THE EFFECT OF A COOPERATIVE ARGUMENTATION MODEL ON LISTENING AND INQUIRY SKILLS AND ARGUMENT LEVEL

Abstract: The aim of this study was to determine the effect of a cooperative argumentation model on the listening and inquiry skills and argument level of pre-service science teachers (PSTs). A mixed method was used. The sample consisted of 54 pre-service science teachers. Two experimental groups were studied and the study was conducted in the Special Issues in Biology course. Co-learning of the cooperative learning model was used in the experimental group (CLG, n=31). Argumentation and co-learning of the cooperative learning model were used in the other experimental group (CLAG, n=23). To collect data, the Listening Skills Scale (LSS), Inquiry Skills Scale (ISS), and written arguments were used. For analyzing the quantitative data the independent samples t test and Mann–Whitney U test were applied. To analyze the qualitative data content analysis was used. A significant difference was found in favor of the CLAG in terms of listening skills ($p<.05$). However, there was no significant difference between the groups in inquiry skills. When the written arguments created by PSTs are examined in terms of inquiry types, they mostly used inquiry based on experimental data, inductive reasoning, inquiry based on values, and inquiry within the framework of an economics perspective. In addition, the levels of arguments formed by the PSTs developed throughout the process.

Keywords: Argumentation, argument level, cooperative learning, inquiry skills, listening skills

Okumuş, Seda, PhD
Assist Prof. Dr.
Kazım Karabekir Faculty of Education
Atatürk University
Turkey
Contact: +90 442 231 4205
E-mail: seda.okumus@atauni.edu.tr
ORCID: 0000-0001-6271-8278

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INTRODUCTION

Socioscientific issues (SSIs) are among the important topics in science education, because SSIs focus on social issues in science and these issues concern both society and science (Sadler, 2004; Topçu, 2017). SSIs are open to discussion and, unlike the basic scientific issues that have been verified, these issues cannot be dealt with in a simple way and an SSI does not have a single solution. In this respect, different solutions are explored in understanding SSIs, and opinions about them may differ from person to person (Christenson, Rundgren & Zeidler; Sadler & Zeidler, 2005). In addition, SSIs pose some legal, ethical, and moral dilemmas (Kolsto, 2001, Okumuş, 2020; Topçu, 2017; Walker & Zeidler, 2007). Understanding SSIs can help students to solve daily life problems and overcome dilemmas and play a role in helping them make the right decisions by encouraging them to think within the framework of science (Kolsto, 2006; Van der Zande, 2009). For this reason, more emphasis should be placed on them and their importance in science education should not be overlooked (Grooms, Sampson & Golden, 2014).

SSIs include biotechnology applications like stem cell studies, genetically modified organisms (GMOs), organ transplantation, genetic replication, gene therapy, and environmental issues like the greenhouse effect, biodiversity, global warming, and nuclear energy (Klop & Severiens, 2007; Sturgis, Cooper & Fife Schaw, 2005). These issues concern both science and society. For this reason, SSIs make it easier for students to better associate everyday life problems with science. In the literature, in the studies about SSIs, researchers stated that students and pre-service science teachers (PSTs) have difficulty in understanding SSIs (Chabalengula, Mumba & Chitiyo, 2011; Lamanauskas & Makarskaite-Petkevičienė, 2008; Steele & Aubusson, 2004; Türkmen, Pekmez & Sağlam, 2017) and they have difficulties in making decisions concerning dilemma issues (Dawson, 2007; Dawson & Soames, 2006). Moreover, the PSTs' anxiety rates about SSIs were high (Tekin & Aslan, 2019; Topçu, 2011). In addition, according to the literature, science teachers have difficulties related to teaching SSIs (Chen & So, 2017; France, 2007). Therefore, science teachers have low self-efficiency to teach them (Lee, Abd-El-Khalick & Choi, 2006). The rapid advancement of science and technology in the 21st century has increased the importance of SSIs (Christenson et al., 2014; Çetin, Doğan & Kutluca, 2014; Foog & Daniel, 2103), because innovations and changes affect not only science but also humanity and direct social life. In this context, using teaching models that make SSIs easier to understand and require discussion will be effective in science teaching.

Argumentation is one of the models that enable understanding of SSIs. Argumentation is the process of supporting and validating claims with data by providing justifications (Toulmin, 1958; Wang & Buck, 2015). Arguments are formed by the participants to include the ideas put forward in the argumentation process. Argument development and the argumentation process aim to improve students' high-level cognitive skills (Kuhn, 2016). Argumentation is a suitable model for teaching both scientific issues and SSIs. Socioscientific argumentation refers to students' in-depth discussions when they encounter an SSI by working on the claims they have made for the solution of this issue (Hefter et al., 2014; Topçu, 2017). Students' skills to think like scientists develop and their inquiring competencies increase with argumentation (Kınık Topalsan, 2020; Mello, Natale, Marzin-Janvier, Vieira & de-Almeida, 2021; Sönmez, Kabataş Memiş & Yerlikaya, 2021). Furthermore, argumentation improves students' critical thinking (Jiménez-Aleixandre & Puig, 2012; Katchevich, Hofstein & Mamlok-Naaman, 2013; Sönmez et al., 2021; Trouche, Johansson, Hall & Mercier, 2016). Argumentation is an effective way to teach SSIs (Belova, Eilks & Feierabend, 2015; Dawson & Venville, 2010, 2013; Hefter et al., 2014, Ozturk, Bozkurt Altan, Yenilmez Turkoglu, 2021), because SSIs include issues open to discussion and this makes it easier for students to participate in the argumentation process. Since argumentation involves claim support and rejecting the counter claim, it is a hard-to-apply model (Ault, Craig-Hare, Frey, Ellis & Bulgren, 2015; Okumuş, 2020). Therefore, students have difficulties with the process. In addition, the students and the PSTs could not form arguments at the desired level and they could not defend their own claims according to the opposing claims in the literature (Dawson & Venville, 2009; Jiménez-Aleixandre, Rodríguez & Duschl, 2000). For this reason, using a different teaching method that will actively add the student to the process besides argumentation would be effective for the teaching of SSIs. One of these is cooperative learning.

Cooperative learning is a student-centered model that requires students to work in cooperative heterogeneous groups (Bayrakçeken, Doymuş & Doğan, 2013; Johnson & Johnson, 2014; Jones & Jones, 2008; Kuuk & Arslan, 2020). Cooperative learning is an effective way for students to gain conceptual understanding (Özdilek, Okumuş & Doymuş, 2018) and social skills (Johnson & Johnson, 1999; Slavin,

1996) as well as to advance their academic achievement (Doymuş, 2007; Gündoğdu, Ozan & Taşgın, 2013; Oyarzun & Morrison, 2013). To integrate argumentation into the cooperative learning process is easy, as it is also used in groups during the argumentation process. In the present study argumentation is integrated into cooperative learning in the teaching of SSIs. The cooperative learning model involves many methods used in classroom applications. In the present study co-learning was used. This method was chosen because it is easy to integrate into the argumentation process and simple to implement.

In science teaching programs developed within the framework of 21st century skills, producing students with high inquiry skills is aimed, not students who accept scientific knowledge as it is. Therefore, it is recommended to use inquiry-based models for science teachers (Ministry of Education [MoE], 2018). Argumentation is one of the recommended models for science learning, because, in the argumentation process, students question their claims using reasoning processes to provide valid reasons and to refute opposing claims. Argumentation is effective to gain inquiry skills (Mello et al., 2021; Sönmez et al., 2021). Evoagorou & Osborne (2013) state that argumentation is a social process and requires cooperation. Therefore, it was considered appropriate to integrate argumentation with cooperative learning. Cooperative learning is a constructivist model that provides active learning among students in heterogenic groups. In addition, cooperative learning supports face to face interaction. Therefore, the discussion process can be generally effective in cooperative learning. This situation affects the inquiry process, because students can discuss, interact, and express their opinions in cooperative learning. Therefore, argumentation and cooperative learning were used in cognition for the development of inquiry skills in the present study.

Communication is explained as the process of exchanging feelings and thoughts between people with symbols that they give common meanings to (Hançerlioğlu, 1993). Since humans are social creatures, they are in constant communication with each other. It is important for people to listen to each other to ensure effective communication. The skill of listening can be defined in two ways. The first is that the listener can hear, repeat, and understand information. According to this perspective, listening is handled by a cognitive approach. The scales developed in this direction have a cognitive nature. The other definition is that the individual's attitudes towards listening affect their listening behaviors. In this framework, listening is not only a cognitive process, but is also related to behaviors and attitudes (Bostrom, 1990, 1997; Cihangir Çankaya, 2015). Active listening facilitates the learning and communication process (Doyle, 2019; Xiao, Zhou, Chen, Yang & Chi, 2020). In this respect, using models including active listening in science teaching will also increase communication skills. Argumentation can be an important way to improve listening skills, because it is a discussion process in itself and the participants must listen to each other during the process. Similarly, cooperative learning necessitates interaction as it is a model that requires working together. Therefore, in cooperative learning, it is important for students to learn to listen to each other effectively while working together. Therefore, argumentation and cooperative learning may improve PSTs' listening skills in the present study.

In addition, the reason for working with PSTs in the present study was to train teachers who have high questioning skills, are willing to discuss, and have advanced listening skills. The aim of this study was to determine the effect of a cooperative argumentation model on the skills of listening, inquiry, and argumentation of PSTs. The research questions are as follows:

1. Do cooperative argumentation practices have an effect on the PSTs' listening skills?

2a. Do cooperative argumentation practices have an effect on the PSTs' inquiry skills?

2b. How do cooperative argumentation practices affect the PSTs' inquiry skills?

3. How do cooperative argumentation practices affect the PSTs' argumentation skills?

METHOD

RESEARCH MODEL

An intervention mixed design was used. This is a mixed research design in which quantitative and qualitative designs are applied simultaneously. According to this design, the qualitative approach may accompany the quantitative approach before, during, and after implementation (Creswell, 2015). In this study, qualitative data were collected during the application in support of the quantitative research data. The study was conducted with two experimental groups and conducted for one semester within the framework of the Special Issues in Biology (SIB) course. The quantitative data were collected with preand post-tests. The qualitative data were obtained from the written arguments and discussion records created by the PSTs during the lesson. The research design is presented in Figure 1.

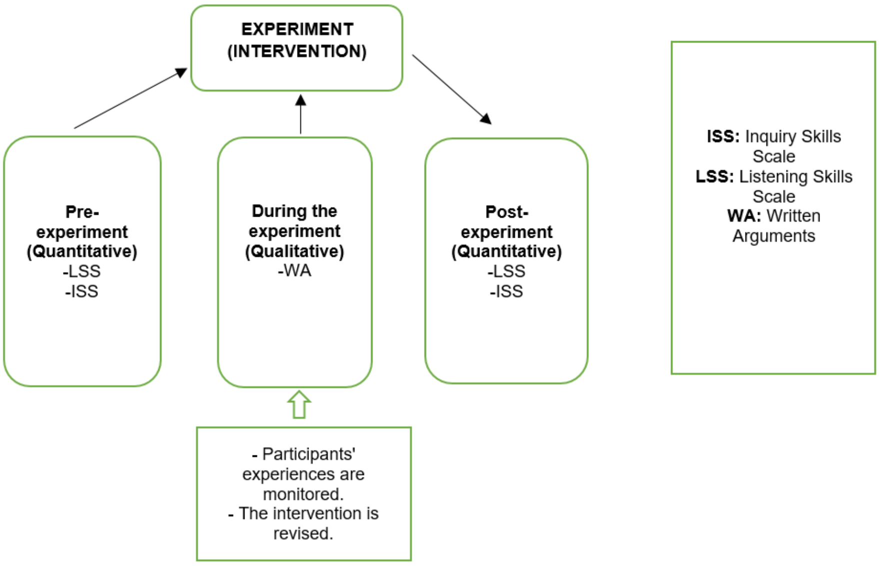

Figure 1. Research design

SAMPLE

The study was conducted with 54 PSTs (46 females, 8 males) who were studying in the fourth year of the Science Teaching Program and attending the SIB course. Two experiments were conducted, with the first experimental group (CLG, n=31; 25 females, 6 males) in which the cooperative learning method was applied and the second experimental group (CLAG, n = 23; 21 females, 2 males) in which the cooperative learning and argumentation were applied together. The sample was expressed based on the PSTs who participated in the last application of the Listening Skills Scale (LSS) and Inquiry Skills Scale (ISS) according to the attendance status of the PSTs; this is the reason for the change in the pre- and post-test. Convenient sampling was used in sample selection, which requires the selection of the sample that prevents loss of time, money, and workforce and is the most suitable for the conditions in terms of applicability (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2012). Convenient sampling was chosen as it was studied with PSTs at the university where the researcher was assigned.

DATA COLLECTION

The LSS and ISS were used to collect quantitative data in the study. In addition, written arguments were used for qualitative data.

LISTENING SKILLS SCALE (LSS)

The LSS is a five-point Likert-type scale developed by Cihangir Çankaya (2012). Scale items were scored as 1 = never, 2 = occasionally, 3 = sometimes, 4 = often, 5 = always. The LSS consists of 15 items; seven of these items are scored in reverse (1, 3, 4, 6, 7, 10, and 12). The highest score that can be obtained from the LSS is 75. Cihangir Çankaya (2012) determined the reliability of the LSS as $\alpha = .84$. In the present study, the reliability of the LSS was re-calculated after the pilot study with 81 PSTs and was determined as $\alpha = .82$. This ratio shows that the scale is highly reliable. Permission was obtained from the owner of the scale.

INQUIRY SKILLS SCALE (ISS)

The ISS is a five-point Likert-type scale developed by Aldan Karademir and Saracaloğlu (2013). Scale items were scored as 1 = never, 2 = rarely, 3 = occasionally, 4 = mostly, 5 = always. The ISS consists of 14 items and includes three sub-factors: Information Acquisition (IA), Knowledge Control (KC), and Self-Confidence (SC). The highest score that can be obtained from the scale is 70. In the reliability analysis performed by Aldan Karademir and Saracaloğlu (2013), the Cronbach-alpha reliability coefficient of the ISS was determined as .82. In the present study, the reliability of the ISS was re-calculated after a pilot study with 80 PSTs and was determined as $\alpha = .87$. This ratio shows that the scale is highly reliable. Permission was obtained from the owner of the scale.

WRITTEN ARGUMENTS

Written arguments were obtained by PSTs' writing their discussions in the argumentation practices during the course. The PSTs had group discussions during the weeks when the argumentation activities were performed, and each group expressed their opinions in writing. Written arguments were used to reveal how the PSTs' inquiry and argumentation skills changed during the process. Written arguments were collected with working papers created by the researcher. In the study, six written arguments were formed by each group over 15 weeks. The written arguments created every week were examined in detail in the data analysis section.

PROCEDURE

Firstly, the LSS and ISS were applied as pre-tests to PSTs studying in two different branches. Later, each branch was heterogeneously divided into cooperative working groups. In both experimental groups, the applications were performed for a period and the constructivist approach was taken as a basis. In the first experimental group, the lesson was conducted with the co-learning of the cooperative learning model. In the second experimental group, co-learning of the cooperative learning model and argumentation were applied together. The application took 15 weeks for both experimental groups. Since the length of each unit in the course is different, the working time in the units also differed. The "Importance of Biology for Society, Science, and Technology", "Genetic Cloning", "Bioinformatics", "Transplantation", "Use of Nanotechnology in Biology", "Biological Sensors" and "Chemical Substances" units were run for one week. However, "Genetically Modified Organisms", "Stem Cells", and "Medicines and Cosmetic Products" units were run for two weeks. The research process is shown in Table 1.

Table 1. Research Process

Process / Units	Period
Importance of Biology for Society, Science, and Technology	1 week
Genetically Modified Organisms	2 weeks
Genetic Cloning	1 week
Stem Cells	2 weeks
Midterm	1 week
Bioinformatics	1 week
Transplantation	1 week
Use of Nanotechnology in Biology	1 week
Biological Sensors	1 week
Medicines and Cosmetic Products	2 weeks
Chemical Substances	1 week
Final exam	1 week
Total	15 weeks

After the in-class applications were completed, the LSS and ISS were applied to all groups as post-tests at the end of the semester.

PROCESS IN THE COOPERATIVE LEARNING GROUP (CLG)

In the CLG, the PSTs were divided into seven heterogeneous study groups, primarily considering the class size. While creating the groups, the scores that the PSTs got when taking the LSS and ISS as pre-tests were considered, and a heterogeneous distribution of the PSTs into the groups according to these scores was ensured. The SIB course was structured in a learner-centered way, taking the constructivist approach into consideration. For this, cooperative learning was applied. Accordingly, the topic of each week was firstly divided among the group so that each member took a certain part of the topic. Later, each member worked on his/her own topic and then explained the subject to the other members of his/her group. The researcher described the subject in general and explained the parts that the PSTs did not understand. The PSTs tried to increase their understanding by researching the specific parts of each topic with the other members of their group. For evaluating, the researcher asked questions to the PSTs using the question/answer technique to provide a general summary of the subject. In this section, to ensure positive dependence, which is one of the main features of cooperative learning, positive/negative points are given for the answers they gave to the PSTs. If a member in a group answers the question correctly, all group members gain a point; if they answer incorrectly, all group members lose a point. In this way, an attempt was made to achieve positive dependence. Positive and negative points were added to midterm and final grades. After all applications were completed, the LSS and ISS were applied again as post-tests.

PROCESS IN THE COOPERATIVE LEARNING-ARGUMENTATION GROUP (CLAG)

In the CLAG, the PSTs were divided into six heterogeneous study groups, primarily considering the class size. In the CLAG, co-learning of cooperative learning was applied as in the CLG, and additional argumentation applications were used. For this purpose, after the groups were formed, the PSTs were informed about what the argument and argumentation model is, and they were able to examine the worksheets containing sample applications and perform argumentation activities. Later, in-class studies were started. Argumentation activities were conducted in the elaborate and evaluate parts of the course. The PSTs were asked to discuss the arguments in the argumentation materials given to them and to reach a common decision as a group. They were asked to write these decisions on the working papers provided to them. Then the opinions of each group on the subject were obtained and discussions were held with other groups. Scientific discussions in the CLAG were conducted with six activities within the scope of the units open to discussion. The applications are shown in Table 2.

Table 2. Argumentation Applications

Unit	Application	Application week
Genetically modified organisms	Theories that compete with stories	Week 3
Genetic cloning	The table of statements	Week 4
Stem cells	Evidence cards	Week 6
Transplantation	Theories that compete with cartoons	Week 8
Use of nanotechnology in biology	Competing theories	Week 9
Medicines and cosmetic products	V diagram	Week 11

Then, as in the CLG, the lessons ended with the question/answer phase. After all applications were completed, the LSS and ISS were applied as post-tests.

DATA ANALYSIS

For the analysis of the quantitative data, normality tests were performed on the data obtained from the LSS and ISS. According to this, Shapiro–Wilk normality tests were performed in groups with a sample less than 30, and Kolmogorov–Smirnov normality tests were performed in groups with a large number of samples. To determine whether there were significant differences between the groups, if the data fitted the normal distribution, the independent samples t test, a parametric test, was used, while the Mann-Whitney U test, a nonparametric test, was used if the data did not fit the normal distribution.

To determine whether the data obtained by applying the LSS as a pre-test conform to the normal distribution or not, the Shapiro–Wilk test was used in both groups because the sample was less than 30 people. Accordingly, the data in the CLG ($p = .582$; $p > .05$) and CLAG ($p = .466$; $p > .05$) showed normal distribution. The Kolmogorov–Smirnov test was used, since the sample in the CLG was more than 30 people, to determine whether the data obtained by the application of the LSS as a final test conform to the normal distribution or not. In the CLAG, the Shapiro–Wilk test was used because the sample was less than 30 people. Accordingly, the data in the CLG ($p = .132$; $p > .05$) and CLAG ($p = .986$; $p > .05$) showed normal distribution. Since the pre-test data of both groups were compatible with the normal distribution, the independent samples t test was used for significance.

The Shapiro–Wilk test was used to determine whether the data obtained by applying the ISS as a pre-test conformed to the normal distribution or not, since the sample was less than 30 people in both groups. Accordingly, the data in the CLG ($p = .449$; $p > .05$) conformed to the normal distribution and the data in the CLAG ($p = .009$; $p < .05$) did not fit the normal distribution. The Kolmogorov–Smirnov test was used, since the sample in the CLG was more than 30 people, to determine whether the data obtained by the application of the ISS as a final test conform to the normal distribution. In the CLAG, the Shapiro–Wilk test was used because the sample was less than 30 people. Accordingly, the data in the CLG ($p = .112$; $p > .05$) and CLAG ($p = .438$; $p > .05$) showed normal distribution. Since the pre-test data of the CLAG did not fit the normal distribution, the Mann–Whitney U test was applied to the pre-test data of the ISS. Since the post-test data of both groups were compatible with the normal distribution, the independent samples t test was used for significance.

Content analysis was performed on the qualitative data. Content analysis is the systematic summing up of some parts of a text in smaller and fewer words (Büyüköztürk et al., 2012). Content analysis was performed on the data obtained from the written arguments created by the PSTs in the cooperative argumentation model process applied in the CLAG.

For the analysis of the data obtained from the written arguments, the types of reasons that the PSTs used during the argumentation process were examined. This was done to reveal the change in the inquiry skills of the PSTs during the process. During the content analysis process, the discussions held every week were analyzed according to themes and codes. In the content analysis, first six themes were created and then the codes for each theme were determined. The codes created by the researcher were then re-coded by an expert. The percentage of agreement between the researcher and the expert was calculated by Miles and Huberman's (1994) formula [Reliability = consistency / (consistency + disagreement) × 100]. The consistency was calculated as 96.7%. The themes were created according to the arguments that the PSTs formed while examining their inquiry skills, according to the explanation type of scientific knowledge, inquiry type, emotional point of view, and pragmatist perspective. Accordingly, five themes and nine codes were created. The themes and codes used in the data analysis are given in Table 3.

Table 3. Themes and Codes Used in the Content Analysis

Theme	Code
Scientific Knowledge (SK)	Experimental (EX)
	Theoretical (TH)
	Observational (OB)
Inquiry (IQ)	Reasoning-Induction (RI)
	Reasoning-Deduction (RD)
Emotional (E)	Beliefs (BE)
	Values (VA)
Pragmatist (P)	Economic (EC)
	Political (PO)

In the *Scientific Knowledge* (SK) theme it is stated on what basis the written arguments are explained. Accordingly, the PSTs construct arguments based on “Experimental (EX)”, “Theoretical (TH)”, and “Observational (OB)” information. In the theme of Inquiry (IQ), it is expressed what kind of reasoning is used in the process of creating arguments. Accordingly, “Reasoning-Inductive (RI)” and “Reasoning-Deductive (RD)” processes are coded. In the Emotional (E) theme, in the process of creating the arguments, which emotional arguments the PSTs deal with are explained. This theme is classified according to “Beliefs (BE)” and “Values (VA)”. The Pragmatist (P) theme explains what benefits are gained in the argument formation process. Accordingly, “Economic (EC)” and “Political (PO)” coding is performed.

Moreover, in the analysis of the written arguments formed by the PSTs, each argument was analyzed by considering the levels of argument expressed by Erduran, Osborne, and Simon (2004). Accordingly, a discussion levels score table was created. According to this score table, the lowest score that can be obtained from discussions is 3, while the highest score is 16. The simplest argument, which consists only of claims, is important in terms of making a difference at the beginning of the discussion, although it is not important in making a judgment. For this reason, the claims were given 3 points. Discussions supported by rebuttal are of higher quality than other arguments. The use of rebuttal at the argument levels at the highest level of argument shows that refuting a scientific debate is a complex and difficult skill, because refuting a scientific debate enables the verification of the original theory by comparing both the correct theory and the false theory (Kuhn, 1991). For this reason, weak rebuttals were given 3 points, 5 points were given to rebuttals, and 7 points were given to multiple rebuttals. The discussion levels score is given in Table 4.

Table 4. Discussion Levels Score

Argument level	Explanation	Level score	
		Score	Total score
Level 1	Claim only	Claim (3)	3
Level 2	Claim, data, warrants, or backings	Claim (3) Data (1) Warrant (3) Backing (2)	9
Level 3	A series of claims or counter-claims, data, warrants, or backings with the occasional weak rebuttal	Claim (3) Data (1) Warrant (3) Backing (2) Weak rebuttal (3)	12
Level 4	A series of claims or counter-claims, data, warrants, or backings and a clearly identifiable rebuttal	Claim (3) Data (1) Warrant (3) Backing (2) Rebuttal (5)	14
Level 5	A series of claims or counter-claims, data, warrants, or backings, and more than one rebuttal	Claim (3) Data (1) Warrant (3) Backing (2) More rebuttal (7)	16

Then, using the score given in Table 4, the discussion levels of the PSTs for each activity were determined and scored. While determining the levels of discussion, to ensure rater reliability, the written discussions were evaluated independently by the researcher herself and a science educator who was knowledgeable about the scientific debate. The researchers who analyzed the scientific discussions evaluated the scientific discussion items in the same discussions according to Miles and Huberman (1994) and the agreement rates were examined. The consistency analysis showed the agreement percentage to be 89.3%. According to Miles and Huberman (1994), correlation values of 80% and greater indicate reliability. Therefore, in the present study, the analyses conducted by the two researchers for the discussions of the PSTs can be considered reliable and consistent with each other. After determining the level of discussion, the discussion levels and discussion skills of the PSTs were examined in each activity.

FINDINGS

FINDINGS REGARDING LISTENING SKILLS

The results of the independent samples t test performed on the data obtained by applying the LSS as a pre- and post-test are given in Table 5.

Table 5. Independent Samples Test Results of the LSS

LSS	Groups	n	X	SD	t	p
Pre-test	CLG	24	54.46	7.813	-.031	.976
	CLAG	25	54.52	6.286		
Post-test	CLG	33	50.48	6.190	-2.587	**.014**
	CLAG	24	56.21	9.464		

According to Table 5, there was no significant difference between the groups in terms of listening skills in the pre-test ($p > .05$). Accordingly, the listening skills of the PSTs in the experimental groups can be regarded as close to each other before practicing. In the post-test, a significant difference was obtained between the groups in terms of listening skills ($p < .05$). The effect size was determined as $d = .69$. Green and Salkind (2005) stated that the effect size d would be interpreted as a small effect between 0 and 0.2, medium effect between 0.2 and 0.5, and large effect between 0.5 and 0.8. Accordingly, a high effect can be assumed. The PSTs in the CLAG increased their listening skills more than the other group after the application.

FINDINGS REGARDING INQUIRY SKILLS

Since the pre-test data of the CLAG did not fit the normal distribution, the Mann–Whitney U test was applied to the pre-test data of the ISS. Table 6 shows the results of the Mann–Whitney U test.

Table 6. Mann–Whitney U Test Results of the pre-ISS

ISS	Groups	n	Mean Rank	Sum of Rank	U	p
Pre-test	CLG	24	26.04	625.00	275.00	.616
	CLAG	25	24.00	600.00		

According to Table 6, there was no significant difference between the groups in terms of inquiry skills in the pre-test ($p > .05$).

Since the post-test data of both groups were consistent with the normal distribution, the independent samples t test was applied to the post-test data. In Table 7, the independent samples t test results for the post-test data of the ISS are given.

Table 7. Independent Sample t Test Results of the post-ISS

ISS	Groups	n	X	SD	t	p
Post-test	CLG	31	53.90	8.615	.196	.846
	CLAG	23	53.43	8.764		

According to Table 7, there was no significant difference between the groups in terms of inquiry skills in the post-test ($p > .05$). The effect size was set at 0.05. From this, it can be inferred that the effect size is very small. In addition, no significant difference was determined between groups in the sub-factors of the ISS (for IA $p>.05$; $p=.88$, for KC $p>.05$; $p=.37$, for SC $p>.05$; $p=.23$).

Moreover, the data obtained from the written arguments were subjected to content analysis to determine how the inquiry skills of the PSTs changed in terms of different characteristics throughout the process. Table 8 shows the change in PSTs' inquiry skills.

ü According to Table 8, while the PSTs' inquiry based on observations (code OB) in the first activity for the classification of scientific knowledge related to SSIs is higher, in all other activities inquiry based on experimental data (code EX) is more prominent. Inductive inquiry is higher in all activities in terms of inquiry style. In the emotional analysis of the written arguments, while no data were obtained for the 5th and 6th activities (*Use of Nanotechnology in Biology* and *Medicines and Cosmetic Products*), values more prominent for other activities were observed. When the written arguments are examined according to the pragmatist theme, the economic perspective is more prominent. However, no data were obtained for this theme in the 3rd and 4th activities (*Stem cells* and *Transplantation*).

Table 8. Analysis of PSTs' Inquiry Skills

Theme	Code	Activities (%)						Examples
		A1	A2	A3	A4	A5	A6	
SK	EX	32.9	60.5	62.5	57.1	53.3	43.8	"The reason for aging is the shortening of telomeres located at the ends of chromosomes. The shortening of telomeres also shortens the life span. Dolly was born at the Roslin Institute in 1996 and lived for only 6 years. The reason for premature aging in Dolly is the telomeres in the chromosome ends. This is because the somatic cell taken from the mature creature united with the host and was placed in the uterus of the carrier female and came into the world. This is why Dolly's telomeres are congenitally old as they have short cells." G3, A2
	TH	32.9	26.3	25	14.3	26.7	22.9	"GMOs are not harmful to human health. Through GMOs, higher quality, developed, large nutrients are created. GMOs improve people's quality of life." G1, A1
	OB	34.2	13.2	12.5	28.6	20	33.3	"Organ donation is beneficial for the society. If organs that will only become dust after death are donated, other people's lives will be saved. After a while, the body begins to decompose." G3, A4
IQ	RI	61.7	61.3	71.4	66.7	100	70.8	"In general, nanotechnology is the arrangement of atomic-sized structures to serve a commercial purpose. Nanomaterials and -structures provide high efficiency in energy storage systems. By using nanomaterials and nanostructures, the efficiency of solar cells has been increased up to 40% in the laboratory environment.

								Solar cells are produced on flexible materials such as polymers and fabrics. Therefore, nanotechnology contributes to obtaining cheap, reliable, and renewable energy sources." G2, A5
	RD	38.3	38.7	28.6	33.3	0	29.2	"Medicines are needed to cure diseases. Without medication, some diseases cannot be treated and the effect of the disease cannot be eliminated. For example, it is not possible to cure cerebellitis, but the effect of the disease can be minimized with medications." G4, A6
E	BE	0	25	14.3	40	0	0	"Human cloning is unethical. The first reason why people are opposed to cloning is that it is contrary to the idea of creation. The second reason is that humans will be used as guinea pigs and physical and mental disorders may occur in humans after cloning." G2, A2
	VA	100	75	85.7	60	0	0	"Stem cell studies conducted on the embryo are unethical. Because the embryo loses its vitality after it is taken for the stem cell. The embryo is also alive and should be respected like a human." G6, A3
P	EC	71.4	50	0	0	69.2	100	"Human cloning is not ethically appropriate, because when people are cloned, some malicious people can make financial profit by selling people's organs." G5, A2
	PO	38.6	50	0	0	30.8	0	"Transgenic agricultural products adversely affect the country's economy. International companies use terminator technology for the transgenic plants they produce. This means that the plant does not give seeds. That is, the plant yields abundantly but cannot produce productive seeds." G2, A1

Scientific knowledge (SK), Experimental (EX), Theoretical (TH), Observational (OB), Inquiry (IQ), Reasoning- Induction (RI), Reasoning-Deduction (RD), Experience-based inference (EBI), Emotional (E), Beliefs (BE), Values (VA), Pragmatist (P), Economic (EC), Political (PO)

Graphics showing the change in the process were prepared for each theme. The graphic prepared for the scientific knowledge theme is given in Figure 2.

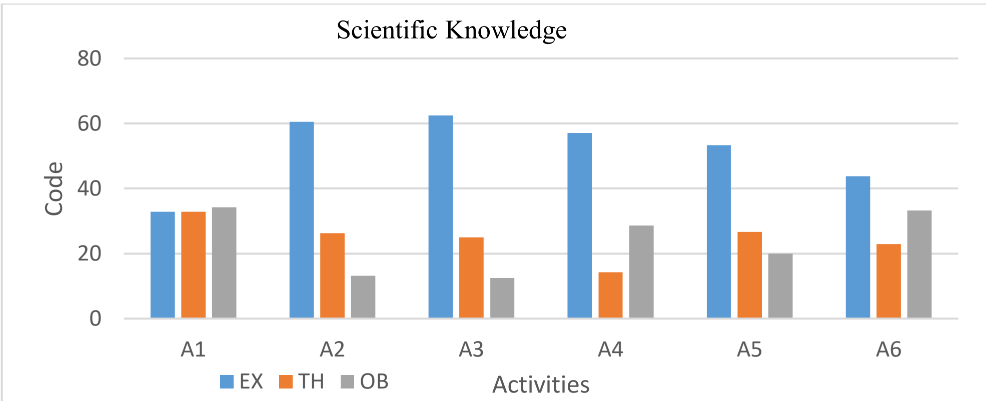

Figure 2. Analysis of the scientific knowledge theme

According to Figure 2, the SSIs classified in the scientific information theme are generally discussed based on experimental information. However, when based on experimental data, the inquiry has slightly decreased towards recent activities. The graphic prepared for the inquiry theme is given in Figure 3.

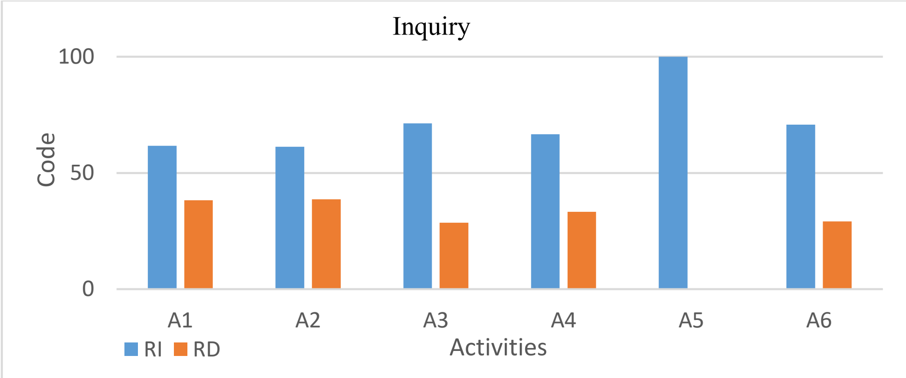

Figure 3. Analysis of the inquiry theme

According to Figure 3, the PSTs use inductive reasoning more in the argument formation process. However, inductive reasoning does not tend to increase continuously in the process. The graphic prepared for the emotional theme is given in Figure 4.

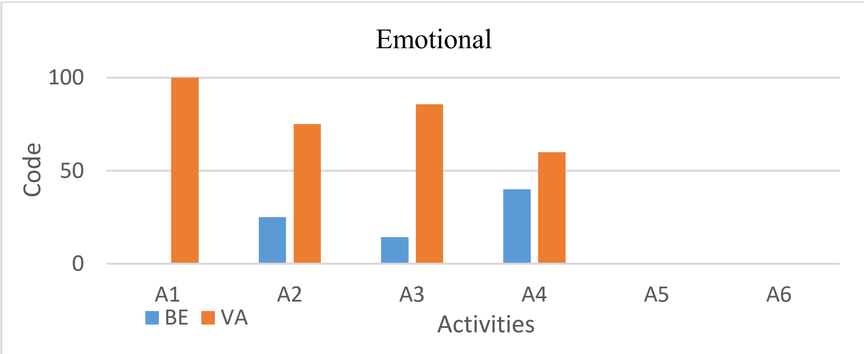

Figure 4. Analysis of the emotional theme

According to Figure 4, when the arguments created in the SSI are examined emotionally, they are based more on values. However, some PSTs associated them with belief. The PSTs did not create arguments for the emotional theme in the A5 and A6 subjects (*Use of Nanotechnology in Biology* and *Medicines and Cosmetic Products*). The graphic prepared for the pragmatist theme is given in Figure 5.

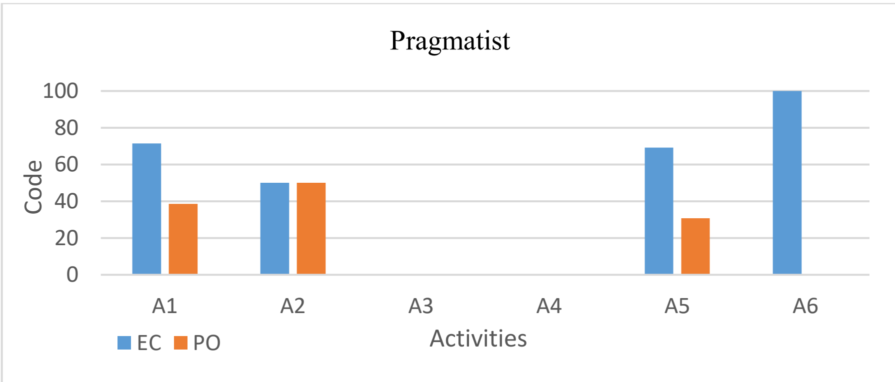

Figure 5. Analysis of the pragmatist theme

According to Figure 5, the PSTs looked at the issues more economically within the pragmatist theme in the written arguments. The PSTs did not create arguments for the pragmatist theme in the A3 and A4 issues (Stem cells and Transplantation).

FINDINGS REGARDING ARGUMENT LEVELS

Written arguments created by the PSTs during the process are presented by Erduran et al. (2004) analyzed according to their level. Accordingly, the argument levels in each activity are given as percentage values in Table 9.

Table 9. Argument Levels in Activities

Argument level	A1 (%)	A2 (%)	A3 (%)	A4 (%)	A5 (%)	A6 (%)	Example
Level 1	2.1	2.8	-	-	-	-	"Transgenic seeds are more resistant to weather conditions" G2, A1
Level 2	75	69.4	16.7	16.7	-	28.6	"The reason for aging is the shortening of telomeres located at the ends of chromosome. Warrant: telomeres are larger in younger cells; as the cell ages, the telomeres shrink". G1, A2
Level 3	12.5	16.7	-	16.7	-	26.2	"If organs that will only become dust after death are donated, other people's lives will be saved. Because after a person dies, soft tissues and organs rot. Organ donation is ethical because the donor died during this time. It is religiously permissible." G6, A4
Level 4	10.4	11.1	50	50	50	35.7	"Nanotechnology will contribute to obtaining cheap, safe, and renewable energy sources. With nanotechnology, many products that will make life easier and increase living standards can be produced at low cost. People's dependence on fossil fuels to produce energy creates environmental and consumption problems. These problems make it necessary to find new methods in the fields of energy production, transport, and consumption. At this point, nanotechnology finds solutions to energy problems. In addition, the fact that developed countries support nanotechnology applications shows that this area is beneficial in terms of energy resources." G3, A5
Level 5	-	-	33.3	16.7	50	4.8	"Stem cell studies performed on the embryo are unethical. The embryo has the potential to grow and become an adult person. Therefore, it should be respected like a human. Using the embryo as a stem cell interferes with life. Also, stem cells taken from a random person are likely to be rejected by the body." G2, A3

A: Activity, G: Group

According to Table 9, most arguments are created at level 2 in the first activity. In the following activities, higher level arguments were started to be formed. It can be considered that there has been progress in terms of argument levels in the process. In the examples given for the argument levels, the arguments formed by the PSTs evolve from the simple argument consisting of the claim to the complex arguments supported by justification, data, and rebuttal. The graph of argument levels is given in Figure 6.

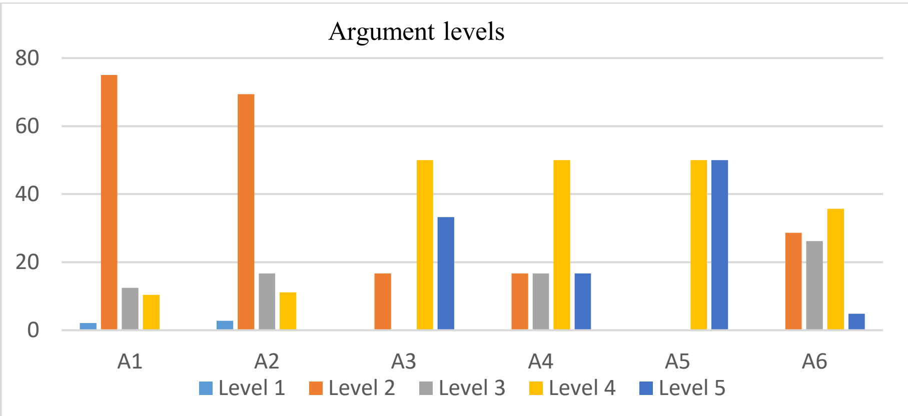

Figure 6. Argument levels

According to Figure 6, an increase in argument levels is observed throughout the process. The PSTs formed stronger arguments in the last weeks. In Figure 7, a graph showing the change in arguments created by the PSTs as a whole during the entire process is given.

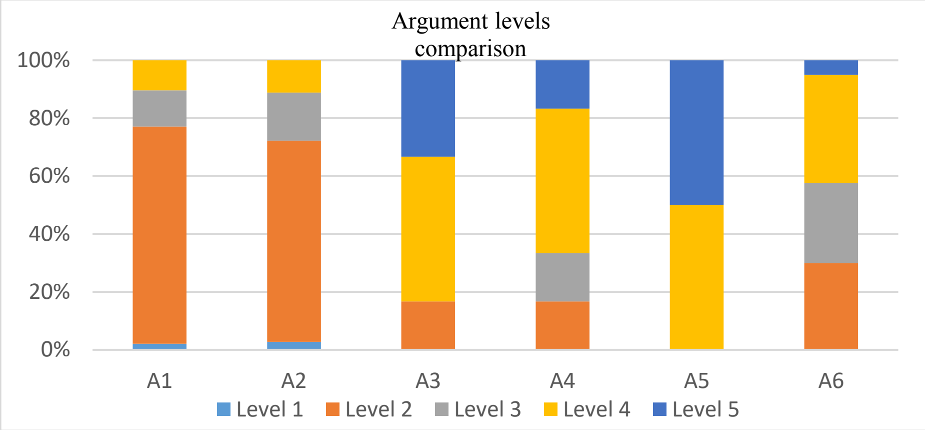

Figure 7. Argument level comparison

According to Figure 7, while the arguments produced at level 2 were more in the first weeks, the arguments produced at level 4 increased in the following weeks. In addition, significant progress was made in level 5. The argument levels that increased as originally targeted during the process were determined.

DISCUSSION AND CONCLUSION

The aim of the present study was to determine the effect of a cooperative argumentation model on the listening and inquiry skills and argument level of PSTs. First of all, their listening skills were compared. Accordingly, no significant difference was found between the groups in the pre-test ($p > .05$). The fact that the PSTs show similarities in terms of educational background, department they read, and class factor may have been influential in the emergence of this situation. In the post-test, the listening skills in the CLAG differed significantly compared to those in the CLG ($p < .05$). This may have been due to the nature of the argumentation, because argumentation is a model that is completely based on discussion and for the discussions to be effective individuals must listen to each other. In this process, it is important not only to listen in terms of hearing, but also to make sense of the sentences expressed by the other party. In this context, argumentation can be required for effective listening. Listening skills are a subject studied in a very large sample. In fact, there are studies that try to improve students' listening skills (Cihangir, 2000; Doveston, 2007), as well as those that measure the listening skills of employees in the sales sector (Drollinger, Comer & Warrington, 2006) and investigate the patient–doctor relationship in terms of listening skills (Brown et al., 2002). Examination of listening skills on such a wide scale is due to the fact that it is one of the basic skills used in interpersonal relationships in daily life. For effective communication, the person should listen to the other person and try to understand him/her. In this context, listening skills are a very important concept for the school environment. For this reason, to use teaching models such as argumentation that improve listening skills and allow students to share their knowledge in a discussion environment is recommended. Firetto et al. (2019) emphasize that argumentation skills are important for learning and communicating academically in various fields. They state that effective learning is important for the communication process and it includes students' criticizing the learning texts and evaluating the arguments expressed in these texts. For this, individuals with improved listening skills will also have better communication. In parallel with the results of the present study, Yeşildağ Hasançebi and Kıngır (2012) stated that listening skills developed positively during the argumentation process.

When the inquiry skills of the PSTs were compared, no significant difference was found between the groups in the pre- and post-tests ($p > .05$). Similarly, no significant difference was found in the sub-factors ($p > .05$). However, although there was no significant difference between the groups, the inquiry skills of the PSTs in the pre- and post-tests were good. Inquiry is very important in science; science progresses by inquiry. Providing students with inquiry skills has a positive effect on their understanding of the nature of science (Stott & Hattingh, 2020), developing scientific process skills (Kar & Çil, 2019; Mutlu, 2020; Ülger & Çepni, 2020), scientific attitude (Kiernan & Lotter, 2019; Rohaeti, Prodjosantoso, & Irwanto, 2020), concept learning process (Bezen & Bayrak, 2020; Sotáková, Ganajová & Babinčáková, 2020), and academic achievement (Jerrim, Oliver & Sims, 2019; Wen et al., 2020). Therefore, the importance of inquiry skills cannot be denied. Argumentation is an important application that increases inquiry skills

(Anderson Quarderer & McDermott, 2020). The argumentation process is also an inquiry process, as it involves developing evidence to validate their claims. Accordingly, an increase in the inquiry skills of the PSTs was expected in the present study. However, this hypothesis was not confirmed. In this respect, this study differs from the literature. The lack of a significant difference between the experimental groups in terms of inquiry skills can be explained by the fact that cooperative learning also contributes to the inquiry process.

In the present study, the arguments formed by the PSTs were also examined in terms of inquiry types. Accordingly, in the Scientific Knowledge type, most of the questions were formed based on experimental data, and it was seen that the inquiry was higher based on Observations only in the first activity. Experimental information is very important for the basis of science. Science progresses through experiments and observations. According to this, the fact that PSTs start from empirical evidence when creating arguments makes sense. Since the cloning, stem cell, transplantation, and nanotechnology issues include more scientifically experimental evidence, it is considered preferable to question them based on experimental data. Pallant and Lee (2015), in their study on how middle and high school students formed arguments about SSIs in the model-based argumentation process, determined that students benefited from experimental information, but the rate was low.

In terms of the form of inquiry, Inductive Reasoning (IR) is used more in discussions. Reasoning can be described as a cognitive process by which people receive information and make an inference based on the data (Johnson-Laird, Legrenzi, Girotto & Legrenzi, 2000; Kurtz Genter & Gunn, 1999). Lawson (2004) emphasized that reasoning is a hypothetical deductive or hypothetical predictive process that includes the processes of assimilation and adaptation that Piaget put forward in learning, from the processing of data in the external world to daily life, from scientific thinking to the learning process. While deductive reasoning usually involves formal reasoning (Sadler, 2004), the reasoning used for SSIs is generally handled within the framework of inductive reasoning (Secor, 1987). Induction involves going from parts to the whole, and since it involves the process of synthesis it is a more difficult process than deduction. In addition, the results achieved in inductive reasoning may not always be correct. Even if the person makes correct associations, his/her general judgment may not be correct (McFarland & Parker, 1990; Perkins, Faraday & Bushey, 1991). In formal reasoning (deductive), the justification supports the result, but in informal reasoning (induction) the justification supports or refutes the result (Zohar & Nemet, 2002). When it is considered in terms of science learning, what is important here is that the student can direct the synthesis process. Argumentation is thought to help students in this context, because, in the argumentation process, they need to prove their claims to the other party (Wang & Buck, 2015). This requires them to gather the data they have about their claims and reach a conclusion. However, not only inductive reasoning is used in the argumentation process. Deductive reasoning is also an important way of thinking. By deducting, it is possible to obtain specific information from the general information available on the subject. In this context, deduction is also very important for making inferences, because the proofs in scientific studies are obtained by deductive reasoning.

When the arguments formed by the PSTs are handled emotionally, values come to the fore more. Values are an important factor when making decisions about SSIs, as they include both social and scientific issues, because SSIs both affect the social life of humanity and are important in making scientific decisions. Studies on SSIs have recently accelerated. Especially with the rapid advances in the field of medicine and biotechnology, the impact of new technologies on human life and the rapidly polluted environment have increased (Foong & Daniel, 2013). As a result of this, the effects of scientific and technological developments on human health, social life, and the change in value judgments have also gained importance. It is important for the PSTs to mention these points in their arguments. Looking at the arguments created, the PSTs attach more importance to values especially in subjects such as transplantation, stem cells, and cloning, which concern life. Moreover, some of the PSTs evaluated transplantation, stem cell, and cloning issues within the framework of their beliefs. Considering that these issues have a sociological structure, it can be considered natural to look at them within these frameworks.

When the arguments formed by the PSTs are handled according to a pragmatist view, the issues are discussed more economically in the discussions. This was especially seen about GMOs, nanotechnology, and medicines and cosmetic products, which concern the country's economy, and economic inquiry about human cloning, which is thought to cause organ trafficking by some of the PSTs. Similar to the present study, Baytelman, Iordanou, and Constantinou (2020) asked university students to create arguments of different types (e.g., social, ethical, economic, scientific, and ecological) related to SSIs, and compared both the types and qualities of the arguments with the students' prior knowledge. They found that students with strong prior knowledge produced more diverse and higher quality arguments.

In addition, the levels of the arguments formed by the PSTs were determined by analysis of the written arguments in the present study. Accordingly, the PSTs increased their argument skills throughout the process. There were more level 2 arguments in the first weeks. This is thought to be due to the fact that the PSTs encountered the argumentation and argument formation process for the first time. Considering that the argumentation model is a difficult model that requires high-level thinking skills (Aullt et al., 2015), the arguments created by the PSTs in their first encounter with the model were at a very high level, which was not expected. In the following weeks, what was desired in the study was achieved, especially with the creation of level 4 and 5 arguments. Written arguments are an important way of improving students' skills in the argument-forming process (Baytelman et al., 2020; Kuhn, Goh, Iordanou, & Shaenfield, 2008; Wu & Tsai, 2011). Consistent with the results of this study, Evagorou and Osborne (2013) found that students formed high-level written arguments in their cooperative argumentation practices they conducted with 12-13 age groups. In addition, Pink, Halim, and Osman (2020) and Uzuntiryaki-Kondakci, Tuysuz, Sarici, Soysal, and Kilinc (2021) determined that argumentation skills increased during the process.

According to the results obtained from the present study, cooperative argumentation was effective in developing listening skills. In this framework, using argumentation with different models to improve listening skills will be effective. However, in this study, cooperative argumentation was not effective enough in developing inquiry skills. According to this, it will be effective to integrate reasoning practices that increase inquiry skills into argumentation for future studies. In addition, the PSTs started out from various bases (scientific knowledge, inquiry, emotional, and pragmatist) during the inquiry process in the present study. This is thought to be important in developing different perspectives. Looking at the levels of argumentation, the desired progress was made in the process. Considering that argumentation skills are important in establishing correct arguments, studies to improve argument levels in this area will contribute to the literature.

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