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Effectivity of Project-Based Science Module to Improve Students Critical Thinking Skills on Independent Curriculum for Junior High School Science Learning

Ika Fitriani[1], I Ketut Mahardika[123], Rusdianto[1]

[1]Science Education Study Program, Faculty of Teacher Training Education, University of Jember
[2]Science Education Magister Study Program, Faculty of Teacher Training and Education, University of Jember
[3]Science Education Doctoral Study Program, Faculty of Teacher Training and Education, University of Jember

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Abstract

Science education cannot be completed without critical thinking abilities since they enable students to address problems in an efficient and effective manner. Improving these abilities is essential to guaranteeing that students are competent in scientific research. Creating cutting-edge instructional resources is essential to encouraging critical thinking and active student participation. Project-based science modules are particularly notable among these resources because of their capacity to pique interest and promote inquiry. This study employs the ADDIE model as its research framework within the Research and Development (R&D). Pretest and posttest questions, as well as student response surveys, are included in the study instruments. When analyzing data, the N-gain test is employed to assess how well the project-based science module is working. Achieving an N-gain value of 0,53 indicates a notable improvement, categorizing it as moderately successful according to the results. Furthermore, a high satisfaction percentage of 91.33% is revealed by examination of student questionnaire replies, showing a very positive reaction towards the module.

Keywords: Module, Effectivity, Project, Critical thinking skills

(*) Corresponding Author: ketut.fkip@unej.ac.id

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INTRODUCTION

Beyond only knowing facts, the study of the natural sciences (IPA) explores the fundamental ideas and theories that underlie natural phenomena (Wahyuni *et al*., 2022). But kids nowadays are not often given the opportunity to develop critical thinking skills because they are often taught that science is only about memorizing formulas, figures, and images. Their limited viewpoint makes it difficult for them to connect scientific ideas with practical applications. However, critical thinking abilities are crucial to scientific education because they give students the tools they need to solve problems, come to their own conclusions, and become independent. Students gain the ability to recognize, comprehend, and assess natural occurrences in line with critical thinking (Damayanti *et al*., 2022).

It has been noted by Amijaya *et al.* (2018) how important critical thinking abilities are to science education. According to Agnafia (2019), critical thinking

requires the ability to reason persuasively as well as impromptu. Rositawati (2018) identified six measures of critical thinking skills: interpretation, analysis, evaluation, inference, explanation, self-regulation. These standards operate as cornerstones for enhancing students' capacity to interact critically with scientific ideas and data.

As per the study conducted by Nuryanti *et al.* (2018), Indonesia faces a concerning trend characterized by a deficiency in students' critical thinking skills. In particular, the SMP Negeri 1 Delanggu survey revealed that pupils' critical thinking proficiency was just 40.46%, which was considered a poor percentage. The findings from research carried out by Rosmalinda et al. (2021) also supported this idea, with 58.1% of respondents reporting a lack of proficiency in answering questions that encourage critical thinking. The inadequate nature of the teaching resources used in the classroom is mostly to blame for this widespread problem. Moreover, students' inadequate skills to think critically is a result of their lack of experience with teaching methods that emphasize active student participation (Nurhayati et al., 2018). Wahyuni (2015) emphasizes that enhancing scientific educational resources could lead to enhancements in students' critical thinking skills. Thus, innovative teaching resources are desperately needed to encourage students' active participation. Modules are one type of instructional resource that is frequently used in classroom instruction.

Modules are instructional resources with instructional information given in a manner that is easy for students to understand and are intended to support independent learning (Puspitasari, 2019). Modules comprise all necessary elements, such as covers, module profiles, usage manuals, concept maps, learning competencies, activity sheets, assessment sheets, quiz sheets, and answer keys (Ramdhani et al., 2020). Modules are widely used by teachers to support the development of critical thinking skills, especially in project-based learning contexts (Setyowati and Widiyatmoko, 2013). Project-based learning is an excellent method for nurturing critical thinking skills as it engages students actively in the learning process. As teaching resources, project-based science modules combine academic information with real-world projects, encouraging students to actively participate in their education.

According to KBBI, a project is a well-organized work plan with well-defined goals that are assiduously pursued. Rati (2017) claims that the project-based learning approach is built on the fundamental concepts of a scientific subject and gives students the freedom to research, work through issues, and take on other pertinent tasks in a way that is focused on them and produces tangible outcomes. According to Santoso et al. (2020), Thomas (2008) goes on to explain how project-based learning gives teachers the ability to plan lessons using student-centered activities that promote student autonomy and critical thinking.

Physics education can help students become more adept critical thinkers by covering subjects like expansion, heat, and temperature. But understanding these intangible ideas is difficult, requiring the use of critical thinking abilities. Furthermore, the use of captivating and inventive pedagogical resources is vital to promote learning. By incorporating markers of critical thinking abilities into their curriculum, educators can aid students in improving their analytical skills. Thus, the goal of this study is to evaluate how well project-based scientific modules

contribute to students' development of critical thinking abilities within a stand-alone curriculum.

RESEARCH METHOD

The creation and assessment of a product is the aim of this study's application of the research and development method. The study's design complies with the five phases of the ADDIE paradigm analysis, design, development, implementation, and evaluation as described by Bagus et al. (2023). This study's developmental technique was used to design a project-based science module that could help students become more adept at critical thinking. Junior high school science curricula can successfully include this subject. The study was carried out at SMP Negeri 5 Jember during the odd semester of the 2023–2024 academic year.

. The target population consisted of all seventh-grade students enrolled in State Middle Schools in Jember during the academic year 2023/2024. From a total of six classes, a sample comprising one class, specifically class VII-A, was chosen for the study.

Pretest and posttest questions, as well as student response questionnaires, were used as research tools in this study. The N-gain test, which can be computed using the following formula, was used as the data analysis technique to assess the efficacy of project-based scientific modules.

$$< g > = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

Information:
<g> = normalized average score
Spost = average posttest score of students
Spre = average pretest score of students
Smax = maximum score

Table 1. *N-gain* Criteria

***N-gain* Score**	**Criteria**
$g \geq 0,7$	High
$0,7 \leq g < 0,3$	Medium
$g < 0,3$	Low

(Hakee, 1998)

RESEARCH RESULTS AND DISCUSSION

Research Result

Efficient learning necessitates the application of thoroughly researched instructional materials. Consequently, data regarding the progression of critical thinking skills, alongside an evaluation of the project-based science module's efficacy, were obtained through student pretest and posttests. Furthermore, after the module was implemented, student response surveys were used to gather feedback, which added to the understanding of its effectiveness.

Pretest and posttest analyses were used to assess how well project-based science courses improved students' critical thinking abilities. These assessments were used to determine whether the project-based science curriculum had improved

students' critical thinking skills. The test's questions were created to correspond with important measures of critical thinking abilities. The differences between the pretest and posttest test results were then carefully examined. The following are the students' average results on the pretest and posttest, which show growth in their capacity for critical thought: Here, enter the average score.

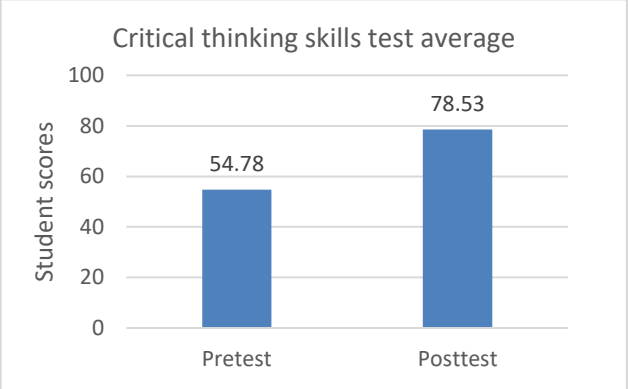

Fig. 1 Average pretest and posttest assessment of critical thinking skills

The mean score of the pretest, administered to 28 students, was 54.78, whereas the mean score for the posttest was 78.53. These findings indicate a notable enhancement critical thinking skills of students in Class VII A subsequent to their engagement with the project-based science module. To further evaluate its effectiveness, the N-gain formula was employed to analyze the results of this improvement. The subsequent section presents the outcomes of this evaluation regarding the effectiveness of students critical thinking skills.

Table 2. Results of analysis of the effectiveness of students' critical thinking skills

Component	Score		*N-gain*	Category
	Pretest	*Posttest*		
The number of students	27.00	27.00	0.53	Medium
Average	54.78	78.53		

Data from SMP Negeri 5 Jember's Class VII pupils show a discernible development in their critical thinking abilities, as shown in Table 2. After the project-based science module was implemented, students' N-gain values were 0.53, placing them in the moderate group. The findings of the pretest and posttest were then examined in order to evaluate the students' critical thinking skills. As Table 3 shows, the N-gain computation results for each indication are displayed in the ensuing section.

Table 3. N-gain results for each indicator of critical thinking skills

Indicator	Average value		*N-Gain*	Category
	Pretest	*Posttest*		

Interpretation	65.74	92.59	0.78	High
Analisys	34.26	55.56	0.32	Medium
Evaluation	48.15	64.81	0.32	Medium
Inference	54.63	76.85	0.49	Medium
Explanation	51.85	83.33	0.65	Medium
Self-regulation	74.07	97.22	0.89	High

Data showing a statistically significant increase in the N-gain value for each critical thinking skills indicator are shown in Table 3. The interpretation indication, which obtained a good grade with an N-gain value of 0.78, is especially remarkable. With an N-gain value of 0.32, the analysis and assessment indicators were categorized as moderate. Similarly, a moderate classification with an N-gain value of 0.49 was obtained from the inference indicator. With an N-gain value of 0.65, the explanatory indication likewise achieved a moderate categorization. Remarkably, the self-regulation indicator (N-gain = 0.89) demonstrated exceptional progress.

Thirty students who had participated in project-based scientific modules filled out answer questionnaires, which were used to gauge the effectiveness of these modules even more. It was possible to gain insight into students' viewpoints after participating in the project-based scientific modules by analyzing their responses. The following table displays the findings from the examination of the student answers.

Table 4. Results of analysis of student response questionnaires

Observed aspects	Percentage (%)	Category
Use	93.52	Very good
Presentation	90.19	Very good
Design	90.28	Very good
Average student response	91.33	Very good

Table 4. presents statistics indicating that the average student answer was 91.33%, which is classified as "very good". This demonstrates how well the science module was received by students. Furthermore, the proportion of student answers for each metric also shows a positive relationship with the use of project-based scientific modules.

DISCUSSION

When assessing a product's performance in an educational setting, effectiveness is an essential factor to consider. According to this study's assessments given by practitioners who have used the project-based IPA module, its efficacy can be determined (Sugiarti et al., 2019). Several sources were used to analyze how effective project-based science modules are at teaching science. These include student response surveys, which record practitioners' evaluations of the produced goods, and pretests and posttests, which gauge students' critical thinking abilities.

Before project-based scientific modules are used for learning activities, a pretest is given to the participants. Following that, a project-based science module trial takes place in science classes. The degree to which the project-based science

module has improved students' critical thinking abilities is then determined by administering a posttest.

Based on the findings of the pretest and posttest, computing N-gain values shows that students' critical thinking abilities have significantly improved. The moderate level of efficacy is indicated by the analytical result of 0.53. These findings support the development of students' critical thinking skills following the introduction of the project-based science curriculum. This is consistent with the study results of Reizal et al. (2020), which suggest that effective teaching resources may have a favorable effect on students' learning outcomes.

Varied indices show varied degrees of critical thinking improvement, according to the N-gain study. With scores of 0.32, 0.32, 0.49, and 0.65, respectively, the analysis, evaluation, inference, and explanation indicators show a moderate improvement. According to Nuryanti et al. (2018), students' deficient analytical skills are still caused by their inability to use question analysis to generate effective problem-solving solutions. Notably, at 0.78 and 0.89, respectively, the interpretation and self-regulation indicators show the greatest N-gain values, classifying them as high. The focus on self-regulation encourages students to actively participate in reaching learning objectives, highlighting the importance of using the right tactics to meet intended academic objectives.

Positive and negative questions from student response questionnaires are analyzed to determine how effective the project-based science module is. The results of these surveys highlight how effective project-based scientific modules are in promoting learning, especially when it comes to helping students develop their critical thinking abilities. An average proportion of 91%, which indicates a "very good" classification, supports this. This claim is corroborated by Sugianto et al. (2018), who observe that student answer questionnaire responses averaged 84.73% after participating in the project-based science module, which is likewise rated as "very good."

CONCLUSION

Based on the results of the previous data analysis, the project-based science module's efficiency is indicated by a moderate N-gain score of 0.53. Additionally, a high degree of satisfaction with the survey responses was noted, as 91.33% of the students gave it a "very good" rating.

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About the Author (s):

Ika Fitriani

Student of Jember University Science Education Study Program