The effect of argumentation applications on fifth grade students' academic achievement and decision-making skills

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ABSTRACT

This study examined the effect of argumentation applications on academic achievement and decision-making skills. Employing a mixed-methods approach, the study was conducted with 35 fifth-grade students attending a boarding secondary school in the Eastern Anatolia Region during the second term of the 2021–2022 academic year. There were 17 students in the control group and 18 in the experimental group. The study was conducted over five weeks during the 'Electric Circuit Elements' unit. Data were collected using an achievement test, a decision-making skills scale, and semi-structured interviews. The achievement test and decision-making skills scale were administered as pre- and post-tests, while semi-structured interviews were conducted at the end of the study to gather students' opinions on the application. Independent samples t-test and ANCOVA analyses were used to analyze the quantitative data. Qualitative data were analyzed by listening to interview recordings, converting them into written documents, and coding them to identify themes. The achievement test revealed a significant difference in favor of the experimental group compared to the control group. The ANCOVA results, which controlled for pre-test scores on the decision-making scale, indicated a significant improvement in decision-making skills for the experimental group. Qualitative analysis showed that the application positively influenced students' attitudes towards learning and the course.

Keywords: *Academic achievement, Argumentation application, Decision-making skills, Education, Fifth-grade students, Science education.*

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Highlights of this paper

- This study examined the effect of argumentation practices on students' academic achievement and decision-making skills.
- Argumentation practices positively affected students' academic achievement.
- Argumentation practices positively developed students' decision-making skills.

1. INTRODUCTION

Children come into the world like scientists, with a desire to discover what is happening around them. However, this curiosity disappears over the years (Parvanno, 1990), raising the question, "How did they lose this desire?" The low level of science achievement in schools and the lack of motivation among students necessitate action in this area.

Alternatives are needed to understand scientific thinking, and science itself is one such alternative. The aim is to relate the thinking activities of scientists to those of children, adolescents, and adults. While attempting to understand the development of scientific thinking, the focus has previously been on the views reached by scientists. However, the importance of expressing and questioning ideas, clarifying them, and defending them has since been understood, and it has been accepted that there is no scientific method that can be separated from debate and argument. In other words, scientific thinking can also be found in children, adolescents, and ordinary adults. Developing scientific thinking is only possible by establishing a connection between the scientific process and the life processes of ordinary people (Kuhn, 1993). For this reason, using the scientific process is important for scientific thinking.

The fundamental process of science involves constructing and critically evaluating arguments. The significant value of argumentation and its centrality to science education serve two functions. Firstly, it involves students in achieving conceptual goals. Secondly, it makes students' cognitive thinking and reasoning skills visible for assessment by educators. This allows students to consider alternatives (e.g., that heavy objects fall faster) rather than simply accepting scientific theory at face value, which can lead to misunderstandings (e.g., that all objects fall at the same speed). Thus, this approach suggests that securing literacy understanding involves gaining an understanding of why some ideas are incorrect and why others are correct (Osborne, Erduran, & Simon, 2004). Understanding the concept of literacy and achieving its objectives requires an understanding of argumentation practices.

Students participating in discussion applications gain research, reading, and discussion skills while creating new knowledge. This enables them to understand the relationship between science, technology, society, and the environment. (Erduran & Jiménez-Aleixandre, 2007). Furthermore, Erduran states that one reason for implementing global science education reforms and including argumentation in the science curriculum is to educate citizens who are knowledgeable about the social, cultural, economic, and political origins of science. A second reason is to relate argumentation to scientific processes, such as research and practical work, in the context of problematising science based on evidence. International examinations such as TIMSS and PISA have emphasized the importance of argumentation by testing students' ability to coordinate evidence and claims. In particular, the inclusion of argumentation in the PISA framework demonstrates that it is considered an important skill. While the PISA assessment framework does not explicitly use the term "argumentation," it emphasizes the importance of evidence when forming conclusions. Therefore, there is a global consensus on the contribution of argumentation to the construction of scientific knowledge (Erduran & Jiménez-Aleixandre, 2007). Efforts to incorporate argumentation practices, whose importance is also recognized in our country, into the education system began with the 2013 Science Teaching Programme (MEB, 2018), which stated that inquiry-based learning strategies would be adopted.

Kuhn (1992) explains argumentation beyond its dictionary meaning as "a dialogue between two people with opposing views." In this process, each person presents their argument with reasons and develops counterarguments to refute the other's view. Developing debating skills is important in classroom environments with strong social

relationships. Experiences within the school encourage attitudes that require the evaluation of claims and the consideration of alternatives. This skill must be acquired at an early age, at the latest by the end of secondary school. Otherwise, it may not be possible to acquire it at a later age (Kuhn, 1992).

Studies have shown that argumentation practices have positive effects on individuals' various skills and academic achievement (Ecevit & Kaptan, 2019; Kara, Yılmaz, & Kıngır, 2020; Tüysüz & Demirel, 2020; Zorlu & Ateş, 2024). The inclusion of argumentation applications in the teaching program has made it necessary for educators to apply this method within science education and to increase the number of studies conducted in this field. When the studies are examined, it is evident that many skills, such as scientific process skills and 21st-century skills (Demirel, 2021; Ecevit & Kaptan, 2019; Seda & Kirindi, 2020), develop during this process, and decision-making skills also show positive developments. These studies indicate that argumentation practices have a positive effect on decision-making skills and that there is a positive relationship between them (Arduç & Kahraman, 2024; Güler, 2023; Gülhan, 2012; Karcılı & Sevım, 2024; Torun, 2019).

Knowledge will continue to evolve, and individuals will continue to seek knowledge to solve problems and make decisions (Choi, Lee, Shin, Kim, & Krajcik, 2011). One of the aims of science education, which is to cultivate scientifically literate individuals, also includes the expression of individuals with decision-making skills (Bozkurt Altan, 2021; Choi et al., 2011). It can be said that educators understand the necessity of developing decision-making skills, which are among the 21st-century skills and whose importance in learning environments is recognized, and transferring these skills to educational environments. Decision-making has been defined as choosing or preferring one option from among alternative options related to a situation (Işığıçok, 2015). Decision-making, problem-solving, and creative thinking are applied forms of thinking that all people need, and what needs to be done to achieve intellectual leadership is to master the practical thinking processes underlying these processes (Adair, 2017). Another explanation states that decision-making is not just about choosing one option from among alternatives but that it represents a process (Bozkurt Altan, 2021).

The main purpose of decision-making is to take action to solve problems encountered and improve job opportunities. Decision-making is not easy at all; it is a process of finding solutions to problems, changing things that are unsatisfactory by evaluating the past, planning and organizing, and taking action by determining the most appropriate alternative among costly options. Decision-making is a rational activity that does not necessarily lead to a definitive conclusion, but rather involves the process of solving problems (Işığıçok, 2015).

The inclusion of decision-making skills among life skills in the Science Teaching Programme (MEB, 2018) and the statement that the specific objectives include the use of socio-scientific topics and the development of reasoning skills and scientific thinking habits, which also involve decision-making skills, demonstrate the importance of imparting and developing this skill in individuals. The inclusion of this skill in the programme implies that these skills can be developed through science lessons. Considering that science lessons are life itself and that decision-making is part of every stage of our lives, it is impossible to separate the two. For example, when we wake up in the morning, we want to have a nice and healthy breakfast. Even in a simple process such as deciding what to eat for breakfast based on the nutritional content we learn in science class, we can see how closely related these two are..

The decision-making process involves finding a solution to a problem and selecting the most appropriate option. During the argumentation process, students propose solutions to a problem by presenting their arguments, justifying them with evidence, and testing whether their ideas are correct. In other words, students who experience the argumentation process also develop their decision-making skills. Increased research in this area will highlight the importance of argumentation and its impact on students' cognitive skills, as well as demonstrate the necessity of its use in science education. For these reasons, this study aims to examine the effect of argumentation practices on

academic achievement and decision-making skills, given their recognized importance in science education. In line with this aim, the following research questions were examined:

1. What is the effect of argumentation practices on students' academic achievement?
2. What is the effect of argumentation practices on students' decision-making skills?
3. What are the views of students in classes where argumentation practices are implemented regarding these practices?

2. METHOD

2.1. Research Model

A mixed-methods approach was used in this study. Mixed methods, an intuitive research approach, is a method that allows for a much better understanding of the research problem than using a single method by combining quantitative and qualitative data (Creswell & Plano Clark, 2020). In the quantitative part of the study, a quasi-experimental approach was adopted, with a control and an experimental group, and pre-tests and post-tests were conducted on the groups. In the qualitative part of the study, semi-structured interviews were conducted with a portion of students from the control and experimental groups. Thus, qualitative data were used to support quantitative data.

2.2. Participants

The study was conducted with 35 fifth-grade students attending a boarding secondary school in eastern Turkey during the second term of the 2021-2022 academic year. There were 17 students in the control group and 18 students in the experimental group. The students were generally from low socioeconomic backgrounds. The researcher who conducted the study is a science teacher who has carried out numerous applications in the field of argumentation.

2.3. Data Collection Tools

The data collection tools used were a unit achievement test, a decision-making skills scale, and semi-structured interviews. The achievement test and decision-making skills scale were administered to the groups as pre-tests and post-tests. Semi-structured interviews were conducted at the end of the process to obtain the students' views on the course.

2.4. Academic Achievement Test

The academic achievement test was administered to both groups as a pre-test and post-test at the beginning and end of the "Electrical Circuit Components" unit. The test consists of a total of 20 questions, including 15 multiple-choice and 5 open-ended questions. After obtaining expert opinions on the test, the final version was prepared, and Cronbach's alpha reliability coefficient was found to be 0.811 in this study.

2.5. Decision-Making Form

The decision-making form developed by Akdaş (2013) was used to measure decision-making skills. The form contains four situations requiring decision-making in daily life. Six open-ended questions were prepared for each situation, based on the decision-making process: identifying options, gathering information about options, evaluating the possible outcomes of options, indicating the value or importance of options, selecting the most appropriate option, and identifying reasons or evidence for the decision. The decision-making form rubric developed by Akdaş (2013) was used to evaluate the decision-making form. The rubric defines four performance levels: 1 (poor), 2 (average), 3

(good), and 4 (very good). This rubric is a rating scale where the student receives 1 point if they do not decide at all, and their score increases as the number of options increases. Akdaş found the Cronbach's alpha reliability coefficient of the decision-making form to be 0.881. In this study, based on the results of the final decision-making test administered to the students, the Cronbach's alpha reliability coefficient was calculated to be 0.931.

2.6. Semi-Structured Interviews

Semi-structured interviews were conducted with a total of eight students, four from the experimental group and four from the control group, at the end of the process. Within the scope of the study, different questions were prepared for the two groups regarding the lesson delivery process. The experimental group students' thoughts on argumentation practices were sought, while the control group students' views on traditional methods were obtained. The questions were designed to learn about the position of the student and teacher in the lesson process, what was done in the process, and the students' thoughts on teaching in this way. To measure decision-making skills, questions were adapted to the students' level and directed at them to identify the dimensions of decision-making, the source of decision-making, whether a decision was made, and if so, the reasons for it.

3. APPLICATION

The study was conducted in the second semester of the 2021-2022 academic year at a secondary school in a district of Van. The application was carried out over a five-week period in the 5th-grade "Electricity and Circuit Elements" unit. Two classes were determined for the experimental and control groups in the application. A unit achievement test and a decision-making skills scale were administered as pre-tests to both groups before the application. Lessons with the control group were conducted using traditional methods, where the teacher explained the subject and questions related to the subject were solved. An example activity was first carried out with the experimental group students to understand the question-claim-evidence triad in the argumentation process. Subsequently, four argumentation activities prepared for each learning outcome were implemented in the classroom. At the end of each activity, students completed an ATBÖ experiment report. At the end of the unit, all students took a post-test consisting of a success test and a decision-making skills scale as a final test. Semi-structured interviews were conducted with four students selected from each group at the end of the implementation.

4. DATA ANALYSIS

4.1. Academic Achievement Test

The SPSS 22 program was used to analyze the test results. The groups showed a normal distribution in the analyses. Therefore, an independent samples t-test was used to analyze whether there was a difference between the academic achievement pre-test results of the experimental and control group students, and the mean and standard deviation values were calculated. Similarly, whether the post-test results for academic achievement differed between the two groups was compared using an independent samples t-test, and the mean and standard deviation values were calculated.

4.2. Decision Form

The decision-making form was scored according to the rubric developed by Akdaş (2013). Since the experimental and control groups showed a normal distribution, an independent samples t-test was used to examine whether there was a difference between the pre-tests and post-tests of the decision-making form for the groups. Although the decision-making pre-test analysis results showed no statistically significant difference between the two groups, a

covariance (ANCOVA) analysis was performed for the decision-making post-test to prevent the effect of other variables from interfering with the analysis results, despite the difference between the means.

4.3. Semi-Structured Interviews

The interviews were analyzed using the thematic analysis method. The interviews were recorded with a voice recorder, and the voice recordings were transcribed into written documents. The transcriptions were then coded, and themes were developed based on these codes.

5. FINDINGS

5.1. Quantitative Findings

5.1.1. Academic Achievement Test

5.1.1.1. Pre-Test

The results of the independent samples t-test conducted to determine whether there was a significant difference between the groups based on the electricity unit pre-test results are presented in Table 1.

Table 1. Independent samples t-test findings of the academic achievement pre-test.

Application groups	N	Mean	Std. Deviation	df	t	p
Experiment	23	34.78	3.03	40	0.643	0.524
Control	19	32.05	2.89			

According to the results of the independent samples t-test, there was no significant difference between the experimental and control group students in the academic achievement pre-test ($t=0.643$, $p>0.05$).

5.1.1.2. Post-Test

The t-test results, conducted to examine whether there was a significant difference between the groups based on the post-test results, are presented in Table 2.

Table 2. Independent samples t-test findings for the academic achievement post-test.

Application groups	N	Mean	Std. Deviation	df	t	p
Experiment	16	74.37	11.41	31	5.447	0.000
Control	17	48.41	15.51			

According to the results of the independent samples t-test, a significant difference in favor of the experimental group was observed between the experimental and control group students in the final academic achievement test ($t=5.447$, $p<0.05$).

5.1.2. Decision Making

5.1.2.1. Pre-Test

The results of the independent samples t-test conducted to determine whether there was a significant difference between the groups based on the pre-test results of the decision-making form are presented in Table 3.

Table 3. Independent samples t-test findings of the decision-making form pre-test.

Application groups	N	Mean	Std. Deviation	df	t	p
Experiment	21	51.57	10.50	38	-0.429	0.671
Control	19	52.78	6.90			

Although no significant difference was observed between the experimental and control groups based on the pre-test analysis results of the decision-making form ($t=-0.429$, $p>0.05$), the control group's score was higher than that of the experimental group when looking at the averages.

5.1.2.2. Post-Test

Although the pre-test analysis results of the decision-making form showed no significant difference between the groups, there was a difference between the means. Covariance (ANCOVA) analysis was performed to prevent other variables from affecting the test results. According to the analysis results, the mean and adjusted mean scores of the groups are given in Table 4, and the ANCOVA analysis results are given in Table 5.

Table 4. Findings related to the final test of the decision-making form.

Application groups	N	Mean	Adjusted mean
Experimental	18	57.22	58.84
Control	20	51.85	50.98

Table 5. ANCOVA findings related to the final test of the decision-making form.

Source of variation	Sum of squares	df	Mean square	F	p	η_p^2
Decision-making pre-test	1858.025	1	1858.025	129.991	0.000	0.791
Group	532.479	1	532.479	34.674	0.000	0.520
Error	491.416	32	15.357			
Total (Adjusted)	2675.600	34				

When examining Table 5, which presents the results of the ANCOVA test, conducted by controlling for the pre-test results of the decision-making form, showed a significant difference in favor of the experimental group between the groups ($F=34.674$, $p<0.05$, $\eta_p^2=0.520$).

5.2. Qualitative Findings

5.2.1. Findings From Interviews With The Control Group

Interviews were conducted with four students randomly selected from the control group, where lessons were taught using traditional methods. The interview questions were designed to evaluate both the lesson delivery process and decision-making skills. The information obtained from the interviews regarding the experimental group, along with codes and frequencies for each theme, is presented in Table 6.

Table 6. Themes, codes, and frequencies of control group student interviews.

Topic	Sub-theme	Codes	Frequency
Process		Conducting experiments	4
		Writing	4
		Having fun	2
Teacher role		Explaining the topic	4
		Aktif	4
		Telling students what to do (Giving commands)	1
		Guide	1
Student role		Striving to learn	2
		Activity	2
		Listens to and follows the teacher's instructions	1
Decision making	Decision making dimension	Identifying options	4
		Awareness	2
		Evaluating/Reviewing options	1
	Decision making source	Authority	4
		Internet	4
		Peer	2
	Decision making	Yes	4
	Justification	Entertainment	4
		Age appropriateness	1

Table 6 shows that each student in the control group, where the unit was taught using traditional methods, viewed the lesson process as a series of conducting experiments and writing. Two students stated that the lessons were enjoyable. In parallel with this process, according to each student in this group, the teacher was in a position of explaining the subject and being active. It is observed that this activity refers to an activity based on explaining the subject and telling the student what to do. Moreover, this situation is described as guidance. Student Ö5 explained this situation with the sentence, *"My teacher explains the subject to us and solves problems,"* and student Ö8 explained it with the sentence, *"Teacher, you're doing an experiment."* The students' roles are described as striving to learn, being active, listening to instructions, and following them. Overall, we see student roles that reflect the traditional process. An important finding in the interviews with the students in the control group is that the students gave short answers. For example, one student used the following statements when explaining this process: *"My teacher explains the subject to us and solves problems. We also do what the teachers say and listen to them."*

After evaluating the lesson process, the answers given to questions aimed at measuring decision-making skills were assessed. While all students could identify the options in the decision-making process, two students were aware of the options, and one student gave an answer appropriate to the option evaluation stage. In addition to identifying authority and the internet as sources of decision-making, two students mentioned peers. It was determined that all students concluded the decision-making process with a decision. Moreover, while all four emphasised enjoyment as a single criterion in making this decision, student Ö7 also emphasised age appropriateness, explaining this situation with two reasons in the following sentence: *"There are animated cartoon characters. So, there are people who are more enthusiastic and such, who are not appropriate for our age, and I don't like them at all; I like the child characters and such better."*

5.2.2. Findings From The Interview With The Experimental Group

The information obtained regarding the experimental group as a result of the interview, along with the codes and frequencies for each theme, is presented in Table 7.

Table 7. Themes, codes, and frequencies of the experimental group students' views.

Theme	Sub-theme	Codes	Frequency
Process		Learning	4
		Experimentation	4
		Enjoyment	3
		Concretisation	2
	Small group decision	Exchange of ideas	4
		Discussion/persuasion	4
		Justification	1
	Large group decision	Presenting evidence	4
		Defence	4
		Rebuttal	3
		Self-awareness/Self-assessment	2
Teacher Role		Guidance	4
		Active	4
		Question Asker	2
Student role		Active in the Process	4
Changes in the student		Learning	4
		Positive Attitude	4
Challenges		Inability to find the correct answer	2
		Formulating a claim	2
		Inability to establish a circuit	2
The situation of requesting the sustainability of the application		Yes	4
	Reason	Learning	4
		Individual activity	3
		Positive attitude	3
		Increased success	1
Decision-making	Decision-making dimensions	Awareness	4
		Identifying options	4
		Evaluating/reviewing options	4
	Decision-making source	Authority	4
		Internet	4
		Expert	2
		Peer	1
		Monitoring for preliminary assessment	1
	Decision-making	Yes	4
	Justification	Entertainment	4

5.2.3. Thoughts on Implementation

Table 7 shows that when describing the lesson process, the experimental group students stated that the process was made concrete through argumentation activities, that learning took place through these activities, that experiments were conducted as part of the nature of the process, and that they enjoyed themselves as a result.

This process facilitated the students' learning. For example, one student (Ö1) described this situation with the following statements: *"When I read it from the notebook or book, I didn't understand it, but I learned that it was easier to understand by doing activities and experiments."* The student coded as Ö2 stated that they were constantly exchanging ideas with their teachers during the process and that they enjoyed learning because they were involved in the process. All students stated that they enjoyed the process, reached the answer themselves, and made an effort to do so. During this process, the students held small and large group discussions. In particular, in the small group, they carried out the peer teaching process by sharing ideas one-on-one and persuading each other. Student Ö2 expressed this as follows: *"We all presented our ideas and reached a common idea."* A similar process occurred during the large group discussions, where students defended their own thoughts against their peers, presented evidence, attempted to refute opposing views, and even changed their own thoughts when necessary through self-evaluation. For example, student

Ö1 clearly emphasised what happened in the process with the statement, *"We learned our mistakes while explaining our claims and evidence,"* while student Ö2 stated, *"We defended our thoughts"* and *"We learned whether our thoughts were right or wrong."* While student Ö1 indicated that they had difficulty finding the correct answer and forming their claims during the process, students Ö2, Ö3, and Ö4 stated that they had difficulty setting up the circuit.

The experimental group students saw the teacher as a guide, active, and asking questions, and expressed themselves actively. In other words, the teacher guided the students in the process by asking them questions to help them form their claims and prepare their justifications, while also maintaining constant communication with the students in an active manner. The students also actively participated in the process to form their own ideas both within and between groups and to justify them. The students described what they and their teacher did as follows:

Ö2: "We discussed with our groupmates. We exchanged ideas. We conducted experiments with circuit components, and you asked us questions."

Ö3: "He tried to help us while we were conducting experiments. We were trying to find the answers ourselves. He would say, 'If you did this, how would it work?'… We would gather among our friends and ask these questions."

When asked about the changes in themselves at the end of the process, all students stated that they had learned the subject and developed a positive attitude towards the lesson. For example, student Ö2 stated that they would want to study more, would like science lessons more, and would be more connected to science lessons. The student with the code Ö3 stated that the lessons where the application was used were more enjoyable than the previous lessons and that they learned things they did not know in daily life. The student with the code Ö4 stated that the topic covered was more relevant to life through the activities. When the students were asked if they wanted other topics to be covered using argumentation applications, all students answered *"Yes"*. Student Ö3 stated, *"We should always do these kinds of activities; they are suitable for every topic,"* while student Ö4 said, *"In the other lessons, you were explaining and we were answering, but these lessons are more fun and we are more motivated."* When asked for the reasons behind these answers, the students stated that they were active in the process, developed a positive attitude towards the course, and that learning took place as their course success increased. Examples from student statements are given below:

Ö1: "Because I understand better here, I think it is better. I believe science lessons contribute more to me. Now, sir, we are more active."

Ö2: "I am more attached to science lessons. My interest has increased."

5.2.4. Thoughts on Decision-Making Skills

When the questions regarding decision-making skills were evaluated after the application, it was observed that all students utilized the stages of the decision-making process: awareness of the stages, identifying options, and evaluating options. For example, student Ö1 demonstrated awareness by stating, *"I look at whether it's boring or not boring."* Student Ö2 demonstrated identification by stating, *"Action and animation,"* expressing different options. Student Ö4 demonstrated the ability to evaluate options by stating that they would choose a film appropriate for their age. While authority and the internet were the most frequently used decision-making sources, experts, peers, and previewing were mentioned as other decision-making sources. Each student linked the decision-making process to a decision, citing enjoyment as the reason for making that decision. For example, student Ö1 explained the situation with the statement, *"Sir, because I think it's much more fun,"* while student Ö2 stated, *"Sir, I enjoy action more, I'm more interested in action."*

6. DISCUSSION AND CONCLUSION

The main objective of this study is to examine the effect of argumentation practices on students' academic achievement and decision-making skills. The results obtained show that argumentation practices increase students' academic achievement and have a positive effect on their decision-making skills.

Argumentation practices are a teaching method that can be applied to equip students with 21st-century skills (Ecevit & Kaptan, 2019). Students who engage in the argumentation process develop their communication skills through group discussions and become more eager to participate in class. Students can participate in discussions without hesitation in expressing their ideas. This is because their teachers, who guide them through the process, frequently remind them that generating ideas, even if they are wrong, is important in reaching scientific knowledge. Thus, students experience the process of forming scientific knowledge by discussing their ideas and arriving at the truth (Uluay & Aydın, 2018). This process, which facilitates learning, increases the retention of information and develops multi-faceted thinking skills (Demirel, 2021). Studies conducted on this subject have also shown that argumentation practices have a positive effect on course success and many skills (Bozkurt & Doğru, 2016; Kara et al., 2020; Seda & Kirindi, 2020; Tüysüz & Demirel, 2020; Zorlu & Ateş, 2024). In addition to increasing students' science achievement, it has also ensured that they develop a positive attitude towards the subject (Günel, Memiş, & Büyükkasap, 2010). This study also supports the positive effect of argumentation practices on students' academic achievement. The inclusion of argumentation in the curriculum indicates that the importance of these practices is recognized.

Decision-making skills, which are among the 21st-century skills, are a prerequisite for acquiring other skills (Torun, 2019). One effective practice in acquiring this skill is argumentation exercises. In lessons involving argumentation exercises, students develop their decision-making skills along with their thinking skills. The process also enhances students' social skills, ensuring their participation in the process and its connection to daily life (Seda & Kirindi, 2020). Students experiencing the argumentation process need to use their decision-making skills to resolve the dilemmas they face (Arduç & Kahraman, 2024). Therefore, the argumentation process also involves the decision-making process. The more students experience the argumentation process, the more their decision-making skills will develop (Karcılı & Sevım, 2024). In this study, when the final test results of the decision-making form were examined, a significant difference in favor of the experimental group was observed. Other studies examining the effect of argumentation practices on decision-making skills have also concluded that there is a positive relationship between argumentation practices and decision-making skills (Gologlu, 2009; Gügük, 2019; Güler, 2023; Gülhan, 2012; Karcılı, 2022; Kardaş, 2013).

At the end of the study, interviews were conducted to learn the thoughts of the control and experimental group students about the process. The interview questions included argumentation activities for the experimental group, while questions about the lesson delivery process and decision-making skills were directed at both groups. The control group viewed the process as experimenting and writing, stating that the teacher was active, guided them, and that they made an effort to learn. The experimental group students stated that experiments were conducted during the process and that learning also took place during the process. They stated that their teachers were active and guiding, and that they themselves were active and developed a positive attitude towards the lesson. Seda and Kirindi (2020) supported these findings with their research, indicating that argumentation-based science teaching enhances students' attitudes and motivation towards the lesson.

In argumentation applications, students have the opportunity to develop social communication skills such as working in groups, understanding how to act within a group, and being part of a group, in addition to individual work. Seda and Kirindi (2020) also made statements supporting the idea that argumentation practices develop

teamwork, cooperation, and communication skills. Thus, even the quietest and most introverted children were included in the process and spoke up.

When the students in the experimental group were observed during and after the argumentation activities, it was seen that they made an effort to convince themselves first, then their group mates, and if they were sure they had reached the right idea, other groups by presenting all their evidence in order to find the correct information through research. If they saw that they had reached the correct information by convincing the other groups, they assimilated and embraced this information, and since they considered it their own, the information was learned in a lasting way.

As the subject was presented through activities related to daily life, the students' attention was captured at the beginning of the process. Students who were reluctant to attend the lesson had caused disciplinary problems in previous lessons, but apart from noise issues arising from group discussions during the activities, no disciplinary problems were experienced. The students interviewed expressed their satisfaction with this situation.

Argumentation practices have such benefits, as seen in our study and literature research. The fact that it is now almost mandatory to include them in the science teaching programme and science education has given importance to studies in this field.

7. RECOMMENDATIONS

This study was conducted to examine the effect of argumentation practices on academic achievement and decision-making skills. It was limited to a specific class level and unit. Argumentation practices could be prepared for other class levels and units, thereby expanding the scope of the study. Again, the study was conducted at the school where the researcher works. The study could be conducted in other provinces and schools to see the results in other schools and cultures.

The study was conducted over a five-week period within a single unit. Conducting argumentation practices over a longer period would naturally lead to more effective results in developing a skill. This is particularly important as the development of thinking and metacognitive skills requires a process.

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