Analysis of Improvements in Students' Critical Thinking Skills Through the Development of a Google Classroom-Assisted Physics Module Based on Problem-Based Learning

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Received: 31st July 2026; **Accepted**: 26th October 2026; **Published**: 10th November 2026
DOI: https://dx.doi.org/10.29303/jpft.v12i2.13003

Abstract - *This study aimed to evaluate the effectiveness of a physics module supported by Google Classroom and developed based on the Problem-Based Learning (PBL) model to enhance students' critical thinking skills in the topic of Newton's Laws. This study was motivated by the limited availability of instructional materials that systematically integrate digital technology and problem-based learning to foster critical thinking skills in line with the demands of 21st-century education. A research and development (R&D) approach was employed using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The developed instructional package comprised a physics module, lesson plans, student worksheets (LKPD), a Google Classroom-based learning environment, and assessment instruments. The products underwent expert validation and were subsequently evaluated through limited-scale and large-scale field trials. The results indicated that the developed module improved students' critical thinking skills, as reflected in an N-gain score of 0.78, which falls within the high category in the experimental class. Furthermore, integrating Google Classroom with the PBL model provided a more interactive, contextual, and student-centered learning environment, encouraging students to participate actively in problem-solving activities. These findings suggest that the developed module is a valuable instructional resource for supporting the development of students' critical thinking skills in physics learning.*

Keywords: *Physics Module; Google Classroom; Problem-Based Learning; Critical Thinking Skills.*

INTRODUCTION

The swift progression of science and technology in the 21st century necessitates that each person acquire higher-order thinking skills (HOTS) to tackle the diverse difficulties of life and employment (Sholihah & Lastariwati, 2020). Initiatives to tackle the educational obstacles of the 21st century can be undertaken by enhancing students' abilities, especially in critical thinking, communication, teamwork, and creativity—vital skills necessary for the learning experience (Mulia, FR, & Makhrus, M., 2024). The deficiency in higher-order cognitive abilities among Indonesian pupils is demonstrated by multiple international evaluation outcomes. An illustration of this is the Program for International Student Assessment (PISA) 2022, which indicates that the academic performance of Indonesian students continues to fall short of the global average. The OECD (2024) reports that Indonesian students achieved an average score of merely 19 out of a potential 60 on the creative thinking evaluation, highlighting the necessity for initiatives aimed at enhancing educational quality to foster higher-order thinking abilities. Analytical reasoning is an essential competency for examining diverse subjects in physics, such as Newton's laws. Educational practices remain primarily characterized by the direct transmission of information, resulting in students mostly functioning as passive users of knowledge instead of actively constructing their own understanding through inquiry. This circumstance leads to students' restricted capacity to recognize issues, evaluate data,

formulate evidence-supported arguments, and reach scientific conclusions. Moreover, the educational resources employed predominantly emphasize the exposition of concepts and practice exercises, thereby inadequately supporting students in cultivating critical thinking abilities as mandated by the Merdeka Curriculum and contemporary educational paradigms. A potential solution to this challenge is to provide free educational tools that not only convey concepts but also assist students in systematically analyzing and resolving difficulties. Instructional resources are essential in facilitating the educational process as they aid students in comprehending concepts, enhancing engagement, and more efficiently attaining learning goals (Purnama et al., 2021; Aryzona et al., 2023). Enhancing the caliber of education necessitates technologies that may tackle diverse obstacles encountered in the teaching-learning dynamic while maximizing student achievement (Larasati, 2021). An innovation that might be created is an open-access module that incorporates the Problem-Based Learning (PBL) framework, as this approach promotes learner-centered education and fosters the acquisition of 21st-century competencies. The Problem-Based Learning framework is an educational method aimed at fostering critical thinking, problem-solving, and autonomous learning abilities by exploring real-world issues (Arends, 2012; Savery, 2006). To enhance its execution, PBL can be incorporated with Google Classroom, a digital learning platform that streamlines the dissemination of resources, allocation of assignments, and evaluation of learning more efficiently (Putri, 2017).

The amalgamation of Google Classroom with a physics curriculum focusing on problem-based learning affords students the chance to engage in independent, collaborative, and problem-solving-focused education. Furthermore, the utilization of this digital platform enables students to obtain educational materials at any time and from any location, so rendering the learning experience more organized and in accordance with the requirements of 21st-century education. Numerous investigations indicate that the amalgamation of Google Classroom with the Problem-Based Learning framework positively influences student engagement, educational efficacy, and enhanced learning results, encompassing critical thinking and problem-solving abilities (Bayarmaa & Lee, 2018; Andhini et al., 2022; Pratama et al., 2022; Abdullah et al., 2024; Mulia & Makhrus, 2024).

A research project by Sinaga (2021) created a physics teaching module based on PBL utilizing Google Classroom for static fluids content, achieving significant validity (93% from subject matter experts, 92.5% from media experts) and remarkable practicality (91.25% teacher feedback rate, student feedback approximately 88–89%). This suggests that pupils' competencies enhanced markedly following the utilization of the module. These results indicate that the amalgamation of the Problem-Based Learning (PBL) framework with Google Classroom is feasible for educational application. In alignment with these results, Aini et al. (2023) conducted a study in geography that demonstrated the substantial impact of PBL facilitated by Google Classroom on enhancing students' critical thinking abilities. The test outcomes revealed a notable disparity between the experimental group and the control group ($p = 0.013$), suggesting that the amalgamation of PBL with a digital learning platform effectively enhances students' critical thinking abilities.

This research presents an innovative

methodology by examining the efficacy of a Google Classroom-supported physics module employing the Problem-Based Learning framework to improve students' critical thinking abilities. In contrast to earlier research that indicated PBL–Google Classroom-based physics modules primarily emphasize cognitive learning outcomes and collaborative elements, the assessment of critical thinking abilities remains inadequately explored. Neither of the prior research has thoroughly established particular and systematic evaluation tools or rubrics for assessing students' critical thinking abilities. Consequently, this research aims to enhance the creation of efficient digital technology-driven physics instructional resources to foster the advancement of students' critical thinking abilities and to function as an alternative educational instrument that aligns with the requirements of 21st-century education.

The creation of a physics module utilizing problem-based learning (PBL) facilitated by Google Classroom is anticipated to function as a novel, contextual, and efficient educational resource aimed at bolstering students' critical thinking abilities and advancing the quality of physics instruction in accordance with 21st-century educational requirements. Consequently, this research seeks to create a physics module utilizing the Problem-Based Learning (PBL) framework, augmented by Google Classroom, that effectively enhances students' critical thinking abilities about Newton's Laws.

RESEARCH METHODS

This research and development (R&D) initiative seeks to create a physics module facilitated by Google Classroom, grounded in problem-based learning (PBL), that fulfills the standards for significantly enhancing students' critical thinking abilities. Developmental research was selected due to its emphasis on both product creation and the evaluation of the product's efficacy through the analysis of pre-test and post-test results from experimental and control groups following classroom implementation. This article concentrates solely on assessing the quality of instructional materials by analyzing the N-Gain score as a measure of the product's usefulness.

The creation of educational resources is founded on the ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation). This model was selected because to its methodical phases and its prevalent application in studies about the creation of instructional resources. The discourse in this article centers on the assessment phase as it pertains to examining the efficacy of the educational resources. These results align with the study conducted by Abdullah et al. (2024), which indicated that the incorporation of problem-based learning facilitated by Google Classroom significantly enhanced students' conceptual understanding, achieving an N-Gain score of 73%, categorized as high.

The created product is a physics educational tool utilizing Google Classroom, focused on problem-based learning, which includes sequences of learning objectives (ATP), lesson plans (RPP), instructional modules, student worksheets (LKPD), and instruments for assessing critical thinking. Google Classroom serves as an auxiliary platform for delivering content, disseminating educational materials, gathering assignments, and promoting engagement between educators and learners throughout the educational experience. The amalgamation of these educational materials with Google Classroom aims to bolster the

execution of the problem-based learning paradigm while promoting a more adaptable learning environment focused on enhancing students' critical thinking abilities.

The participants in this research comprised 11th-grade students categorized into two groups: an experimental group and a control group at SMAN 2 Mataram. The experimental group comprised 36 students engaged in lessons utilizing a physics module facilitated by Google Classroom through the Problem-Based Learning (PBL) framework, whereas the control group included 27 students who followed conventional teaching materials employed by educators. These two groups were chosen to evaluate the efficacy of the created module in enhancing students' critical thinking abilities.

The tools employed in this research comprised assessments of critical thinking skills. All tools were created in accordance with the research aims and authenticated by specialists prior to their application in the execution stage. The assessment tools were employed to evaluate students' critical thinking abilities prior to (pre-test) and subsequent to (post-test) training. Critical thinking abilities were assessed through the IDEALS indicators put forth by Facione, which include Identify (recognizing issues), Define (ascertaining pertinent information), Enumerate (identifying multiple alternative solutions), Analyze (examining information and alternative solutions), List (offering logical reasoning in solution determination), and Self-Correct (evaluating and enhancing the problem-solving process and outcomes). The test outcomes are subsequently examined to assess the module's efficacy in enhancing students' critical thinking abilities.

The analysis of data in this research was performed to assess the efficacy of a physics module implemented through Google Classroom utilizing the Problem-Based Learning (PBL) framework. The evaluation of efficacy was grounded in enhancements of pupils' analytical reasoning abilities.

The efficacy of the module was evaluated by examining the enhancements in pre-test and post-test scores through the Normalized Gain (N-Gain) metric. This examination seeks to assess the extent of enhancement in students' critical thinking and problem-solving abilities following their engagement with a physics module facilitated via Google Classroom utilizing the Problem-Based Learning approach. The equation for the N-gain score as proposed by Meltzer (2002) is outlined below:

$$N - gain = \frac{(Spost) - (Spre)}{(Smax) - (Spre)} \text{ x } 100\% \quad (1)$$

Description :

S_{mak}	:	Maximum value
S_{post}	:	Post-test score
S_{pre}	:	Pretest score

Categories of interpretation of the N-Gain (%) effectiveness according to Hake (1999) in the following table:

Table 1. N-Gain Score Categories Adapted from Hake (1998)

Range	Conversion (%)	Category
$g < 0.3$	$g < 30$	Low
$0.7 > g \geq 0.3$	$70 > g \geq 30$	Medium
$g \geq 0.7$	$g \geq 70$	High

The *N-Gain* values obtained are then interpreted based on the categories proposed by Hake (1999), namely the low category if $g < 0.30$, the medium category if $0.7 > g \geq 0.3$, and the high category if $g \geq 0.7$. The higher the *N-Gain* value obtained, the higher the module's effectiveness in improving students' critical thinking and problem-solving skills.

RESULTS AND DISCUSSION

This research assessed the efficacy of a Google Classroom-supported physics module grounded in problem-based learning (PBL) by evaluating the enhancement of students' critical thinking abilities following their engagement with Newton's laws. The assessment was performed utilizing a critical thinking skills evaluation given prior to (pretest) and subsequent to (posttest) the educational intervention in both the experimental and control groups.

Result

Effectiveness (N-Gain Test) of Critical Thinking Skills

The data indicates that students' critical thinking abilities enhanced in both groups, although the experimental group exhibited a more significant improvement than the control group. The enhancement of critical thinking abilities was assessed by Normalized Gain (N-Gain) scores.

Table 2. Results of the N-Gain Calculation for Thinking Skills

Class	Pretest	Posttest	N-Gain	Category
Experiment	54,89	89,89	0,78	High
Control	52,30	72,07	0,42	Medium

The research results demonstrate that the integration of a physics module facilitated by Google Classroom can promote more engaged and learner-focused education. By presenting contextual challenges, facilitating group dialogues, conducting inquiries, and utilizing Google Classroom as a digital educational platform, students acquire enhanced opportunities to build knowledge, participate in discussions, and methodically showcase their problem-solving outcomes. These circumstances enhance pupils' analytical abilities concerning Newton's principles. The findings of the study suggest that the physics module, facilitated by Google Classroom and grounded in problem-based learning, is successful for instructing physics. This is demonstrated by the enhancement of students' critical thinking abilities, reflected in elevated N-Gain scores in the experimental group, alongside statistical analyses revealing a notable disparity in critical thinking capabilities relative to the control group.

Discussion

This research assessed the efficacy of a physics module facilitated by Google Classroom employing the Problem-Based Learning (PBL) approach, focusing on enhancements in student learning outcomes through an examination of pre-test, post-test, and N-Gain scores related to critical thinking and problem-solving abilities. Furthermore, the efficacy of the product was corroborated by the outcomes of the learning implementation and the feedback from educators and learners, which suggested that the module was user-friendly throughout the educational process.

According to the research results, students who utilized a physics module facilitated by Google Classroom via the Problem-Based Learning (PBL) approach exhibited superior advancements in learning outcomes relative to those who received traditional instruction. Regarding critical thinking abilities, the experimental class's mean pre-test score of 54.89 rose to 88.89 in the post-test, yielding an N-Gain of 0.78 or 78%, categorizing it as “highly effective.” Conversely, in the control group, the mean pre-test score of 52.30 rose to 72.07 in the post-test,

yielding an N-Gain of 0.42 or 42%, categorizing it as moderate and deemed adequately successful. The N-Gain disparity of 0.44 signifies that the enhancement of critical thinking abilities in the experimental group surpassed that of the control group.

This enhancement in critical thinking abilities is not incidental but rather stems from a meticulously structured educational methodology employing the Problem-Based Learning (PBL) strategy. In the problem-orientation phase, learners are presented with contextual challenges pertaining to the practical application of Newton's laws in daily scenarios. These challenges force students to recognize existing data, ascertain the necessary facts, and articulate the difficulties that require resolution. These tasks explicitly cultivate the "Identify" and "Define" competencies under the IDEAL framework of critical thinking as stated by Facione (2015). Subsequently, in the phase of coordinating students and directing their inquiries, learners are prompted to explore diverse knowledge sources, deliberate on different answers, and relate physics principles to observable events. These tasks enhance students' capacity to compute diverse potential solutions and evaluate the information gathered prior to identifying the best suitable answer. The collective analytical process allows students to articulate ideas, exchange viewpoints with their classmates, and enhance their comprehension through scientific discourse. In the phase of formulating and deliberating the findings of the inquiry, students are required to infer inferences from the evidence gathered during the investigative process. This task enhances their capacity to enumerate or articulate rational justifications for the selected resolution. Subsequently, in the analysis and assessment phase of the problem-solving process, students are instructed to contemplate the outcomes of the discussion and reassess the solutions they have derived. This introspective exercise pertains to the self-correcting indicator, which signifies the capacity to rectify mistakes and enhance the cognitive process that has occurred. Consequently, the comprehensive problem-based learning structure progressively enhances the cultivation of each critical thinking ability indicator inside the IDEAL framework.

The modules' effectiveness is additionally influenced by the use of Google Classroom as a digital learning platform and the implementation of the Problem-Based Learning (PBL) model. Google Classroom serves as a platform for the dissemination of worksheets, the uploading of instructional videos, the supervision of group discussions, the provision of feedback on student assignments, and the facilitation of communication between educators and learners throughout the educational journey. This integration enables students to engage in conversations and access resources beyond traditional classroom hours, thereby facilitating a more adaptable learning experience. This framework provides students with the opportunity to improve their understanding of Newton's laws through ongoing educational pursuits.

According to Nieveen (1999), a product is considered high-quality if it meets three primary criteria: practicality, efficacy, and validity. The efficacy of a product is demonstrated by its ability to achieve the specified learning objectives. The primary objective of developing the module in this study was to improve the critical thinking skills of students. According to the research results, the experimental group exhibited a significant improvement in these competencies, indicating that the module that was developed has met the efficacy requirement. These findings are consistent with Plomp's (2013) assertion that the efficacy of educational resources can be assessed by the improvement in learning outcomes that occurs after the product is

implemented with users. A successful product not only enhances cognitive functions but also encourages students to participate actively in the learning process. This research indicates that the module facilitated a substantial learning experience for the students, as evidenced by the substantial N-Gain score, the effective execution of the educational process, and the increase in scores from the pre-test to the post-test. The findings of this study are consistent with Setia's (2017) research, suggesting that modules that emphasize problem-based learning (PBL) and are facilitated by Google Classroom can significantly improve students' academic performance by enabling them to tackle contextual issues. These findings are consistent with the research conducted by Handayani et al. (2017) and Aji et al. (2017), which has shown that the Problem-Based Learning (PBL) model can enhance higher-order cognitive abilities, particularly critical thinking and problem-solving skills, in the context of physics education. These comparable findings indicate that the integration of digital educational technologies and the Problem-Based Learning (PBL) framework is a highly effective method for improving the quality of physics instruction.

The integration of Problem-Based Learning (PBL) methodology, the structured delivery of content in the modules, and the facilitation offered by Google Classroom as a digital educational platform are all factors that contribute to the improvement of students' critical thinking abilities. These three components complement one another by cultivating an educational environment that encourages students to engage in reflective, logical, and analytical thinking. As a result, the Physics module, which is facilitated by Google Classroom and utilizes the Problem-Based Learning (PBL) approach, has been shown to be effective in improving the critical thinking skills of students.

CONCLUSION

The enhancement of students' critical thinking abilities in relation to Newton's Laws has been demonstrated to be a positive outcome of the development of a Google Classroom-assisted physics module that is based on problem-based learning (PBL). The module's efficacy is evident in its capacity to promote student-centered, contextual, collaborative, and active learning, in addition to its enhanced learning outcomes. The incorporation of the problem-based learning approach with Google Classroom offers students the chance to construct knowledge through problem-solving activities, discussions, investigations, and reflection, thereby enhancing the relevance of the learning process.

Based on the N-Gain analysis, the experimental group achieved a score of 0.78, which falls into the high category, while the control group obtained a score of 0.42, which falls into the medium category. These findings indicate that the improvement in students' critical thinking skills was greater in the experimental group than in the control group. The difference in N-Gain scores provides descriptive evidence that the implementation of the Google Classroom-assisted physics module based on PBL was associated with greater improvements in critical thinking skills than the learning approach implemented in the control group. However, N-Gain scores describe the magnitude of improvement and do not, by themselves, establish whether the difference between the two groups is statistically significant. Therefore, further inferential statistical analysis, such as an independent-samples t-test or analysis of covariance (ANCOVA) controlling for pretest scores, could be considered to strengthen the empirical evidence regarding differences in outcomes between the experimental and

control groups.

These findings suggest that the development of critical thinking skills, which are one of the critical competencies of the 21st century, can be facilitated by the integration of digital technology and an appropriate learning model.. Consequently, the module that has been developed can be utilized as a pertinent alternative teaching resource for physics in order to facilitate the implementation of innovative learning in high schools. The Google Classroom-assisted physics module, which is based on problem-based learning, can be used by teachers as an alternative teaching aid to improve the critical thinking skills of students, particularly in relation to Newton's Laws, as indicated by the research. The module's implementation will be more effective if teachers are prepared to consistently employ the problem-based learning framework and utilize Google Classroom as an integrated digital learning environment.

In order to gain a more comprehensive understanding of the module's effectiveness in supporting the development of 21st-century skills, it is recommended that future research be conducted to develop modules on other physics topics or different subjects, test their implementation across a wider range of educational levels and student characteristics, and integrate more adaptive learning technologies, such as learning analytics.

AKNOWLEDGEMENT

This research was successfully conducted due to the support of all parties involved, which the author would like to express with gratitude. Special appreciation is extended to the research advisor and validators for their contributions to the research product's refinement, as well as to the school principals, physics instructors, and students at SMAN 3 Mataram and SMAN 2 Mataram who participated in the research pilot study. The author is also grateful for the academic support provided by the Master's Program in Science Education at Mataram University during the research process. This study was successfully concluded as a result of the collaboration and contributions of all parties involved.

REFERENCES

Abdullah, E. N. W., Ayub, S., & Doyan, A. (2024). Pengembangan Perangkat Model Problem Based Learning Dengan Google Classroom Untuk Meningkatkan Penguasaan Konsep Suhu Dan Kalor Peserta Didik. *Jurnal Penelitian Pendidikan IPA*, 10(6), 2906-2915. https://doi.org/10.29303/jppipa.v10i6.5205

Aini, A. N., Wirahayu, Y. A., & Budijanto, B. (2022). Pengaruh model problem based learning berbantuan google classroom terhadap kemampuan berpikir kritis peserta didik pada mata pelajaran Geografi. *Jurnal Integrasi Dan Harmoni Inovatif Ilmu-Ilmu Sosial*, 2(12), 1236-1248. https://doi.org/10.17977/um063v2i12p1236-1248

Aji, SD, Hudha, MN, & Rismawati, AY (2017). Pengembangan modul fisika berbasis Problem Based Learning pada materi keseimbangan dan dinamika rotasi. *Jurnal Pendidikan Fisika Indonesia*, 13(2), 89–98.

Arends, RI (2012). *Belajar Mengajar* (edisi ke-9). McGraw-Hill.

Aryzona, E. F., Asrin, A., & Syazali, M. (2023). Analisis kompetensi guru dan desain pembelajaran dalam melaksanakan kegiatan pembelajaran sesuai kurikulum merdeka SD Negeri 1 Jantuk tahun pelajaran 2022-2023. *Jurnal Ilmiah Profesi Pendidikan*, 8(1), 424–432. https://doi.org/10.29303/jipp.v8i1.1156.

Branch, R. M., & Varank, İ. (2009). *Instructional design: The ADDIE approach* (Vol. 722, p. 84). New York: Springer.

https://doi.org/10.1007/978-0-387-09506-6.

Facione, PA, & Gittens, CA (2015). *Inquiry: Critical Thinking Across the Disciplines* , 30 (2), 17-53. https://doi.org/10.5840/inquiryct20153029

Handayani, S., Gunawan, G., & Harjono, A. (2017). Pengembangan modul fisika berbasis Problem Based Learning pada materi usaha dan energi untuk meningkatkan kemampuan berpikir peserta didik kritis. *Jurnal Pendidikan Fisika dan Teknologi,* 3(2), 151–160.

Mulia, FR, & Makhrus, M. (2024). Pengaruh Model Problem Based Learning Berbantuan Google Classroom untuk Meningkatkan Kolaborasi dan Kreativitas Peserta Didik pada Materi Fisika. *Jurnal Pendidikan, Sains, Geologi, dan Geofisika (GeoScienceEd Journal)* , 5 (4), 856-872. https://doi.org/10.29303/goescienceed.v5i4.404

Nieveen, N. (1999). *Pembuatan Prototipe untuk Mencapai Kualitas Produk. Dalam J. van den Akker, R. Branch, K. Gustafson, N. Nieveen, & T. Plomp (Eds.), Pendekatan dan Alat Desain dalam Pendidikan dan Pelatihan (hlm. 125–135*). Kluwer Academic Publishers.

Savery, JR (2006). Gambaran Umum Pembelajaran Berbasis Masalah: Definisi dan Perbedaan. *Jurnal Interdisipliner Pembelajaran Berbasis Masalah* , 1(1), 9–20.

Putri, D. A. (2025). *Pengaruh Model Pembelajaran Creative Problem S0lving Tehadap Kemampuan Pemecahan Masalah Ditinjau Dari Self ESTEEM* (Doctoral dissertation, Universitas Islam Negeri Sultan Syarif Kasim Riau).http://repository.uin-suska.ac.id/id/eprint/86277

Purnama, L. N. L., Asrin, A., & Jiwandono, I. S. (2021). Kompetensi guru dalam pengelolaan pembelajaran kelas di SD Negeri Tampar-Ampar Kecamatan Praya Tengah Kabupaten Lombok Tengah. *JIKAP PGSD: Jurnal Ilmiah Ilmu Kependidikan,* 5(2), 195–203. https://doi.org/10.26858/jkp.v5i2.19756.

Plomp, T. (2013). *Penelitian Desain Pendidikan: Sebuah Pengantar* . Institut Pengembangan Kurikulum Belanda (SLO).

Savery, JR (2006). Gambaran Umum Pembelajaran Berbasis Masalah: Definisi dan Perbedaan. *Jurnal Interdisipliner Pembelajaran Berbasis Masalah* , 1(1), 9–20.

Setia, M. (2017). *Pengembangan Modul Fisika Berbasis Problem Based Learning Berbantuan Google Classroom pada Materi Fluida Statis (Tesis Magister).* Universitas Mataram.

Sholihah, TM, & Lastariwati, B. (2020). Pembelajaran berbasis masalah untuk meningkatkan kompetensi berpikir kritis dan pemecahan masalah. *Jurnal Pendidikan dan Pembelajaran (EduLearn)* , 14 (1), 148-154. https://doi.org/10.11591/edulearn.v14i1.13772