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Preservice Classroom Teachers' Applications of Science Experiments with Cooperative Learning Model: A Mixed Design Research[1]

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Abstract

This study aimed to determine the effect of a cooperative learning model (CLM) on preservice classroom teachers' attitudes towards science experiments. The sample consisted of 45 students in the department of primary education of the faculty of education of a public university in the 2017-2018 academic year. The sample was divided into two groups: experimental (n=24) and control (n=21). The experimental group received an education based on a CLM, while the control group received an education based on the conventional method specified by the curriculum. The study employed a mixed research design and consisted of two parts: quantitative and qualitative. In the quantitative part, an semi-experimental pretest-posttest control group design was used. In the qualitative part, phenomenology was used. The quantitative data were collected using the Scale of Attitudes Towards Science Experiments (SATSE) and analyzed using a t-test. The qualitative data were collected using an interview questionnaire and analyzed using content analysis. The experimental group had a significantly higher mean SATSE score than the controls. The experimental group also had a higher mean posttest than pretest SATSE score, which was statistically insignificant. The control group had a significantly lower mean posttest than pretest SATSE score. Content analysis showed that the CLM improved some participants' attitudes towards science experiments. They were more interested in science experiments and enjoyed participating in them more, and believed that the CLM made science experiments fun and easier to understand. However, some other participants stated that the CLM did not affect their attitudes towards science experiments.

Keywords: Cooperative Learning Model, Science Experiments, Science Laboratory, Preservice Classroom Teachers.

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Introduction

The primary goal of education is to turn students into people equipped with 21st-century skills. Today, making sense of knowledge and putting it into practice is more important than just having it (MoNE, 2017). Given the implications of applied science on social life, we can see how important science learning and teaching today is. Students who receive high-quality science education are more likely to understand science concepts, catch up with scientific advances, and use scientific methods to solve everyday problems (Hançer, Şensoy & Yıldırım, 2003). In and out-of-school educational settings should promote cognitive and mental development to get students to develop scientific skills and put them to use. National and international studies highlight the significance of science learning environments (Çetin & Cengiz, 2021; Hofstein & Lunetta, 2004; Özdemir & Kaptan, 2013). Most studies address the effect of lab use and lab-learning approaches on the quality of science teaching (Karaer, Karademir & Tezel, 2020; Lunetta, 1998; Townsend, 2012; Ulu, 2019). Labs allow students to gain hands-on experience, develop hypotheses, and discuss and test them to solve problems and understand the nature of science (Tobin, 1990). Laboratories are settings where students define problems and develop manual and processing skills. In laboratories, students make observations or acquire abstract perception experiences, turning abstract concepts into concrete questions and grasping the significance of knowledge. Laboratories promote psychomotor skills, make learning fun, facilitate group work, and most importantly, provide learning retention as they allow students to learn by living and doing (Partalcı, Topsakal & Özkan, 2019). Lab classes turn abstract concepts into concrete forms and encourage students to relate science concepts to daily life, construct science knowledge, solve problems scientifically, and collaborate (Baran & Doğan, 2004; Önen ve Çömek, 2011). Lab classes help students develop a wide range of skills at different stages of education. However, the role of lab classes in science teaching has changed throughout history. In the past, science class was based on theoretical knowledge presentation and then demonstration experiments, but today students conduct lab experiments individually or in groups during science class (Baran & Doğan, 2004). Experiment-based science learning refers to the translation of scientific knowledge into everyday experiences. Students question the causes of natural phenomena and propose solutions and experimentally test their accuracy (Annagün & Duban, 2014). Experiments provide first-hand information, make difficult subjects easier to learn, encourage students to question, research, and observe, thus helping them better understand nature. Therefore, students participating in experiments are more likely to develop positive attitudes towards experiments in particular and science in general (Doğan, 2010). Theoretical learning with only mental activities appeals to cognitive or cognitive-affective learning domains while ignoring the motor learning domain. On the other hand, experiments achieve learning in all three domains. Students who do not participate in lab activities cannot achieve psychomotor learning outcomes (Ergin, Pekmez & Erdal, 2012). Therefore, lab activities play a crucial role in science teaching. Teachers are responsible for conducting effective lab activities and teaching students how to use simple lab equipment and benefit from out-of-classroom lab settings. Primary school students learn science from classroom teachers. The Science Teaching Program revised in 2013 stipulates that science education start from the third grade of primary school, allowing students to learn about living things and natural phenomena at an early age through observation and experimentation (Ministry of National Education (MoNE), 2013). Students are exposed to science for the first time in primary school. Therefore, classroom teachers have a great responsibility for science teaching (Genç, Deniş & Demirkaya, 2010). Students can conduct a wide range of experiments with simple everyday life materials in science labs (Önen & Çömek, 2011). However, research shows that preservice teachers know little about how to use lab equipment and conduct experiments. Therefore, before starting out their professional career, preservice teachers should be trained to encourage their students to develop scientific process skills and conduct experiments with everyday life materials (Yu & Bethel, 1991). Preservice teachers should learn how to use labs effectively before they graduate so that they can teach that to their students. This, above all things, depends on their perceptions and attitudes towards labs (Şenler, Karışan & Bilican, 2017) because those with positive perceptions, beliefs, and attitudes towards labs are likely to integrate lab activities more into their teaching (Feyzioğlu et al., 2011). Therefore, if we want to make sure that students can use labs and conduct experiments effectively, we should first help teachers develop positive attitudes towards labs and experiments. Teachers' attitudes affect students' attitudes and performance. Therefore, it is of paramount importance to know about teachers' and preservice teachers' attitudes towards teaching. What is more, students' attitudes affect and are affected by their performance because there is a positive correlation between attitude and academic achievement (Uyanık, 2017; Bozdağ, 2019).

Science experiments allow students to understand difficult subjects easily and learn by doing and living. Therefore, lab activities should be designed in a way that they can promote student engagement, meaningful and permanent learning, and positive attitudes towards experimentation. In this context, cooperative learning models (CLMs) are very useful for getting students to carry out classroom and lab activities (individual or group) with simple equipment. Cooperative learning is a model where small and heterogeneous groups of students help each other learn. Cooperative learning models are used in different cultures, geographies, areas, and levels of education (Dendup & Onthanee, 2020; Garcia, 2021; Han & Son, 2020; Sulfemi & Kamalia, 2020; Van Ryzin, Roseth & Biglan, 2020; Yıldız, Çalıklar & Şimşek, 2020). Cooperative learning is a pedagogical method that helps students interact and collaborate to achieve shared goals, and thus, develop cognitive, affective, and psychomotor skills (Samosa, 2021; Yıldız, Ağgül, Çalıklar & Şimşek, 2020). This was the focal point of this study, which focused on determining the effect of a CLM on preservice classroom teachers' attitudes towards science experiments. We believe that the results will guide future studies and contribute to science and classroom education.

Research Objective

This study aimed to determine the effect of (CLMs) on preservice classroom teachers' attitudes towards science experiments. The study sought answers to the following subquestions:

Is there a significant difference in pretest scores between the experimental and control groups?

Is there a significant difference between pretest and posttest scores for the experimental group?

Is there a significant difference between pretest and posttest scores for the control group?

Is there a significant difference in posttest scores between the experimental and control groups?

How does the experimental group think the CLM affects their attitudes towards science experiments?

Method

Research Model

The explanatory sequential design was the mixed research design of choice in this study to ensure that participants understood the research questions. The explanatory sequential design consists of two stages: qualitative and quantitative (Creswell & Plano-Clark, 2015). In the first stage, quantitative data are collected, and statistical tests are used to overview the subject of interest. In the second stage, qualitative data are collected and analyzed based on quantitative results. The qualitative data helps the researcher explain and enrich the quantitative data (Creswell, 2009). Figure 1 shows the path diagram of the design.

Figure 1. Explanatory Sequential Design

The quantitative stage employed an semi-experimental pretest-posttest control group design, in which participants' scores are measured before and after an experiment concerning the same dependent variable. Participants are divided into two groups: experimental and control (Karasar, 2005).

The qualitative stage employed phenomenology, which seeks answers to the question, "What is the truth? Phenomenology is used by researchers interested in how people experience a phenomenon or a situation and what meaning they attribute to it. Phenomenology is a descriptive form of research in which defining facts is more critical than generalizing (Akturan & Esen, 2008). In this study, the experimental group participants were interviewed after the CLM. Interviews were held with volunteer participants (n=22).

Participants

The sample consisted of 45 second-year students (30 women and 15 men) of the department of primary education of the faculty of education of a public university in the 2017-2018 academic year. The sample was randomized into two groups: experimental (n=24) and control (n=21). Participants were recruited by the researcher using convenience sampling within the scope of the "Science Laboratory Activities" course.

Data Collection Tools

Quantitative data were collected using the Scale of Attitudes towards Science Experiments (SATSE) developed by Yıldız, Aydoğdu, Akpınar, and Ergin (2007). SATSE consists of 19 items scored on a five-point Likert-type scale. It has an item-total score correlation coefficient of .33 to .88, an internal consistency coefficient of.91 to .94., and a Cronbach's Alpha of .92, indicating high reliability.

Qualitative data were collected through individual semi-structured interviews to determine how participants thought the CLM affected their attitudes towards science experiments. In the interviews, they were asked, "How did the CLM affect your attitudes towards science experiments?" followed by probe questions for clarification and elaboration when needed.

Data Analysis

In the quantitative stage, the Shapiro–Wilk test was used for normality testing. The results showed that the data were normally distributed, and therefore, were analyzed using a t-test (Büyüköztürk, 2010). Tables 1 and 2 show the normality results for the experimental and control groups, respectively.

Table 1. Normality Testing for Experimental Group SATSE Pretest and Posttest Scores

Experimental group	n	Shapiro- Wilk	X	df	sd	Skewness	Kurtosis
Pretest	24	.098	3,07	23	.329	-.684	-.400
Posttest	24	.309	3,24	23	.257	-.684	-.400

The SATSE pretest and posttest scores of the experimental group were normally distributed (S-W=.098, sd=.329 and p>.05; S-W= .309, sd=.257 and p>.05) (Table 1), and therefore, were analyzed using a t-test.

Table 2. Normality Testing for Control Group SATSE Pretest and Posttest Scores

Control group	n	Shapiro- Wilks	X	df	sd	Skewness	Kurtosis
Pretest	21	.778	3.24	20	.282	.358	.035
Posttest	21	.147	3.04	20	.159	.-758	.282

The SATSE pretest and posttest scores of the control group were normally distributed (S-W=.778, sd=.282 and p>.05; S-W= .147 sd=.159 and p>.05) (Table 2), and therefore, were analyzed using a t-test.

The qualitative data were analyzed using content analysis. The interviews were transferred to a computer and made ready for analysis. The researcher and an expert read them multiple times and then coded them. Concepts were determined based on the interviewees' views on the effects of the CLM on their attitudes towards science experiments. This allowed the researcher to see how many interviewees reflected on the same concepts. After coding, a code list was created to determine the shared aspects of the codes, and then, themes were developed to outline the results. In qualitative research, reliability is the consistency between codes developed by multiple researchers (Creswell, 2013). The codes were compared, and those that did not match were classified into corresponding categories or were eliminated. Direct quotations were used to provide an accurate and coherent picture of the interviewees' views and to increase the reliability of the study (Yıldırım & Şimşek, 2011). The themes were defined and interpreted in the "Results" section.

Experimental Process

This section addressed the applications carried out in the experimental and control groups during the research process.

Procedure in Experimental Group

The experimental group was informed about the purpose, content, and procedure prior to the learning together method which is the one of the CLM. Afterward, they took SATSE as a pretest. The whole process lasted 12 weeks (one experiment each week). The experimental group participated in learning together method experiments two hours a week for 12 weeks (48 hours in total). The experiments were as follows:

1. The reflection of sound and light waves
2. The image in the mirror
3. Heat and temperature
4. Acids and bases
5. Magnetism
6. Separating mixtures
7. Buoyancy, floating-sinking
8. Changes of state
9. Force and motion
10. Electricity
11. Pressure
12. Germination

The experimental participants were divided into six groups of four before the experiments. The groups were randomly assigned tasks, such as doing research about the experiments and providing materials. The participants in learning together group were randomly assigned roles; an observer (motivating group members for participation and high performance and taking observation notes), a supplier (procuring materials), a recorder (writing down experimental outcomes on a piece of paper), and a spokesperson (communicating with other groups and informing the teacher of in-group problems). They conducted the experiments according to the instructions. All participants did research on the same topic and fulfilled the duties assigned to them. For evaluation, a randomly selected group explained the subject assigned to them and conducted the related experiment, and then presented a report to the class. Another group selected by the teacher asked one or all group members questions about the subject. The groups took notes in each class. The in-group roles were reassigned every week. The experimental group completed SATSE (posttest) and was interviewed after the experiments. Figure 2 shows procedure in experimental (learning together) group.

Figure 2. Research Process for the Experimental Group

Procedure in Control Group

The control group was informed about the purpose, content, and procedure prior to the CLM. Afterward, they took SATSE as a pretest. The whole process lasted 12 weeks (one experiment each week). The control group participated in the CLM two hours a week for 12 weeks (48 hours in total). They conducted the same experiments as the experimental group and covered classes as specified by the curriculum.

The participants were divided into five groups of four and five (one group) at their request at the beginning of the procedure. They conducted the experiments according to the instructions. During the experiments, the teacher walked around and answered questions and offered assistance when needed. Participants drew up reports on the experiments and handed them over to their teachers the following week. Their performance was evaluated based on those reports. They completed SATSE (posttest) after the experiments. Figure 3 shows procedure in control group.

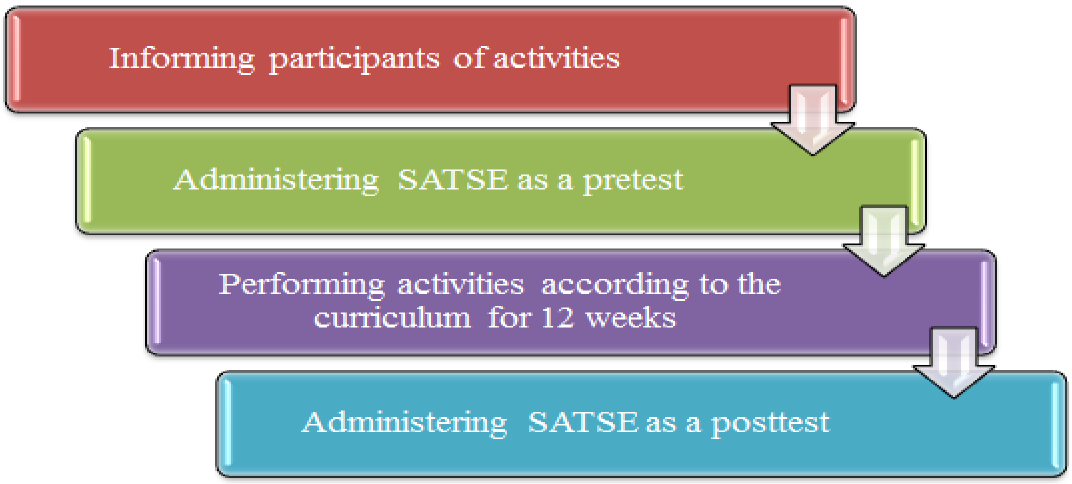

Figure 3. Research Process for the Control Group

Results

This section addressed the results of the qualitative and quantitative analysis.

Quantitative Results

A t-test was used to answer the first research question. Table 3 shows the results.

Table 3. SATSE Pretest and Posttest T-Test Results for Experimental Group

Experimental group	n	X	ss	sd	t	p
Pretest	24	2.73	.371	23	-1.280	.213
Posttest	24	2.88	.462			

There was no statistically significant difference between SATSE pretest and posttest scores for the experimental group (t=-1.280 and p>.05) (Table 3).

A t-test was used to answer the second research question. Table 4 shows the results.

Table 4. SATSE Pretest and Posttest T-Test Results for Control Group

Control group	n	X	ss	sd	t	p
Pretest	21	2.76	.220	20	2.714	0,213
Posttest	21	2.63	.242			

The control group had a significantly lower mean posttest than pretest SATSE score (t=2.714 and p<.05) (Table 4).

A t-test was used to answer the third research question. Table 5 shows the results.

Table 5. SATSE Pretest T-Test Results for Experimental and Control Groups

Groups	n	X	ss	sd	t	p
Experimental	24	2.73	.371	44	-.351	.727
Control	21	2.76	.220			

There was no significant difference in mean SATSE pretest scores between the experimental and control groups (t= -.351 and p>.05).

A t-test was used to answer the fourth research question. Table 6 shows the results.

Table 6. SATSE Posttest T-Test Results for Experimental and Control Groups

Groups	n	X	ss	sd	t	p
Experimental	24	2.88	.462	44	2.271	.028
Control	21	2.63	.242			

The experimental group had a significantly higher mean SATSE posttest score than the control group (t= 2.271 and p<.05) (Table 6).

Qualitative Results

The experimental group participants (n=22) were interviewed to seek answers to the fifth research question. Figure 4 shows the results.

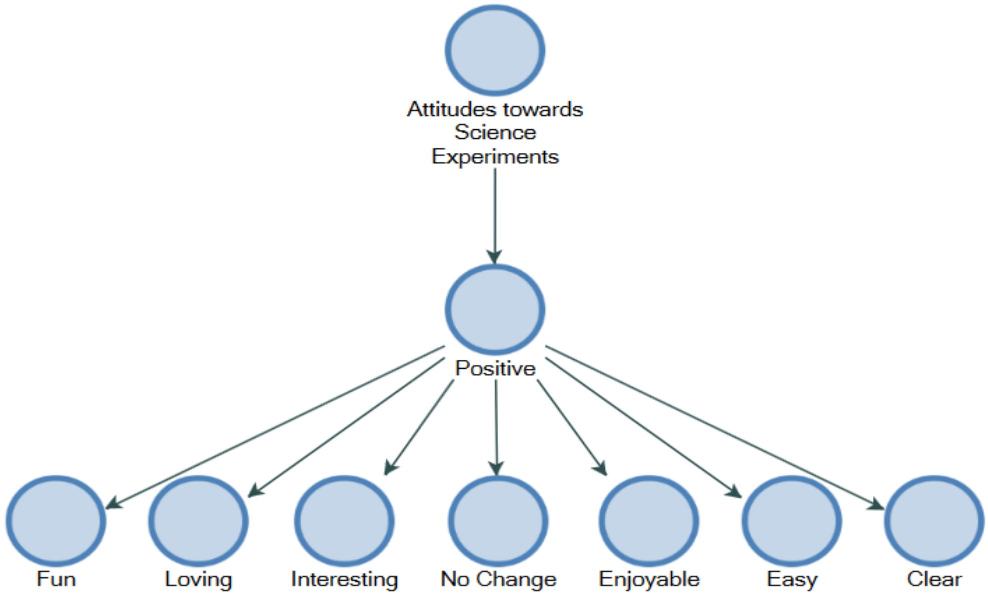

Figure 4. Participants' Attitudes towards Science Experiments

The interviewees' attitudes towards science experiments were grouped under the theme of "positive," which consisted of the codes of "Easy (f=5)," "Loving (f=5)," "Fun (f=4)," "Interesting (f=3)," "Enjoyable (f=2)," "Clear (f=2)," and "No change (f=6)" (Figure 4). The following are direct quotations from interviewees (pseudonyms):

Filiz: We shared the materials, which made the whole thing cheaper. We did the experiments after collecting theoretical information. It helped us better understand the experiments. Plus, everybody knew what they were supposed to do, so we could work together.

(Positive, clear)

Aygül: It helped me express myself and feel comfortable around my groupmates and see my own shortcomings. I love teamwork and experiments better now.

(Positive, loving)

Ibrahim: The point of this method is getting us to do research. I was not that interested in and did know much about the subjects I was searching for, so the experiments helped me learn about them. Science experiments are fun, so I will do the same with my students in the future.

(Positive, interesting, fun)

Zerrin: I wouldn't understand the experiments at all, If I was the only one doing them. I did them with four classmates in learning together group, which made it easier for me to learn and achieve learning retention

(Positive, easy, clear)

Davut: We helped each other and had different responsibilities during the experiments. We all observed the experiments and tried to reach a consensus. However, it didn't change my attitude towards experiments because I already love science experiments.

(Positive, no change)

Discussion, Conclusion and Recommendations

This study investigated the effect of a cooperative learning model (CLM) on preservice classroom teachers' attitudes towards science experiments. The results were discussed in the light of the literature.

Before the procedure, all participants completed the scale of attitudes towards science experiments (SATSE) as a pretest. Their prettest scores were analyzed using a t-test. There was no statistically significant difference in mean SATSE pretest scores between the experimental and control groups, indicating that all participants had similar attitudes towards science experiments before the procedure.

The experimental group participated in the learning together method. Their mean SATSE pretest and posttest scores were analyzed using a t-test. However, the results showed no significant difference between their scores, indicating that the learning together method did not significantly affect the participants' attitudes towards science experiments. Although not statistically significant, the learning together method slightly improved the participants' attitudes towards science experiments. This is due to the critical properties of learning together method. During the experiments, the tasks were carefully distributed and then redistributed each week, which reduced the participants' workload and strengthened the bond between them, allowing them to do the experiments more easily. This led to a slight improvement in their attitudes towards science experiments. The participants did research on the subjects of the experiments and informed their groups about them beforehand. Altıparmak and Nakipoğlu (2002) also found that CLMs improved students' biology lab performance but did not change their attitudes towards science experiments. Taşdemir (2004) reported that CLMs made students academically more successful but did not improve their attitudes towards science experiments. These results support ours. Yapıcı, Hevedanlı, and Oral (2009) compared the effects of CLMs and conventional methods on students' lab performance and attitudes. They determined that CLMs made students more successful, with little improvement in their attitudes towards science experiments.

The control group's mean SATSE pretest scores were analyzed using a t-test. They had significantly lower posttest than pretest scores, indicating that the activities based on the current curriculum negatively affected their attitudes towards science experiments. This may be because the control group could not build a strong bond and failed to get organized during the activities, resulting in a few participants doing most of the work. This might have negatively affected their attitudes towards science experiments. Besides, the control group did not do much research on the subjects, which may also have negatively affected their attitudes towards science experiments.

The experimental and control groups' mean posttest SATSE scores were analyzed using a t-test. The results showed that the experimental group had significantly higher scores than the controls, indicating that the CLM was better at improving the participants' attitudes towards science experiments than the current curriculum, which is also supported by the qualitative results. In the interviews, most participants stated that the CLM positively affected their attitudes towards science experiments in various ways. However, others stated that the CLM did not significantly change their attitudes because science experiments helped them understand abstract science concepts or because they already loved and were interested in science experiments and found them enjoyable and entertaining. The participants shared responsibility in the CLM activities, which reduced their workload and helped them conduct the experiments easily. Therefore, they loved science experiments better thanks to the CLM activities. Exchanging information, learning from each other, and correcting incomplete or inaccurate information made the experiments easier to understand. Interaction, naming the group, and reassigning the tasks weekly made the science experiments more fun for the participants. Sontay and Karamustafaoğlu (2018) argue that students who collaborate to conduct science experiments are likely to share, organize, interact, and collaborate more. Positive commitment (the group fails if one of the group members fails), an indispensable component of cooperative learning, made the participants more eager to do the experiments. Townsend (2012) notes that students should be encouraged to conduct interesting and cost-effective experiments that can be conducted with easy-to-access materials. Research shows that students who interact and collaborate during lectures help each other learn without even knowing that they do (Arslan & Zengin, 2016; Doymuş, Şimşek & Bayrakçeken, 2004; Güvenç & Açıkgöz, 2007). The experimental group had higher SATSE scores than controls, probably because CLMs support social and emotional development (Şimşek, Şimşek, & Doymuş, 2006). There is no published research examining the effect of learning models on preservice classroom teachers' attitudes towards science experiments. Most studies examine teachers' or students' attitudes towards science, physics, chemistry, and biology laboratories or focus on their perceptions and views on science experiments (Çil & Çalışoğlu, 2020; Genç et al., 2010; Sezen Vekli, 2018; Şenler, Karışan & Bilican, 2017). However, earlier studies have reported results similar to ours (Collison, 1993; Foley & McPhee, 2008; Lang, Wong & Fraser, 2005; Önen & Çömek, 2011; Townsend, 2012). Yıldız, Akpınar, Aydoğdu, and Ergin (2006) found that science teachers had positive attitudes towards the goals of science experiments. They also determined that teachers considered science experiments important because they appealed to senses, facilitated learning and cooperation, and helped them develop manual, observational, and reasoning skills. According to Kaya and Böyük (2011), students have positive attitudes towards science experiments because they regard them as exciting and useful activities that promote collaboration and learning retention. Our participants also stated that they found the science experiments more interesting and fun after the CLM. Çil and Çalışoğlu (2020) argue that students love applied science courses better than theoretical ones. Our participants also stated that they started to like science experiments after the CLM.

This study will contribute to the literature given that science experiments do not necessarily have to be conducted in a lab, but they can also be conducted in a classroom.

This study looked into the effect of a CLM on preservice classroom teachers' attitudes towards science experiments. The first result was that the CLM was better at improving preservice classroom teachers' attitudes towards science experiments than the current curriculum. Therefore, CLMs should be integrated into both lab and classroom activities. Future studies should focus on the impact of different CLMs on preservice classroom teachers' academic performance, perception, vision, cognitive, and social skills. Future studies should also investigate the effects of CLMs on primary school students' attitudes towards science experiments. Encouraging preservice classroom teachers to conduct undergraduate experimental activities with primary school students can make them more successful in professional life. Classroom teachers should be provided with in-service training on conducting science experiments in labs and when there is no lab to conduct experiments in. The primary school curriculum should offer more experiments that can be done with simple equipment.

Limitations

This study is limited to the answers given to the scale and interview questions of pre-service classroom teachers and pre-service classroom teachers studying in the 3rd grade of a public university in the 2017-2018 academic year.

References

Akturan, U. & Esen, A. (2008). Fenomenoloji. T. Baş ve U. Akturan (Ed.) içinde, *Nitel araştırma yöntemleri.* Seçkin Yayıncılık.

Altıparmak, M., & Nakipoğlu, M., (2002). Lise Biyoloji Laboratuarlarında İşbirlikli Öğrenme Yönteminin Tutum ve Başarıya Etkisi. *Proceeding of V. National Science and Mathematics Semposium, I,* (40-45).

Annagün, Ş. & Duban, N. (Ed.) (2014). *Fen Bilimleri Öğretimi.* Anı Yayıncılık.

Arslan, A., & Zengin, R. (2016). İşbirlikli öğrenme yönteminin fen öğretimi laboratuar uygulamaları dersine yönelik öğrencilerin tutumlarına etkisi. *İnönü Üniversitesi Eğitim Fakültesi Dergisi*, *14*(2), 37-49. https://doi.org/10.17679/iuefd.17245785

Baran, Ş. & Doğan, S. (2004). Erzurum il merkezindeki liselerin biyoloji laboratuarlarının araç ve gereçleri bakımından durumu. *Erzincan Eğitim Fakültesi Dergisi, 6*(1), 23-33.

Bozdağ, H. C. (2019). 5. sınıf öğrencilerinin fen bilimlerine yönelik motivasyonları, tutumları ve fen başarıları arasındaki ilişki. *Mersin Üniversitesi Eğitim Fakültesi Dergisi, 15*(3), 720-740. https://doi.org/10.17860/mersinefd.592823

Büyüköztürk, Ş. (2010). *Sosyal bilimler için veri analizi el kitabı.* Pegem Yayıncılık.

Creswell, J. W. (2009). *Research design: qualitative, quantitative, and mixed methods approaches.* SAGE Publication.

Creswell, J. W. (2013). *Nitel araştırma yöntemleri: Beş yaklaşıma göre nitel araştırma ve araştırma deseni.* Siyasal Kitabevi.

Creswell, J. W., & Plano-Clark, V. L.(2015). *Karma yöntem araştırmaları: Tasarımı ve yürütülmesi,* Çev. Ed.: Totan, T., Anı Yayıncılık.

Collison, G. E. (1993). *Teacher attitudes toward hands-on science instruction versus traditional teaching methods.* Reports-Research/Technical, Georgia Southwestern College.

Çetin, A., & Cengiz, M., (2021). Laboratuvar Uygulamalarının Dokular Konusunda Fen Bilgisi Öğretmen Adaylarının Akademik Başarılarına ve Tutumlarına Etkisi. *Academia Eğitim Araştırmaları Dergisi*, *6*(1), 37-45. Retrieved from https://dergipark.org.tr/en/pub/egitim/issue/58093/792783

Çil, S. & Çalışoğlu, M, (2020). Sınıf Öğretmenlerinin Fen Bilimleri Dersi "Maddenin Özellikleri " Ünitesinde Deney Yönteminin Kullanılmasına Yönelik Görüşleri. *Ağrı İbrahim Çeçen Üniversitesi Sosyal Bilimler Enstitüsü Dergisi /AİCUSBED),* *6*/1, 451-473. https://doi.org/10.31463/aicusbed.767673

Dendup, T., & Onthanee, A. (2020). Effectiveness of Cooperative Learning on English Communicative Ability of 4th Grade Students in Bhutan. *International Journal of Instruction*, *13*(1), 255-266.

Doğan, Ö. F. (2010). *Okul Öncesi Eğitimde Fen ve Doğa Etkinlikleri Saatinde Öğretmenlerin, Deney Yöntemine Yer Verme Durumlarının İncelenmesi* [Yayımlanmamış Yüksek Lisans Tezi], Selçuk Üniversitesi.

Doymuş, K., Şimşek, Ü., & Bayrakçeken, S. (2004). İşbirlikçi öğrenme yönteminin fen bilgisi dersinde akademik başarı ve tutuma etkisi. *Türk Fen Eğitimi Dergisi*, *1*(2), 103-115.

Ergin, Ö., Pekmez, E. Ş., & Erdal, S. Ö. (2012). *Kuramdan uygulamaya deney yoluyla fen öğretimi* (2.Baskı). Dinazor Yayınevi.

Feyzioğlu, B., Demirdağ, B., Ateş, A., Çobanoğlu, İ., Altun, E., & Akyıldız, M. (2011). Students' views on laboratory applications: Izmir sample. *İlköğretim Online*, *10*(3), 1208-1226.

Foley, B. J., & McPhee, C. (2008). Students' attitudes towards science in classes using hands-on or textbook based curriculum. *American Educational Research Association*, 1-12.

Garcia, M.B., (2021). Cooperative learning in computer programming: A quasi-experimental evaluation of Jigsaw teaching strategy with novice programmers. *Education and Information Technologies 26,* 4839–4856. https://doi.org/10.1007/s10639-021-10502-6

Genç, H., Deniş, H. & Demirkaya, H. (2010). Sınıf Öğretmeni Adaylarının Fen Bilgisi Öğretimi Dersine Yönelik Tutumlarının Çeşitli Değişkenlere Göre İncelenmesi. *Mehmet Akif Ersoy Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 2*, 133-149. Retrieved from https://dergipark.org.tr/en/pub/makufebed/issue/19425/206577

Güvenç H., & Açıkgöz, K. Ü. (2007). İşbirlikli öğrenme ve kavram haritalarının öğrenme stratejisi kullanımı üzerindeki etkileri. *Kuram ve Uygulamada Eğitim Bilimleri*, *7*(1), 95-127.

Han, S. I., & Son, H. (2020). Effects of Cooperative Learning on the Improvement of Interpersonal Competence among Students in Classroom Environments. *International Online Journal of Education and Teaching*, *7*(1), 17-28.

Hançer, A., H., Şensoy, Ö., & Yıldırım, H., İ. (2003). İlköğretimde çağdaş fen bilgisi öğretiminin önemi ve nasıl olması gerektiği üzerine bir değerlendirme. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *1*(13), 80-88.

Hofstein, A., & Lunetta, V.N. (2004). The laboratory in science education: foundation for the 21st century. *Science Education*, *88*, 28-54.

Karaer, G., Karademir, E., & Tezel, Ö. (2020). Proje Tabanlı Öğretimin Fen Laboratuvarı Dersinde Kullanımının Sınıf Öğretmeni Adaylarının Görüşlerine Göre Değerlendirilmesi. *Eğitimde Nitel Araştırmalar Dergisi*, *8*(1), 73-95. https://doi.org/10.14689/issn.2148-2624.1.8c.1s.4m

Karasar, N. (2005). *Bilimsel Araştırma Yöntemi*. Nobel Yayınları.

Kaya, H. & Böyük, U. (2011). İlköğretim II. kademe öğrencilerinin fen ve teknoloji dersine ve fen deneylerine karşı tutumları. *TÜBAV Bilim Dergisi, 4*(2), 120-130. Retrieved from https://dergipark.org.tr/en/pub/tubav/issue/21523/230940

Lang, Q. C., Wong, A. F. L., & Fraser, B. J. (2005). Student perceptions of chemistry laboratory learning environments, student–teacher interactions and attitudes in secondary school gifted education classes in Singapore. *Research in Science Education, 35*, 299–321.

Lunetta, V. N. (1998). The school science laboratory: Historical perspectives and contexts for contemporary teaching. *International Handbook of Science Education*, *1*, 249-262.

Ministry of National Education (MoNE). (2013). *İlköğretim Kurumları (İlkokullar ve Ortaokullar) Fen Bilimleri Dersi (3, 4, 5, 6, 7 ve 8. sınıflar) Öğretim Programı*. Milli Eğitim Bakanlığı.

Ministry of National Education (MoNE), (2017). *Hayat Bilgisi Dersi Öğretim Programı (İlkokul 1, 2 ve 3. Sınıflar)*. Milli Eğitim Bakanlığı.

Önen, F. & Çömek, A. (2011). Öğretmen Adaylarının gözüyle basit araç-gereçlerle yapılan fen deneyleri. *Batı Anadolu Eğitim Bilimleri Dergisi, 1*(3), 45-71. Retrieved from https://dergipark.org.tr/en/pub/baebd/issue/3340/46236

Özdemir, M., & Kaptan, F. (2013). Sınıf öğretmeni adaylarının bilimsel süreç becerileri ve fen öğretimine yönelik tutumlarının incelenmesi. *Karaelmas Eğitim Bilimleri Dergisi*, *1*(1), 62-75.

Partalcı, O., Topsakal, Ü. U., & Özkan, G. (2019). Laboratuvar Etkinliklerinin Öğrencilerin Laboratuvara Karşı Tutumuna Etkisi. *ERPA International Congresses on Education, In Book of Proceedings*, 1-5.

Samosa, R. C. (2021). Cooperative Learning Approach as Innovation to Improve Students' Academic Achievement and Attitude in Teaching Biology. *Journal of World Englishes and Educational Practices, 3*(1), 01-10.

Sezen Vekli, G. (2018). Sınıf öğretmeni adaylarının bilimsel süreç becerilerine dayalı deney tasarlama ve uygulama becerilerinin incelenmesi. *Sakarya University Journal of Education, 8*(3), 128-141. https://doi.org/10.19126/suje.411723

Sontay, G. & Karamustafaoğlu, O. (2018). 'Sıvı basıncı' konusunda basit araç gereçlerle yapılan bir deney etkinliğine ilişkin öğretmen görüşleri. *Journal of Research in Educatıon and Society, 5*(1), 220-246. Retrieved from https://dergipark.org.tr/en/pub/etad/issue/37928/364637

Sulfemi, W. B., & Kamalia, Y. (2020). Jigsaw Cooperative Learning Model Using Audiovisual Media to Improve Learning Outcomes. *JPsd (Jurnal Pendidikan Sekolah Dasar), 6*(1), 30-42.

Şenler, B., Karışan, D. & Bilican, K. (2017). Sınıf öğretmeni adaylarının fen ve teknoloji laboratuvarına yönelik algı ve tutumlarının incelenmesi. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi. 42*, 105-122. https://doi:10.21764/efd.14921

Şimşek, U., Şimşek, Ü. & Doymuş, K. (2006). İşbirlikçi öğrenme yöntemi üzerine derleme çalışması III: İşbirlikçi öğrenme yönteminin eğitim ortamındaki faydaları. *Kazım Karabekir Eğitim Fakültesi Dergisi,13,* 414-437. Retrieved from https://dergipark.org.tr/en/pub/ataunikkefd/issue/2774/37178

Taşdemir, A. (2004). *Fen bilgisi öğretmenliği kimya laboratuvarı dersinde çözeltiler konusunun öğrenilmesinde işbirlikli öğrenme yönteminin etkileri* [Yayınlanmamış Yüksek Lisans Tezi]. Gazi Üniversitesi.

Tobin, K. (1990). Research on science laboratory activities: In pursuit of better questions and answers to improve learning. *School Science and Mathematics, 90*(5), 403-418.

Townsend, L. A. (2012). *The Effects of laboratory-based activities on student attitudes toward science*. (Master thesis), Montana State University, Bozeman, Montana. https://scholarworks.montana.edu/xmlui/handle/1/2435

Ulu, C., (2019). Argümantasyon Tabanlı Bilim Öğrenme Yaklaşımına Dayalı Laboratuvar Uygulamalarının Üstbilişsel Bilgi ve Becerilere Etkisi. *Uluslararası Bilim ve Eğitim Dergisi*, *2*(1), 11-23. Retrieved from https://dergipark.org.tr/en/pub/ubed/issue/48031/437451

Uyanık, G. (2017). İlkokul Öğrencilerinin Fen Bilimleri Dersine Yönelik Tutumları İle Akademik Başarıları Arasındaki İlişki. *Tübav Bilim Dergisi*, *10*(1), 86-93. Retrieved from https://dergipark.org.tr/en/pub/tubav/issue/27928/296802

Van Ryzin, M. J., Roseth, C. J., & Biglan, A. (2020). Mediators of effects of cooperative learning on prosocial behavior in middle school. *International journal of applied positive psychology*, *5*(1), 37-52.

Yapıcı İ. Ü., Hevedanlı M., & Oral B., (2009). İşbirlikli öğrenme ve geleneksel öğretim yöntemlerinin tohumlu bitkiler sistematiği laboratuarı dersine yönelik tutum ve başarıya etkisi. *Pamukkale*

Üniversitesi Eğitim Fakültesi Dergisi, 26, 63-69. Retrieved from https://dergipark.org.tr/en/pub/pauefd/issue/11117/132955

Yıldırım, A. & Şimşek, H. (2011). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin Yayıncılık.

Yıldız, E., Ağgül, Ö., Çalıklar, Ş., & Şimşek, Ü., (2020). Eğitsel Oyun ve İşbirlikli Öğrenmenin 6. Sınıf Öğrencilerinin Akademik Başarılarına, Sosyal Becerilerine ve Öğrenme Motivasyonlarına Etkisi. *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, *8*(6), 1703-1716. https://doi.org/10.18506/anemon.671575

Yıldız, E., Akpınar, E., Aydoğdu & Ergin, Ö. (2006). Fen bilgisi öğretmenlerinin fen deneylerinin amaçlarına yönelik tutumları. *Journal of Turkish Science Education*, *3*(2), 2-18.

Yıldız, E., Aydoğdu, B., Akpınar, E. & Ergin, Ö. (2007). Fen Bilgisi öğretmenlerinin fen deneylerine yönelik tutumları. *Boğaziçi Üniversitesi Eğitim Dergisi, 24(2),* 71-86.

Yıldız, E., Çalıklar, Ş., & Şimşek, Ü. (2020). Gazların kinetik teorisi konusunun öğretiminde üç farklı işbirlikli öğrenme yönteminin etkisi. *Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi Dergisi*, (49), 24-42.

Yu, S. M. & Bethel, L. J. (1991). The influence of hands on science process skills training on preservice elementary teachers' anxiety and concerns about teaching science activities Taiwan, Republic of China. *The Annual Meeting of the National Association for Research in Science Teaching,* Lake Geneva (April 7-10, 1991).