



# Development of Diagnostic, Formative and Summative Assessment Instruments in the PjBL Model to Stimulate Students' Critical and Creative Thinking Skills

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Received: May 12, 2024

Revised: August 06, 2024

Accepted: October 25, 2024

Published: October 31, 2024

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DOI: [10.29303/jppipa.v10i10.8757](https://doi.org/10.29303/jppipa.v10i10.8757)

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**Abstract:** It is hoped that current education can produce human resources who have strong critical and creative thinking abilities. Students must have critical and creative thinking skills to be able to solve problems efficiently and effectively. The benchmark for determining student success in learning is through evaluation which includes measurements and assessments. The aim of this research is to develop diagnostic, formative and summative assessment instruments in the PjBL model to stimulate critical and creative thinking skills. This type of research is research & development using the ADDIE model. The results of this research obtained the validity of the assessment instrument in the project based learning model with a valid category. The level of practicality of the assessment instrument was categorized as practical by teachers and students. The results of the effectiveness of the knowledge aspect with the results of the pretest and posttest are seen from the classical completeness of each skill which has reached a level of completeness above the minimum expected score. The N-Gain value shows results that meet the high criteria.

**Keywords:** Assessment; Creative; Critical

## Introduction

Critical and creative thinking is part of the 4C skills (creativity, critical, collaboration and communication) which are 21st century skills. Critical and creative thinking skills are very necessary to face changing times which are increasingly changing and full of challenges. Critical thinking skills must be mastered by human resources in the 21st century which refers to the foundations of science and technology (Ariani et al., 2019). Through critical thinking, students can conclude and utilize the information they obtain to solve a problem (Wahyuni et al., 2024). Critical thinking skills are the ability to understand, analyze and evaluate information that is useful for making rational and reasonable decisions (Jumanto et al., 2024). Creative thinking is a skill in generating ideas in a specific context

by looking at situations in different ways (Susanti, 2022). Creative thinking skills make students use intuition and imagination to develop new ideas in solving problems in everyday life (Asrizal et al., 2023).

Assessment is used by students, educators and education personnel to improve the quality of learning. Minister of Education and Culture Regulation No. 21 of 2022 article 9 paragraph (1) assessment of student learning outcomes takes the form of formative and summative assessments (2) formative assessments are carried out at early childhood education, basic education levels, and secondary education levels (3) summative assessments are carried out at education levels primary, and secondary education levels. Various things have been done to improve students' skills, including the development of a new curriculum, namely the independent curriculum, which includes a Pancasila

### How to Cite:

Asiah, S., & Festiyed. (2024). Development of Diagnostic, Formative and Summative Assessment Instruments in the PjBL Model to Stimulate Students' Critical and Creative Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, 10(10), 7486–7492. <https://doi.org/10.29303/jppipa.v10i10.8757>

student profile that includes critical and creative thinking dimensions. The Merdeka Curriculum establishes two assessments to see the achievement of learning objectives, namely formative assessment (at the beginning/in the learning process) and summative assessment (at the end of learning).

Efforts made to improve critical and creative thinking skills by conducting several studies include developing authentic assessments based on student worksheets integrated with digital literacy to assess 21st century skills. Afriana et al. (2022), the influence of implementing performance assessment using the PjBL model on critical thinking skills and students' creativity (N. S. Y. Putri et al., 2020) and research conducted by Mappalesye et al. (2021) regarding the development of critical thinking ability test instruments for physics learning. Research conducted by Sari et al. (2020) which implemented performance assessment through virtual laboratories to improve students' creative thinking skills.

The reality in the field is that students' critical and creative thinking skills are still relatively low because students only memorize without understanding the lesson material, and this results in the next lesson material being difficult (Nainggolan et al., 2023). So far, the implementation of assessments tends to focus on summative assessments which are used as a reference in learning outcomes reports, this shows that assessments have not been used as feedback to improve learning. Even though it is generally seen that teachers with their teaching experience and knowledge of the characteristics of their students have the ability to prepare assessments, there are still very few teachers who use accurate instruments, because to get an accurate instrument requires a lot of testing both qualitatively and quantitatively which is quite time consuming long time. Moreover, educators have difficulty in making assessments based on indicators of critical and creative thinking. One of the causes of low critical thinking skills is that the evaluation instruments used have not been able to empower students' critical thinking skills (Noris et al., 2024).

Observations were conducted at two schools and analysis results were obtained through questionnaires given to educators regarding the learning models used. The average results for the application of each model are 85% problem based learning, 80% inquiry learning and 70% discovery learning, while the application of the project based learning model is 45% with less criteria. This means that educators have implemented several models that are in accordance with the current curriculum, but the application of the project based learning model is rarely used by educators because in implementing this model educators need time to design an appropriate project and assessment. Project-based

learning is learning that facilitates students to produce work either individually or in groups (Imbaquingo et al., 2023; Lestari et al., 2022; Ngereja et al., 2020). The project-based learning model requires students to be able to solve problems, make decisions or carry out investigations so as to provide the opportunity to be independent in producing realistic products or presentations (Hossein-Mohand et al., 2021; Podgórska et al., 2022; Sukacké et al., 2022; Wróblewska et al., 2020).

Analysis of the assessment techniques carried out found that the assessments were in the form of daily assessments, mid-semester tests and end-of-semester assessments. Educators' daily assessment usually uses questions in textbooks or created questions. The assessment instruments contained in the modules prepared by educators do not yet provide detailed assessment types and do not pay attention to indicators of critical and creative thinking skills. The instruments used in schools that have been made by teachers do not meet the requirements for good instruments because the instruments created have not been validated and tried out because the time required to develop instruments that are in accordance with evaluation theory takes a long time so this is difficult to do.

Analysis was carried out on students' critical and creative thinking skills and it was found that critical thinking skills were (45.05%) while creative thinking skills were (47.07%). This shows that students' critical and creative thinking skills are still in the deficient category. Students need to be routinely given critical and creative thinking skills assessment instruments so that they can stimulate these two skills and become accustomed to answering them.

Based on the problems found to overcome the problems found above, the solution offered is the development of diagnostic, formative and summative assessment instruments using the PjBL model to stimulate students' critical and creative thinking skills. The use of the PjBL model is because this learning model is still underused. Meanwhile, the project based learning model is the learning model recommended in the Merdeka curriculum. In line with research conducted by Sutrial et al. (2023) which states that the application of the PjBL model is very effective for students' critical and creative thinking skills. The same thing was also stated in research by Ananda et al. (2021) where analysis was carried out and it was found that the use of the PjBL model was very effective in improving critical and creative thinking skills. Project-based learning has an effect on improving 4C skills (Azmi et al., 2023). There is a significant influence on improving critical thinking skills with the use of the project based learning model. (Yanti et al., 2023).

**Method**

Development research is a type of research, using the ADDIE model. Stages in the model ADDIE consists of five main stages, namely: (1) Analysis stage, the developer reads literature studies, both relevant books and other research results. This stage is the actual information search stage that occurs in the field by exploring as much information as possible, such as needs analysis, curriculum analysis, student analysis and analysis of students' critical and creative thinking skills. (2) Initial design stage, namely the developer needs to design according to what will be researched. At this stage, it is the initial product design stage, namely in the form of diagnostic, formative and summative assessment instruments in the PjBL model to stimulate students' critical and creative thinking skills. (3) Development stage, namely after a product has been designed and produced, validation is required. Product validation assessment is needed to validate or assess the feasibility of a product being designed whether it is valid or not. (4) Implementation stage, namely the implementation stage, namely the product trial stage which aims to implement the assessment product in the form of an assessment activity sheet that has been created. (5) Evaluation stage, namely at each ADDIE stage an evaluation will be carried out which aims to minimize errors and ensure the suitability of the final product.

The subjects of this research were activity and assessment sheets and the subjects of the research trials were students in class XI MAN 1 Mandailing Natal. The instruments used are questionnaires and essay tests. The data obtained for the validation test from the validator is in the form of quantitative data. This data uses a Likert scale score with 5 levels, namely 1, 2, 3, 4 and 5, which is then analyzed for the total empirical score using Aiken's equation formula:

$$V = \frac{\sum s}{[n(c-1)]} \times 100\% \tag{1}$$

The validation results obtained from the test instruments are then categorized according to the validity category based on table 1.

**Table 1.** Validity Criteria

Average value	Evaluation criteria
< 0.92	Invalid
≥ 0.92	Valid

Practicality analysis uses a Likert scale. The results of the practicality analysis aim to see the level of practicality of the product that has been made using equation 2.

$$Final\ score = \frac{Score\ acquisition}{minimum\ score} \times 100\% \tag{2}$$

**Table 2.** Practical Product Assessment Criteria

Percentage (%)	Criteria
0-20	Very Impractical
21-40	Impractical
41-60	Less Practical
61-80	Practical
81-100	Very Practical

Based on the criteria in Table 2, the assessment activity sheet developed can be said to be practical in learning physics if the percentage value is more than 60.

The improvement of students' knowledge competency on activity sheets and assessments can be seen through the provision of tests before and after using the activity sheets and assessments that have been developed. The data is analyzed and measured using the N-Gain analysis adapted from the N-Gain formula.

$$\langle g \rangle = \frac{\% (s\ post) - \% (s\ pre)}{100 - \% (s\ pre)} \tag{3}$$

The N-gain results will be converted using the criteria in Table 3.

**Table 3.** N-gain Criteria

Score $\langle g \rangle$	Normalized gain Criteria
$\langle g \rangle > 0.7$	Tall
$0.7 \geq \langle g \rangle > 0.3$	Currently
$\langle g \rangle \geq 0.3$	Low

Activity sheets and assessments experience an increase in knowledge competency if the N-Gain value is in the medium and high criteria with a score greater than 0.3.

**Results and Discussion**

The results of the development carried out by researchers were to produce assessment instruments in the form of activity and assessment sheets. At the analysis stage it was found that students' critical and creative thinking skills were still low. Based on the collection of this information, it is necessary to develop an assessment instrument using the project based learning model to stimulate students' critical and creative thinking skills. In line with the statement from Ritdamaya et al. (2016) the use of appropriate critical thinking skills instruments/assessments accompanied by continuous and continuous practice can also train and develop students' critical thinking skills.

Assessment is carried out by educators during the learning process and at the end of the lesson. During the learning process or during daily assessments, educators

usually use questions from books, worksheets or questions created by the educators themselves, as well as in mid-semester exams or final exams, questions are usually created by a team of subject educators. Assessment instruments created by educators do not pay attention to critical and creative thinking skills. The assessments used by educators are also not in accordance with the principles of good assessment. Assessment is only applied to the assessment of assignments and from the results of daily assessments, mid-semester assessments and final semester assessments. This is reinforced by research conducted by Festiyed et al. (2022) that teachers focus more on summative assessments even though in the Independent Curriculum there are other types of assessments, namely diagnostic assessments and formative assessments. In line with research conducted by Kurniawan et al (2023) that using diagnostic tests can identify students' learning difficulties.

The initial design stage aims to design assessment instruments in the form of activity and assessment sheets in the PjBL model in accordance with the needs to produce draft activity and assessment sheets that can be used by students and educators to assess students in the physics learning process, especially in thermodynamics material. This activity and assessment sheet is designed based on the structure of the student's activity sheet which is combined with the assessment.

Stage is validated by experts with the aim of finding out whether the product being developed is suitable for use or not. The activity and assessment sheets were validated by three validators. Assessment of activity sheets and assessments in the PjBL model to stimulate students' critical and creative thinking skills is assessed using validation instruments. The validation instrument used consists of four assessment components which are analyzed by the lecturer on the assessment. Each component consists of several assessment indicators. The assessment components used are the appropriateness of content, use of language, appropriateness of presentation and graphical assessment components. The results of validation by experts can be seen in table 4.

**Table 4.** Expert Validity Results

Assessment Components	Aiken's V value	Criteria
Eligibility of content	0.93	Valid
Language use	0.92	Valid
Feasibility of presentation	0.92	Valid
Assessment graphics	0.92	Valid
Average	0.92	Valid

Based on table 4, it is found that the average Aiken's V value for each component is 0.92 with valid criteria. Based on the data obtained, activity sheets and

assessments can be used in learning activities. A product is said to be feasible if it meets validity criteria, which means the level of confidence in the product to be used can measure what it wants to measure (Bogataj et al., 2020; Fourilla et al., 2021; Sember et al., 2020).

The implementation phase is carried out in a trial after the activity and assessment sheets are declared valid by the validator to determine the practicality and effectiveness of the product being developed. The practicality test was carried out by physics subject educators at MAN 1 Mandailing Natal. The educator response questionnaire related to the practicality of activity sheets and assessments in the PjBL model developed consists of three aspects, namely ease of use, attractiveness and efficiency. The results of practicality by educators can be seen in table 5.

**Table 5.** Practicality of Educators

Aspect	Mark (%)	Criteria
Ease of use	93.33	Very practical
Attractiveness	83.33	Very practical
Efficiency	86.67	Very practical
Average	87.78	Very practical

Based on the data obtained, the activity sheets and assessments that have been developed can be practically used by educators in the learning process. The student response questionnaire related to the practicality of the activity sheets and assessments consisted of three aspects, namely ease, attractiveness and efficiency. Practicality results can be seen in table 6.

**Table 6.** Practicality of Students

Aspect	Mark (%)	Criteria
Ease of use	85.61	Very practical
Attractiveness	85.96	Very practical
Efficiency	85.15	Very practical
Average	85.82	Very practical

Based on this data, activity sheets and assessments in the project based learning model to stimulate practical critical and creative thinking skills are used by students in learning activities.

After the activity and assessment sheets are declared valid and practical, the effectiveness of the activity and assessment sheets is then tested in terms of improving critical and creative thinking skills. This knowledge assessment is determined by carrying out a test before (pretest) and a test after (posttest) using activity sheets and assessments. The number of students who took the pretest and posttest was 33 people. Before the questions are given to students, the questions are tried out first. The results of the analysis of the test questions are valid and reliable. The results of the

analysis of student pretest and posttest data can be seen in Table 7.

**Table 7.** Data Analysis of Student Pretest and Posttest Calculations

Statistical parameters	Pretest	Posttest	Gains	Criteria
Average value	20.66	80.99	0.76	Tall
Lowest rate	4.55	59.09		
The highest score	75.00	93.18		
Completion percentage	6.06	87.88		

Based on Table 7, there is an increase in the average value of students after using the assessment activity sheet, namely 20.66 to 80.99. The increase in students' grades did not only happen to a few people, but was also followed by almost all students. This can be seen from the lowest score obtained by students on the pretest was 4.55 and the posttest was 59.09. An increase also occurred in the highest score from 75.00 to 93.18. Almost all students experience an increase in critical thinking skills and creative thinking skills in knowledge competency. Based on this data, it can be seen that after using the activity sheet and assessment through post-test results, it is considered that classical learning has been completed. This is because in the posttest there were  $\geq 75\%$  of students who had completed their studies, in accordance with the KKTP value set at school, namely 75, with the percentage of completion increasing from 6.06% to 87.88%.

The average increase in critical thinking skills and creative thinking skills of students can be seen from the gain score. This can be seen from the gain score of 0.76 with high criteria. It was concluded that activity sheets and assessments can increase students' knowledge competency and are declared effective for use in the learning process to stimulate students' critical thinking skills and creative thinking skills. This assessment of effectiveness, which is assessed from student competency, is also strengthened by Putri (2018) opinion which states that learning effectiveness is measured by the level of achievement of student competency and producing products that are valid, practical and effective. Asrizal et al. (2020) stated that teaching materials are needed to create an effective learning process. With the support of appropriate media or teaching materials in the learning process, critical and creative thinking skills can be honed (Desnita, 2022).

The evaluation stage consists of two stages, namely formative and summative evaluation. Formative evaluation is obtained from the results of revisions at each stage of ADDIE development, namely at the analyze, design, develop and implement stages. Input from supervisors, validators and practitioners is considered so that the product developed becomes better. The results of the summative evaluation are to see

the achievement of development in accordance with the expected goals. Thus the product is declared valid, very practical and effective.

## Conclusion

The results of the data analysis have been carried out and it was found that the diagnostic, formative and summative assessment instruments in the PjBL model to stimulate students' critical and creative thinking skills in the form of activity sheets and assessments are valid, practical and effective. Educators are advised to use project based learning model assessment activity sheets which are useful for stimulating students' critical and creative thinking skills.

## Acknowledgments

The author would like to thank all parties who have contributed to the completion of this article. It is hoped that this article will be useful in the fields of education and science.

## Author Contributions

This article was prepared by two authors S and F. All authors worked together in carrying out each stage of preparation.

## Funding

There was no receipt of external funding for this research.

## Conflicts of Interest

None of the authors have any conflicts of interest.

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