JPII 11(2) (2022) 237-245

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

IMPLEMENTATION OF 5E PLUS LEARNING MODEL ON ENERGY SUBJECT MATTER TO IMPROVE STUDENTS' ARGUMENTATION SKILLS

B. Wikara*[1], S. Sutarno[2], S. Suranto[3], S. Sajidan[4]

[1.2.3.4]Sebelas Maret University, Indonesia

DOI: 10.15294/jpii.v11i2.30567

Accepted: June 8th 2021. Approved: June 27th 2022. Published: June 30th 2022

ABSTRACT

Argumentation skills consist of 2 elements: skills to construct arguments and implement them. However, some studies show that students' argumentation skills were low. This study proposed the 5E Plus learning model to improve students' argumentation skills. The model consists of an element named Enliven and six syntaxes: Orientation, Engagement, Exploration, Explanation, Elaboration, and Evaluation. This study aimed to investigate the effectiveness of the 5E Plus learning model in improving students' argumentation skills. This study used Energy subject matter (which consisted of 3 topics, Mechanical, Heat, and Electrical Energy). The study's sample consisted of 40 1st semester college students from the Natural Science department and was taken randomly. We used One-Group Pretest-Posttest as a research design and collected data using an argumentation skills test. The data was examined using an Independent sample t-test to determine the effectiveness of the 5E Plus learning model. The results were: 1) the 5E Plus learning model was effective for improving students' argumentation skills, 2) All components of students' argumentation skills were successfully improved, which warrant experienced the highest improvement, 3) Students' argumentation skills in all three topics were successfully improved, which in Mechanical Energy topic the skills experienced the highest improvement.

Keywords: 5E Plus learning model; argumentation skills; energy subject matter

INTRODUCTION

Argumentation skills consist of 2 elements: skills to construct arguments and implement them (Lazarou et al., 2017). Constructing and implementing an argument involves five components: claim, data, warrant, backing, and rebuttal. In general, the claim is an opinion; data is a fact; the warrant is reasoning that connects data and claims; backing can be considered a secondary warrant, whereas rebuttal is a refutation to an argument (Toulmin, 2003). When argumentation skills involve a scientific element, they are associated with a strong understanding of concepts, improved critical thinking skills, and scientific literacy (Noviyanti et al., 2019). Those three need the connection between prior knowledge and new information. Efforts to connect the two factors can outcome the students' argumentation skills. Furthermore, logical evidence, understanding and acknowledgment of a range of perspectives are required by thoughtful argument (Friedrich & Fox, 2018).

Argumentation skills are needed in judgments to take decisions, and the skills also include critical thinking skills. Therefore, argumentation skills can be considered part of HOTS (Higher-Order Thinking Skills). HOTS are urgent in 21st-century learning (Afandi, 2017). Hence, it is emphasized today that global science learning must accommodate practices and argumentation skills to support learning in the 21st-century (Chu et al., 2017). Argumentation skills that are used here cover four domains. These are digital literacy, inventive thinking, effective communication, and high productivity (Turiman et al., 2012).

***Correspondence Address**
E-mail: berthawikara@student.uns.ac.id

Argumentation skills are essential competencies in the 21st-century related to objective learning. In curriculum, the skills are considered necessary (Wang & Jiang, 2018). Moreover, in real life, argumentation skills are considered necessary to settle many life challenges. For example, social, economic, or political activities need argumentation skills. Hence, educators admit the need to support individuals in developing argumentation skills (Newell et al., 2015; Songsil et al., 2019; Rohayati et al., 2020; Iordanou & Rapanta, 2021).

However, it was found that the argumentation skills of some students were low. A study conducted in a college showed that students' argumentation skills were low, with a mean score of claim was 52 %, data was 42%, reasoning was 15%, and rebuttal was 10% (Probosari et al., 2016). Along with that result, another study showed that the argumentation skills of some college students in the Biology Education department were still at level 2. This means they could conduct claim and warrant, but not with backing or rebuttal (Setiawati & Nurlaelah, 2017). Meanwhile, a more recent study result, which involved students of an academic writing course as the sample, suggested that more practice should be given to the students to improve their argumentation skills (Sundari & Febriyanti, 2021).

Since argumentation skills are essential, but they are found to be low in students, it is urgent to improve them. This paper proposed a new learning model named 5E Plus to improve students' argumentation skills. This model was built based on the 5E learning model. The 5E model, which is also widely known as BSCS 5E instructional model, was chosen as the basis since it has two advantages; 1) its syntaxes are suitable for argumentation skills training, and 2) they have a positive long-term effect on students (Ong et al., 2021; Garcia et al., 2021). 5E learning model consists of 5 syntaxes, Engagement, Exploration, Explanation, Elaboration, and Evaluation. In Engagement, a problem or phenomenon is presented to students to motivate or provoke their curiosity. In exploration, students are ordered to gather information/facts related to the problem or phenomenon. In explanation, students should answer or explain the problem or phenomenon based on the information/facts and their reasoning. In Elaboration, students develop their understanding and skills gained in the syntaxes before, especially in explanation. At last, in Evaluation, students' understanding and skills are assessed by themselves and the teacher. By those 5E's syntaxes, students are trained to think selves, support and wake up selves believing in the communication, enhance processing skills, or increase specific science concept understanding (Chitman-Booker & Kopp, 2013; Bybee et al., 2015; Rodriguez et al., 2019; Ruiz-Martin & Bybee, 2022).

Students' argumentation skills can be improved using the 5E learning model, through the model's syntaxes, for example, explanation. This syntax conducts discussion or debate activities, widely acclaimed as an effective pedagogical tool that can improve language elements in argumentation skills (El Majidi et al., 2021; & Masito et al., 2022). The 5E learning model also supports scientific argumentation discourse, that is, students' ability to debate scientific concepts through discussion with others in collaborative settings (Lobczowski et al., 2020). Also important, an argumentative task that raises students' motivation and curiosity to learn science topics (Sukardi & Agustrianti, 2017) is contained in 5E's syntaxes, especially in Engagement and Elaboration. Furthermore, understanding, engaging, and analyzing an argument, essential in argumentation skills (Ferretti & Graham, 2019), can be trained using the 5E learning model.

Somewhat different from the 5E learning model, the 5E Plus learning model proposed consists of 6 syntaxes, Orientation, Engagement, Exploration, Explanation, Elaboration, and Evaluation. Therefore, one added syntax to the 5E learning model (5E Plus' basic model) is the Orientation. This syntax was added to shorten the time needed for syntax Exploration. This was considered necessary since the 5E learning model implementation in classes, in a few cases, exceeded the time that had been allocated (Polgampala & Shen, 2016). In syntax Orientation, more information that is related to the topic will be taught by the teacher (the topic is also related to the problem or phenomenon that will be presented in syntax Engagement) is given to students so that they will not need much time to collect information during syntax Exploration.

Furthermore, the 5E Plus learning model has one more additional element which is not possessed by to 5E learning model, which is Enliven. The element is not considered as the syntax but tends to be a fashion that is how syntaxes are presented to students. Enliven means presenting a joyful learning atmosphere in syntaxes. Enliven is included in syntax Orientation, Engagement, and Elaboration. This was important since students, in a few cases, felt bored when they underwent the 5E learning model (Polgampala & Shen, 2016).

This study aimed to determine whether the 5E Plus learning model effectively improves students' argumentation skills. Energy was used as subject matter in the study. The subject matter was divided into three topics; Mechanical Energy, Heat Energy, and Electrical Energy. They can be considered general topics in natural science and play a fundamental role in students' daily life.

METHODS

This study was quantitative research. The population was 1st-semester college students in the Natural Science department. The sample consisted of 40 students and was taken randomly from the population.

A quantitative method, a One-Group Pretest-Posttest design, was used here. Before treatment (implementation of the 5E Plus learning model to students), a pretest was conducted to obtain data about students' argumentation skills. The data showed the initial argumentation skills of the students. After treatment, a posttest was conducted to obtain data about students' argumentation skills. The data showed students' argumentation skills after using the 5E Plus learning model. The description of the One-Group Pretest-Posttest design is shown in Table 1.

Table 1. One-Group Pretest-Posttest Design

O_1 (Pretest)	X (Treatment)	O_2 (Posttest)

(Creswell & Creswell, 2003)

The activity of each stage in Table 1 is shown in Table 2. Table 2 served to clarify the practice of the research design in Table 1. In Table 2, students' argumentation skills were considered a dependent variable.

Table 2. The Activity of Each Stage of the One-Group Pretest-Posttest Design

Pretest	Treatment	Posttest
Measuring students' argumentation skills in the Mechanical Energy topic.	Students using the 5E Plus learning model when studying the Mechanical Energy topic.	Measuring students' argumentation skills in the Mechanical Energy topic.
Measuring students' argumentation skills in the Heat Energy topic.	Students use the 5E Plus learning model when studying the Heat Energy topic.	Measuring students' argumentation skills in the Heat Energy topic.
Measuring students' argumentation skills in the Electrical Energy topic.	Students using the 5E Plus learning model when studying the Electrical Energy topic.	Measuring students' argumentation skills in the Electrical Energy topic.

Data about students' argumentation skills were collected using an argumentation skills test. At the pretest, students' argumentation skills were examined using an argumentation skills test containing questions related to Energy subject matter (Mechanical, Heat, and Electrical Energy). Each test question started with a presentation of a problem or phenomenon which students should answer or explain. The answer or explanation should consist of a short answer and an extended (essay) one. The long answer tells the reason behind the short answer. The same rule was also applied to the posttest. Using the rule, the five components of students' argumentation skills (claim, data, warrant, backing, and rebuttal) are automatically contained in the students' pretest and posttest answers. Hence, students' skills in performing each component could be assessed. So, the five components of argumentation skills in the students' answers were used as assessment indicators here. As mentioned in Table 2, there was a treatment between pretest and posttest. In the treatment, the 5E Plus learning model was implemented in learning. It meant that students (sample) underwent learning using the 5E Plus learning model's syntaxes, which are Orientation, Engagement, Exploration, Explanation, Elaboration, and Evaluation.

Further, the students' answers to both tests (pretest and posttest) were collected for being assessed. Those answers were then scored to analyze the process in the following steps. The score, which in statistics is more commonly referred to as data, is then analyzed to gain a descriptive statistic. The presentation of descriptive statistics here was aimed to show the full result description of the pretest and posttest. In this paper, the data is also presented in the form of graphics to facilitate its interpretation.

Furthermore, the data underwent a Normality test to determine whether it was categorized as normally distributed. After the data was found as normally distributed, it underwent a Homogeneity test to find out whether the data was

categorized as homogeny. Next, after the data was proven as homogeny, it was examined using the Independent sample t-test. The use of the test helped examine whether the difference between the pretest's and posttest's scores was categorized as significant. If significant, it can be concluded that the 5E Plus learning model is effective in improving students' argumentation skills. On the contrary, if not significant, then the 5E Plus learning model was less effective in improving students' argumentation skills.

RESULTS AND DISCUSSION

As stated above, the score of students' answers to the pretest and posttest was analyzed statistically to obtain a descriptive statistic. The result is shown in Table 3.

Table 3. Descriptive Statistic of the Score of Students' Answers

		Pretest	Posttest
N	Valid	40	40
	Missing	0	0
Mean		42,05	83,20
Median		43,05	81,50
Mode		47,00	81,00
Std. Deviation		6,12	5,88
Variance		37,43	34,63
Minimum		30,00	75,00
Maximum		50,00	95,00
Sum		1682	3328

Table 3 shows descriptive statistics, which contained mean, median, mode, and others. By that, we can compare the result of the pretest and posttest. Mean, median, mode, and so on of pretest in Table 3 were calculation results of the total score of students' argumentation skills before the treatment. Meanwhile, the mean, median, mode, and others of the posttest were calculation results of the total score of students' argumentation skills after the treatment. Table 3 facilitated us to compare scores of students' argumentation skills before and after treatment. By comparing the two scores, it was clear that students' argumentation skills were increased after the treatment. Therefore, it seemed that the 5E Plus learning model effectively improved students' argumentation skills.

Nevertheless, it was not known whether the difference between the two results was significant. An independent sample t-test was conducted on the data to find out about it. This was done after the data was proven to be normally distributed and homogeny. The result of the Independent sample t-test is shown in Table 4.

Table 4. Independent Sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Gain	Equal variances assumed	.440	.510	-1.495	68	.139	-3.55000	2.37400	-8.28724	1.18724
	Equal variances not assumed			-1.516	65.412	.134	-3.55000	2.34192	-8.22658	1.12658

Table 4 shows the result of the calculation by using the Independent sample t-test. The test examined whether the difference between the pretest and posttest scores was significant. Table 4 denoted that the obtained significance value here was 0.510. Since the significance level used in the test was 5%, it can be said that the difference between the pretest and posttest scores was significant. This means that students' argumentation skills were indeed improved after the students underwent the 5E Plus learning model. In other words, the 5E Plus learning model effectively improved students' argumentation skills.

As mentioned above, the 5E Plus learning model has six syntaxes: Orientation, Engagement, Exploration, Explanation, Elaboration, and Evaluation. Syntax Orientation is helpful as a means to shorten the time needed for syntax Exploration. This guarantees the success of implementing the other syntaxes and the model itself. Using syntax Orientation, students can undergo the other syntaxes (5 syntaxes of the 5E Plus' basic model) without being hindered by time constraints. Therefore, argumentation skills training held by the other syntaxes can run smoothly. This was suspected to be the cause of this study's argumentation skills improvement. As stated above, the 5E learning model's syntaxes (which are used too in the 5E Plus learning model) support argumentation skills improvement, but sometimes the model implementation is disturbed by the amount of time spent on syntax Exploration. Moreover, the combination of inquiry and instruction, similar to the addition of syntax Orientation into the 5E learning model, was proven effective in improving students' argumentation skills (Muntholib et al., 2021).

Further, the data of this study was presented in the form of graphics to make it easier to be interpreted. First, the pretest and posttest data were presented based on their components of argumentation skills. There were five components: claim, data, warrant, backing, and rebuttal. Each component had its own score, which contributed to the score of students' argumentation skills (both scores of the pretest and posttest). In this case, students could be experts in one component (so that the contribution of the component's score to the score of students' argumentation skills was high). However, at the same time, they could be weak in other components (the contribution of the component's score to the score of students' argumentation skills was low). The graphic of the contribution of argumentation skills components in the pretest was presented in Figure 1.

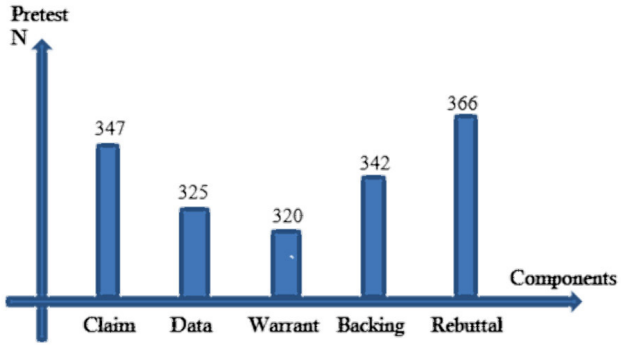

Figure 1. The Contribution of Argumentation Skills Components in Pretest

In Figure 1, each bar's number shows the component's score. This score contributed to the score of students' argumentation skills. As seen in Figure 1, before students underwent the 5E Plus learning model, rebuttal gave the highest contribution to the score of students' argumentation skills, whereas warrant gave the lowest. Rebuttal is a refutation or disagreement to an argument, whereas warrant is reasoning using data to form a claim (Toulmin, 2003; Cottrell, 2017). The phenomenon of the rebuttal and warrant in Figure 1 probably was caused by students' weakness in building complete arguments, which happened before their argumentation skills were trained using the 5E Plus learning model. A complete argument (also called basic argumentation skills) only needs data, warrant, and claim. At the same time, backing and rebuttal are components of the second argument used for refuting the prior argument. Backing needs reasoning, whereas rebuttal could not (Utomo, 2019). Figure 1 also showed that rebuttal and claim had higher scores than the other components. However, this was likely because claim and rebuttal can be raised without support from data, warrant, and backing. In other words, claim and rebuttal are opinions that anyone can express. On the other hand, data, warrant, and backing are not so easy to be obtained

or raise. Data is obtained through exploration, whereas warrant and backing should involve reasoning to be raised. Therefore, claim and rebuttal had higher scores here, whereas data, warrant, and backing had lower scores. Along with Figure 1, the graphic of the posttest is also presented in this paper. Same as Figure 1, the graphic of the posttest also described the contribution of each argumentation skills component. The graphic of the posttest is shown in Figure 2.

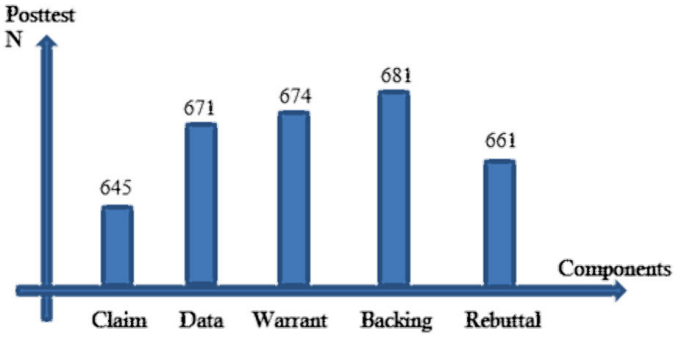

Figure 2. The Contribution of Argumentation Skills Components in Posttest

When we compared Figures 1 and 2, it was clear that all components of students' argumentation skills improved after the treatment. The components' scores of argumentation skills of the posttest were all higher than the pretest. This finding showed that the 5E Plus learning model improved all components of students' argumentation skills. Further, the amount of each component's improvement could be known by calculating the score difference of each component. So, claim was improved by 298, data by 346, warrant by 354, backing by 339, and rebuttal by 295. Therefore, warrant experienced the highest improvement, whereas rebuttal experienced the lowest.

In argumentation skills, warrant is created by using reasoning or logic, which can be challenging for some students. However, students' skills in creating warrant (and arguments, in general) can be improved by interactive discussion in the classroom (Probosari et al., 2017; Antonio & Prudente, 2021). One of the 5E Plus learning model's syntaxes, that is explanation, facilitated interactive discussion so that students' skills in creating warrant managed to be trained and finally improved. The improvement of warrant was the highest among the other components, likely because the syntax Explanation was more suitable for warrant creating training.

In this paper, the contribution to students' argumentation skills is not only shown from the point of view of argumentation skills' components. Next, we showed the contribution of the subject matter used in this study to students' argumentation skills. As mentioned before, the subject matter was divided into three topics: Mechanical Energy, Heat Energy, and Electrical Energy. On each topic, students achieved a specific argumentation skills score. The score contributed to the total score of students' argumentation skills. The contribution of the three topics was presented in the form of the graphic, the same as the components of argumentation skills before. The three topics' contribution to the pretest is presented in Figure 3.

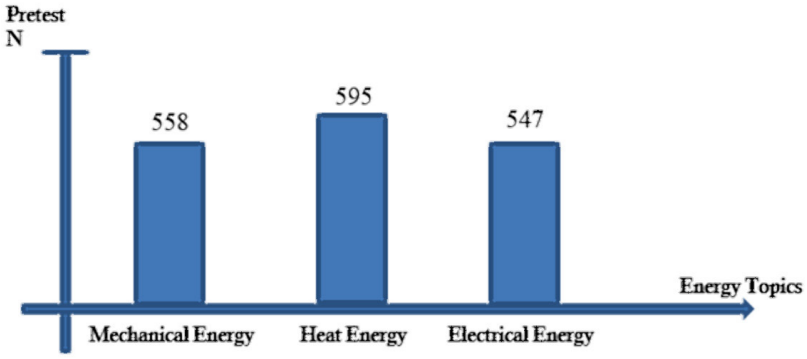

Figure 3. The Contribution of Energy Topics in Pretest

Figure 3 denoted that the Heat Energy topic contributed the highest to the students' argumentation skills score. In other words, students gained the highest score on argumentation skills when the topic was Heat Energy. This meant that students' argumentation skills were at their best regarding the Heat Energy topic.

The use of different topics at the pretest, even though all topics were related to Energy, evidently resulted in different scores of students' argumentation skills. The students' argumentation skills score was highest on the Heat Energy topic, probably because the students' understanding of the topic was better than the other topics. Meanwhile, the argumentation skills' components related to this case were data and warrant. A better understanding of the Heat Energy topic meant that students were superior in concept mastering and reasoning activity in the topic. Therefore, students already had robust data and warrant when they showed their argumentation skills on the topic.

However, the result presented in Figure 3 should be compared with the posttest result. The contribution of Mechanical, Heat, and Electrical Energy in the posttest is shown in Figure 4.

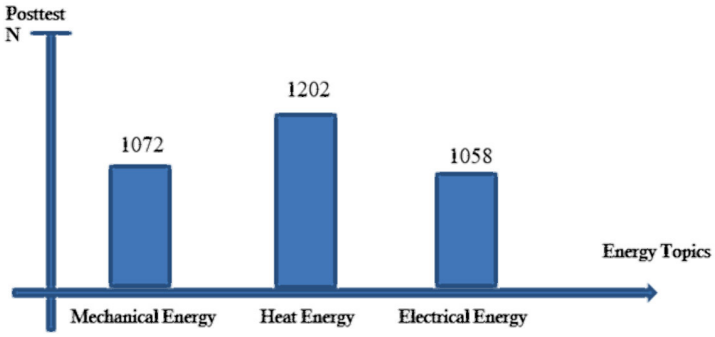

Figure 4. The Contribution of Energy Topics in Posttest

In Figure 4, the Heat Energy topic again gave the highest contribution to students' argumentation skills scores. However, it was natural considering that students' argumentation skills in the initial test (pretest) were at their best regarding the Heat Energy topic. Furthermore, all topics in the posttest seemed to obtain a higher score than the pretest. According to this finding, it was likely that the treatment (the 5E Plus learning model implementation) managed to improve students' argumentation skills evenly. Students' argumentation skills in each topic were successful in being improved. This was probably because implementing the 5E Plus learning model on the three topics was balanced.

Farther, the amount of argumentation skills improvement in each topic could be known by calculating the score difference between pretest and posttest. So, the Mechanical Energy topic was improved by 514, the Heat Energy topic by 427, and the Electrical Energy topic by 511. This result showed that students' argumentation skills in Mechanical Energy topic obtained the highest improvement. This phenomenon was possibly caused by the implementation of syntax Orientation and or Enliven, which was slightly better on the Mechanical Energy topic than on the other topics.

In addition, Mechanical Energy is more accessible and related to logic than Heat and Electrical Energy since its processes involve more prominent or visible objects. Hence, students' Computational Thinking (CT) skills were more facilitated here so that the score of students' argumentation skills on the topic improved. When CT skills are good, argumentation skills are also good (Fakriyah & Masfuah, 2021). Since CT skills are also related to academic performance, argumentation skills are undoubtedly related to academic performance (Lemay et al., 2021).

Nonetheless, the improvement of students' argumentation skills in the Heat Energy topic was not as high as in the Mechanical Energy topic. Since students' argumentation skills at the pretest were already at their best in the Heat Energy topic, it was natural that the skills in the same topic were hard to get the highest improvement.

CONCLUSION

5E Plus learning model, which consists of an element named Enliven and six syntaxes, which are Orientation, Engagement, Exploration, Explanation, Elaboration, and Evaluation, was effective for improving students' argumentation skills. All components of students' argu-

mentation skills, which are claim, data, warrant, backing, and rebuttal were successfully improved here, which warrant experienced the highest improvement. Students' argumentation skills in all topics used in this study (those were Mechanical, Heat, and Electrical Energy) were also successfully improved. In this case, the skills in Mechanical Energy topic experienced the highest improvement.

REFERENCES

Afandi, S. (2017). Stimulasi Keterampilan Berpikir Tingkat Tinggi; Konsep dan implementasinya dalam pembelajaran Abad 21. Surakarta: UPT.

Antonio, P. R., & Prudente, S. M. (2021). Metacognitive Argument-Driven Inquiry in teaching antimicrobial resistance: Effects on students' conceptual understanding and argumentation skills. *Journal of Turkish Science Education, 18*(2), 192-217.

Bybee, R., Taylor, J. A., Gardner, A., Van Scotter, P., Carlson Powell, J., Westbrook, A., & Landes, N. (2015). *The BSCS 5E instructional model*. Arlington, TX: NSTA press.

Cottrell, S. (2017). *Critical thinking skills: Effective analysis, argument and reflection*. Bloomsbury Publishing.

Chitman-Booker, L., & Kopp, K. (2013). *The 5Es of inquiry-based science*. Teacher Created Materials.

Chu, S. K. W., Reynolds, R. B., Tavares, N. J., Notari, M., & Lee, C. W. Y. (2021). *21st century skills development through inquiry-based learning from theory to practice*. Springer International Publishing.

Creswell, J. W., & Creswell, J. (2003). *Research design* (pp. 155-179). Thousand Oaks, CA: Sage publications.

El Majidi, A., Janssen, D., & de Graaff, R. (2021). The effects of in-class debates on argumentation skills in second language education. *System*, *101*, 102576.

Fakhriyah, F., & Masfuah, S. (2021, April). The analysis of scientific argumentation skill and computational thinking skill of the primary educational teacher department students. In *AIP Conference Proceedings* (Vol. 2331, No. 1, p. 030005). AIP Publishing LLC.

Ferretti, R. P., & Graham, S. (2019). Argumentative writing: Theory, assessment, and instruction. *Reading and Writing*, *32*(6), 1345-1357.

Friedrich, L., Bear, R., & Fox, T. (2018). For the sake of argument: An approach to teaching evidence-based writing. *American Educator, 42*(1), 18–23.

Garcia I Grau, F., Valls, C., Piqué, N., & Ruiz-Martín, H. (2021). The long-term effects of introducing the 5E model of instruction on students' conceptual learning. *International Journal of Science Education*, *43*(9), 1441-1458.

Iordanou, K., & Rapanta, C. (2021). "Argue with me": a method for developing argument skills. *Frontiers in Psychology*, *12*, 631203.

Lazarou, D., Erduran, S., & Sutherland, R. (2017). Argumentation in science education as an evolving concept: Following the object of activity. *Learning, culture and social interaction*, *14*, 51-66.

Lemay, D. J., Basnet, R. B., Doleck, T., Bazelais, P., & Saxena, A. (2021). Instructional interventions for computational thinking: examining the link between computational thinking and academic performance. *Computers and Education Open*, *2*, 100056.

Lobczowski, N. G., Allen, E. M., Firetto, C. M., Greene, J. A., & Murphy, P. K. (2020). An exploration of social regulation of learning during scientific argumentation discourse. *Contemporary Educational Psychology*, *63*, 101925.

Masito, F., Oka, I., Cahyadi, C., Komalasari, Y., Anes, A., & Risdianto, E. (2022). Scientific Argumentation Skills Through The Rasch Model on Analysis of Survey Data on The Importance of Aviation Vocational Education in Indonesia. *Journal of Innovation in Educational and Cultural Research, 3*(3), 487-498.

Muntholib, M., Hidayati, K., Purnajanti, L., Utomo, Y., & Hariyanto, H. (2021, March). Impact of explicit scientific inquiry instruction on students' scientific argumentation skills in salt hydrolysis. In *AIP Conference Proceedings* (Vol. 2330, No. 1, p. 020045). AIP Publishing LLC.

Newell, G., Bloome, D., & Hirvela, A. (2015). *Teaching and learning argumentative writing in high school English language arts classrooms*. Routledge.

Noviyanti, N. I., Mukti, W. R., Yuliskurniawati, I. D., Mahanal, S., & Zubaidah, S. (2019, June). Students' scientific argumentation skills based on differences in academic ability. In *Journal of Physics: Conference Series* (Vol. 1241, No. 1, p. 012034). IOP Publishing.

Ong, E., Govindasamy, D., Swaran Singh, C., Ibrahim, M., Abdul Wahab, N., Borhan, M., & Tho, S. (2021). The 5E inquiry learning model: Its effect on the learning of electricity among Malaysian students. *Cakrawala Pendidikan*, *40*(1), 170-182.

Probosari, M. R., Ramli, M., Harlita, Indrowati, M., & Sajidan. (2016). Profil ketrampilan argumentasi ilmiah mahasiswa pendidikan biologi FKIP UNS pada mata kuliah anatomi tumbuhan. *Bioedukasi, 9*(1), 29-33.

Probosari, R., Widyastuti, F., Suranto, M., & Prayitno, B. (2017, October). Tracing the Development of Student's Argumentation in Science Classroom: Knowledge Acquisition and Motivation. In *International Conference on Teacher Training and Education 2017 (ICTTE 2017)* (pp. 602-608). Atlantis Press.

Rodriguez, S., Allen, K., Harron, J., & Qadri, S. A. (2019). Making and the 5E learning cycle. *The Science Teacher*, *86*(5), 48-55.

Rohayati, Y. T., Zubaidah, S., Mahanal, S., & Setiawan, D. (2020, April). The correlation between student scientific argumentation skills and cognitive achievement on PBL and RICOSRE learn-

ing models in biology classes. In *AIP Conference Proceedings* (Vol. 2215, No. 1, p. 030014). AIP Publishing LLC.

Setiawati, I., & Nurlaelah, I. (2017). Analisis Profil Kemampuan Berargumentasi Guru dan Mahasiswa Calon Guru Dalam Pembelajaran Biologi Menggunakan Model Toulmin's Argumen Pattern (TAP) dan Upaya Perbaikannya. *Quagga: Jurnal Pendidikan dan Biologi*, *9*(01).

Songsil, W., Pongsophon, P., Boonsoong, B., & Clarke, A. (2019). Developing scientific argumentation strategies using revised argument-driven inquiry (rADI) in science classrooms in Thailand. *Asia-Pacific Science Education*, *5*(1), 1-22.

Sukardi, R. R., & Agustrianti, Y. V. (2017, January). Analysis of Students' Argumentation Skill and Conceptual Knowledge in Friction Force Lesson through Argumentative Task. In *International Conference on Mathematics and Science Education* (pp. 80-84). Atlantis Press.

Sundari, H., & Febriyanti, R. H. (2021). The Analysis of Indonesian EFL Argumentative Writing Using Toulmin's Model: The Structure and Struggles from the Learners. *Scope: Journal of English Language Teaching*, *5*(2), 67-78.

Toulmin, S. (1958). The Uses of ArgumentCambridge University Press. *Cambridge, UK*.

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st century skills through scientific literacy and science process skills. *Procedia-Social and Behavioral Sciences*, *59*, 110-116.

Ruiz-Martín, H., & Bybee, R. W. (2022). The cognitive principles of learning underlying the 5E Model of Instruction. *International Journal of STEM Education*, *9*(1), 1-9.

Utomo, Y. S. (2019, June). Argumentation Skills Profile on 8th Grade Students using Toulmin's Argument Pattern on Controversial Topic. In *Journal of Physics: Conference Series* (Vol. 1233, No. 1, p. 012095). IOP Publishing.

Wang, Y., & Jiang, W. (2018). An automatic classification and clustering algorithm for online learning goals based on cognitive thinking. *International Journal of Emerging Technologies in Learning, 13*(11), 54-66.