

Enhancing Critical Reasoning Character in Pancasila Students: A STEAM Approach by E-Module PRISMA

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Abstract: This study aimed to assess the Prisma e-module's impact on elementary school students' critical reasoning abilities. A pre-experimental Pretest Posttest Control Group Design was employed. Two groups – experimental and control – received different treatments. The experimental group used e-modules, while the control group relied on books. Pre- and post-treatment tests were conducted to evaluate the e-module's effect. An Independent Sample t-test was used to compare the two groups, with results showing a Sig. (2-tailed) value of 0.000, leading to the rejection of H₀ and acceptance of H_a. The N-Gain test measured improvements in various critical reasoning elements. The experimental group showed significant improvement, with the highest N-Gain of 0.74 in "obtaining and processing information and ideas" and the lowest of 0.71 in "reflecting and evaluating one's thoughts." The overall N-Gain was 0.72, classified as "high." These findings indicate that the Prisma e-module effectively enhanced critical reasoning in fifth-grade students. Future research is encouraged to explore other aspects of Pancasila students' character development

Keywords: Critical reasoning; E-module; Enhancing; Human circulatory; STEAM

Introduction

The development of technology provides significant changes in the world of education in Indonesia (Ellianawati et al., 2021). Educational institutions have responded to the current situation by implementing technology for the learning process in the classroom (Rasmussen et al., 2020). According to Özdemir et al. (2018), Technology devices are an appropriate resource for educational programs, with innovative program success and more significant

potential for advancing learners' learning (Utaminingsih et al., 2023). Indirectly, this requires educators to use technological advances to maximize learning (Serevina et al., 2018).

Considering the rapid integration of technology in education and the increasing demand for critical reasoning skills in the 21st century, this study holds significant importance. It aligns directly with Indonesia's national education objectives of fostering democratic, productive, and high-achieving citizens (Rahayu et al., 2024). Furthermore, the inherent

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complexity of subjects such as human blood circulation, which often involves abstract concepts, necessitates more innovative pedagogical approaches. Traditional textbooks, while valuable, lack the interactive elements required for deep comprehension and critical analysis (Khasanah et al., 2022). The Prisma e-module addresses these gaps by offering an interactive, STEAM-based learning experience that facilitates content mastery and cultivates critical thinking, a key competency in developing future-ready learners.

STEAM (Science, Technology, Engineering, Art, and Mathematics) has recently been increasingly in demand by researchers worldwide (An, 2020). STEAM helps increase learning effectiveness (Quigley et al., 2020). In addition, it can provide exciting learning experiences (Atiaturrahmaniah et al., 2022). Further, it can increase learners' curiosity to explore science more critically (Baek et al., 2022). In their findings, Jesionkowska et al. (2020) said that the STEAM approach could increase meaningfulness, solve science problems, and increase students' science literacy (Izzania et al., 2021). STEAM directs students to gain real experience through learning (Perignat & Katz-Buonincontro, 2019) and answers the technological era's challenges (Utaminingsih et al., 2023).

The learning process for students in the fifth grade of Supriyadi Elementary School is still complicated and needs to be improved. Semarang is the topic of human blood circulation. The fifth-grade teacher conveyed this during the interview. Furthermore, the teacher said the topic contains complex material, and the unfamiliar language is too complex for students to master. The statement has also been conveyed by Utaminingsih et al. (2023) in the results of their study, who found that human circulatory material is one of the materials that are difficult for students to master because students must go through abstract thinking to be able to master it. Rofiyadi and Handayani added that this material is more accessible if only textbooks were used because it requires proper visualization to be delivered (Rofiyadi & Handayani, 2021). The material teachers at Supriyadi Elementary School have delivered is only sourced from books from the Ministry of Education.

This study presents a novel approach by integrating STEAM principles into an e-module, specifically designed to enhance critical reasoning skills, often underdeveloped in elementary education. Unlike previous research, which mainly focuses on subject comprehension through traditional or digital resources, this research incorporates a Pancasila-based critical reasoning framework tailored to the Indonesian educational context (Utaminingsih et al., 2024). By combining STEAM and critical reasoning, the Prisma e-module addresses the dual challenge of fostering scientific literacy and character development

simultaneously. This research is crucial as it responds to the 21st-century educational demands by improving content mastery and promoting higher-order thinking skills, thus contributing to the formation of well-rounded, critical citizens, as outlined in Indonesia's Pancasila Student Profile (Suminar et al., 2023).

Teachers need exciting and interactive teaching materials so students are motivated and directly involved in learning (Sihaloho et al., 2022). Given the learning difficulties of learners and challenges in the technological era (Sihaloho et al., 2022), the use of teaching materials by educators should lead to e-modules (Nugraha et al., 2020), which includes elements (Atiaturrahmaniah et al., 2022). The character leads to the competencies needed in 21st-century education (Irawati et al., 2022).

The elements of critical reasoning that will be collaborated with the e-module must be adjusted to the needs of students (Sutiyono, 2022). The results of interviews with teachers also found that the critical reasoning character of students cannot be said to be good. The data implies that selecting e-modules as teaching materials should also contain critical reasoning characters (Rahmawati et al., 2022). The character of critical reasoning is also one of the crucial elements in building the nation's character (Sutiyono, 2022). The information in the Regulation of the Minister of Education and Culture Number 22 of 2020 is to create superior human resources (HR) by defining six characters in the Pancasila Student Profile, one of which is the character of critical reasoning (Kemdikbud, 2020).

The character of critical reasoning is one of the characteristics of Pancasila students designed to answer the competencies that the Indonesian education system wants to produce (Kurniawaty et al., 2022). In addition, it aims to make Indonesian citizens democratic, superior, productive, and characterized in the 21st Century (Kemendikbudristek, 2022). Given the vital role of the critical reasoning character in the learning process, the content of the critical reasoning character should be involved in selecting teaching materials (Kahfi, 2022). Based on the problems described, this study aims to use teaching materials developed in research conducted by Utaminingsih (2023), namely the Prisma e-module, a STEAM-based e-module containing human circulatory topics containing critical reasoning characters.

Method

The method used in this study was a pre-experimental design type: a pretest-posttest control group design. The following flowchart illustrates the research methodology, which aimed to assess the impact of STEAM-based e-modules on the development of critical reasoning and science literacy in fifth-grade

students. The process begins with selecting the population and sample, followed by pretesting, administering the treatment, conducting posttests, and finally analyzing the data using statistical tests to determine the effectiveness of the intervention. Outlines the research methodology presented in Figure 1.

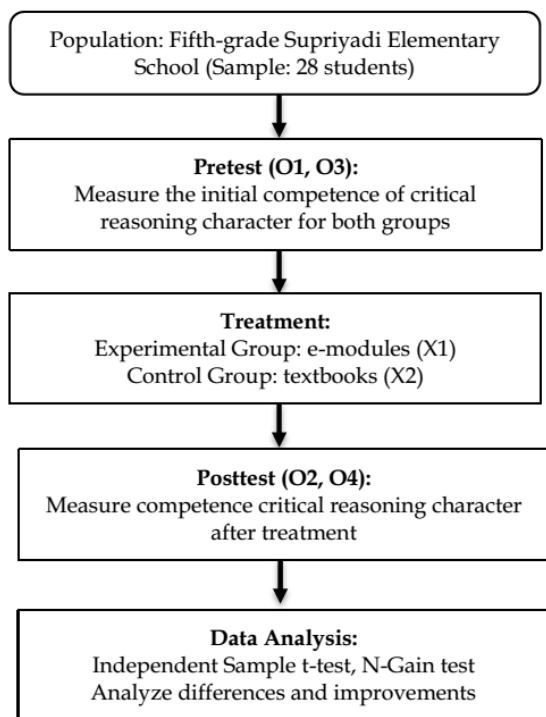


Figure 1. Flowchart research methodology

The population in this study is fifth-grade Supriyadi Elementary School. The sampling technique used is total sampling with a sample of 28 students. The research design used in this study is pre-experimental. Experimental research is the most purely quantitative research (Imleesh et al., 2023). This method is validation or testing, which tests the influence of one variable on another variable.

Pretest Posttest Control Group Design research design, there are two groups selected. The experimental and control groups have the same characteristics (homogeneous). Furthermore, both groups were given a pretest with the same test to determine the initial state. Then, the experimental group was given special treatment, namely learning using STEAM-based e-modules, while the control group was given the usual treatment, namely learning using textbooks. After treatment, both groups were given posttests with the same tests. Furthermore, the results of the two final tests were compared, and the initial test results were compared with the final test in each group. The Pretest-Post-test Control Group Design is presented in Table 1 in detail.

Table 1. Pretest-Post-test Control Group Design

Group	Pretest	Treatment	Posttest
Experiment	O1	X1	O2
Control	O3	X2	O4

Information:

- X1 : Providing treatment (X1), namely providing material with e-modules STEAM-based against the research sample
- X2 : Provide treatment (X2) which is the provision of material with textbooks against the research sample
- O1 : Measuring the critical reasoning character experiments group before treatment (given pretest)
- O2 : Re-measure critical reasoning character after experiments group treatment (given posttest)
- O3 : Measuring the competence the critical reasoning character Control before treatment (given pretest)
- O4 : Re-measure critical reasoning character control group after treatment (given posttest).

Data analysis was used with the help of the SPSS 25 Program using the Independent Sample t-test to determine whether there were differences in test results in the experimental and control groups. The result can be seen from the value of Sig. (2-tailed), that is if the value of Sig. (2-tailed) < 0.05, then H₀ (no effect of using e-module) is rejected, and H_a (there is an effect of using e-module) is accepted. After obtaining the results, proceed with the N-Gain test to determine the increased value of each element studied. The N-Gain equation used in this study is presented in the following formula.

$$N - Gain = \frac{T_{pos} - T_{pre}}{T_{maks} - T_{pre}} \tag{1}$$

Information:

- T_{pos} : Average score posttest
- T_{pre} : Average score pretest
- T_{max} : Ideal maximum score

The N-Gain score obtained by the equation can be analyzed for categories using the gain score interpretation by Wahab et al. (2021) is presented in Table 2.

Table 2. N-Gain Value Categories (g)

Value (g)	Category
(g) > 0.7	Tall
0,3 ≤ (g) ≤ 0.7	Keep
(g) < 0.3	Low

Result and Discussion

Table 3 shows that the data were typically distributed because of the Sig. (2-tailed) value across classes > 0.05, so parametric statistical analysis can be

performed. Furthermore, to determine the difference in increasing critical reasoning characters in the experimental class and the control class, a hypothesis test was carried out with the Independent Sample t-test. The results of the Independent Sample t-test analysis obtained a Sig. (2-tailed) value of 0.000 or <math><0.05</math>, then H_0 was rejected, and H_a was accepted. It means there is a difference in the average score between the experimental and control classes. The use of the Prisma e-module in the experimental group significantly influenced the critical reasoning character of elementary school students.

Table 3. Normality Test Results of Critical Reasoned Characters (Shapiro-Wilk)

Class	Df	Sig. (2-tailed)
Pretest Experiment	53	0.15
Posttest Experiments	53	0.166
Pretest Control	49	0.09
Posttest Control	49	0.78

The Implementation of Experiment Group

The critical reasoning character is measured by giving a pretest and posttest using the instrument of critical reasoning character. The instrument was developed by (Utaminingsih, 2023). The instrument has been tested for validity, reliability, differentiation, and difficulty. The results of measuring the character of critical reasoning are presented in Figure 1 and Figure 2.

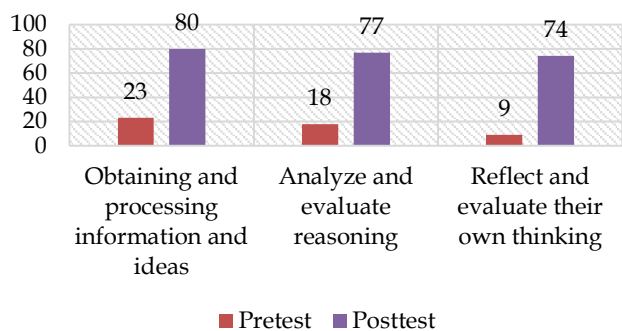


Figure 1. Experimental class critical reasoned pretest-posttest result

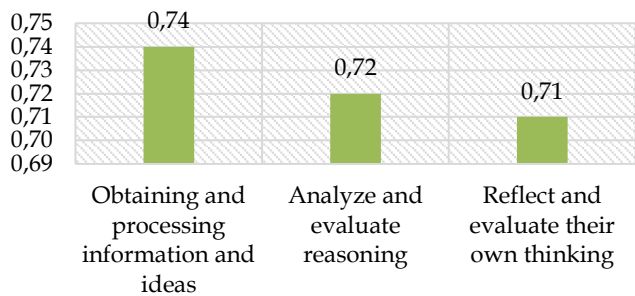


Figure 2. Experimental class critical reasoned character n-gain value

Figure 1 and Figure 2 show that the use of the Prisma e-module improved the critical reasoning character of grade V students in the experimental group at Supriyadi Elementary School. Improvement occurs in all elements of critical reasoning. The highest increase was in the N-Gain score of 0.74 in "obtaining and processing information and ideas," and the lowest was in "reflecting and evaluating one's thoughts," with an N-Gain score of 0.71. However, the total N-Gain score is 0.73 in the "high" criterion. Based on these results, the Prisma e-module effectively improves the critical reasoning character of grade V elementary school students.

Implementation of Control Group

In the learning process of the control group, the learning procecco was used as a textbook from the Educational Ministry. The steps are a pretest, learning by textbooks, and a posttest. The results of the control group evaluations are presented in Figures 3 and 4.

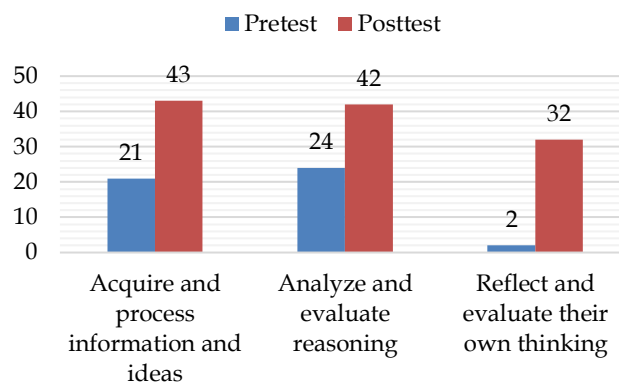


Figure 3. Critical reasoning improvement of control group

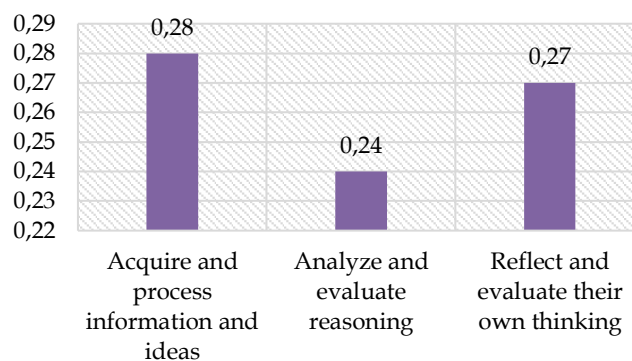


Figure 4. N-gain value of critical reasoning

Based on the picture above, it can be concluded that learning the topic of human blood circulation using textbooks from the Ministry of Education can improve students' critical reasoning character with the criteria of "low" improvement or with an N-Gain score of 0.26.

The Differentiation between Experiment and Control Group

The evaluation results between the experimental and control groups are significant. These results can be seen from the N-Gain value obtained. The difference in N-Gain results between both groups is presented in Figure 5.

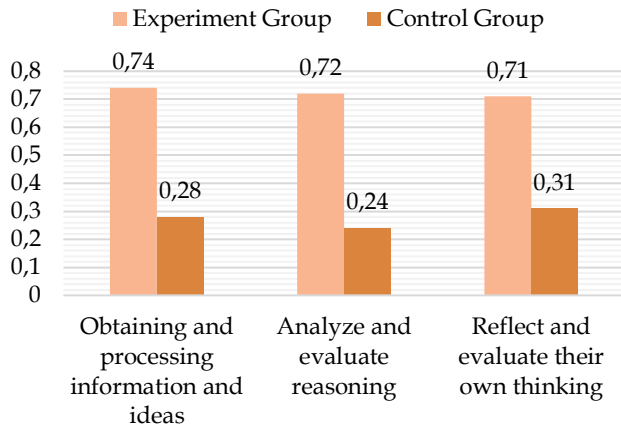


Figure 5. The difference in the n-gain value of the experimental group and control group

Figure 5 shows a significant difference in the N-Gain scores of the experimental group's critical reasoning characters with the control groups. The further emphasizes the difference in the increase in critical reasoning characters between the experimental and control classes. The score on each element indicates this difference. In all three elements, both the experimental group and the control group improved. However, in the experimental class, all critical reasoning elements experienced a significant increase with the "high" criterion. The result indicates that the Prisma e-module has a positive influence on improving students' critical reasoning character.

Other research to improve the character of critical reasoning in science learning has been conducted by Ernawati et al. (2022). However, the research is limited to the development of design learning, and the character of critical reasoning in the research only focuses on its activities. However, it is crucial to improve the character of critical reasoning, considering that the formation of the critical reasoning character is one of the efforts to realize a superior national character (Irawati et al., 2022).

Critical reasoning is essential to training because learners will be curious, ask relevant questions, identify and clarify ideas and information obtained, and process the information (Ernawati & Rahmawati, 2022b). Armed with these abilities, they can make decisions appropriately based on information from various relevant and accurate sources (Rumtini et al., 2022). Students can provide accurate explanations in problem-

solving and decision-making (Suharini & Handoyo, 2019). Finally, they can prove their reasoning with various arguments in the conclusion (Badridduja et al., 2022). Furthermore, they can continue to develop their capacity through reflection, efforts to improve strategies, and persistence in testing various alternative solutions (Kemdikbud, 2020).

Excellence in this study, efforts to improve the character of critical reasoning not only through activities during learning but also through the e-module that have been developed are the primary means to improve the character of critical reasoning supported by learning activities. The e-Prisma module supports improving students' critical reasoning skills through the features in the e-module. Prisma e-modules are equipped with images, sounds, and audiovisuals capable of enhancing the character of critical reasoning. The statement is supported by Liu et al. (2022) and Asri et al. (2022) findings that learning media that display images, sounds, and audiovisuals can improve the character of critical reasoning. The media requires students to master how to apply concepts (Fazryn et al., 2023) and use skills in various new and different situations (Ardianti & Wanabuliandari, 2021).

Furthermore, students can analyze and interpret information to determine choices and actions (Pinontoan et al., 2021). It can train the habit of thinking before making decisions and lead them to draw conclusions based on solid evidence. Students automatically improve their critical reasoning character (Kibtiyah, 2022).

Students with a critical reasoning character can objectively process information qualitatively and quantitatively (Rumtini et al., 2022). They can establish linkages between various information (Slam, 2021). In line with that, Prisma e-modules can build linkages between various information learners need. It was supported by the material features provided, especially video material, and then students were asked to provide reviews or opinions related to videos that have been aired. In the next step, they are given examples of similar cases and then asked for their opinions. Students are given freedom of thought in solving a problem; it trains the emergence of various critical opinions that can help stimulate the ability to reason critically (Rahmawati et al., 2022). In line with the statement, Utaminingsih (2023) also said that material packaged in videos presented through Android-based applications stimulates students to process information qualitatively and objectively. In addition, students were directed to build linkages between various information (Utaminingsih, 2023), analyze information, and evaluate and infer it (Pinontoan et al., 2021).

Elementary school students need to be stimulated and nurture their critical reasoning skills in making

decisions that can be accounted for by them (Imania et al., 2022). This assumes that the earlier the character of critical reasoning, the more students will increase their ability to process and analyze information (Kibtiyah, 2022) and evaluate their thinking (Suminar, 2022). Hence, using the Prisma e-module can stimulate learners to improve their critical reasoning skills. With good stimulus support, students' thinking skills will develop optimally (Slam, 2021). Therefore, the e-Prism module effectively improves learners' critical reasoning character.

The Prisma e-module is considered very effective because of the increase in the N-Gain score. What is obtained meets the "high" criteria in every aspect and as a whole. Quoting from the findings of Pinontoan et al. (2021), the class in which the learning process uses e-The module improves reasoning ability higher than the class taught conventionally. The reasoning improvement control class is lower than the experimental class, so using e-Modules in the learning process supports good reasoning skills (Rahmawati et al., 2022).

A series of learning processes using e-modules were also added to create activity mind-mapping for learners. Implementation of good assessment, accompanied by assignments, by achieving learning objectives (Aulia et al., 2021). The assignment leads students to explore and use reasoning and analytical thinking in solving given problems (Badridduja et al., 2022). Learners seek to obtain and process information and ideas by analyzing and evaluating their reasoning in solving problems in learning (Leaning, 2019). Students think about the relationship between the material that has been obtained and the tasks given (Kibtiyah, 2022). In addition, learners reflect on thoughts, and a thought process occurs to solve problems (Fazryn et al., 2023).

Through the assignments given, learners can describe the results of investigations, observations, hypotheses, and conclusions about a scientific phenomenon (Patonah, 2014). Learners will also understand phenomena through their experiences and direct learners to make observations, remember events, and be able to communicate what they understand (Nuvitalia, 2016). This series of activities certainly trains students' critical reasoning skills (Suminar, 2022).

STEAM and Critical Reasoning Character

The experimental group that had participated in STEAM-based learning showed better mastery of all three elements of the critical reasoning character. Integrative and interdisciplinary STEAM learning provides learners with a more complex and profound stimulus in understanding human circulatory topics. The STEAM concept guides students in learning scientific concepts and applying the principles behind

the phenomenon (Utaminingsih et al., 2023). The behavior triggers students to extract information by increasing the elements of "obtaining and processing information" more actively and independently, comparing with other sources, and compiling conclusions based on evidence and strong logic (Ahied et al., 2020).

The STEAM approach invites students to look at and explore problems from various perspectives; this can be seen from the element of "analysis and evaluate reasoning." In the context of human blood circulation, students were led to understand not only from the side of biology but also from the side of technology and engineering in medical devices (Utaminingsih et al., 2023). The medical device in question is related to topics related to blood circulation and the use of mathematical principles to understand blood volume and pressure contained in the STEAM-based e-module that has been developed.

STEAM-based e-modules can also support the improvement of elements of "reflect and evaluate their thinking" by providing opportunities for students to reflect on the learning process they have done. Through activities designed in the e-module to train students in reflecting and evaluating, learners were led to identify strengths and weaknesses in their thinking, become aware of their own mental processes (Utaminingsih et al., 2023), and consider ways of improvement in the future (Utaminingsih et al., 2023). The STEAM approach to learning has a positive, inert impact, increasing the critical reasoning character of grade V elementary school students. The STEAM concept not only emphasizes information absorption (Azizah et al., 2020) but also leads to process skills (Sarwi et al., 2019), reasoning, and reflective abilities that are crucial competencies in the 21st Century (Ellianawati et al., 2020).

Conclusion

This study demonstrated that the Prisma e-module significantly improved the critical reasoning character of fifth-grade elementary school students. The Independent Sample t-test results indicated a Sig. (2-tailed) value of 0.000, leading to the rejection of H_0 and acceptance of H_a , confirming a meaningful difference between the experimental and control groups. The experimental group, using the e-module, showed substantial improvement across all critical reasoning elements, with the highest N-Gain value of 0.74 in "obtaining and processing information and ideas" and the lowest of 0.71 in "reflecting and evaluating one's thoughts." The overall N-Gain was 0.72, classified as high. These results suggest that the Prisma e-module effectively enhances critical reasoning and offers a promising tool for educational development in

Indonesia. Further research should explore other aspects of Pancasila students' character development.

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Author Contributions

Conceptualization, E. S. U., A. A., A.A., and C. L.; methodology, E. S. U., M. S. A.; validation, E. S. U., B. Y. I., and M. S. S.; formal analysis, R. A. E.; investigation, M. N. S., and C. H. S. A.; resources, A.A. And A.I.; data curation, M. S. A. and E. S. U.; writing—original draft preparation, E. S. U. and C. L.; writing—review and editing, M. S. A. and B. Y. I.; visualization, A. I., and M. S. S. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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