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Application of jigsaw cooperative learning type based on socio-scientific issues to improve argumentation skills on nervous system material

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ABSTRACT

The use of a jigsaw type cooperative learning model based on socioscientific issues in nervous system material can be used as a way to provide students with argumentation skills. This research aims to obtain information regarding the application of jigsaw type cooperative learning based on socioscientific issues in improving students' argumentation skills regarding the nervous system. This research uses classroom action research methods. The sample in this study was class XI students consisting of 36 people. The results of this research show that there is a significant difference in the average between before and after action research in argumentation skills. In cycle 1, the pretest score achieved argumentation level 1 (score 64.36), while in the posttest score achieved argumentation level 2 (score 72.75). After treatment in cycle 2, namely the application of jigsaw type cooperative learning based on socioscientific issues, it was able to improve students' argumentation skills. The posttest score achieved argumentation level of 3 (score 76.17) becomes a score of 80.39 with an argumentation level of 4. So, based on this classroom action research, the application of jigsaw type cooperative learning based on socioscientific issues and improves students' argumentation skills in nervous system material.

INTRODUCTION

Currently, the world is in the 21st century, which is a century where human life is experiencing rapid changes and encouraging competitiveness between humans (Van Laar et al., 2017) which is different from the life system in the previous century. The development of 21st century skills has a major impact in various fields, one of which is education (Egan et al., 2017).

The rapid development of technology and science in the 21st century cannot be separated from the role of quality education which can encourage greater competitiveness (Manzuoli et al., 2019). The world of education is experiencing changes and developments so that the nation's next generation needs quality human resources and has various skills (Wüstenberg et al., 2014). The Ministry of Education in the United States identifies the skills or competencies needed in the 21st century, namely communication, collaboration, creative thinking and critical thinking (Chen et al., 2016). 21st century skills consist of skills in problem solving, creativity, critical thinking, collaboration, and communication (Foong & Daniel, 2013).

Critical thinking skills are one of the important skills to provide students with problem solving skills, creativity, critical thinking, communication and collaboration. Argumentation skills are skills that support the process of critical thinking skills which can develop reasoning and improve students' skills so they can assess appropriate information (Hanegan & Bigler, 2009). Argumentation skills lie at the meeting point between creative and critical thinking, creative thinking and critical thinking can be achieved through argumentation skills (Glassner & Schwarz, 2007). The ability to construct and present effective arguments, known as argumentation skill, is an essential skill that everyone should possess. This skill allows individuals to defend their viewpoints and opinions in a logical and persuasive manner, enabling them to communicate their ideas clearly to others. Argumentation skills are also crucial in the problem-solving process, as they help analyze issues from multiple perspectives and find more comprehensive solutions.

According to previous research, students' argumentation skills are in the very poor category, the low average score of argumentation skills, especially in students' nervous system material, can be influenced by various factors, including less innovative learning models, students' lack of seriousness in taking the tests given, and lack of habit in providing opportunities for students to express opinions (Holstermann et al., 2010). So far, students are rarely trained in argumentation skills, students are rarely invited to discuss, debate, in the learning process. Students' argumentation skills need to be trained to answer these challenges, so that students can analyze problems related to science or science according to existing evidence and facts. In this class, students achived argumentation level 1 (score 68). It means the student’s argument contains one simple claim.

So far, students are rarely trained in argumentation skills, students are rarely invited to discuss, debate, in the learning process. Students' argumentation skills need to be trained to answer these challenges, so that students can analyze problems related to science or science according to existing evidence and facts. Furthermore, strong argumentation contributes to the decision-making process, allowing individuals to make better-informed and rational choices by gathering and evaluating various arguments. Beyond just communication, argumentation skills also support personal development by encouraging critical thinking and the analysis of different viewpoints, which in turn improves one's intellectual abilities. Overall, the importance of argumentation skill cannot be overstated, as it is a fundamental capability that empowers individuals to effectively express their ideas, solve problems, and make sound decisions in various personal and professional contexts.

The condition of students' argumentation skills is still relatively low. This can be seen from Indonesia's achievements in the Trends in International Mathematics and Science Study (TIMSS) in 1999, 2003, 2007, 2011 and 2015 (Probosari et al., 2016). The ranking of Indonesian students is almost at the bottom. The results of this research show that students in Indonesia are not yet accustomed to solving problems that require high-level thinking skills such as reasoning,

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application, analysis and evaluation (Rahmadhani et al., 2020). Previous research shows that students lack reasoning abilities, such as students who have never spoken in front of the class and students who are not confident speaking in front of the class (Faridah & Sari, 2019). This shows that strengthening students' discussion skills in schools has not been utilized optimally.

Argumentation skills are important for students, and argumentation skills play an important role in creating explanations, models, and theories for studied concepts (Macagno et al., 2015). Because practicing arguing means practicing cognitive and emotional skills that help students understand basic concepts and processes for understanding the subject. Apart from teaching cognitive skills, learning ideally also teaches argumentation skills. Argumentation skills are considered important in the learning process because they are a very basic core activity for students (Cavlazoglu & Stuessy, 2018). Learning requires discussion to strengthen student understanding.

One way for students to be able to express their arguments is by using discussion activities that discuss socio-scientific issues because these discussion activities provide a problem to be debated so that students can make decisions (Chen et al., 2016). Learning that uses a socio-scientific problem approach can improve 21st century skills, such as critical thinking skills (Pratiwi et al., 2016), decision making, argumentation skills (Purwati et al., 2019), and problem-solving skills (Pauzi & Windiaryani, 2021). In this context, students can debate their ideas using life experiences, ethical values, and scientific evidence (Chowdhury et al., 2020). Engaging with socioscientific issues can help improve argumentation skills in several ways. Such as snalyzing socioscientific issues encourages critical thinking, as individuals need to identify relevant information, evaluate the credibility of sources, and assess the strength of different claims and evidence. Many socioscientific issues have ethical implications, which necessitates the development of moral reasoning skills. Students must consider the potential consequences of their arguments and positions, and justify them based on ethical principles.

Socio-scientific issues are characterized by two important elements, namely the relationship between scientific content and social interests (Topçu et al., 2018) which is complex, open, and controversial (Lindahl & Lundin, 2016), thus providing opportunities for students to carry out evaluations (Topçu et al., 2018) and discussions (Tidemand & Nielsen, 2017) in finding and identifying the concepts or principles being studied (Potter & France, 2018). The problems presented in the learning process are unstructured or complex everyday problems that lead to various perceptions (Rosli et al., 2013) and will encourage representations that will support claims so that good arguments are formed (Namdar & Shen, 2016). Socio-scientific issues in the nervous system material are found in the sub-materials of tissue culture, cloning, genetic engineering, food/conventional nervous systems, pharmaceutical/medical nervous systems, animal husbandry nervous systems, agricultural nervous systems, forensic nervous systems, environmental nervous systems, and ethics in the nervous system.

Nervous system material is one material that can equip students with critical thinking skills, and one of the skills that can be provided is argumentation skills. Apart from that, the nervous system is a material that has many socioscientific issues. One learning model that can be developed to teach students is the jigsaw type cooperative learning model. This cooperative learning model is a learning model that can teach students through a structured approach and can improve social skills in various groups. The jigsaw method of learning can improve argumentation skills in several ways. By engaging in the multifaceted process of the jigsaw method, students have the opportunity to strengthen their critical thinking, perspective-taking, collaborative skills, and overall argumentation abilities. The jigsaw method provides a structured framework for students to practice these essential skills in a supportive and interactive learning environment.

With this jigsaw type cooperative learning model based on socio-scientific issues, it is hoped that students will be able to have truly advanced argumentation skills on nervous system material.

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Based on the background description, contemplation/reflection is carried out to examine this problem in a study.

METHODS

The procedures or steps carried out in this research were carried out in activities in the form of a research cycle. This classroom action research was planned in several cycles and meetings to look at argumentation skills in nervous system material at SMA Negeri 8 Bandung using the jigsaw-type cooperative learning model. According to the Kemmis and McTaggart Model which in each research cycle there are four main activities, namely, planning, implementation, observation and reflection (Cahyaningtyas et al., 2023). Each cycle consists of excretory system material, namely kidneys, skin, liver, lungs, and disorders of the excretory system, the other cycle consists of nervous system material, namely the brain, neurons, central nervous system and peripheral nervous system.

The measurement of the quality of students' arguments can be analyzed through the answers put forward by students during the initial test and final test. The reference used to see the quality of students' arguments is Erduran's Analytical Framework

Table 1. Erduran's Analytical Framework for Assesing Quality of Arguments

Level/Score	Characteristic	Information
1	The argument contains one simple claim	Poor
2	An argument contains a claim with supporting data but does not contain a rebuttal.	Less than satisfactory
3	Arguments contain claims with supporting data and a few rebuttals.	Satisfactory
4	Argumentation contains a clear rebuttal and has several claims or arguments contain claims with data or supporters with one clear refutation.	Good
5	Argumentation presents an expanded argument with more than one rebuttal or argumentation contains several arguments with more than one clear rebuttal.	Excelent

Erduran et al. (2004)

The analytical technique used in this research to analyze the data collected is descriptive techniques. Descriptive techniques are used for quantitative data. This research uses descriptive analysis. Descriptive is describing the actual situation that occurred during the research. Quantitative data was used to determine the use of the jigsaw-type cooperative learning model based on socio-scientific issues in class XI of SMA Negeri 8 Bandung after the action was implemented.

RESULTS AND DISCUSSION

Cycle 1

This research consists of two cycles, in cycle 1 using a cooperative learning model using socio-scientific issues in learning. The results of the pretest and posttest argumentation skills are listed in Table 2. Based on the class average score, namely the pretest, which is at 1.47 from a maximum score of 5 for the posttest, 2.39 from a maximum score of 5 for the control class, it can be stated that the students' level of argumentation in the pre-test (initial test) is at level 1, level 1 is an argument containing a claim without data.

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Table 2. Pretest and posttest of argumentation skills

	Pretest	Posttest
The Student's argument	Agreed because hepatitis is getting more dangerous	In my opinion, what Indonesia has done by conducting data collection, providing education on disease control and giving antivirals to pregnant women is appropriate because it can reduce the number of people infected with hepatitis.
Score	64.36	72.75
Levels	1.47	2.39

In cycle 1, students were given a socio-scientific issue regarding disorders of the excretory system, namely hepatitis. This is in accordance with the results of research at the high school level which is dominated by level 1 although there are also those who reach level 2. The dominance of argumentation skills at level 1 is likely influenced by cognitive development at the high school level which is at the formal operational stage. At this stage, high school students can provide arguments on a problem from different points of view, or provide ideas or ideas that they think are useful in providing arguments for the issues provided in the research instrument (Amalia et al., 2018). The percentage of pretest argumentation levels is shown in Figure 1.

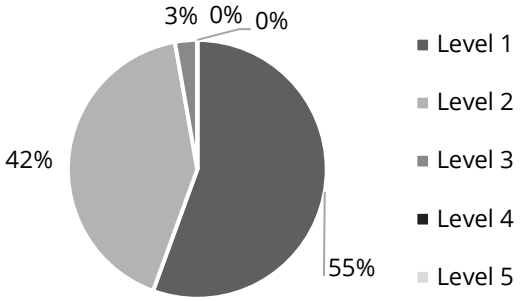

Figure 1. Recapitulation of pretest argumentation skill levels

In Figure 1, students have 55% level 1 and 42% level 2 skills, which means that students' argumentation skills are still below the minimum expected limit. After carrying out the pretest, students are then given learning using the jigsaw module cooperative learning model, socio-scientific issues are only displayed on the LKPD sheet without being discussed, so students only read independently. After learning is complete, students are tested again and a post-test is carried out. The results of the post-test analysis can be seen in Figure 2 below.

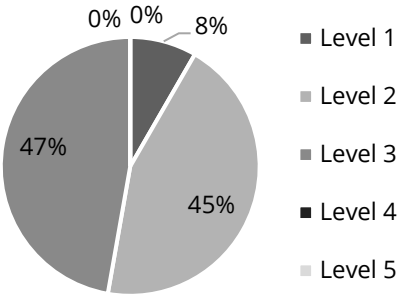

Figure 2. Recapitulation of posttest argumentation skill levels

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In Figure 2, students have 9% level 1 skills, 44% level 2, and 47% level 3, meaning that students' argumentation skills are still below the minimum expected limit. After the posttest was carried out, then in the second cycle students were given learning using the jigsaw module cooperative learning model, socio-scientific issues were displayed on LKPD sheets and discussed during learning, so there was a discussion process in class. After learning is complete, students are tested again and the second cycle is carried out.

Cycle 2

The results of the pretest and posttest argumentation skills in cycle 2 are listed in Table 2.

Table 3. Table of Argumentation Skill Levels

	Pretest	**Posttest**
The student's Argument	I agree, drugs must be prevented as early as possible, parents must provide education to their children so that they do not participate in free association	The issue is good because in this case prevention of misuse is much more useful to make people aware of the dangers of drugs. The real action that the author thinks is useful is to establish a Drug Education Museum managed by both the private sector and the government like in other countries. I think all forms of counseling, seminars and advertisements in the media are less effective as a means that are useful for the community. Given the quantity and quality of the counseling, it does not raise public awareness and fear not to touch drugs.
Score	76.17	80.39
Levels	2.86	3.56

In cycle 2, students are given a socio-scientific issue regarding a drug case that is closely related to the nervous system. In Table 3 data, the average level of argumentation achieved by students is higher compared to the average value achieved in cycle 1. Students who carry out learning using the jigsaw-type cooperative learning model based on socio-scientific issues obtain superior results by level argumentation 3.00 compared to students in cycle 1. A recapitulation of pretest argumentation skill levels is in Figure 3.

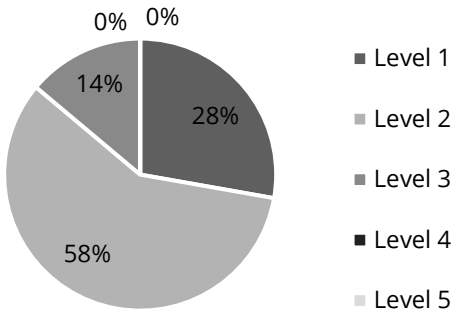

Figure 3. Recapitulation of Pretest Argumentation Skill Levels

In Figure 3, students have 27% level 1 and 58% level 2 skills, level 3 is 15%, which means that students' argumentation skills are still below the minimum expected limit. After carrying out the pre-test, students are then given learning using the jigsaw module cooperative learning model, socio-scientific issues are only displayed on the LKPD sheet and discussed during the lesson. After

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learning is complete, students are tested again and a post-test is carried out. The results of the post-test analysis can be seen in Figure 4 below.

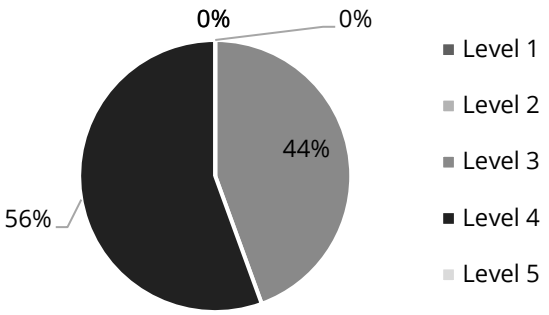

Figure 4. Recapitulation of Posttest Argumentation Skill Levels

In Figure 4, students have 44% level 3 and 56% level 4 skills. If it is based on the target of success in classroom action research, namely 100% of students have an argumentation level of more than or equal to 3, this means that students' argumentation skills have reached the minimum expected limit.

Socio-scientific issue-based learning environments engage students in independent science learning, argumentation, and moral reasoning (Friedrichsen et al., 2021). In learning socio-scientific issues, controversial social issues related to science are raised by students (Friedrichsen et al., 2021). So that during learning it is easier for students to argue, because the socio-scientific issues discussed are closely related to contextual life.

The increase in the level of argumentation in cycle 2 may also be caused by the content or material used, namely issues related to the nervous system. The nervous system is one of the concepts from biology subjects that can test students' critical thinking skills, and one of the skills that can be raised is argumentation skills (Christenson et al., 2017). Apart from that, the nervous system is also full of socio-scientific problems. This is in line with the statement put forward by (Dawson & Venville, 2009) that this is because in general nervous system issues do not only involve scientific content, but also involve socio-scientific issues in the form of social, economic and political aspects. So, it often becomes a debate and is a developing field of science and technology.

As stated by Norris & Phillips (2003), students can integrate and apply understanding of science content and basic understanding, namely, being able to read/write science texts and various modes of representation of scientific literacy in a socio-scientific issue-based environment. This environment engages students in conveying diverse ideas to achieve argumentation skills as they work cooperatively through the application of their understanding of argument to a science issue or topic. That is, students are asked to use their understanding of what is considered good evidence and what is considered a good claim in this kind of environment to debate, discuss, defend, and debunk (Yapıcıoğlu, 2018).

The difference in the value increase for cycle 1 and cycle 2 is influenced by the way of discussing socio-scientific issues used during learning, this is in line with what was stated by Iordanou & Constantinou (2015) that in terms of debating, students are able to build arguments and share them to get public criticism to understand the strengths and weaknesses of the argument and then revise them. The process of construction and critique engages students in improving their arguments and making better decisions. Socio-scientific issue-based argumentation activities involve students in the decision-making process with the support of evidence and foster their understanding of how decisions informed by socio-scientific issues are made by society.

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CONCLUSION

Learning using a jigsaw-type cooperative learning model based on socio-scientific issues can improve argumentation skills in nervous system material. This research provides information regarding a jigsaw-type cooperative learning model based on socio-scientific issues regarding argumentation skills on nervous system material.

There are differences in argumentation skills between students from cycle 1 or classes that use the jigsaw-type cooperative learning model based on socio-scientific issues which are only listed on the LKPD and students in cycle 2 or classes that use the jigsaw-type cooperative learning model based on socio-scientific issues that use discussion learning in class. significant average to improve argumentation skills. 100% of students have the level of argumentation skills in accordance with the minimum threshold for achieving student argumentation skills.

REFERENCES

Amalia, N. F., Riandi, R., Widodo, A., & Rochintaniawati, D. (2018). Complexity of argumentation based on socio-scientific issues at elementary, middle school and high school levels. *Assimilation: Indonesian Journal of Biology Education*, *1*(1), 29–32.

Cahyaningtyas, D., Wardani, N. S., & Yudarasa, N. S. (2023). Upaya peningkatan hasil belajar dan sikap kerjasama siswa melalui penerapan discovery learning. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *13*(1), 59-67.

Cavlazoglu, B., & Stuessy, C. (2018). Examining science teachers' argumentation in a teacher workshop on earthquake engineering. *Journal of Science Education and Technology*, *27*(4), 348–361.

Chen, S. Y., Chu, Y. R., Lin, C. Y., & Chiang, T. Y. (2016). Students' knowledge of, and attitudes towards biotechnology revisited, 1995-2014: Changes in agricultural biotechnology but not in medical biotechnology. *Biochemistry and Molecular Biology Education: A Bimonthly Publication of the International Union of Biochemistry and Molecular Biology*, *44*(5), 475–491.

Chowdhury, T., Holbrook, J., & Rannikmäe, M. (2020). Socio-scientific Issues within science education and their role in promoting the desired citizenry. *Science Education International*, *31*(2), 203–208.

Christenson, N., Gericke, N., & Rundgren, S. N. C. (2017). Science and language teachers' assessment of upper secondary students' socio-scientific argumentation. *International Journal of Science and Mathematics Education*, *15*(8), 1403–1422.

Dawson, V., & Venville, G. J. (2009). High-school students' informal reasoning and argumentation about biotechnology: An indicator of scientific literacy?. *International Journal of Science Education*, *31*(11), 1421–1445.

Egan, A., Maguire, R., Christophers, L., & Rooney, B. (2017). Developing creativity in higher education for 21st century learners: A protocol for a scoping review. *International Journal of Educational Research*, *82,* 21–27.

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's Argument Pattern for studying science discourse. Science Education, 88(6), 915–933.

Faridah, H. D., & Sari, S. K. (2019). Utilization of microorganisms on the development of halal food based on biotechnology. *Journal of Halal Products and Research*, *2*(1), 33-43.

Foong, C. C., & Daniel, E. G. S. (2013). Students' argumentation skills across two socio-scientific issues in a confucian classroom: Is transfer possible?. *International Journal of Science Education*, *35*(14), 2331–2355.

Friedrichsen, P. J., Ke, L., Sadler, T. D., & Zangori, L. (2021). Enacting co-designed socio-scientific issues-based curriculum units: A case of secondary science teacher learning. *Journal of*

DOI: https://doi.org/10.17509/aijbe.v7i2.68809
e-ISSN 2621-7260

Science Teacher Education, *32*(1), 85–106.
Glassner, A., & Schwarz, B. B. (2007). What stands and develops between creative and critical thinking?. Argumentation? *Thinking Skills and Creativity*, *2*(1), 10–18.
Hanegan, N. L., & Bigler, A. (2009). Infusing authentic inquiry into biotechnology. *Journal of Science Education and Technology*, *18*(5), 393–401.
Holstermann, N., Grube, D., & Bögeholz, S. (2010). Hands-on activities and their influence on students' interest. *Research in Science Education*, *40*(5), 743–757.
Iordanou, K., & Constantinou, C. P. (2015). Supporting use of evidence in argumentation through practice in argumentation and reflection in the context of the SOCRATES learning environment. *Science Education*, *99*(2), 282–311.
Lindahl, M. G., & Lundin, M. (2016). How do 15–16 year old students use scientific knowledge to justify their reasoning about human sexuality and relationships?. *Teaching and Teacher Education*, *60*, 121–130.
Macagno, F., Mayweg-Pope, E., & Kuhn, D. (2015). Argumentation theory in education studies: coding and improving students' argumentative strategies. *Topoi*, *34*(2), 523–537.
Manzuoli, C. H., Vargas, M. A., Erika, S. M., & Bedoya, D. (2019). Digital citizenship: A theoretical review of the concept and trends. *The Turkish Online Journal of Educational Technology*, *18*(2), 10–18.
Namdar, B., & Shen, J. (2016). Intersection of argumentation and the use of multiple representations in the context of socio-scientific issues. *International Journal of Science Education*, *38*(7), 1100–1132.
Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, *87*(2), 224–240.
Pauzi, R. Y., & Windiaryani, S. (2021). The critical thinking skills on global warming issue: Effect of the socio-scientific problems approach on problem-solving toward student's. *Biosfer: Jurnal Pendidikan Biologi*, *14*(2), 228-237.
Potter, P., & France, B. (2018). Informing a pedagogy for design and problem-solving in hard materials by theorizing technologists' learning experiences. *International Journal of Technology and Design Education*, *28*(1), 101–120.
Pratiwi, Y. N., Rahayu, S., & Fajaroh, F. (2016). Socio-scientific issues (SSI) in reaction rates topic and its effect on the critical thinking skills of high school students. *Indonesian Journal of Science Education*, *5*(2), 164–170.
Probosari, R. M., Ramli, M., Harlita, H., Indrowati, M., & Sajidan, S. (2016). Profile of scientific argumentation skills of FKIP UNS biology education students in the plant anatomy course. *Bioeducation: Journal of Biology Education*, *8*(2), 29-33.
Purwati, R., Suranto, S., Sajidan, S., & Prasetyanti, N. M. (2019). Problem-based learning modules with socio-scientific issues topics to closing the gap in argumentation skills. *TOJET: The Turkish Online Journal of Educational Technology*, *18*(4), 35–45.
Rahmadhani, K., Priyayi, D. F., & Sastrodihardjo, S. (2020). Kajian profil indikator kemampuan argumentasi ilmiah pada materi zat aditif dan zat adiktif. *Natural: Scientific Journal of Science Education*, *7*(1), 1-9.
Rosli, R., Goldsby, D., & Capraro, M. M. (2013). Assessing students' mathematical problem-solving and problem-posing skills. *Asian Social Science*, *9*(16), 54–60.
Sadler, T. D., & Zeidler, D. L. (2005). Patterns of informal reasoning in the context of socio-scientific decision making. *Journal of Research in Science Teaching*, *4*(1), 112–138.
Tidemand, S., & Nielsen, J. A. (2017). The role of socio-scientific issues in biology teaching: From the perspective of teachers. *International Journal of Science Education*, *39*(1), 44–61.
Topçu, M. S., Foulk, J. A., Sadler, T. D., Pitiporntapin, S., & Atabey, N. (2018). The classroom observation protocol for socio-scientific issue-based instruction: development and implementation of a new research tool. *Research in Science and Technological Education*, *36*(3), 302–323.

DOI: https://doi.org/10.17509/aijbe.v7i2.68809
e-ISSN 2621-7260

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2017). The relationship between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, *72*, 577–588.

Wüstenberg, S., Stadler, M., Hautamäki, J., & Greiff, S. (2014). The role of strategy knowledge for the application of strategies in complex problem solving tasks. *Technology, Knowledge and Learning*, *19*, 127–146.

Yapıcıoğlu, A. E. (2018). Advantages and disadvantages of socio-scientific. *International Online Journal of Education and Teaching (IOJET)*, *5*(2), 361–374.

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