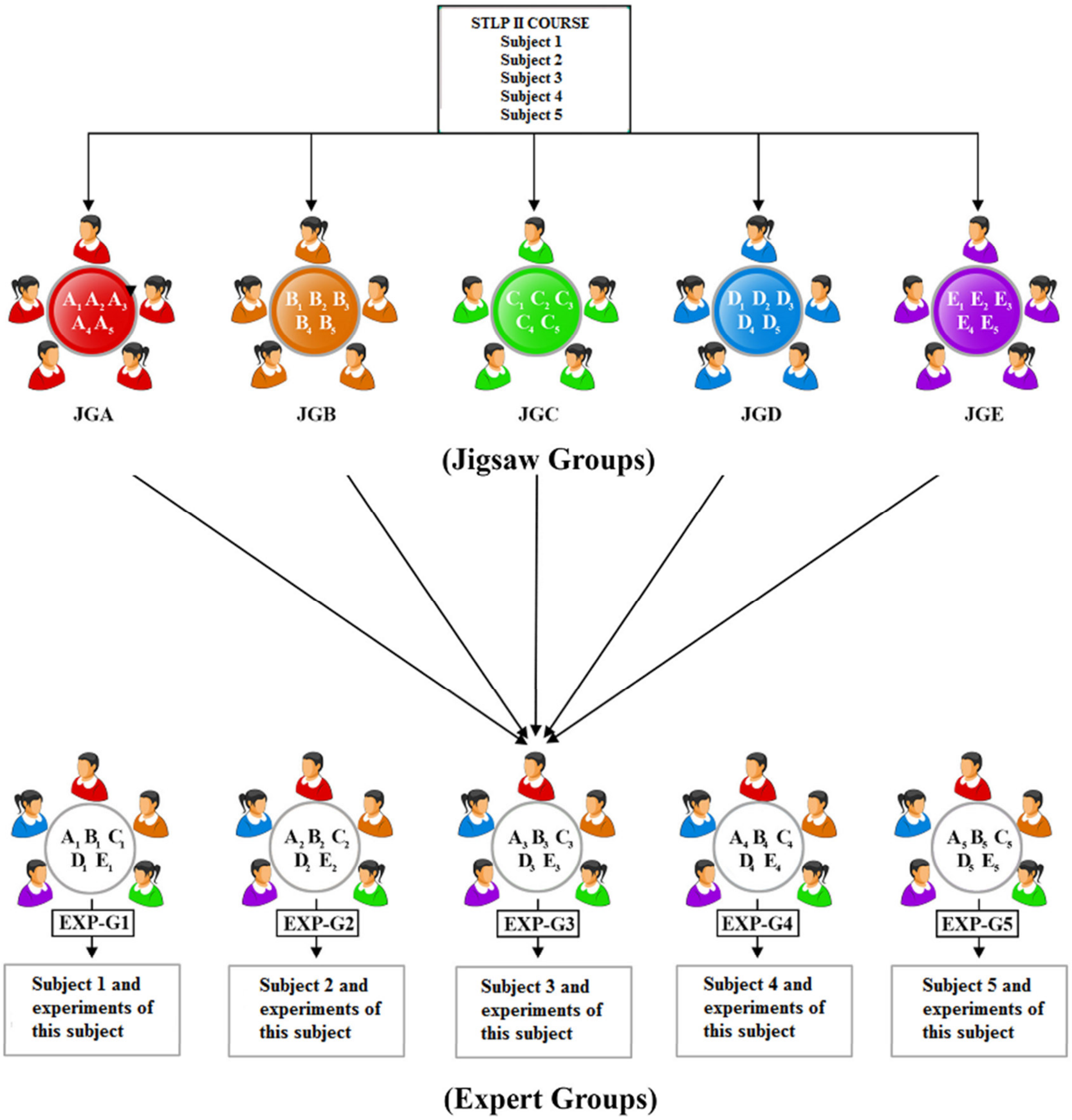

Figure 1. Working order in cooperative groups

Confirmatory Laboratory Approach

In the control group where confirmatory laboratory approach was applied, SELA course was conducted in two phases. While theoretical information about the course content was presented in the first phase, experiments in the practice aspect were conducted in the second phase. The topics in the first phase of the course were presented by the professor through narration according to previously prepared lecture notes. During the presentations, examples were provided to the students, they were asked to give examples, questions were asked and their responses were taken. The formulas, numerical operations and drawings regarding the topics were transferred to the student teachers by using a writing board. Student teachers asked questions to the professor about the topics and concepts that they did not understand or they wondered. The professor informed the student teachers by answering the questions, revising or using various viewpoints. Following the completion of professor's presentations, student teachers were given the page numbers of the experiment book that included the experiments that would be conducted in the application procedure, and they were asked to get prepared for the next lessons. Student teachers started to do the experiments which were planned and prepared by the professor about the topics on the fields of Physics, Chemistry and Biology. The equipment that would be used for the experiments in the course content was placed on separate experiment tables. The student teachers in the control group (N=23) formed five groups, two groups with four people and three groups for five people. Group members were ensured to work together till the experiments were completed. The groups performed the experiments in each table for two class hours. Each group conducted a different experiment at the same time. In the next class, all the experiments on five tables were carried out by changing the experiment tables according to topic number. After completing the experiments on each table, the groups prepared individual reports about these experiments until the next class. Each of the applications done in the fields of Physics, Chemistry and Biology of the course took up 5 weeks (20 class hours). While the half of the class hours for each field (10 class hours) was allacoted for theoretical work, the other half was for the experiments.

2.5 Data analysis

Descriptive statistics regarding the scores of SPST pre-test and post-test and SOS pos-test were computed. As SPST pre-test scores of the research groups were taken as the common variable, covariance analysis (ANCOVA) was used for the SPST pos-test scores. Independent samples t-test was employed for SOS post-test scores of the participants. The responses of the participants given for the open-ended questions in SOS were analyzed descriptively.

3. Results

This section includes the findings regarding the scientific process skills of the participants and their opinions about the techniques used in the treatment procedure.

3.1 The Findings regarding the Scientific Process Skills of the Groups

Descriptive statistics of the SPST pre-test and post-test scores are given in Table 1.

Table 1. Descriptive statistics of the SPST pre-test and post-test scores

Variable	Group	N	X	SS
SPST pre-test	Control	23	19,09	5,57
	Experimental	25	22,20	5,12
SPST post-test	Control	23	24,65	4,58
	Experimental	25	30,00	2,58
The highest score that can be taken in SPST is 36.				

According to Table 1, it is clear that average SPST pre- and pos-test scores of the participants in the experimental group were higher than those of the control group. Independent samples t-test was used to find out whether there is a significant difference between the average SPST pre-test scores of the groups. The analysis showed that there was a significant difference between the average SPST pre-test scores of the control and experimental groups (t=2,019; p=0,049). Considering that the difference between the levels of the scientific process skills of the groups prior to the treatment may have an effect on the scientific process skills after the treatment, the correlation between the SPST pre- and post-test scores was calculated. Pearson correlation analysis findings indicated that there was a moderate positive correlation between the SPST pre- and post-test scores of the student teachers (r=0,387; p<0,01; N=48).

Taking the SPST pre-test scores as the common variable, covariance analysis (ANCOVA) was done for the SPST post-test scores to see the effect of SPST pre-test scores on the SPST pos-test scores, and the findings are given in Table 2.

Table 2. ANCOVA results of the SPST post-test scores

Source	Type III Sum of Squares	df	Mean Square	F	p
SPST pre-test	49,137	1	49,137	3,865	,055
Groups	1600,474	2	800,237	62,947	,001
Error	572,080	45	12,713		
Total	37099,000	48			

As can be seen in Table 2, there is a statistically significant difference between the average SPST post-test scores of the control and experimental groups (F(1,45)=62,947; p=0,001). The analysis of the average SPST post-test scores revealed that the difference was on the favor of the experimental group ($X_{Experimental}$= 29,711; $X_{Control}$= 24,966).

3.2 The Findings regarding the Opinions of the Groups on the Techniques Used for the Treatment

Descriptive statistics of the SOS scores of the groups were calculated, and the findings of the independent samples t-test for the SOS scores are given in Table 3.

Table 3. Descriptive statistics and t-test results of the SOS scores

Grup	N	X	SD	t	p
Control	23	50,00	13,122	1,276	0,208
Experimental	25	54,92	13,540		
The highest score that can be taken in SOS is 80.					

As it is clear in Table 3, average SOS scores of the student teachers in the experimental group were higher than those in the control group. However, independent samples t-test, which was done to see whether there was a statistically significant difference between the average SOS scores of the groups, showed that no statistically significant difference existed between the average SOS scores of the control and experimental groups (t=1,276; p=0,208).

The responses given to the SOS open-ended question, which was asked for additional positive or negative comments about the teaching procedure of STLA course, were analyzed descriptively through document analysis. The utterances of the student teachers and their frequencies are given in Table 4 for the experimental group and Table 5 for the control group.

Table 4. The opinions of the experimental group student teachers on teaching-learning procedure

General expressions describing student opinions	f
Narrating the topics to each other and our discussions allowed information exchange.	2
We had a more fruitful work in the first groups, yet it was not the same in the second groups.	1
All the group members were devoted and participating.	2
I could make up my lack of information about the experiments and topics thanks to my group friends.	3
It was fruitful that each member of the group studied a different topic and taught	2
We had more detailed information about the topics as there was an expert in each topic.	1
During group work, I realized that I had lack of prior knowledge.	3
I could teach my topic to my group members well.	1
I think I was successful at my topic.	2
I had very good relations with my friends.	1
I did not get much from my friends.	3
The fact that some of my group members did not prepare well for their topics affected my learning in a negative way.	5
I prefer studying alone.	3
All of us could not participate in all the experiments as the group members conducted the experiments in their own expertise.	2
We did not have a fruitful work as our group members were not competent enough in their own expertise topic and experiments.	2
It was fruitful in terms of doing research, teaching-learning the topics and practice.	1
I feel myself more equipped thanks to these work.	1
It was very helpful for us to study the topics prior to the experiments.	1
These activities were also useful for both the experiment skills and content knowledge.	1
It was helpful that the teacher made up our deficiencies.	4
The activities and experiments we conducted were effective in our learning.	3
The experiments helped us to concretize the abstract knowledge.	1
The laboratory environment was appropriate for our work.	5
Lack of time affected our work in a negative way.	5
We got bored of the high number of the experiments, and this affected our learning badly.	9
While conducting the experiments, the professors should have helped us more.	1
We got bored as we conducted some of the experiments in the previous laboratory courses.	5
The experiments were easy for our level. We needed more complicated experiments.	3

Table 4 indicates that the student teachers in the experimental group shared their opinions about the practices carried out through Jigsaw technique such as the positive effect of having an expert in each group on learning, the positive effect of group work on knowledge acquisition and the harmonious work of the group members. Moreover, the student teachers stated that they became aware of the lack of knowledge in the activities they conducted with their friends.

Some of the student teachers in the experimental group expressed that although they fulfilled their responsibilities, the fact that other group members did not appropriately complete their tasks affected other group members' learning negatively. Some students stated that they tended to do the experiments in a way preventing the participation of others for the topics that they studied in their expert groups.

The student teachers in the experimental group imported that cooperative laboratory practices based on Jigsaw method provided important attainments in terms of both subject area knowledge and experiment experience. Some student teachers also emphasized the importance of teacher support in laboratory practices.

The experimental group student teachers pointed out that the laboratory environment was appropriate for the practices. Yet, some student teachers told that they got bored when the experiments conducted were similar to those conducted in the laboratory applications at previous grades. Some others delivered the opinion that the experiments were easy to conduct and they needed to do more complex ones. The student teachers in the experimental group expressed that the high number of the experiments and time inadequacy affected their learning in a negative way.

Table 5. The opinions of the control group students on teaching-learning procedure

General expressions describing student opinions	f
Working in groups in the laboratory was effective in learning the topics.	2
These activities motivated us to do research and learn.	1
We found the opportunity to discuss our knowledge no matter it is right or wrong.	2
We worked neatly and harmoniously as a group in the laboratory, our work was fruitful.	6
The activities in the laboratory enabled me to concretize the abstract knowledge in my mind.	1
In the activities we carried out in the laboratory, I became aware of my lack of knowledge and eliminated this deficiency.	4
We could exactly learn the expected concepts by performing eas science experiments.	1
We found the opportunity to acquire new knowledge thanks to the activities we performed in the laboratory.	2
Learning about the topics before conducting the experiments enabled us to perform the experiments more easily.	2
Working in groups in the laboratory improved our friendship relationships.	2
Our work was fun, enjoyable and informative.	2
We were glad that our friends were interested and responsible in the group work in the laboratory.	2
Laboratory practices increased my interest and willingness to the course.	1
Our group members' not workin harmoniously reduced our motivation.	4
Participating in the laboratory practices enabled me to see myself as a part of a task.	1
The experiments we conducted were easier than our topics.	6
We got bored of the high number of the experiments and this affected our learning in a negative way.	8

The student teachers in the control group stated that the group work based on confirmatory laboratory method was effective in learning the topics through discussion and research. The student teachers told that they found the opportunity to notice and eliminate their lack of knowledge through the activities, and learning about the topics before performing the experiments facilitated the practices. Moreover, the student teachers imported that the activities carried out in the laboratory were fun, enjoyable and informative, they conducted the activities in harmony and with a sense of responsibility, and these activities improved their friendship relations and increased their interest and willingness towards the course and learning. However, the student teachers expressed the fact that some group members were not in harmony with the other members affected their work negatively. Also, they viewed the high number and the simplicity of the experiments as drawbacks.

4. Conclusion and Discussion

The statistical analysis of the current study indicated that the effects of laboratory approach based on Jigsaw method were higher than those of the confirmatory laboratory practice on the development of student teachers' scientific process skills. It was found out that there was no statistically significant difference between the opinions of student teachers regarding the applied laboratory approaches. The responses given to the open-ended question in SOS by the student teachers were evaluated descriptively through document analysis. Based on the opinions of the student teachers in the experimental group regarding the teaching procedure of the course, it was concluded that having an expert in each group for each topic or unit had a positive impact on students' learning. However, as in all the group work activities, some student teachers' not doing their job properly affected other student teachers' learning badly. It was deduced from the findings of the written interview that the activities carried out through Jigsaw method enabled student teachers with significant attainments in terms of knowledge, skills and emotions. The student teachers in the control group where the confirmatory laboratory method was employed mostly expressed that the interactive working environment as a result of the activities done in the laboratory and the group work had positive effects on learning in cognitive and affective areas. The findings of the current research are supported by those of science teaching research in the area of laboratory teaching and cooperative learning. In their study, Yadav and Mishra (2013) found out that the scientific process skills development of learners through laboratory approach was higher. It is concluded as a result of the findings that the laboratory approach is more useful for the learners. Therefore, laboratory approach is offered for educators in learning and teaching science. Adesoji, Omilani and Nyinebi (2015) investigated the effect of cooperative learning strategies on the chemistry achievement of students. Based on their findings, the researchers confirmed that cooperative learning strategy is effective in enhancing the chemistry achievements of the students. Tran (2016) came up with the finding that cooperative dicussions improved the learners' skills of information exchange and sharing. The findings of the study revealed that the learners studying through Jigsaw technique found this technique more cooperative, more student-centered and less teacher-centered than teaching through traditional methods. The same study also proved that students at tertiary level believed that they understood the topics in the course deeply and learnt more when they were involved in cooperative learning activities by making explanations to and taking explanations from other people. Zhan and Georgia (2011) ascertained that the activities via Jigsaw technique made students more active learners, and these activities were more interesting for the students than a traditional class.

Within the context of this research, the main topics of Physics, Chemistry and Biology areas of STLA course and the experiments that can be conducted in Science courses of the secondary schools were identified. More than one experiment for the basic topics in each area was determined and conducted. However, the student teachers in both groups expressed that the high number of the experiments, the simplicity of the experiments and the lack of time affected their learning in a negative way. As the student teachers imported, the experiments did not take too much time to get prepared and to collect data since they were easy experiments. The reason for taking this situation as a drawback may be the fact that the student teachers conducted more complicated experiments for each topic in the laboratory applications of the courses of General Physics, General Chemistry and General Biology in the previous grades of their tertiary education, and the number of the experiments was low. For this reason, it would be useful to make more careful choices in terms of the number of the experiments and experiment procedures for the future studies. The drawbacks of the group work conducted through both the Jigsaw method and confirmatory laboratory approach have also been pointed out in the previous studies. Gillies and Boyle (2010) investigated the opinions of secondary school teachers applying the cooperative learning in their courses. The participating teachers stated that they encountered some problems in class practices of the cooperative learning although they had positive experiences with the approach. These problems were the time managemenet, necessary preparation issues, and the students' getting socialized during the group work and not studying well. In a study, Herrmann (2013) examined the effect of cooperative learning on the student participation and the perceptions of undergraduate students regarding the cooperative learning. The findings of the study indicated that some of the students enjoyed being more active in the class and they appreciated the contributions and perspectives of their peers. On the other hand, the students wanted their teachers to have more control in the classes. Some students preferred teacher narration to having to listen to the non-educational explanations from their peers.

The findings of the current study revealed that the use of laboratory approach based on Jigsaw method for both the theoretical and practice aspects of science courses provided important attainments for learners in knowledge, skills and affective domains as well as the development of learners' scientific process skills. Based upon these findings, it is suggested that science teachers and educators can employ Jigsaw technique built on cooperative learning by integrating it into laboratory practices. In this way, they can contribute to the development of learners' cognitive skills.

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