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# Sosyo-Bilimsel Konularda Argümantasyon Temelli Öğrenme ve P4C Yaklaşımı: Yedinci Sınıf Üzerine Bir Çalışma

**Öz:** Bu çalışma, yedinci sınıf öğrencilerine sosyobilimsel konuların öğretiminde argümantasyon temelli bir öğrenme ve P4C yaklaşımı etkililiğini incelemiştir. Toplam 23 öğrenci ile geliştirilen dokümanlar ile öğrenme etkinlikleri ile fen bilimleri dersi işlenmiştir. Çalışma bir akademik yıl boyunca sürmüştür. Yarı deneysel bir çalışma olmasına rağmen bu makale de sadece nitel verilerin analizi yapılmış ve sunulmuştur. Nitel veriler, deney grubundaki öğrencilerle akademik yılın sonunda bireysel görüşmeler yoluyla toplanmış ve tematik analiz kullanılarak veriler analiz edilmiştir. Çalışmanın sonuçları, P4C ve argümantasyon temelli öğrenme yaklaşımının öğrencilerin argüman geliştirme, kanıta dayalı düşünme ve karar verme becerilerini geliştirmede etkili olduğunu göstermiştir. Verilerden ortaya çıkan temalar arasında geliştirilmiş eleştirel düşünme becerileri, artan ilgi ve motivasyon ve sosyobilimsel konuların karmaşıklığına ilişkin daha büyük farkındalık yer almıştır. Bu çalışmanın bulguları, argümantasyon temelli öğrenme yapılan önceki araştırmalarla uyumludur. Çalışma, fen eğitiminde P4C ve argümantasyon temelli öğrenme yaklaşımlarının dahil edilmesinin öğrencilerin eleştirel düşünme becerilerini artırmasına ve gerçek dünya bağlamında bilinçli kararlar almalarına hazırlamasının önemini vurgulamaktadır.
**Anahtar Kelimeler:** Argümantasyon Tabanlı Öğrenme, P4C, Sosyobilimsel Konular, Fen Eğitimi, Veri Analizi

**Güler, O., Şengül, A. A. (2023), Argumentation-Based Learning and P4C Approach: A Seventh-Grade Study on Socio Scientific Issues. Kaygı. Bursa Uludağ Üniversitesi Fen-Edebiyat Fakültesi Felsefe Dergisi, 22 (3), 457-481.**
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# Argumentation-Based Learning and P4C Approach: A Seventh-Grade Study on Socio-Scientific Issues

**Abstract:** This study examined the effectiveness of argumentation-based learning and the P4C (Philosophy for Children) approach in teaching socioscientific topics to seventh-grade students. The study involved a total of 23 students and utilized developed materials and learning activities to teach science subjects. The research spanned an entire academic year. Although it was a semi-experimental study, this article focuses solely on the analysis and presentation of qualitative data. Qualitative data were collected through individual interviews with students in the experimental group at the end of the academic year, and thematic analysis was used to analyze the data. The results of the study indicated that the P4C and argumentation-based learning approach were effective in enhancing students' argumentation skills, evidence-based thinking, and decision-making abilities. Themes emerging from the data included improved critical thinking skills, increased interest and motivation, and greater awareness of the complexity of socioscientific topics. These findings align with previous research on argumentation-based learning. The study underscores the importance of incorporating P4C and argumentation-based learning approaches in science education, as they prepare students to enhance their critical thinking skills and make informed decisions in real-world contexts.
**Keywords:** Argumentation-Based Learning, P4C, Socioscientific Issues, Science Education, Data Analysis

## Introduction

In recent years, science education has seen a growing emphasis on equipping students with critical thinking skills and the ability to make informed decisions about complex socio-scientific issues. Recognizing the significance of fostering these skills at an early stage, educational researchers have explored innovative teaching approaches that go beyond traditional methods. One such approach gaining traction is the integration of argumentation-based learning and Philosophy for Children (P4C) in science education. The present study delves into the effectiveness of the argumentation-based learning and P4C approach in teaching socio-scientific issues to seventh-grade students. The focus lies on empowering students to engage deeply with real-world problems, analyze evidence, and construct sound arguments, thereby enabling them to make informed decisions. This study seeks to contribute to the existing body of knowledge on effective pedagogical strategies for nurturing critical thinking and decision-making skills among young learners. The interdisciplinary nature of socio-scientific issues necessitates a comprehensive understanding that extends beyond factual knowledge. Embracing a holistic approach, argumentation-based

learning encourages students to explore various viewpoints, appreciate the complexities of societal challenges, and critically assess the implications of scientific advancements. P4C, on the other hand, provides a philosophical thinking for students to engage in meaningful discussions, articulate their thoughts, and develop empathy for differing perspectives. To investigate the impact of this combined approach, the study involved 23 seventh-grade students who were exposed to argumentation-based learning activities throughout the academic year. Qualitative data were collected through individual interviews with students, and thematic analysis was employed to discern patterns and insights from the data. In the forthcoming sections, this article will delve into the thematic analysis, presenting the key themes that emerged from the students' experiences. It will shed light on how the argumentation-based learning and P4C approach influenced students' understanding of socio-scientific issues and contributed to the development of their decision-making skills. Furthermore, the study will explore the practical applications of this approach through examples of students using argumentation-based learning to make informed decisions on relevant socio-scientific topics. As the importance of equipping students with critical thinking abilities and ethical decision-making skills becomes ever more evident in today's complex world, this study aims to provide valuable insights for educators, curriculum designers, and policymakers. By fostering active and informed citizens who can navigate global challenges with thoughtful consideration, the argumentation-based learning and P4C approach offer promising implications for science education and beyond.

## 1. Literature Review

### 1.1. Argumentation-Based Learning (Abl)

In science education, argumentation-based learning (ABL) is an approach that helps students develop critical thinking and reasoning skills by engaging them in the process of constructing and evaluating scientific arguments. ABL is

particularly effective in teaching students how to think like scientists, as it encourages them to consider evidence, make claims, and justify their reasoning. In ABL, students are presented with a scientific question or problem, and then asked to develop an argument in response. They must gather evidence, evaluate the strength of that evidence, and use it to support their argument. This process helps students develop skills in scientific inquiry, data analysis, and logical reasoning. One of the key benefits of ABL in science education is that it helps students develop a deeper understanding of scientific concepts and principles. By engaging in argumentation, students are forced to confront their preconceptions and consider alternative viewpoints, which can lead to a more nuanced understanding of the subject matter (Osborne vd. 2003). Furthermore, ABL can also help students develop communication skills, as they must present and defend their arguments to their peers. This can be especially valuable in collaborative learning environments, where students must work together to construct a convincing argument. Overall, argumentation-based learning is an effective approach to science education that can help students develop critical thinking, reasoning, and communication skills. It provides a framework for students to engage with scientific concepts in a meaningful and productive way, which can ultimately lead to a greater understanding and appreciation of science (Erduran & Dagher 2014; Osborne vd. 2003).

In addition to the benefits mentioned earlier, ABL has several other advantages in science education. These include:

1. Increased engagement: ABL allows students to take an active role in their learning by encouraging them to explore and evaluate scientific concepts. This can increase engagement and motivation, as students feel more invested in the learning process.
2. Improved retention: By engaging in argumentation, students are more likely to remember and retain the scientific concepts they have learned.

This is because they have had to actively engage with the material and apply it to real-world situations.

3. Better assessment: ABL provides teachers with a more authentic way to assess student learning. Instead of simply regurgitating information, students must demonstrate their understanding by constructing and defending arguments. This allows teachers to assess not only what students know, but also how well they can apply that knowledge.
4. Preparation for future careers: ABL helps prepare students for careers in science, technology, engineering, and math (STEM) fields. These fields require critical thinking, problem-solving, and the ability to communicate complex ideas to others all skills that are developed through ABL. These are just a few examples of how argumentation-based learning can be used to teach socio-scientific issues in science lessons. By engaging with authentic scientific practices and exploring real-world problems, students can develop a deeper understanding of the role of science in society and the ways in which scientific knowledge can be used to address complex and controversial issues (Erduran & Dagher 2014; Osborne vd. 2003).

### 1.2. Socioscientific Issues (SSI)

Overall, argumentation-based learning is a powerful tool for science educators. By engaging students in the process of constructing and evaluating scientific arguments, ABL helps develop critical thinking, reasoning, communication, and other important skills that are essential for success in science and beyond. Socio-scientific issues (SSI) are complex and controversial societal problems that have significant scientific components. These issues are relevant to science education because they provide an opportunity for students to engage in authentic scientific inquiry while also developing their ability to make informed decisions about social and scientific issues. Some examples of SSI include climate change, genetic engineering, stem cell research, and food safety in science

education, SSI-based learning involves exploring and investigating real-world problems that have scientific and societal dimensions. This approach promotes students' critical thinking skills, scientific literacy, and their ability to communicate effectively about science-related topics. Teachers can use SSI-based teaching to enhance students' understanding of the nature of science and how science intersects with society (Brossard & Lewenstein 2010; Osborne vd. 2003). In addition to developing students' scientific literacy, SSI-based teaching also supports the development of their citizenship skills. This approach emphasizes the importance of making informed decisions based on evidence, ethical considerations, and societal values. By engaging with SSI, students can learn to participate in meaningful dialogue and take action on complex issues that affect their lives and the world around them. Socio-scientific issues can be used to teach a wide range of science concepts and skills, including biology, chemistry, physics, and environmental science. By exploring SSI, students can develop their ability to ask questions, design experiments, analyze data, and evaluate scientific evidence. They can also learn how to recognize and analyze the social, political, and economic factors that influence science and technology (Gibson 2015; Lelliott & Rollnick 2010).

One of the challenges of teaching with SSI is that these issues are often complex, controversial, and emotionally charged. This requires teachers to create a safe and respectful learning environment where students can express their views and engage in constructive dialogue with others who hold different perspectives. Teachers also need to help students develop skills for critically analyzing sources of information and evaluating claims about science and society. There are various SSI frameworks that teachers can use to guide their instruction. One such framework is the 6E model, which involves engaging students with the issue, exploring multiple perspectives, explaining scientific concepts, elaborating on the issue, evaluating evidence, and empowering students to take action. Other frameworks include the Socio-Scientific Issues-Based Decision-Making Model

(SSIDMM) and the Socioscientific Issues Framework (SSIF). Overall, teaching with SSI provides a valuable opportunity for students to develop their scientific literacy and citizenship skills by engaging with real-world problems that have significant scientific and societal dimensions (Brossard & Lewenstein 2010; Sadler vd. 2011).

### 1.3. P4C (Philosophy for Children) Education

P4C is an approach that involves engaging children in the thinking process, encouraging them to ask philosophical questions, and expressing their own thoughts. This process allows children to think deeply, consider various perspectives, and defend their ideas. As a result, children begin to understand their thinking process and develop their own consciousness. P4C teaches children critical thinking skills, including logical reasoning, constructing arguments, presenting evidence, and evaluating different viewpoints. These skills enable children to approach information critically and distinguish reliable knowledge. P4C also fosters ethical evaluation. It provides students with opportunities to think about ethical issues and engage in discussions. This helps children understand their values, explore different ethical perspectives, and become more constimulatescious and responsible individuals. Implementing P4C encourages collaboration and communication in the classroom. Students learn to listen to and understand different ideas while effectively expressing their own thoughts. This cultivates better communication and teamwork skills. One of the advantages of P4C is that it grants children the freedom to think and express their ideas. This boosts their self-confidence, allows them to articulate themselves better, and provides them with the opportunity to contribute with unique thoughts. In conclusion, P4C is an effective educational approach that enhances critical thinking, logical reasoning, ethical evaluation, collaboration, and communication skills in children. By engaging in P4C, children become more profound, critical thinkers, empathetic, and problem-solving individuals. They learn to ask philosophical questions, think critically, and express their thoughts to others. P4C

encourages students to explore their thinking, develop their unique perspectives, and make informed decisions. It creates a foundation for their future achievements. Introducing philosophical questions at the beginning of science lessons or during topic transitions stimulate students thinking and encourages reflection. For instance, posing questions like "How do plants grow and develop?" or "What can we infer from the data obtained in this experiment?" prompts students to engage with the subject matter on a deeper level. Creating small discussion groups for philosophical debates allows students to express their ideas, share thoughts, and assess different viewpoints related to science topics. This group interaction fosters critical thinking and effective communication. Integrating P4C into science experiments involves asking students philosophical questions about their experimental findings. For example, inquiring about the assumptions supported or challenged by the results or exploring the philosophical implications behind their observations enhances their analytical thinking skills. Emphasizing ethical and sustainability aspects in science discussions encourages students to reflect on the consequences of scientific and technological advancements on nature, the environment, and society. Addressing ethical dilemmas prompts them to question their values and think critically. Challenging students with philosophical questions related to real-world problems, such as combating climate change or addressing ethical concerns about sustainable energy sources, stimulates their critical thinking abilities. Overall, incorporating P4C in science education not only deepens students' grasp of scientific concepts but also cultivates their critical thinking, communication, and ethical decision-making abilities. Encouraging students to explore philosophical questions and participate in thoughtful discussions nurtures their holistic development, making them reflective individuals who can ethically apply their scientific knowledge in practical situations (Bybee 2014; Liu 2017).

### 1.4. Argumentation-Based Learning and P4C Education on Socio-Scientific Issues (SSI)

Argumentation-based learning is a powerful approach to teaching socio-scientific issues (SSI) in science education. This approach emphasizes the development of students' critical thinking, communication, and argumentation skills, as well as their ability to make informed decisions based on scientific evidence and societal values (Kelly & Chen 1999). In argumentation-based learning, students engage in structured discussions and debates about SSI. They analyze scientific evidence, consider multiple perspectives, and make evidence-based arguments to support their positions. Teachers facilitate these discussions by providing relevant resources, guiding questions, and feedback on students' arguments (Erduran & Dagher 2014). Argumentation-Based Learning and Philosophy for Children (P4C) education are two effective approaches for addressing socio-scientific issues in education. Both methodologies promote critical thinking, decision-making, and ethical evaluation skills in students, enabling them to engage meaningfully with complex real-world problems. Argumentation-Based Learning focuses on teaching students to construct arguments, use evidence-based reasoning, and make informed decisions. When applied to socio-scientific issues, this approach encourages students to analyze diverse perspectives, evaluate evidence, and defend their viewpoints logically. By engaging in argumentation about socio-scientific topics, students develop a deeper understanding of the complexities involved and become better equipped to participate in informed debates and decision-making processes. On the other hand, P4C education involves encouraging students to explore philosophical questions and engage in thoughtful discussions. When integrated with socio-scientific issues, P4C prompts students to contemplate the ethical dimensions, social implications, and potential consequences of scientific advancements or environmental challenges. This approach nurtures students' empathy, moral reasoning, and sense of responsibility in addressing these issues. By combining Argumentation-Based Learning and P4C education, students benefit from a comprehensive learning experience. They learn how to analyze scientific data, construct well-reasoned

arguments, and critically evaluate various perspectives. Simultaneously, they develop their ethical and moral thinking by pondering philosophical questions related to socio-scientific problems.

Furthermore, both approaches foster collaboration and effective communication, as students are encouraged to share their ideas, actively listen to others, and engage in respectful dialogues. Through cooperative learning environments, students gain a deeper appreciation for the value of diverse opinions and the importance of open-mindedness when dealing with complex socio-scientific issues. In conclusion, incorporating Argumentation-Based Learning and P4C education in the context of socio-scientific issues provides students with a powerful platform for developing critical thinking, ethical reasoning, and decision-making skills. As students grapple with real-world challenges and explore philosophical dimensions, they become more active and informed citizens, ready to tackle complex societal and scientific dilemmas with empathy, criticality, and integrity.

## 2. The Significance of the Study

This study holds paramount importance as it delves into the integration of Argumentation-Based Learning and the Philosophy for Children (P4C) approach in teaching socio-scientific issues to seventh-grade students. By investigating the impact of these two innovative methodologies on students' learning outcomes, critical thinking skills, and decision-making abilities, the research contributes valuable insights to the field of science education.

Firstly, this study addresses a crucial aspect of contemporary education by focusing on socio-scientific issues. As the world faces increasingly complex and interconnected challenges, equipping students with the necessary skills to analyze and engage with such issues becomes imperative. Socioscientific issues (SSI) can be incorporated into all of the in-class activities I mentioned earlier as a means to engage students in real-world issues related to science and technology. SSIs are

complex, multifaceted issues that require critical thinking, scientific reasoning, and ethical considerations, making them ideal topics for decision-making activities in the classroom. For example, in a case study activity, students could analyze a real-world SSI such as the use of genetically modified organisms in agriculture, and evaluate the potential benefits and risks associated with this technology. This could involve considering scientific evidence, ethical concerns, and practical implications for food production and sustainability. Similarly, in a simulation or role-playing activity, students could engage in a debate or negotiation related to an SSI such as climate change policy or renewable energy development. This would require students to consider different perspectives, weigh evidence, and make informed decisions based on the available information (Kolstø 2006; Osborne vd. 2003). In a collaborative problem-solving activity, students could work together to identify potential solutions to an SSI such as the management of plastic waste or the development of sustainable transportation systems. This would require students to consider multiple factors such as scientific feasibility, economic viability, and ethical implications. By incorporating SSIs into decision-making activities in the classroom, students can develop their critical thinking, scientific reasoning, and ethical decision-making skills in a meaningful and engaging way, while also learning about important real-world issues related to science and technology. The integration of Argumentation-Based Learning and P4C not only allows students to develop a deeper understanding of these socio-scientific topics but also nurtures their ability to critically evaluate evidence, consider multiple perspectives, and make informed decisions.

Secondly, the study contributes to the existing literature on argumentation-based learning and its implications for science education. By extending the application of this approach to socio-scientific contexts, the research adds to the growing body of evidence supporting the efficacy of argumentation-based learning in fostering students' argumentation skills and evidence-based thinking. Furthermore, the study sheds light on the potential benefits of integrating

philosophical discussions through P4C, enhancing students' ethical reasoning and sense of social responsibility in addressing socio-scientific dilemmas. The findings of this study are anticipated to have significant implications for science educators, curriculum designers, and policymakers. Educators can glean valuable insights into effective instructional strategies for teaching socio-scientific issues, encouraging critical thinking, and fostering ethical decision-making among students. Curriculum designers may consider incorporating argumentation-based learning and P4C approaches in science curricula to promote more comprehensive and engaging learning experiences. Policymakers can be informed about the potential benefits of integrating these methodologies in science education, thus supporting evidence-based educational reforms.

Ultimately, this study's significance lies in its potential to contribute to the holistic development of students as active and informed citizens capable of addressing real-world challenges with thoughtfulness and ethical consideration. By promoting critical thinking and decision-making skills within the context of socio-scientific issues, this research endeavors to prepare the next generation of individuals to tackle complex societal problems and contribute positively to the global community.

## 3. Problem Questions

1. What are the effects of argumentation-based learning and P4C approach on seventh-grade students' argumentation, evidence-based reasoning, and decision-making skills when learning socioscientific issues?
2. What are the themes that emerged from the qualitative data collected through individual interviews with seventh-grade students who received argumentation-based learning and P4C approach and how do these themes support the effectiveness of the approach?

## Method

The study employed a quasi-experimental design in which 23 seventh-grade students were randomly assigned to either an experimental group or a control group. The participants in this study were 23 seventh-grade students (10 girls and 13 boys) from a public middle school in Bursa. The school was affiliated with the Ministry of National Education and provided education according to the national curriculum. The study lasted for one academic year, during which the experimental group received the argumentation-based learning approach to teaching socioscientific issues. The control group received traditional instruction on the same topics. The argumentation-based learning and P4C approach involved presenting students with socioscientific issues and facilitating classroom discussions that focused on argumentation, evidence-based reasoning, and decision-making skills. The approach was implemented through a series of 10 lessons, each lasting for 45 minutes, which were integrated into the regular science curriculum.

The experimental group received the argumentation-based learning and P4C approach, while the control group received traditional instruction. The study lasted for one academic year, during which the experimental group received a series of 10 lessons integrated into the regular science curriculum. The control group received the same number of science lessons but did not receive the argumentation-based learning and P4C approach. Qualitative data was collected through individual interviews with the students in the experimental group at the end of the academic year. Thematic analysis was used to analyze the data and identify themes that emerged from the students' experiences with the argumentation-based learning approach. The study's research design allowed for a comparison of the effectiveness of the argumentation-based learning and P4C approach with traditional instruction in enhancing students' argumentation, evidence-based reasoning, and decision-making skills. The use of qualitative data

collection and analysis methods also provided rich insights into the students' experiences with the argumentation-based learning and P4C approach and allowed for a more nuanced understanding of the approach's impact on their critical thinking skills and engagement with socioscientific issues. Materials and Procedures: The study used an argumentation-based learning approach to teach socioscientific issues to the experimental group, while the control group received traditional instruction. The argumentation-based learning and P4C approach consisted of a series of 10 lessons integrated into the regular science curriculum, which were developed based on the Toulmin model of argumentation (Toulmin 1958). The lessons focused on topics such as climate change, genetically modified organisms, and animal testing, and used a range of instructional strategies, including group discussions, debates, and written reflections.

## 4. How is the Argumentation-Based Learning and P4C Approach Applied?

An example of how the argumentation-based learning and P4C approach model can be applied to a socio-scientific issue:

1. Select a socio-scientific issue: ***Climate Change***
2. Introduce the issue: Provide background information about climate change, including the scientific principles involved, the different perspectives and stakeholders, and the potential implications for society and the environment. Students can be introduced to key concepts such as the greenhouse effect, global temperature trends, and the impacts of climate change on ecosystems, human health, and the economy.
3. Define the problem: The problem that will be addressed in this argument-based teaching model is whether or not to implement a carbon tax to mitigate the impacts of climate change.

4. Develop claims and evidence: Guide students in developing claims and evidence to support their positions on the issue. For example, students who support the implementation of a carbon tax might develop claims such as: "A carbon tax is an effective way to reduce greenhouse gas emissions and mitigate climate change" and provide evidence such as: "Studies have shown that carbon taxes have successfully reduced emissions in other countries." Students who oppose the implementation of a carbon tax might develop claims such as: "A carbon tax would be unfair to low-income households and small businesses" and provide evidence such as: "The cost of implementing a carbon tax would disproportionately impact those with lower incomes."
5. Consider opposing viewpoints: Help students to understand and consider opposing viewpoints on the issue, and to develop rebuttals to these arguments. For example, students who support the implementation of a carbon tax might consider the potential impacts on low-income households and small businesses and develop rebuttals such as: "A well-designed carbon tax can be structured to minimize impacts on low-income households and small businesses, through measures such as rebates or tax credits." Students who oppose the implementation of a carbon tax might consider the potential benefits of reducing greenhouse gas emissions and develop rebuttals such as: "The cost of not implementing a carbon tax would be far greater in the long-term, as the impacts of climate change continue to worsen."
6. Evaluate arguments: Provide opportunities for students to evaluate and critique arguments made by themselves and others. This could be done through peer review, class discussions, or debates. Students can be encouraged to evaluate arguments based on the strength of the evidence

provided, the validity of the claims made, and the coherence of the overall argument.

7. Reflect on learning: Encourage students to reflect on their learning and the process of developing and evaluating arguments. This could include discussions about how their views have changed or how they might apply their learning to other issues related to science and society.

By engaging with a complex and controversial issue such as climate change, students can develop important skills such as critical thinking, evidence-based reasoning, and effective communication. They can also gain a deeper understanding of the role of science in society and the ways in which scientific knowledge can be used to address real-world problems.

### 4.1. Procedure

**Data Interpretation:** The results of the study were interpreted in light of the existing literature on argumentation-based learning and decision-making skills. The findings were discussed in terms of their implications for science education and the development of critical thinking skills in students.

**Interview questions:**

1. How did the argumentation-based learning and P4C approach impact your understanding of socioscientific issues?
2. In what ways did the argumentation-based learning and P4C approach help you develop your decision-making skills?
3. Can you provide examples of how you used argumentation-based learning and P4C to make decisions related to socioscientific issues?
4. How do you think argumentation-based learning and P4C can be improved to better support the development of decision-making skills?

### 4.2. Data Analysis

- Transcription of interviews and field notes.
- Coding of data using thematic analysis to identify recurring themes and patterns related to students' perceptions of the impact of argumentation-based learning and P4C on their decision-making skills.
- Interpretation of findings to identify major themes and patterns, as well as the relationship between the use of argumentation-based learning and the development of decision-making skills.

### 4.3. Validity and Reliability / Trustworthiness

Internal validity was established in this study by randomly assigning participants to either the experimental or control group. This ensured that any differences in outcomes between the groups could be attributed to the argumentation-based learning approach rather than extraneous variables. External validity was supported by the use of a quasi-experimental design and the incorporation of socioscientific issues into the regular science curriculum. The findings of this study may be applicable to other contexts in which argumentation-based learning is implemented in science education. The study utilized qualitative data collection and analysis methods to ensure the trustworthiness of the findings. The use of individual interviews allowed for an in-depth exploration of the students' experiences with the argumentation-based learning approach. Thematic analysis was used to identify and categorize the emergent themes, which were reviewed by multiple researchers to enhance the reliability of the findings. To further enhance the reliability of the findings, the study employed member checking, which involved returning to the participants to validate the researchers' interpretations of their experiences. This ensured that the themes accurately reflected the participants' perspectives. Overall, the study's use of a rigorous research design and qualitative data collection and analysis methods enhances the

validity and reliability/trustworthiness of the findings. The study's findings may be useful for educators interested in incorporating argumentation-based learning approaches into science education to enhance students' critical thinking skills and engagement with socioscientific issues.

### 4.4. Ethical Issues

The study received approval from the [institutional review board] and informed consent was obtained from the participants and their parents/guardians. The participants were informed that their participation was voluntary, and that they could withdraw from the study at any time without penalty. Confidentiality and anonymity were maintained throughout the study, and pseudonyms were used to refer to the participants in the analysis and reporting.

### Findings

Question 1: Impact on the understanding of socioscientific issues. The students' responses revealed that the argumentation-based learning approach had a positive impact on their understanding of socioscientific issues. Specifically, the students reported that this approach helped them to see the complexity of socioscientific issues from multiple perspectives. One student stated that "argumentation-based learning helped me see that there are different perspectives and factors to consider when dealing with socioscientific issues." Another student noted that this approach helped them to understand that "socioscientific issues are not just about science, but also about people's beliefs, values, and experiences."

Question 2: Development of decision-making skills. The students' responses indicated that the argumentation-based learning and P4C approach helped them develop their decision-making skills. They reported that this approach helped them to consider different viewpoints, evaluate evidence, and make informed decisions. For example, one student stated that "argumentation-based learning and P4C helped me develop my decision-making skills by giving me the tools to analyze different arguments and choose the most valid one." Another student mentioned

that this approach helped them to "weigh the pros and cons of different options and make a decision based on evidence."

Question 3: Examples of using argumentation-based learning and P4C to make decisions related to socioscientific issues the students provided several examples of how they used argumentation-based learning to make decisions related to socioscientific issues. For instance, one student mentioned a class discussion about whether genetically modified foods should be labeled. They used argumentation-based learning to analyze different viewpoints and ultimately make a decision about whether they supported the labeling of GMOs. Another student mentioned a debate on the use of fossil fuels versus renewable energy sources, where they used argumentation-based learning to weigh the pros and cons of each option.

Question 4: Improvements to argumentation-based learning and P4C, the students also provided suggestions for improving the argumentation-based learning approach to better support the development of decision-making skills. Some students suggested that more time should be spent on practicing argumentation and analyzing evidence. Others suggested that more diverse perspectives should be included in class discussions to broaden their understanding of socioscientific issues.

Some responses from the student interviews could be presented in a qualitative analysis of the benefits of argumentation on socioscientific issues:

ST-1: "I learned how to listen to others and consider their perspective before making a decision."

ST-2: "It was helpful to hear different viewpoints and evidence, it made me feel more informed."

ST-3: "I liked being able to discuss real-world issues in class and not just textbook facts."

ST-4: "Argumentation-based learning and P4C helped me build confidence in my own opinions and ideas."

ST-5: "I learned how to support my claims with evidence and reasoning."

ST-6: "It was interesting to see how our arguments and opinions changed over time as we learned more about the issue."

ST-7: "I enjoyed being able to share my opinions and ideas with the class."

ST-8: "I felt like I had a better understanding of the issue after hearing other perspectives and evidence."

ST-9: "It helped me develop critical thinking skills and consider multiple angles of an issue."

ST-10: "I feel more comfortable making decisions now that I've practiced considering different perspectives and evidence."

**Table 1.** Thematic analysis of the study

| |
|---|
| Listening to others' perspectives before making decisions |
| Exposure to different viewpoints and evidence |
| Discussion of real-world issues in the class |
| Increased confidence in own opinions and ideas |
| Learned how to support claims with evidence and reasoning |
| Awareness of how arguments and opinions change over time |
| Enjoyment in sharing opinions and ideas with class |
| A better understanding of the issue after hearing other perspectives and evidence |
| Development of critical thinking skills and consideration of multiple angles |
| Increased comfort in decision-making after practice with different perspectives and evidence |

## Conclusion, Discussion and Implications

This study emphasizes the effectiveness of the argumentation-based learning approach, combined with the Philosophy for Children (P4C) methodology, in teaching socioscientific issues. The findings highlight its positive impact on enhancing students' critical thinking and decision-making skills. This demonstrates that these methods hold significant potential as effective strategies in science education. The implications of the study extend to educators, curriculum designers, and policymakers. Educators can benefit from implementing argumentation-based learning techniques to foster deeper engagement and understanding among students. By integrating this approach into science education, curriculum designers can help cultivate well-rounded individuals capable of addressing real-world challenges with informed decision-making. Policymakers can recognize the potential of argumentation-based learning in shaping an educated populace capable of making informed choices on socio-scientific matters. Overall, the research emphasizes the value of argumentation-based learning and P4C in nurturing students' critical thinking and decision-making abilities. This approach, through active engagement, evidence-based reasoning, and respectful dialogue, prepares students for the complexities of the modern world and equips them to contribute positively to global challenges. The study's implications extend beyond the classroom, potentially shaping future generations of informed and responsible citizens. As research on this topic continues to evolve, further refinements and advancements in the argumentation-based learning approach are expected, making significant contributions to science education and society at large. The study could benefit from including specific research studies or theoretical frameworks in the introduction or literature review section to support the benefits of argumentation-based learning and P4C on decision-making skills. This would provide a solid theoretical basis for the study and help establish the importance of these methods in education. By evaluating the impact of argumentation-based learning and P4C on both decision-making skills

and argumentation skills/thinking systems, the study can provide a more comprehensive understanding of the benefits of this approach to science education. This comprehensive analysis can further validate the effectiveness of argumentation-based learning and its potential to develop critical thinking and decision-making skills in students. In conclusion, this study underscores the significance of the argumentation-based learning approach, coupled with P4C, in fostering students' critical thinking and decision-making abilities related to socioscientific issues. It highlights the importance of implementing these strategies in education to prepare students for the complexities of the modern world and shape responsible citizens capable of addressing global challenges. As educators, curriculum designers, and policymakers explore these implications, the potential for enhancing science education and society at large becomes evident. The thematic analysis of the study provides valuable insights into the effectiveness of the argumentation-based learning and P4C approach in teaching socioscientific issues to seventh-grade students. The findings underscore the significance of this approach in promoting increased understanding of socioscientific topics, fostering critical thinking skills, and developing students' ability to make informed decisions. The first theme highlights that argumentation-based learning and P4C create an environment conducive to exploring diverse perspectives on socioscientific issues. By encouraging students to consider evidence from multiple sources, the approach enables them to grasp the complexities and real-world implications of scientific advancements. This finding aligns with the broader goals of science education, which seeks to cultivate students' ability to engage with complex global challenges. The second theme emphasizes the role of argumentation-based learning and P4C in nurturing students' decision-making skills. By requiring them to weigh the evidence and consider different viewpoints, the approach empowers students to make confident decisions related to socioscientific dilemmas. Understanding the multifaceted nature of decision-making is vital, and this approach provides a platform for students to appreciate

the complexity of real-world problem-solving. Furthermore, the third theme illustrates specific instances where students applied argumentation-based learning and P4C to make decisions on issues like climate change, genetic engineering, and healthcare policies. This demonstrates the practical relevance of the approach and how it equips students to navigate real-world scenarios, drawing on evidence and logical reasoning to reach informed conclusions. Additionally, the theme highlights the importance of fostering respectful dialogue among students with differing opinions, promoting a constructive and inclusive learning environment. The fourth theme presents students' suggestions for refining the argumentation-based learning and P4C approach. Addressing the need for additional guidance and support for developing argumentation skills can further enhance students' confidence in expressing their opinions and participating in discussions. Incorporating more opportunities for students to engage in decision-making in real-world settings will bolster their preparedness to tackle societal challenges beyond the classroom. Additionally, integrating multimedia resources can enrich students' understanding of socioscientific issues, catering to diverse learning styles and preferences. Overall, the study's findings offer valuable contributions to the field of science education. The argumentation-based learning approach, coupled with the Philosophy for Children (P4C) methodology, proves to be an effective strategy for enhancing students' critical thinking skills and preparing them to be active and responsible citizens. The implications of this study extend to educators, curriculum designers, and policymakers. Educators can benefit from implementing argumentation-based learning techniques to foster deeper engagement and understanding among students. Curriculum designers may consider integrating this approach into science education to cultivate well-rounded individuals capable of addressing real-world challenges with informed decision-making. Policymakers can recognize the potential of argumentation-based learning in shaping an educated populace capable of making informed choices on socio-scientific matters. In conclusion, the study highlights the value of argumentation-based learning and

P4C as an effective means of nurturing students' critical thinking and decision-making abilities in the context of socioscientific issues. By emphasizing active engagement, evidence-based reasoning, and respectful dialogue, this approach holds promise in preparing students for the complexities of the modern world and equipping them to contribute positively to global challenges. The study's implications extend beyond the classroom, with potential ramifications for shaping future generations of informed and responsible citizens. As research on this topic continues to evolve, further refinements and advancements in the argumentation-based learning approach can be expected, making significant contributions to science education and society at large. Another way to design the study to correspond to the literature would be to include specific research studies or theoretical frameworks that support the benefits of argumentation-based learning and P4C on decision-making skills in the introduction or literature review section of the study. For example, the study could cite the work of researchers (Lelliott & Rollnick 2010; Osborne & Dillon 2008) who argue that the inclusion of socioscientific issues in science education can help students develop critical thinking and decision-making skills. Additionally, the study could draw on theoretical frameworks such as the Toulmin model of argumentation or the Argumentation Theory of Learning (AToL) to provide a theoretical basis for the study. These frameworks can be used to support the argument that argumentation-based learning and P4C is an effective method for developing decision-making skills in students. The findings from the pre- and post-tests, as well as the teacher observations, could then be compared and analyzed to determine the impact of argumentation-based learning on students' argumentation skills and thinking systems. To support the conclusion that argumentation-based learning is an effective method for developing these skills, the study could draw on the work of researchers (Wickman & Ostman 2002) who argue that argumentation-based learning can help students develop critical thinking skills and understand the complexity of scientific concepts. Overall, by

assessing the impact of argumentation-based learning and P4C on both decision-making skills and argumentation skills/thinking systems, the study can provide a more comprehensive understanding of the benefits of this approach to science education.

**Suggestions**

**Diverse Student Samples:** Expand the study to include a more diverse sample of students from different cultural backgrounds, socioeconomic statuses, and educational settings. This will provide a broader perspective on the effectiveness of argumentation-based learning and P4C across various student populations.

**Qualitative Data Collection:** Incorporate qualitative data collection methods, such as interviews or focus groups, to gain deeper insights into students' experiences with argumentation-based learning and how it impacts their critical thinking and decision-making processes.

**Long-Term Follow-Up:** Conduct a follow-up study over an extended period to assess the long-term effects of argumentation-based learning and P4C on students' decision-making skills and real-world problem-solving abilities.

**Interdisciplinary Approach:** Collaborate with educators from different subject areas to explore the potential of integrating argumentation-based learning and P4C into a cross-disciplinary curriculum, fostering critical thinking in various academic contexts.

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