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

by B Wikara
IMPLEMENTATION OF 5E PLUS LEARNING MODEL ON ENERGY SUBJECT MATTER TO IMPROVE STUDENTS’ ARGUMENTATION SKILLS

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DOI:

Accepted: . Approved: . Published: .

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 experiencing 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: argumentation skills, 5E Plus learning model, energy subject matter

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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 et al., 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 & Sajidan, 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 (Turman et al., 2012).

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; Kalypso & 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 & Nurfadlah, 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 (Jumariati et al., 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 SE Plus to improve students’ argumentation skills. This model was built based on the SE learning model. The SE 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., 2020; Graw et al., 2021). SE 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 SE’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, 2015; Rodriguez et al., 2019; Ruiz-Martin & Bybee, 2022).

Students’ argumentation skills can be improved using the SE 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 (Majidhi et al., 2021). 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 & Agustianti, 2016) is contained in SE’s syntaxes, especially in Engagement and Elaboration. Furthermore, understanding,
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 first-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.

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<th>Table 1. One Group Pretest-Posttest Design</th>
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(Creswell, 2014)

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>
<thead>
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<th>Table 2. The activity of each stage of the One Group Pretest-Posttest Design</th>
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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 means that students (sample) underwent learning using the 5E Plus learning model's syntaxes, which are Orientation, Engagement, Exploration, Explanation, 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 homogeneity. Next, after the data was proven as homogeneity, 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 score 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                                | 40      | 40      |
| Valid                            | 0       | 0       |
| Missing                          |         |         |
| Mean                             | 42.05   | 83.20   |
| Median                           | 43.00   | 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 showed 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 homogeneity. The result of the independent sample t-test is shown in Table 4.
Table 4. Independent Sample T-Test

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<td>Levene's Test</td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>Variance</td>
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<td>510</td>
</tr>
<tr>
<td>t-test for Equality of Means</td>
<td>-1.516</td>
<td>65.412</td>
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</table>

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 improved after the students underwent the SE Plus learning model. In other words, the SE Plus learning model effectively improved students' argumentation skills.

As mentioned above, the SE 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 SE 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 SE learning model's syntaxes (which are used too in the SE 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 SE learning model, was proven effective in improving students' argumentation skills (Muntholf 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](image)

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 SE 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' weaknesses 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 et al., 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](image)

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.

![Pretest](image)
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 SE 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 SE Plus learning model on the three topics was balanced.

Further, 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 & Masfiah, 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 Erdiven and six syntaxes, which are Orientation, Engagement, Exploration, Explanation, Elaboration, and Evaluation, was effective for improving students’ argumentation skills. All components of students’ argumentation 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.

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