JPPIPA 9(3) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Effect of Argumentation-Based Teaching on Students' Understanding, Reasoning and Decision-Making Concerning Food Preservatives

Ari Widodo[1*], Intania Zainul Nurul Huda[2], Diana Rochintaniawati[1], Riandi[1]

[1] Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Indonesia, Bandung, Indonesia
[2] SMAN 1 Jampang Tengah, Sukabumi, Indonesia

Received: January 18, 2023
Revised: March 25, 2023
Accepted: March 28, 2023
Published: March 31, 2023

Corresponding Author:
Ari Widodo
widodo@upi.edu

DOI: 10.29303/jppipa.v9i3.2951

Abstract: Misuse of food preservatives in the society is alarming that it is necessary to raise students' awareness about the danger to their health. Educating children about healthy food requires more than just promoting understanding but more importantly practicing reasoning and decision making. This study analyses the impact of lessons designed to improve students' understanding, reasoning, and decision making on the use of food preservatives. Participants of the study were 30 students of 7th grade junior high school taught by a teacher who has been trained on argumentation-based teaching strategies. During the lessons students were provided with dilemmatic cases that stimulate their thinking followed by discussion before finally making a decision. Data were collected prior and after the lessons using a three-tier test that require students to provide answers that consist of explanation, reason, and evidence. The study shows improvement of students' understanding of the content, reasoning skills, and decision making. Moreover, the study also reveals that the majority of the students tend to view food preservatives from the usefulness side but ignore the danger. The findings suggest that argumentation-based teaching strategy results in students' deeper understanding of the content, reasoning and decision-making skills. This study recommends that efforts to promote students' awareness of food preservatives and healthy diet can be done through a systematic and well-planned teaching strategy that encourage students to reason and to think deeply about the positive and the negative sides of food preservatives.

Keywords: Argumentation-based teaching; Decision Making; Food Preservatives; Reasoning

Introduction

The use of food additives (flavouring, artificial colouring, and preservatives) is very common in daily life. Unfortunately, there are food producers that carelessly abuse those substances and ignore food production regulations. One of the most common misused substances is food additives. WHO estimates that unhealthy, heavily-preserved food has costed approximately 2 million lives, especially kids (BPOM, 2015). Besides regulation and tight controls on food, teaching children about healthy food consumption is undeniably necessary since it can help children to develop understanding and shape their diet behaviour. Despite efforts to promote students' awareness of healthy food consumption, it seems that changing children's food consumption behaviour is not easy (Beck et al., 2021). Mindful is an important concept to be considered when educating children about healthy diet. Mindful eating actually also covers food-related practices, such as gardening, cultural food traditions, and cooking (Méndez et al., 2019). Appreciation for food as part of mindful eating is also considered as important for shaping children health (Kawasaki & Akamatsu, 2019). They reported that appreciation for food covers several aspects, such as attitudes toward healthy food,

How to Cite:
Widodo, A., Huda, I.Z.N., Rochintaniawati, D., & Riandi, R. (2023). Effect of Argumentation-Based Teaching on Students' Understanding, Reasoning and Decision-Making Concerning Food Preservatives. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1418–1424. https://doi.org/10.29303/jppipa.v9i3.2951

recommended food preferences, and school educational experiences. The notion of mindful eating Schools can play important roles in promoting children' mindful eating behaviour. However, tt should be noted that simply presenting the danger of unhealthy food does not necessarily lead the children to consume healthy food as children tend to base their decision on personal preferences instead of their understanding and reasoning.

Understanding and reasoning skills are two interrelated foundations needed for children to be responsible decision makers concerning their food choice. Reasoning ability affects argumentation skill and students' capability in presenting argument also reflect their reasoning skill as well. Reasoning process is required to make a decision between the right and the wrong. Previous study on students' reasoning shows that students' reasoning skills develop alongside with grade levels (Widodo et al., 2017) and that students' reasoning can be improved through teaching strategies specifically designed to promote reasoning.

The purpose of this study was to promote children consumption of healthy food consumption, especially avoiding food with preservatives in it. It is done by conducting a teaching strategy that aims at raising children' understanding, reasoning, and decision-making skills. Unlike other studies that raise children awareness by verbal or visual campaigns, this study focus on improving children decision making capacity as the strategy to change children consumption behaviour.

In the national curriculum the topic of food additives is presented as part of the lesson on food and digestive system. As a result the issue of healthy diet is not sufficiently addressed in the school. The increasing issues on healthy diet, especially amongst children, is a strong indicator of the need for healthy diet education. As reported by previous study (Afshin et al., 2019), healthy diet could reduce the possibility of chronical diseases. Educating children about healthy diet is not a simple and short program. It requires a teaching strategy that can raise students' knowledge, motivation and skills on healthy food choice (Beinert et al., 2022). Furthermore, they also recommended that lessons should focus on everyday food choices.

Previous study on the issue of formaldehyde misuse for food preservation (Wikanta, 2010) shows that even though the large part of society have realized the danger of formaldehyde use in preserving food, some remain ignorant and barely make efforts to avoid it. This finding suggests that the decision related to the food consumption require more than just knowledge about it. The process of making a decision can be done through self-argumentation or argumentation with others as the process of argumentation require one to justify the arguments. Argumentation and problem based teaching is also reported to contribute to changes of behaviour (Fettahlıoğlu & Aydoğdu, 2020). Argumentation promote critical thinking (Giri & Paily, 2020) that in turn lead to changes of behaviour. This suggests that argumentative teaching strategies can be effective in changing students' decision making on food consumption may use.

One of the most commonly used reasoning models is the one proposed by Toulmin (1958). He proposed that an argument embodies of claim (statement), data (facts or evidence to prove the statement), warrant (justification or logical explanation that connects claim and data), backing (amplifying warrant), qualifier (limitation = conditions and restrictions that set the validity of an argument), and rebuttal (refusal = statement that signifies validity of a claim). This framework has been employed in a number of studies in variety of areas (Bonnin, 2019; Ebadi et al., 2020; Kim & Roth, 2018; Yu & Zenker, 2020).

Reasoning plays a very important roles in life and it is observed even in very young children ((Hardy et al., 2021). Despite the importance of reasoning, schools often do not sufficiently focus on fostering students' reasoning and decision-making ability. A number of research reported that reasoning closely relates to understanding (Ageitos et al., 2019; Owens et al., 2021) and that reasoning in turns affect decision making. Therefore, understanding, reasoning and decision making are linked together.

Decision making is an important competence since in our life we have to make many decisions. To be able to make a responsible decision one has to have decision making competencies. There are at least six decision making competencies, i.e. applying decision rules, resistance to sunk costs, resistance to framing, consistency in risk perception, recognizing social norms, and under/overconfidence (Bruin et al., 2020).

Literature on decision making categorised several types making decision, such as rationalistic, intuitive, and emotive (Sadler & Zeidler, 2005), head, heart, and gut (Soosalu et al., 2019), rationalistic, moral-based, emotive and intuitive (Han-Tosunoglu & Ozer, 2021). Based on a synthesis of these literature this study uses the terms intuitive (a decision based on individual subjectivity), heuristic (a decision based on knowledge and empirical evidence), and rational (a decision based on rational consideration and common sense).

Method

Data were collected from 30 students in 7th Grade in a junior high school in Bandung. The class was taught by a teacher who has been trained in implementing argumentation-based teaching strategy. Throughout the lessons students were presented with dilemmatic cases

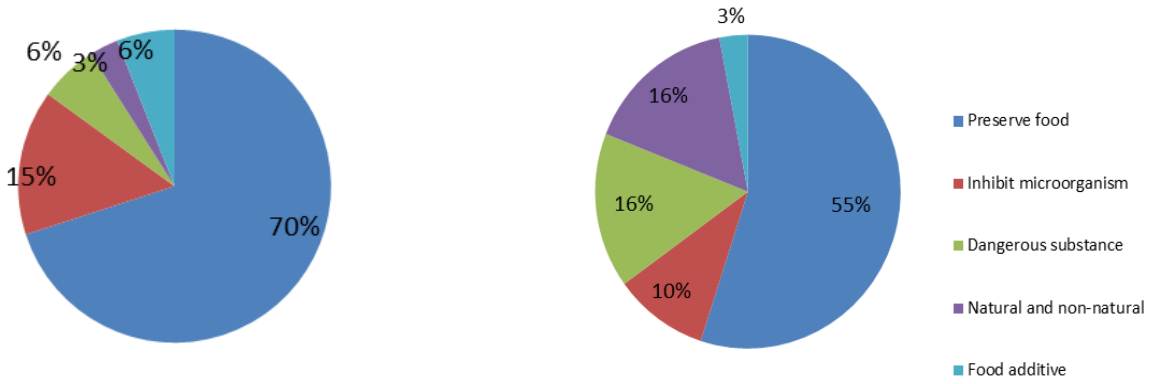
on food preservatives that require them to think deeply and critically prior to making any decision.

A pre and post written tests were administered to assess students' understanding, reasoning, and decision-making skills. The test consists of three-tier open ended questions that require students to provide explanation, reasons, and evidence before making any decision. This strategy pushes students to think deeply and to evidence-based decision. Stimulated recall interviews we conducted to some students to clarify their answers and to collect more information.

Three analysis strategies were done to the data. Firstly, the analysis was carried out to gain the insights of students' understanding on food preservatives which are divided into three smaller groups namely complete understanding, partial understanding, and misconception. The analysis also allows to identify students' conceptual change. Secondly, students' reasoning ability and argumentation skills along with their coherence were investigated according to a rubric that previously have been developed (Widodo et al., 2016). The rubric allow argumentation to be categorised into different levels and the coherence. Thirdly, a careful examination was also done on students' decision making on the use of food preservatives. The decision is classified into three facets that are intuitive, heuristic, and rationalistic.

Result and Discussion

The result on students' understanding on food preservatives is illustrated in fig. 1. This figure shows that the majority of the students considered food preservatives as a substance needed to preserve food. Very few students considered the negative impact of food preservatives. This indicates that students concerned more on the functions of additives but ignored its negative impacts on our health. This finding is in line with the previous studies that students do not really care about the negative consequences of food preservatives (Wikanta, 2010). Students' one-sided view of the use preservatives is likely stems from the students' less critical attitude toward food additive and food preservatives.



(a) (b)

Figure 1. Students' understanding of food preservatives: (a) before lessons; (b) after lessons

This finding suggests the importance of systematic and well-planned teaching to improve students' comprehension of positive and negative sides of food preservatives. In the curriculum food safety is not sufficiently addressed as food is usually presented as a part of lessons on human digestive system. The study on the impact of nutrition education shows that students' knowledge and attitude can be transformed with better education plan (Beinert et al., 2022; Kawasaki & Akamatsu, 2019; Olan et al., 2019). Nutrition and health education are highly essential considering young generation's preference to fast food, abandoning traditional healthy diet processed from fresh, nutritional ingredients.

Further analysis on students' understanding shows that the lesson could reduce students' misconception (figure 2). Although the number of students who hold misconceptions is relatively few, still is necessary to address them as misconception tends to persist and is difficult to be changed.

Analysis of the lessons reveals that the teacher encouraged the students to critically review their understanding of food preservatives. This step is designed to provoke thinking that leads cognitive dissatisfaction to their current understanding. Discrepant events (data or phenomena) are good source of cognitive conflict that lead to conceptual change (Anggoro et al., 2019). In this study lessons that presented dilemmatic issues provoked argumentation and pushed the students to critically think their own ideas and the ideas of others (Giri & Paily, 2020) that result in changes of their conceptions. In fact collaborative argumentation may result in long lasting conceptual change (Li et al., 2021).

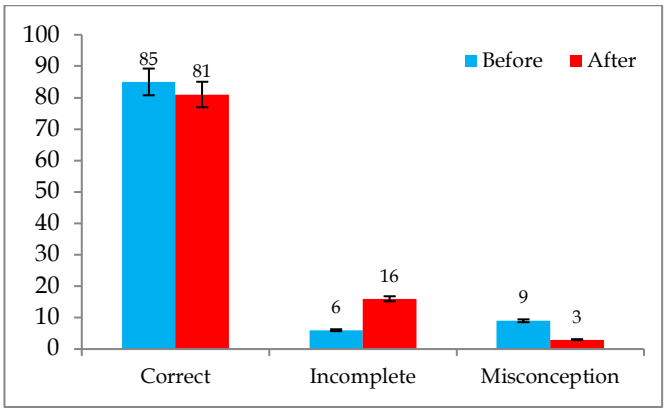


Figure 2. Students' understanding of food preservatives before and after the learning process.

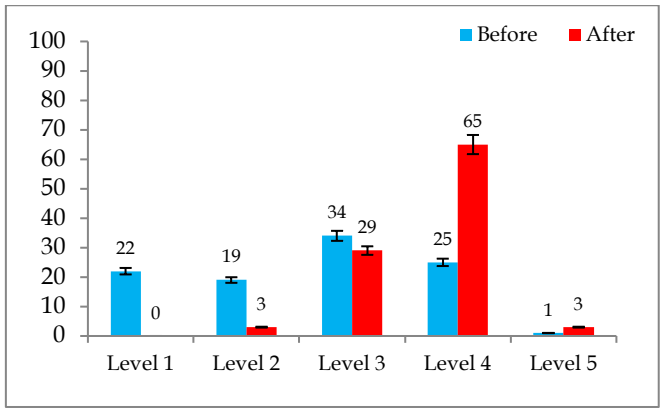


Figure 3. Students' reasoning level before and after the class

Cognitive conflict is not the sole factors that promote conceptual change. For conceptual to occur, affective factors, such as motivation, belief, value, attitude, and social power also play important roles. Although some studies on conceptual change suggest that cognitive conflict or even personal interest are not significant predictors of conceptual change (Thomas & Kirby, 2020) but our data show that both are important for conceptual change to happen. Situational interest is certainly a strong factor for conceptual change but it should not ignore the roles of cognitive conflict and personal interest.

This finding indicates that dilemmatic cases presented in the lessons create cognitive conflict that lead to changes of students' conceptions. The dilemmatic situations forced students to reconsider their conceptions and create dissatisfaction to their current conceptions (Anggoro et al., 2019). Subsequently dissatisfaction lead students to explore alternatives and better ideas that in the end result in the changes of their conceptions. So, the cognitive conflict strategy chosen by the teacher and the situational interests (Thomas & Kirby, 2020) created during the lessons seem to contribute to this results.

Students Reasoning Concerning Food Preservatives

The ability of students to reason can be measured from two sides, i.e. the level of the arguments and the coherence of the arguments. An argument is categorised into level 1 if it only consist of claims; an argument can be categorized into level 2 if it consists of claims that are backed with data or warrant; an argument can be classified into level 3 if it comprises data-supported claim, warrant, backing or qualifier or rebuttal; an argument can be categorized to level 4 if consists of claim, data, warrant, backing, and qualifier or rebuttal; finally, an argument belongs to level 5 if it contains claim, data, warrant, backing, qualifier, and rebuttal (Widodo et al., 2016). Students' reasoning prior and after the lessons are presented in figure 3.

Figure 3 suggests that there is an improvement of students' reasoning after the lessons. Prior to the teaching most of the arguments were at level 1 but after the lessons they moved to level 2 or higher. The improvement of students' arguments indicates that lessons that present dilemmatic situation provoke argumentation that lead to improvement of argumentation skills. The role of a teacher in promoting students' argumentation skill is not only achieve through teaching techniques, such as modelling, scaffolding, or organisation of the class but also through encouragement and creating learning environment where students feel free to air their opinions (Firetto et al., 2019; Hardy et al., 2021; Widodo, 2017).

One of the indicators of a strong arguments is the coherence that include how claim is supported by a evidence. The coherence of students' arguments before and after learning process, is illustrated in fig. 4. The figure shows that before the lessons very few students could not make coherence arguments but after the lessons they could formulate coherence arguments. Similarly, this finding is also reported in the previous study (Widodo et al., 2016). Lessons that linked students' prior knowledge and everyday life phenomena seem to contribute to this result. Activating students' knowledge generated from their everyday life helps them to create coherent knowledge (Chen, 2020).

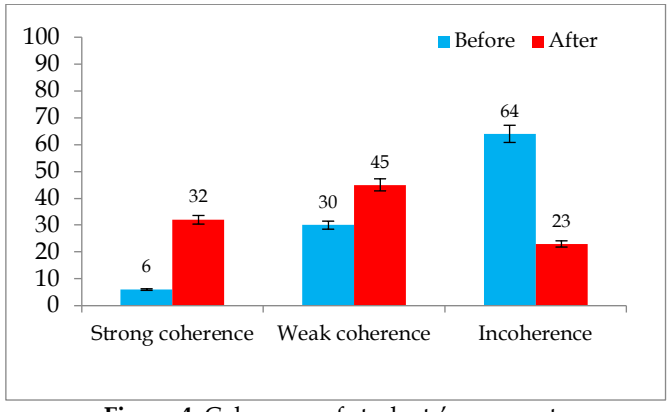


Figure 4. Coherence of students' arguments

The analysis of the learning process reveals that the teacher always tries to challenge students' idea or opinion by providing different evidences. This strategy often creates cognitive conflict on students therefore they have to re-think what they have understood, figure out other alternatives and find the right evidences. Lessons were organised into phases of presenting dilemmatic issues, inviting students to express their opinions, arguing, and settling the resolution. This strategy eventually encouraged students to create strong and coherent arguments. The following excerpts illustrate this.

"*In my opinion, food additives or preservatives inflict our stomach the most [claim] because our food is digested in this organ [data] thus the preservatives may harm our stomach [warrant]. Furthermore, plenty of people suffer from gastritis due to the consumption of preserved food [backing].*
"*Stomach is the organ that may be at risk [claim] as food additives or preservatives are heaped in this part [data] thus a lot of people may suffer from gastritis [warrant].*

These responses show that the students started to think systemically about the impact of food preservatives on digestion system. These statements are categorized into logical and interrelated statement thus the students have provided a coherent opinion.

Though students' argumentation skills may increase naturally through maturation, this study finds that by implementing the right learning strategy, students ability in making a coherent argument can be bolstered. This finding confirms the prior research that students' reasoning skill can be developed by specifically designing the right activity (Bunge & Leib, 2020; Chen, 2020; Firetto et al., 2019). The core of the learning process is involving students in discussion and problem solution that demands them to put forward, assess, and evaluate their argument.

The bases of students' decision

Figure 5 shows that prior to the lessons, most students based their decision making on intuitive reasoning but the situation changes after lessons as they moved toward rational thinking. Prior to the lesson students relied heavily on their subjective consideration only. The following excerpt clearly illustrate that students do not think about the effects of food preservatives.

"*I will still use food preservatives because they can preserve the food that I usually buy*"

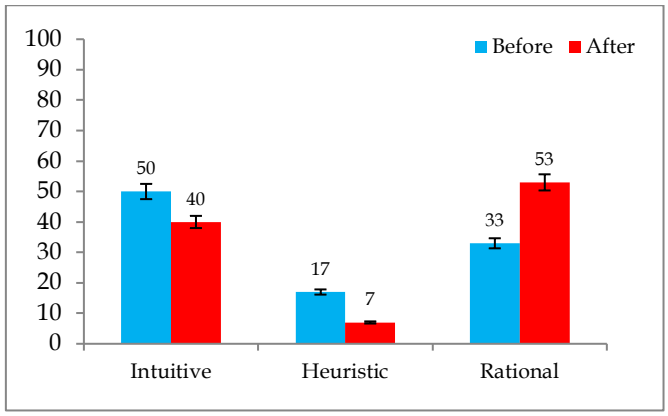


Figure 5. The bases of students' decision making before and after the learning process

The bases of students' decision making was their personal experience and their subjective judgements. Such argument is considered as weak since it is not supported by strong evidences. As a result, those who decided intuitively tend to change their opinion easily as they based their reasoning mainly on informal reasoning (Widodo, 2017).

Although intuitive decision making does not necessarily mean a bad practice. In some contexts, intuitive approach may provide better alternatives in solving complex problem rather than rationalistic. Intuitive decision making denotes a method of deciding fast, automatically, and requires less efforts compared to the other similar approaches that are time consuming, continuous, and demands rigorous efforts. Intuitive decision making is not only common in young age. Even preservice teachers were reported to use intuitive decision making (Han - Tosunoglu & Ozer, 2021). However, in the scientific field rational thinking more preferable (Soosalu et al., 2019).

After the learning process, most students base their decision reasoning on rational thinking (53%). As the students use more rational thinking, their decision on the use of food preservatives also changes. Now, they tend to be more cautious before using food preservatives.

"*I will not use any food preservative [claim] despite its function to preserve food longer [rebuttal]. In addition, preservatives contain dangerous chemical substance [warrant], thus, lead to diseases such as diarrhoea, gastritis, and stomach ache [data]*"
"*Yes, I allow the use of preservatives [claim] if the substances do not pose any threats [qualifier] because preserving food can be done in a healthy way [warrant], thus we can still maintain the quality of the meal [data]*"

Based on the given response, the students were able to describe clearly about their rationale in making a decision with better conceptual understanding and reasoning skill. The mastery of concept and reasoning

are the components that correspond to each other. Reasoning support students to learn a concept and understanding of concepts lead to better reasoning. This study finds that the decrease of students' understanding was largely contributed by incomplete knowledge reconstruction process. Before the learning process, the decision making was largely attributed by inconsistent understanding and poor ability to reason. After the learning process, most of students have been able to decide by using their understanding and reasoning. For instance, at one time a student said:

"*Food preservative digested to our body may endanger our appendix [claim] because this organ helps to digest food hence the food preservatives may amass inside [warrant]*".

This statement embodies three logical explanations and demonstrates good coherence level due to better comprehension and reasoning ability. The findings obviously reflect the teacher's effort to motivate students to think about evidence to support their claim. The finding in in line with the previous studies that students' reasoning can be built through well-designed teaching activities (Bunge & Leib, 2020). When reasoning and conceptual understanding are well developed, students can make a better decision making. Teaching should not only take into account cognitive aspects but also affective aspects since decision making involves more than just cognitive (Bruin et al., 2020).

Conclusions

Throughout the lessons students gradually developed a better understanding and change their conceptions. This indicate that argumentative lessons can facilitate students' conceptual change. Students' reasoning skills also show improvement. They improve not only in terms of the level but also the coherence. The improvement of students' understanding and reasoning in turn affect their decision making. Their decision-making shift from intuitive toward rational. Overall, this study highlights the link between students' understanding, reasoning, and decision-making skill. In the context of promoting healthy food consumption amongst students, this study suggest that school may contribute by designing lessons that focus students' deep learning. This can be achieved by conducting argumentative lessons about daily life and contextual issues.

References

Afshin, A., Sur, P. J., Fay, K. A., Cornaby, L., Ferrara, G., Salama, J. S., & Mullany, E. C. (2019). Health effects of dietary risks in 195 countries. *Lancet*, *393*. https://doi.org/10.1016/S0140-6736(19)30041-8

Ageitos, N., Puig, B., & Colucci-Gray, L. (2019). Examining Reasoning Practices and Epistemic Actions to Explore Students' Understanding of Genetics and Evolution. *Science & Education*, *28*(9), 1209–1233. Retrieved from https://link.springer.com/article/10.1007/s11191-019-00086-6

Anggoro, S., Widodo, A., Suhandi, A., & Treagust, D. F. (2019). Using a Discrepant Event to Facilitate Preservice Elementary Teachers' Conceptual Change about Force and Motion. *EURASIA Journal of Mathematics, Science and Technology Education*, *15*(8), 1–21. https://doi.org/10.29333/ejmste/105275

Beck, A. M., Nielsen, S. B., & Bjørnsbo, K. S. (2021). Grandchildren's food workshop: Impact of an intergenerational cooking program on dietary habits, food courage, cooking skills and two-way interaction in Danish children and their grandparents. *Nutrition and Health*, *27*(4), 413–421. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/0260106021991637?journalCode=naha

Beinert, C., Sørlie, A. C., Åbacka, G., Palojokic, P., & Vik, F. N. (2022). Does food and health education in school influence students' everyday life? *Health Education Journal*, *81*(1), 29–39. https://doi.org/10.1177/00178969211045722

Bonnin, T. (2019). Evidential reasoning in historical sciences: applying Toulmin schemes to the case of Archezoa. *Biology & Philosophy*, *34*(2), 1–21. https://doi.org/10.1007/s10539-019-9677-z

BPOM. (2015). *Warta POM: Media Internal Badan POM*. BPOM.

Bruin, W. B. ., Parker, A. M., & Fischhoff, B. (2020). Decision-Making Competence: More Than Intelligence? *Current Directions in Psychological Science*, *29*(2), 186–192. https://doi.org/10.1177/0963721420901592

Bunge, S. A., & Leib, E. R. (2020). How Does Education Hone Reasoning Ability? *Current Directions in Psychological Science*, *29*(2), 167–173. https://doi.org/10.1177/0963721419898818

Chen, Y.-C. (2020). Dialogic Pathways to Manage Uncertainty for Productive Engagement in Scientific Argumentation A Longitudinal Case Study Grounded in an Ethnographic Perspective. *Science & Education*, *29*(2), 331–375. Retrieved from https://link.springer.com/article/10.1007/s11191-020-00111-z

Ebadi, S., Ashtarian, S., & Zamani, G. (2020). Exploring Arguments Presented in Predatory Journals Using Toulmin's Model of Argumentation. *Journal of Academic Ethics*, *18*(4), 435 – 449. https://doi.org/10.1007/s10805-019-09346-0

Fettahlıoğlu, P., & Aydoğdu, M. (2020). Developing

Environmentally Responsible Behaviours Through the Implementation of Argumentationand Problem-Based Learning Models. *Research in Sciece Education*, *50*(3), 987–1025. https://doi.org/10.1007/s11165-018-9720-0

Firetto, C. M., Murphy, P. K., Greene, J. A., Li, M., Wei, L., Montalbano, C., & Croninger, R. M. V. (2019). Bolstering students' written argumentation by refining an effective discourse intervention: negotiating the fine line between flexibility and fidelity. *Instructional Science*, *47*, 181–214. Retrieved from https://link.springer.com/article/10.1007/s11251-018-9477-x

Giri, V., & Paily, M. U. (2020). Effect of Scientific Argumentation on the Development of Critical Thinking. *Science & Education*, *29*(3), 673–690. Retrieved from https://link.springer.com/article/10.1007/s11191-020-00120-y

Han-Tosunoglu, C., & Ozer, F. (2021). Exploring Pre-service Biology Teachers' Informal Reasoning and Decision-Making About COVID-19. *Science & Education*. https://doi.org/10.1007/s11191-021-00272-5

Hardy, I., Stephan-Gramberg, S., & Jurecka, A. (2021). The use of scaffolding to promote preschool children's competencies of evidence-based reasoning. *Unterrichtswissenschaft*, *49*(1), 91–115. https://doi.org/10.1007/s42010-020-00094-4

Kawasaki, Y., & Akamatsu, R. (2019). Appreciation for food, an important concept in mindful eating: association with home and school education, attitude, behavior, and health status in Japanese elementary school children. *Global Health Promotion*, *27*(3), 140–149. https://doi.org/10.1177/1757975919875650

Kim, M., & Roth, W.-M. (2018). Dialogical argumentation in elementary science classrooms. *Cultural Studies of Science Education*, *13*(4). https://doi.org/10.1007/s11422-017-9846-9

Li, X., Li, Y., & Wang, W. (2021). Long-Lasting Conceptual Change in Science Education: The Role of U-shaped Pattern of Argumentative Dialogue in Collaborative Argumentation. *Science & Education, 32*(1), 123-168. https://doi.org/10.1007/s11191-021-00288-x

Méndez, R., Goto, K., Song, C., Giampaoli, J., Karnik, G., & Wylie, A. (2019). Cultural influence on mindful eating: traditions and values as experienced by Mexican-American and non-Hispanic white parents of elementary-school children. *Global Health Promotion*, *27*(4), 6–14. https://doi.org/10.1177/17579759198786

Olan, E. L., Campbell, L. O., & Jahani, S. (2019). Examining Second Graders' Healthy Food Choices: Through Literacy and Active Learning. *Nutrition and Metabolic Insights*, *12*, 1–7. https://doi.org/10.1177/11786388198390

Owens, D. C., Sadler, T. D., Petitt, D. N., & Forbes, C. T. (2021). Exploring Undergraduates' Breadth of Socio-scientific Reasoning Through Domains of Knowledge. *Research in Science Education*, *51*. https://doi.org/10.1007/s11165-021-10014-w

Sadler, T., & Zeidler, D. (2005). Patterns of informal reasoning in the context of socioscientific decision making. *Journal of Research in Science Teaching*, *42*, 112–138. https://doi.org/10.1002/tea.20042

Soosalu, G., Henwood, S., & Deo, A. (2019). Head, Heart, and Gut in Decision Making: Development of a Multiple Brain Preference Questionnaire. *SAGE Open*, *9*(1), 1–17. https://doi.org/10.1177/2158244019837439

Thomas, C. L., & Kirby, L. A. J. (2020). Situational interest helps correct misconceptions: An investigation of conceptual change in university students. *Instructional Science*, *48*(3), 223–241. https://doi.org/10.1007/s11251-020-09509-2

Toulmin, S. (1958). *The uses of argument*. University Press.

Widodo, A. (2017). Teacher pedagogical content knowledge (PCK) and students' reasoning and wellbeing. *Journal of Physics: Conference Series*, *812*(1), 12119. Retrieved from http://stacks.iop.org/1742-6596/812/i=1/a=012119

Widodo, A., Saptarani, D., Riandi, & Rochintaniawati, D. (2017). Development of students' informal reasoning across school level. *Journal of Education and Learning*, *11*(3), 273–282. https://doi.org/10.11591/edulearn.v11i3.6395

Widodo, A., Waldrip, B., & Herawati, D. (2016). Students argumentation in science lessons: A story of two research projects. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 199–208. Retrieved from https://journal.unnes.ac.id/nju/index.php/jpii/article/view/5949

Wikanta, W. (2010). Persepsi masyarakat tentang penggunaan formalin dalam bahan makanan dan pelaksanaan pendidikan gizi dan keamanan pangan. *Jurnal Bioedukasi Pendidikan Biologi*, *1*(2), 1–12. https://doi.org/10.24127/bioedukasi.v1i2.189

Yu, S., & Zenker, F. (2020). Schemes. *Critical Questions, and Complete Argument Evaluation*, *34*(4), 469–498. https://doi.org/10.1007/s10503-020-09512-4