

The Effectiveness of the Problem-Based Learning with Google Classroom (PBL-GC) Model in Enhancing High School Students' Scientific Literacy on Newton's Laws

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Article Info	Abstract
Article history: Received: September 2, 2025 Accepted: October 17, 2025 Published: October 29, 2025 Keywords: Newton's law PBL-GC Scientific literacy This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. © 2025 Berkala ilmiah Pendidikan Fisika	Students' misconceptions about Newton's Laws are still common, even though these laws can be applied in everyday life. This study aims to determine the effect of the Problem-Based Learning model assisted by Google Classroom (PBL-GC) in improving the scientific literacy skills of high school students. The PBL-GC Learning Model provides material through an e-learning platform or Learning Management System, accompanied by practicums to enhance student understanding. The learning materials provided in PBL-GC are quite varied, fostering students' curiosity about Newton's laws. Measurement of achievement is carried out by classifying students' scientific literacy levels based on pre-test and post-test work. In addition, analyses were carried out using normality tests, paired sample t-tests, and N-Gain. The study obtained an N-Gain test value of 0.3592, which is classified as moderate. Students' scientific literacy regarding Newton's laws I and III tends to increase from a conceptual to a multidimensional understanding. In contrast, students' scientific literacy regarding Newton's laws II tends to be at the functional level. These results indicate that PBL-GC is effective in improving scientific literacy skills. The findings imply that this blended learning model can be a practical strategy for physics educators to address misconceptions, although specific concepts like Newton's Second Law may require additional interventions.
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INTRODUCTION

Newton's laws of motion are paradoxically one of the most misconception-ridden topics among students (Ahmad et al., 2025; Rusilowati et al., 2021). Simple phenomena such as a passenger being pushed forward when a car brakes suddenly, or why we feel a force when going against a wall, are often explained with flawed logic that contradicts Newton's principles. These deep-rooted misconceptions, such as the assumption that force is always required to maintain motion, hinder the understanding of more advanced physics concepts and indicate low levels of scientific literacy. Students' failure to apply these fundamental concepts to explain everyday phenomena indicates a significant gap between theoretical knowledge learned in the classroom and its application in the real world (Ghorbani et al., 2020).

Newton's laws are fundamental principles of mechanics that explain the relationship between the forces acting on an object and its motion. This concept serves as the basis for describing phenomena that occur in everyday life. Newton's laws consist of three laws, namely the 1st, 2nd, and 3rd. Newton's 1st law explains inertia ([Br Sitepu et al., 2019](#); [Tamm, 2024](#)). Newton's 2nd law, which Euler then developed, explains the correlation between force, mass, and acceleration ([Darrigol, 2020](#); [Parra-Zeltzer et al., 2025](#)). Newton's 3rd law states that actions and reactions are equal in magnitude but opposite in direction ([Bao & Fritchman, 2011](#); [Pereyra et al., 2025](#)). Since Newton's laws are fundamental concepts that everyone should understand, these concepts must be taught at the school level. Based on the revised K-13 curriculum for grade 10 at high school, one of the core competencies that must be mastered is the ability to analyze interactions between forces, the correlation between force, mass, and the linear motion of objects, and their application in daily life. The core material in these competencies focused on Newton's laws of motion and their application in daily life ([Fatkhurrohman et al., 2024](#)).

The primary objective of physics education is to ensure that students understand Newton's Laws in the classroom and apply them to explain phenomena, design simple analyses, and make evidence-based decisions in their daily lives ([Mahajan, 2020](#)). However, conventional teaching methods often focus on rote memorization of formulas and mechanistic problem-solving, which have proven ineffective in achieving this objective ([Yap, 2016](#)). Consequently, students' understanding usually remains shallow, and they cannot use the concepts to solve real-world problems. This failure indicates that traditional assessment methods, such as test scores, are insufficient. Therefore, a more authentic framework is needed to holistically assess student understanding. This is where scientific literacy emerges as a crucial indicator of learning success, as it directly assesses students' ability to use their knowledge in relevant contexts—an aspect often overlooked by conventional instruction.

Scientific literacy is defined as students' ability to engage with scientific issues and scientific thinking ([Yacoubian, 2018](#); [Yuliati et al., 2018](#)). Scientific literacy skills are closely associated with decision-making skills. This shows that scientific literacy is intertwined with other important aspects of science learning ([Almeida et al., 2023](#); [Dewantara et al., 2019](#)). Scientific literacy is the ability of individuals to use scientific knowledge, identify questions, and draw conclusions based on evidence to understand and make decisions about everyday phenomena ([Parno et al., 2020](#)). Scientific literacy extends beyond understanding scientific facts to encompass scientific processes, attitudes toward science, and the ability to apply scientific knowledge in personal and social contexts. Therefore, the concept of scientific literacy expects students to develop critical thinking skills regarding scientific information that can be used in daily life. In this digital, globalized era, scientific literacy is crucial for adapting to technological developments and solving complex problems.

Misconceptions about Newton's laws are common in various levels of society ([Ahmad et al., 2025](#); [Rusilowati et al., 2021](#)). This misconception is because Newton's laws are often considered abstract, even by high school students. Studies have shown that many students are unfamiliar with the terms used in Newton's laws. Although many students understand Newton's laws, they can still not integrate scientific knowledge, the scientific process, and its impact on the social and technological dimensions. Several factors, including the learning method, can cause this. Although various studies have proposed innovative learning models to address these misconceptions, few studies have focused on comprehensively integrating scientific literacy into active learning models for Newton's Laws.

This research gap is critical because it perpetuates a learning environment in which physics is perceived as merely a collection of formulas, detached from real-world relevance. This context-deficient approach fails to correct misconceptions and diminishes

students' interest in the subject ([Ghorbani et al., 2020](#)). Therefore, a learning model is needed that explicitly targets the development of scientific literacy, rather than just conceptual understanding, to make learning more meaningful and applicable.

One of the science-based learning models recommended in the revised K13 curriculum and the current Merdeka curriculum is Problem-Based Learning (PBL). PBL is a learning approach that uses real-world problems as triggers for learning. This learning model focuses on problem analysis, student-centered learning, and applying that knowledge ([Misbah et al., 2025](#); [Sari et al., 2021](#); [Yuberti et al., 2019](#)). In this method, students must actively find solutions through investigation, collaboration, and reflection. PBL encourages high cognitive engagement and fosters critical thinking, conceptual understanding, and scientific skills. Implementing this learning model is highly effective and encourages more interactive and engaging classes ([Gürses et al., 2022](#); [Wijnia et al., 2024](#)). Other studies also show that learning Newton's Laws using PBL with contextual problems can improve students' creativity and overcome misconceptions ([Nurlaili et al., 2021](#); [Suwasono et al., 2023](#)). The application of PBL allows students to see the relevance of physics in daily life.

Appropriate learning media must support the PBL learning model so that students can understand the material taught well. Educational technology will support flexible, interactive, and collaborative learning processes per the characteristics of today's digital generation. Nowadays, e-learning is quite popular due to several factors, namely its ease of use, flexibility, and the possibility of easy access to online materials. ([Akhter et al., 2021](#); [Gherhes et al., 2021](#)). E-learning-based learning applications are called Learning Management Systems or LMS ([Simanullang & Rajagukguk, 2020](#)).

One LMS learning medium is Google Classroom. Google Classroom provides features for discussions, assignments, feedback, and integration with various other digital resources ([Almio & Sri, 2019](#); [Yani et al., 2021](#)). Google Classroom is well-suited to the learning process, supporting PBL, as teachers can provide students with more interactive and engaging materials, such as videos and learning illustrations.

Research on the effectiveness of the Google Classroom PBL (PBL-GC) learning approach, which integrates real-world problem contexts and educational technology to improve students' scientific literacy, is needed. This aims to measure the impact of the learning method on aspects of scientific literacy, such as conceptual understanding, problem-solving, and the ability to explain phenomena scientifically. In addition to quantitative effects, this study will describe changes in students' scientific literacy levels for material related to Newton's laws, thereby determining the extent to which the learning intervention has a conceptual impact.

This research will provide an alternative, more effective, and contextually relevant learning model to improve students' scientific literacy, thereby helping teachers become more adaptable to the challenges of 21st-century learning. The results of this study can be used as a reference for designing physics lessons that are more collaborative and relevant to students' daily lives. Furthermore, this research can open space for other learning innovations integrating digital technology with a scientific, problem-solving approach.

METHODS

This study aims to determine the effectiveness of PBL-GC learning in improving 10th-grade students' scientific literacy skills related to Newton's Laws. The scientific literacy skills referred to in this study are students' skills in understanding, evaluating, and using scientific information in everyday life, as well as being able to engage critically. Scientific literacy skills in this study were measured using a three-question essay test, and the assessment and categorisation of scientific literacy levels were based on Schwartz's research and an interview ([Schwartz et al., 2006](#)). The pre-test was conducted at the beginning, before treatment was given using the PBL-GC learning model. At the end of the meeting, a post-test was administered to assess students' scientific literacy.

The method used in this study is a one-group pretest-posttest design to assess changes in a single group (Bierer et al., 2025). The subjects were 36 grade X science students, with a 90-minute learning duration per meeting. The data obtained were then analysed using prerequisite tests, namely the normality test, paired sample t-test, N-gain test, and effect size test. Next, the students' scores were converted into their scientific literacy levels. Data on scientific literacy skills scores and interview results were converted according to the categories in Table 1.

Table 1 Literacy levels (Shwartz et al., 2006; Utami et al., 2015)

Code	Category (Literacy Levels)
0	No Answer
1	Illiteracy
2	Nominal
3	Functional
4	Conceptual
5	Multidimensional

The lesson begins by providing students with an explanatory video about Newton's First, Second, and Third Laws, uploaded to Google Classroom (see Figure 1). Students are instructed to study the video independently before starting the lesson. During this independent learning, students must provide feedback or responses in Google Classroom on the material they are learning, thus encouraging interaction and initial reflection on the concept. In addition, students will also receive illustrations in the form of interactive games about Newton's laws. Students also receive student worksheets containing practical guidelines related to Newton's laws. The first practical test of the concepts of the 1st law (Inertia) and the 3rd law (Action-Reaction) was by quickly pulling a piece of paper under a drinking glass. From there, it will be seen that the glass will remain still due to inertia. The second practical concerns Newton's Second Law ($F = m \cdot a$), in which students pull a piece of wood connected to varying weights to observe changes in acceleration as force and mass vary. After the practical, the teacher provides a live explanation in class to reinforce student understanding and discuss the experimental results. This approach combines independent learning, collaboration through Google Classroom, and hands-on laboratory experience.

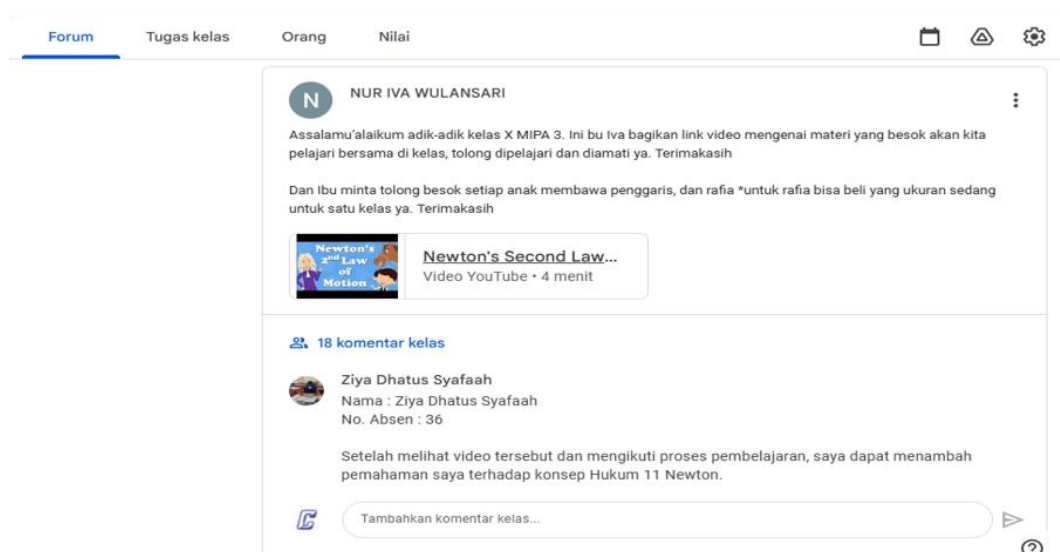


Figure 1 Learning management system using google classroom

Three pre-test and post-test questions were used to test the effect of learning on students' scientific literacy levels.

1. In the film "It Happened One Night" (Columbia Pictures, 1934), Clark Gable is standing on a stationary bus opposite a seated Claudette Colbert. Then the bus suddenly starts moving forward, and Clark falls into Claudette's lap. Why does this happen?
2. When Siva wants to know his weight, he can use a scale by raising both feet on the scale, displaying his weight. Explain how a scale works, relating it to Newton's Third Law!
3. A 20 kg box fell from a pickup truck in the middle of the road, causing a traffic jam. Ahyo then removed the 20 kg box from the middle of the road by pushing it with a force of 250 N, causing it to move in the same direction as the applied force. What would happen to the rock if the box were replaced with a rock of the same mass?

RESULTS AND DISCUSSION

Newton's Laws in the Context of Scientific Literacy

Newton's laws are the foundation of classical mechanics, explaining the relationship between force and motion. Students often experience misconceptions about Newton's laws. Some of the misconceptions encountered include assuming that a stationary object has no force, not understanding that action and reaction act on different objects, and difficulty distinguishing between constant velocity and acceleration in the context of force. These misconceptions indicate weak scientific literacy, particularly in applying concepts to real-world phenomena such as moving vehicles, pushing objects, and so on. Implementing PBL (Public-Based Learning) is expected to encourage students to examine these phenomena critically and scientifically, improving their functional to conceptual or even multidimensional literacy.

Scientific Literacy Levels

Schwartz (our father) stated that scientific literacy includes three main dimensions, namely scientific knowledge, the scientific process (science as inquiry), and science in a social context (science as a human endeavour).

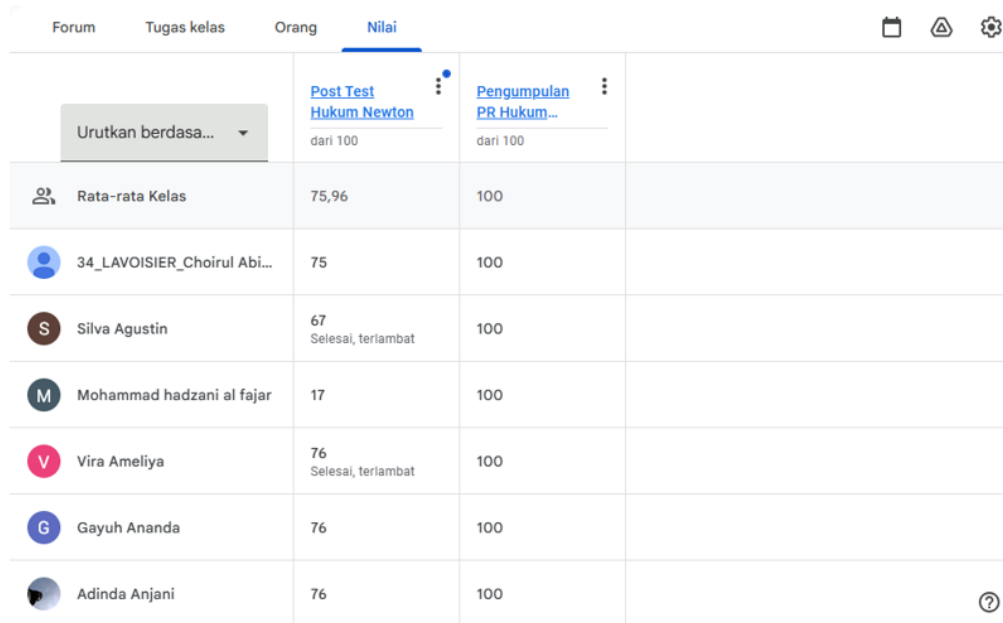
Scientific literacy can also be classified based on ability level, namely:

1. Science Illiteracy: Individuals do not understand basic scientific terms and concepts
2. Nominal Literacy: Individuals recognize scientific terms without an in-depth understanding
3. Functional Literacy: Individuals understand basic concepts and can use them in specific situations only
4. Conceptual Literacy: Individuals understand concepts comprehensively and can apply them in various contexts
5. Multidimensional literacy: Individuals can integrate scientific knowledge, scientific processes, and their impacts in the social and technological dimensions.

The literacy level categories in this study range from 0 to 5. Level 0 indicates that students provided no answer or response, thus providing no measurable evidence of literacy. Level 1 indicates illiteracy, meaning the answers provided are completely irrelevant to scientific concepts. Level 2 suggests that students know the terms but do not understand their meanings or applications correctly. Level 3 indicates that students have a basic understanding to use scientific information in simple contexts in common situations. Level 4 indicates that students have a comprehensive understanding of scientific concepts, can relate them to principles and theories, and can explain the reasons behind a scientific phenomenon. Level 5 indicates the level of student ability to integrate various concepts and to engage in critical analysis and complex problem-solving. This study's classification was based on categorizing these scientific literacy levels. This was done to determine the impact of the intervention on PBL-GC learning.

Learning using PBL-GC is interactive between teachers and students, as evidenced by the abundance of student feedback on the learning materials provided through GC. This indicates that PBL-GC increases student interest in learning. Furthermore, materials posted on GC can be downloaded repeatedly, making it easier for students to recall previously learned material.

Figure 2 shows assessment scores on the LMS interface using GC through a teacher account. The advantage of using GC is that students can view their assessment scores. It makes the scoring more transparent. Besides that, teachers can provide comments on each assessment, which can serve as evaluation material for each student, helping them know which areas of the assessment need improvement.



	Post Test Hukum Newton dari 100	Pengumpulan PR Hukum... dari 100
Rata-rata Kelas	75,96	100
34_LAVOISIER_Choirul Abi...	75	100
Silva Agustin	67 Selesai, terlambat	100
Mohammad hadzani al fajar	17	100
Vira Ameliya	76 Selesai, terlambat	100
Gayuh Ananda	76	100
Adinda Anjani	76	100

Figure 2 Students' post-test scores on LMS

The first question emphasizes students' understanding of Newton's First Law, namely, inertia. Therefore, the answer needs to relate to the concept of inertia and include the property of inertia that an object possesses. Inertia is the property of maintaining an object's initial state. If the object is initially at rest, it will strive to remain at rest, and if it is moving, it will maintain its motion ([Bussotti, 2021](#)).

The results of the pre-test and post-test for Question 1, classified by students' scientific literacy level, are shown in Figure 3. The pre-test results for this question showed that most students were at the functional level (78%). This indicates that students could name the basic terms of Newton's First Law, which includes inertia. However, students could not connect them to the phenomena that occurred. As many as 14% of students had reached the conceptual and multidimensional levels. Only a few students could explain why objects can maintain their initial state. This also indicates that students could explain cause and effect by linking it to the concept of inertia.

The post-test results showed a significant shift in understanding to the conceptual and multidimensional levels. This indicates that students began to explain the problem more comprehensively and could relate the phenomenon to the concepts of inertia and its properties. Furthermore, the number of students at the functional level also decreased from 78% to 14%, indicating that more students could answer according to the expected answer key.

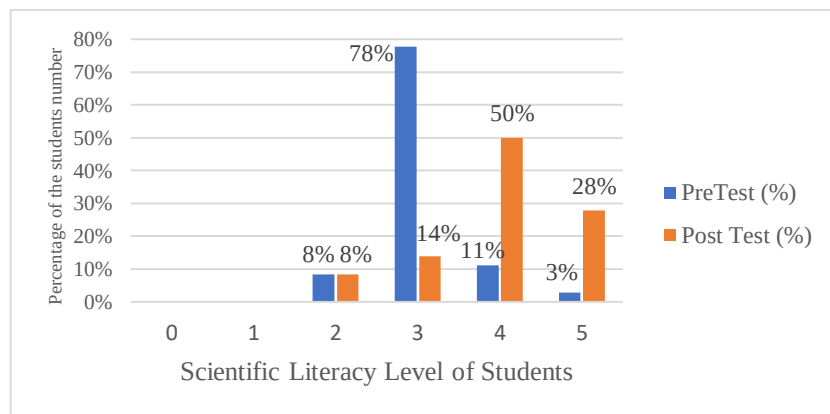


Figure 3 Scientific literacy level of students in exercise number 1

The second question emphasizes Newton's Third Law, using a scale as an example. Newton's Third Law states that every action is balanced by an equal but opposite reaction ([Rajput & Yahalom, 2021](#)). In the phenomenon of weighing, the object's body exerts a downward force on the scale in the form of gravity. Based on Newton's second law, the scale also exerts an upward reaction force equal in magnitude but opposite in direction to the force exerted by the object. This reaction force is transmitted to a spring or sensor on the scale so that the moving needle or digital number will indicate the magnitude of the action force exerted by the object's gravity.

Based on Figure 4, the pre-test results of question 2 showed that 25% of students fell into category 0. This indicates that many students initially did not understand the relationship between the action-reaction concept and everyday life. After the intervention, the post-test results showed that no students answered. The graph shows that 60% of students could explain that the scale works because of the object's downward force and the scale's upward reaction force. This means that students are not only able to use scientific terms but also to explain phenomena using the action-reaction concept. On the other hand, some students are still at the nominal level. This indicates that students can only use the action-reaction term without explaining the cause-and-effect relationship. Furthermore, this shows that despite the improvement, some students still have not achieved a complete conceptual understanding. Overall, the results show a significant increase in conceptual and reflective learning. This shift is in line with the question's objective, namely that students can explain the scale phenomenon based on Newton's third law of action and reaction.

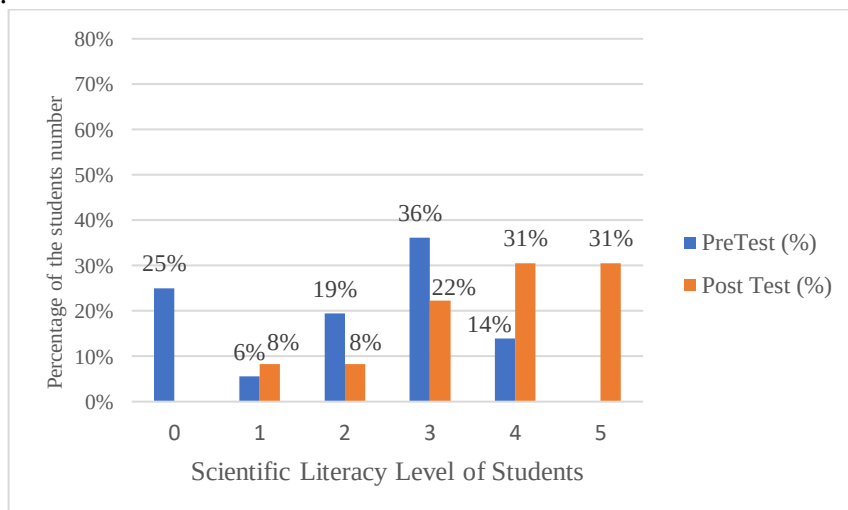


Figure 4 Scientific literacy level of students in exercise number 2

Figure 5 showed that, based on the pre-test results in question 3, 19% of the students were in category 0. Furthermore, 16% of students reached a category above the functional level. The functional level is characterized by students who answered mathematically correct ($F = m \cdot a$), but did not consider the context of friction or the reality of what occurred. After the intervention, all students could answer the questions, meaning no students were at level 0 anymore. The most significant student development was shown by an increase in functional levels by 44%. Furthermore, there was also an increase at the conceptual and multidimensional levels by 11% and 8%, respectively.

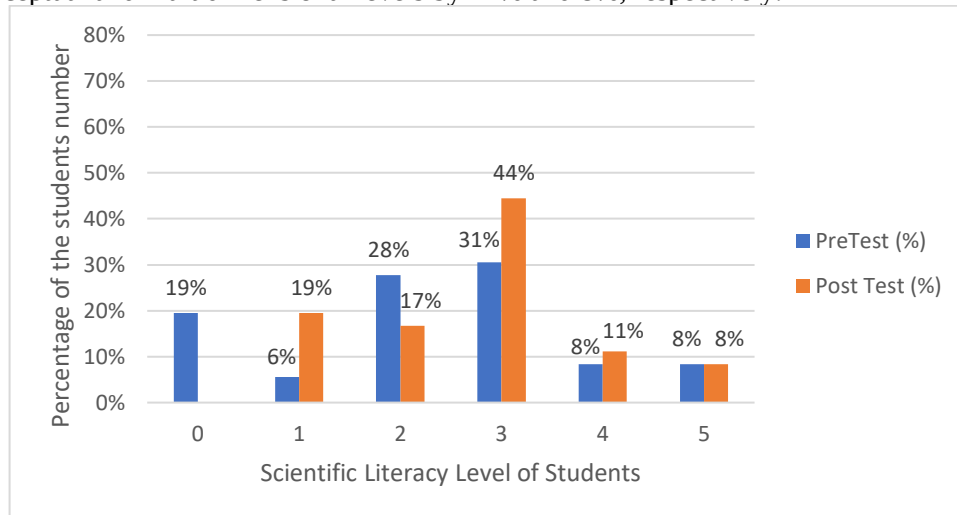


Figure 5 Scientific literacy level of students in exercise number 3

Question 3 demands a more complex contextual understanding that combines Newton's second law with real-world situations. scientific literacy levels have not shown significant improvement, as indicated by pre- and post-test results. Furthermore, many students remain at the functional level, meaning most fail to apply Newton's second law correctly in real-world contexts. therefore, a more explicit teaching approach is needed in friction, mass versus weight, and the interpretation of net force.

PBL-GC has proven effective in improving scientific literacy, particularly in conceptual and dimensional aspects, by providing contextual videos, student worksheets, and discussion forums. practicum assessment is conducted not only through student worksheets but also through teacher-led question-and-answer sessions during the practicum. the teacher can determine the students' understanding of the occurring phenomena through these questions and answers. after the practicum, students will present their results. Practicum activities are assessed using indicators such as teamwork, data presentation methods, understanding of student worksheet procedures, and group management. this learning process can activate students' scientific thinking skills, enabling them to connect theory to real-world contexts. furthermore, this learning method can encourage students' reflection and scientific argumentation. however, problems in real-world physical contexts involving multiple variables, such as friction, remain challenging and necessitate explicit intervention in learning.

Quantitative Statistics Results

Based on pre-test and post-test data on students' scientific literacy, descriptive and inferential statistical analyses were conducted to assess the effectiveness of the PBL-GC learning model on Newton's laws. The test results included a normality test, a paired-samples t-test, and N-Gain results.

Normality Test

The normality test used the *Shapiro-Wilk* method. This is because this study used a sample of no more than 100 students. Besides that, this method was relatively better than the other. The Shapiro-Wilk significance value is 0.065; values > 0.05 indicate that the data are normally distributed ([Ahmad & Khan, 2015](#)). Therefore, the next parametric test is a paired-samples t-test. In addition, this value indicates a difference between the pre-test and post-test scores that can be validly tested using inferential statistical methods.

Paired Sample t-Test

The significance value from the t-test was 0.000, indicating a significant difference in students' scientific literacy scores before and after the learning process ([Hedberg & Ayers, 2015](#); [Rietveld & van Hout, 2017](#)). This significant improvement reflects the structured progression of the learning stages. The initial asynchronous phase in Google Classroom provided students with the foundational knowledge to explain phenomena scientifically. This conceptual base was then reinforced and applied during the in-class practicum, where hands-on activities guided by worksheets directly engaged students in designing inquiries and interpreting data. Therefore, the statistical significance demonstrates the effectiveness of the learning design, where the correlation between foundational theory and practical application successfully elevated students' overall scientific literacy. This means that PBL-GC had a statistically significant impact on improving students' scientific literacy, thus indicating that the learning intervention successfully improved students' abilities.

N-Gain

The N-Gain value obtained was 0.3592. Based on the categorization in Table 1, the results obtained indicate that this value is included in the moderate category. This result can be interpreted by analyzing the role of each learning activity. The initial phase, conducted asynchronously via Google Classroom, primarily used videos and simulations to build foundational knowledge, targeting the scientific literacy competency of explaining phenomena scientifically. This method proved effective for initial conceptual exposure. The subsequent in-class practicum was designed to reinforce these concepts and develop higher-order competencies, namely designing scientific inquiry and interpreting data. The practicum session included structured worksheets that guided students in organizing their observations and analyzing data, thereby targeting the competency of interpreting evidence. Furthermore, the class discussion forums would encourage students to move from passive to active learning by requiring them to justify their initial understanding of the concepts. These N-Gain results indicate that the improvement from the intervention, given for a short 1-month duration, is very good, as scientific literacy is not just memorizing concepts but also includes reasoning skills, linking theory to real contexts, and the ability to explain scientific phenomena in depth. Higher literacy levels, conceptual and multidimensional, require more time and intensive practice. Based on the results of the statistical test, the PBL-GC model has moderate effectiveness in improving students' scientific literacy, and this learning model can be considered a promising learning model and is worthy of further development ([Christman et al., 2024](#); [Nissen et al., 2018](#)).

CONCLUSION

PBL-GC effectively improves scientific literacy, especially for contextual and familiar questions. There was a significant increase in the pre-test and post-test results, as indicated by the paired t-test. Learning is quite effective in the moderate category, with an N-Gain of 0.3592. In questions 1 and 2, which include Newton's first and third laws, many students moved up from conceptual and multidimensional levels, while in question 3, which provides for Newton's 2nd law, many students were at the functional level, where this question emphasised the context of $F = m \cdot a$ and friction. Concept number 3 needs further

reinforcement. This study implies that physics educators can adopt the PBL-GC model as an alternative 21st-century blended learning strategy. This can be achieved by incorporating more targeted reflection exercises and in-depth conceptual discussions within the PBL-GC framework to elevate student understanding to a multidimensional level.

The research was conducted with a limited sample size in a single school, which may limit the generalizability of the findings. Furthermore, the intervention was relatively short. Therefore, future research is recommended to replicate this study with a larger, more diverse sample and over a longer period. Additionally, further investigation is needed to identify specific pedagogical strategies within the PBL-GC model that can more effectively address students' difficulties with quantitatively complex concepts such as Newton's Second Law.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

CSW: Give direction and guidance, format analysis, and draft the manuscript. NIW: Conceptual, Method, Data Collection, Data Analysis. SU: Supervision, Validation

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