Tarbawi: Jurnal Ilmu Pendidikan
p-ISSN: 1858-1080|e-ISSN: 2615-6547
Vol. 21, No. 1, June 2025, 73-84

Students' Problem-solving Skills and Perceptions through Problem-based Learning Assisted by Google Classroom

Nur Iva Wulansari, Febi Dwi Putri, Lia Yuliati, Nasikhudin

Universitas Negeri Malang
ivawulansari@gmail.com

Abstract. Problem-solving skills are crucial for students to have in learning Newton's laws. However, it has been found that students are still relatively unsatisfied with these skills, which are still relatively unsatisfactory, so learning innovations that support and train these problem-solving skills are needed. In addition to training, students' perceptions of learning must be considered. This study aims to enhance problem-solving skills through the PBL model, assisted by Google Classroom (PBL-GC), on Newton's law material, and to investigate student perceptions of learning using a mixed-methods approach. The mixed-methods design used is an explanatory sequential design. Quantitative data were collected with a one-group pretest and posttest design and then analyzed with descriptive and inferential statistics. Then, qualitative data were collected to see students' thoughts about problem-solving skills and their perceptions of PBL-GC. The instruments used were problem-solving tests and semi-structured interview guidelines. The results indicate that PBL-GC has proven to improve problem-solving skills with an effect size of 1.62 in the strong category, and students have positive perceptions of their learning. The implications of the findings of this study strengthen theory and previous research and support educators in using the PBL model with different tools.

Keywords: Problem-solving skills, problem-based learning, Google Classroom, learning perception

INTRODUCTION

Newton's law, essential in understanding motion dynamics, is the foundation of physics concepts and trains problem-solving skills by connecting basic principles with real situations, such as analyzing force, acceleration, and mass to solve complex problems. However, several studies have revealed that students' problem-solving skills on Newton's law material are unsatisfactory (Pasaribu et al., 2020; Supeno et al., 2018; Wahyuni & Umam, 2020). But there are also studies that state that students' skills are moderate (Ayumniyya & Setyarsih, 2021; Hijriani & Hatibe, 2021; Khoirunnisa & Dwikoranto, 2021). Students face difficulties solving problems on Newton's law material because it is difficult to determine which formula to use. (Hijriani & Hatibe, 2021; Wahyuni & Umam, 2020)Students lack understanding of Newton's concept and the friction force (Hijriani & Hatibe, 2021; Januarifin et al., 2018). Students only memorize the mathematical equations of Newton's law without understanding the physical meaning. Students do not check the solution process and answer again (Hijriani & Hatibe, 2021). Research by Ayumniyya and Setyarsih (2021). This shows that the indicators of problem-solving skills, namely, the specific application of physics and mathematical procedures, are low. Most students still use basic logic (Khoirunnisa & Dwikoranto, 2021). Therefore, learning innovations that aim to train problem-solving skills on Newton's law material are needed; several studies (Januarifin et al., 2018; Pasaribu et al., 2020; Supeno et al., 2018) also support this.

Learning innovation as an essential effort to improve students' thinking skills and its implementation is often realized through learning strategies. Strategies aimed at learning Newton's law include Problem-based Learning (Setioningsih, 2021), discovery learning (Hermala & Sapri, 2021)New Todame media (Ghinatri et al., 2024), multi-representation (Hermawan et al., 2022; Sari, 2023)Textbooks that implement TPACK (Bakri et al., 2021), STEM-based virtual laboratory (Laila & Anggaryani, 2021), simulation-based formative assessment (Putri et al., 2021), and Interactive Demonstration (Susiana et al., 2018). Among these various learning strategies, the Problem-based Learning (PBL) model is one of the relevant approaches to improving students' thinking skills, especially in improving problem-solving skills. However, the research by Setioningsih (2021) Action research aims to improve learning outcomes. PBL encourages students to actively solve authentic problems, strengthen concept understanding, and train thinking skills (Arends, 2012; Nicholus et al., 2023; Siregar et al., 2023). This is reinforced by the implementation of PBL to improve physics problem-solving skills. Significant improvements in problem-solving skills on simple machine topics, such as pulleys (Gumisirizah et al., 2023), fluids (Retno et al., 2019), harmonic motion (Apriliasari et al., 2019), impulse-momentum (Yanto et al., 2021), electricity (Argaw et al., 2017)equilibrium, and rotational dynamics (Hudha et al., 2017).

Implementing the PBL model itself can be integrated with digital platforms such as Google Classroom, which acts as a medium to distribute materials, facilitate group discussions, provide feedback, and manage problem-based tasks in a structured and efficient manner. Problem-based learning is more effective when using Google Classroom than relying on conventional learning alone (Erlangga et al., 2021). Research by Ramaghani et al (2019)The flipped-problem-based learning model based on LMS-Google Classroom can improve learning outcomes. Research by Azizah (2021) Obtained an increase in learning outcomes with Google Classroom. However, these studies were conducted on mathematics learning and only used the image feature on Google Classroom. Suindhia (2022) Conducted PBL class action research using Google Meet and Google Classroom applications, which can show the significance of physics learning outcomes in each cycle. Other studies have also demonstrated the effectiveness of using Google Classroom with problem-based learning (Karmila et al., 2021) and in showing problem-solving skills (Ningsih et al., 2021)Previous studies have shown the effectiveness of Google Classroom-based PBL, but most of them are still limited to mathematics learning, the use of features is not optimal, and they have not focused in depth on measuring the improvement of problem-solving skills in the context of physics learning, especially on the topic of Newton's laws.

The PBL model assisted by Google Classroom can influence students' perceptions of learning because this combination presents a more interactive, flexible, and technology-based learning experience, which can increase student involvement and satisfaction in the learning process. Reviewing the importance of student perceptions of the PBL model, it shows that student responses tend to be positive, where all students express pleasure in learning (Setioningsih, 2021)Students who think it can increase awareness of their responsibility (Jaeger & Adair, 2014)As many as thirty students agree that PBL can make them apply skills in solving problems, and can connect and build different ideas (Sulaiman, 2010)Students think that the learning carried out is beneficial in improving concept solving (Nesi et al., 2022), but Amalia et al (2024) Showed that there was still a low perception of student learning activities on implementing the problem-based learning model in physics learning, but some students had a high perception of the purpose of implementing the PBL model in physics learning and its benefits in physics learning. Moreover, these studies were conducted through questionnaires. Therefore, this study aims to improve problem-solving skills through the PBL model assisted by Google Classroom on Newton's law material and student perceptions of learning with mixed methods.

METHOD

The method used is a mixed method with an explanatory sequential design. This research design allows the collection of quantitative and qualitative data to help explain the results of the quantitative data (Creswell & Creswell, 2023). The research flow with this design is shown in Figure 1 below.

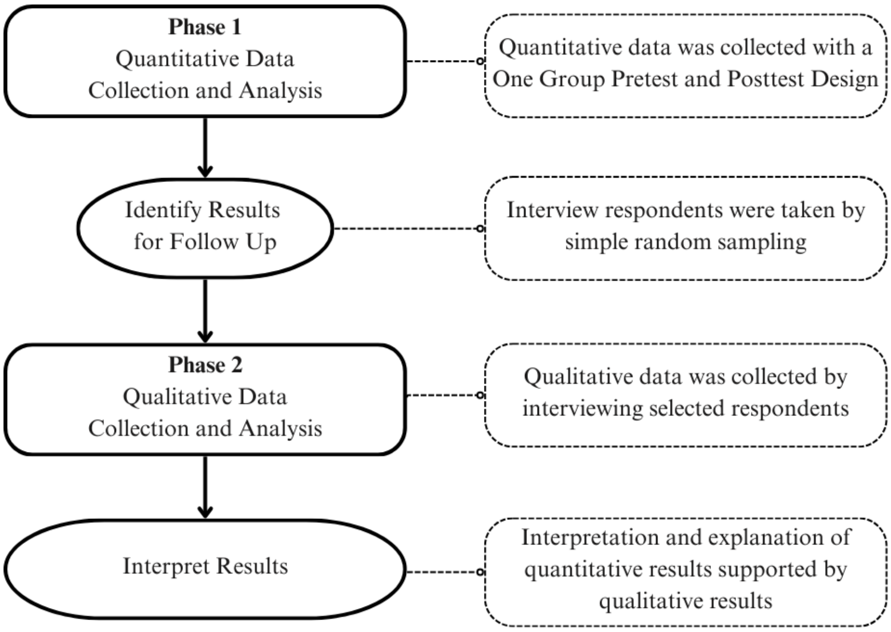

Figure 1. Research Flow with Explanatory Sequential Design

The first phase included quantitative data collection and analysis. Quantitative data collection was conducted using a one-group pretest and posttest design (Cresswell, 2015; Schreiber & Asner-Self, 2011). Data collection was conducted on 36 students in class X MIPA 3 at one of the high schools in Tuban Regency. We chose students of the X MIPA 3 class in this research because this class had not understood the concept of Newton's 3rd law before. The characteristics of the students in this class were quite active in the learning process. In addition, students in this class like to play with gadgets, so learning methods such as PBL-GC will be quite adequate for this class.

We select Data collection began by giving a pretest of problem-solving skills and then learning Newton's law material using Problem-based Learning by referring to the syntax of Arends (Arends, 2012) Assisted by Google Classroom (PBL-GC), the learning ended by conducting a posttest of problem-solving skills. The assessment instrument used refers to the assessment rubric (Selçuk et al., 2008), consisting of three description questions from seven questions that have been valid and reliable with a Cronbach Alpha value of 0.784. The analysis techniques used are descriptive and inferential statistics, which include a normality test, paired t-test, and n-gain with categorization based on Hake (1998), and effect size with categorization based on Cohen et al(2007)Based on the results of the quantitative analysis, interview respondents were randomly selected using the simple random sampling technique. Three respondents were chosen at random: Rara, Roni, and Rani. The names of the three respondents were disguised.

The second phase was carried out by collecting and analyzing qualitative data. Data collection by conducting semi-structured interviews to explore the problem-solving skills of one problem and student perceptions of learning Newton's law with PBL-GC. Data analysis was carried out with the stages of data reduction, data coding, data presentation, and interpretation (Cresswell, 2015). The results of quantitative analysis, supported by the qualitative study, were then interpreted and presented descriptively.

FINDINGS

Improvement of Problem-solving Skills through PBL-GC

Problem-solving skills refer to indicators that include understanding the problem, devising a plan, carrying out the plan, and looking back (Selçuk et al., 2008). Overall, the descriptive statistical results of problem-solving skills are as follows.

Table 1. Descriptive Statistical Results of Problem-Solving Skills

Descriptive Statistics	Pretest	Posttest
N	36	36
Mean	24,44	29,94
Minimal	18	22
Maximal	33	35
Standard Deviation	3,791	2,9947

It is known that the average value increases after being given treatment in the form of PBL-GC. The increase can be seen in the average posttest score, which increased by 5.5. The highest score obtained during the pretest was 33 points from the maximum score of 36, while the highest posttest score was 35. The following is a diagram of the results of acquiring each indicator of problem-solving skills.

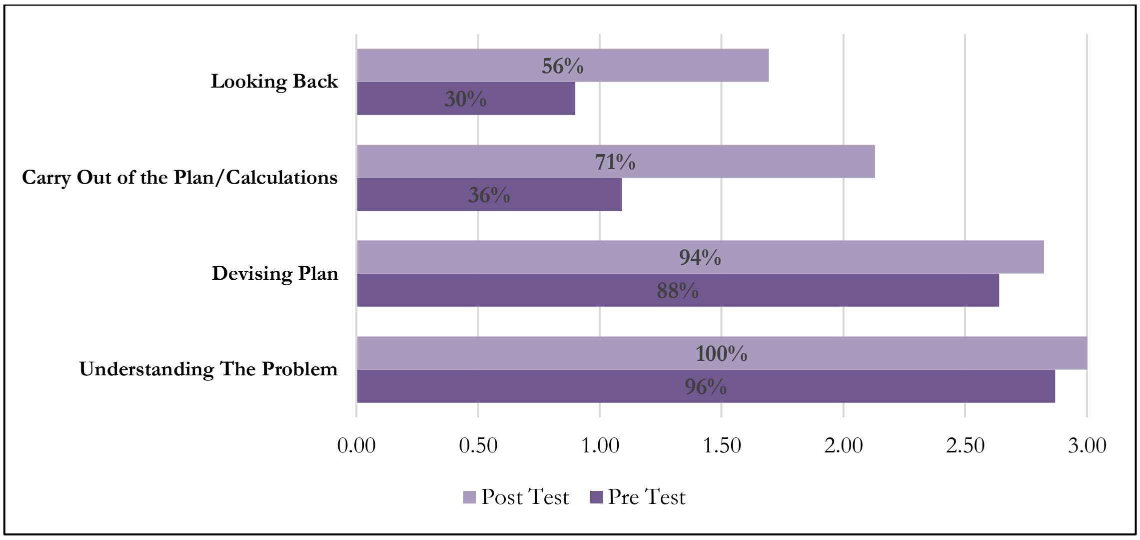

Figure 2. Diagram of Average Percentage of Problem-solving Scores for Each Indicator

The diagram results show increased students' problem-solving skills in all indicators after the PBL-GC learning intervention. The Understanding the problem indicator showed the highest result with a pre-test value of 96%, which increased to 100% in the post-test, indicating that students' understanding of the problem was excellent from the start and became perfect. The devising plan indicator increased from 88% to 94%, showing improvement in designing a problem-solving plan. The most significant increase was seen in the carry out of the plan/calculations indicator, which was from 36% to 71%, indicating that students were increasingly able to carry out the plan well. The looking back indicator also increased from 30% to 56%, reflecting improvements in the ability to evaluate solutions. The results of the problem-solving skills test on Newton's law material using PBL-GC provided quite improved results for students.

Furthermore, the normality test was carried out, which obtained a significance of more than 0.05, so the data was categorized as normally distributed. Furthermore, a paired samples t-test was conducted to see the difference in pretest-posttest data before and after learning Newton's law with PBL-GC. The results of the difference test are presented in Table 2 below.

Table 2. Paired Sample t-Test Results

	t value	Sig.
Pretest-Posttest	-7.924	0.000

These results support the descriptive statistical data showing a significant difference between the pre- and post-scores of students' problem-solving skills. After PBL-GC learning, the score increased significantly, so the intervention or PBL-GC learning effectively improved students' problem-solving skills on Newton's law material. Furthermore, the n-gain test was conducted with the following results to determine how much improvement occurred.

Table 3. N-gain Results

N-gain	Category
0.395	Medium

Based on the data above, the N gain number is 0.395. This number can be classified as medium since the range of the medium category was between 0.3 and 0.7 (Hake, 1999). It can be concluded that the improvement in students' problem-solving skills is classified as medium or moderate. Then, the effect size test was conducted to determine how much PBL-GC learning influenced student skills.

Table 4. Effect Size Results

Mean (posttest-pretest)	Effect Size	Category
5.50	1.62	Strong

$$d = \frac{M_A - M_B}{SD_{pooles}} \tag{1}$$

Where:
d: *Effect Size*
M_A: average variables 1
M_B: average variables 2
SD_{pooled}: Average Deviation Standards

The mean is the average value of the posttest-pretest section. The effect size value shows the effect of learning with PBL GC on students' problem-solving skills. The effect size is obtained from the calculation using equation (1). The effect size value of 1.62 is categorized as strong since the effect size value above 1 is categorized as strong (Cohen, 2007). Based on this result, the learning activities with PBL-GC given to students effectively improve problem-solving skills on Newton's law material.

Quantitative data is supported by qualitative data, including the results of interviews with three respondents on question number 1 below.

1. Ami bought a motorbike. Ami was not allowed to drive at high speed, since it was a new motorbike. On a straight track, Ami looks at the speedometer, and it shows 40 km/h. When the gas lever is pulled, it will increase the forward thrust (F1) and the speed of the motorbike will also increase. When the gas lever is released, the speed of the motorbike will decrease due to the drag force (F2) which is directed backward as shown in the picture on the side. If Ami wants to minimie the fuel consumption at constant speed (40 km/h), what should Ami do? And what is Ami's speed at t = 10 seconds?

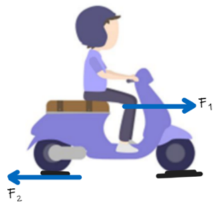

Figure 3. Problem-solving Test Number 1

Rara scored pretest 11 and posttest 12. Roni and Rini scored pretest 8 and posttest 11. Based on these results, it is concluded that the three students proved that PBL-GC could improve their problem-solving skills. The following is how students think about test question number 1, which is contained in the following interview answers:

> Ami rides a motorcycle at a speed of 40 km/h. She must balance the thrust (F1) and drag (F2) to maintain a constant speed. If the throttle lever is pulled, the thrust increases, and the motorcycle accelerates. If released, the drag force slows the motor. To keep it moving at 40 km/h without wasting fuel, Ami must adjust the throttle lever so that F1 = F2. Because the speed is constant, even at t = 10 seconds, Ami's speed remains 40 km/h. Ami must understand that the balance between thrust and the drag force is essential for fuel efficiency. This way, the motorcycle can run stably without accelerating or decelerating excessively." – Rini.

Students need additional information to answer this question more accurately, such as the following interview excerpt:

> "Needing additional information, such as the mass of the motor and the coefficient of friction, will help us to calculate the thrust and drag more specifically, as well as how the motor maintains a constant speed or how much speed it reaches after a certain time." – Rara

Deepening Conceptual Understanding Through PBL-GC

Students' perceptions of learning Newton's law using PBL-GC were revealed through the interview results. Students feel the benefits of using Google Classroom, which is practical and interactive during learning. This can be seen from one of the following interview excerpts:

> "In my opinion, the use of Google Classroom in learning Newton's Law material can be very effective, especially in the context of more interactive and organized learning. Moreover, my friends and I can try virtual practicum through the PhET Simulation link that my mother gave, then YouTube videos that help me understand the material, as well as be able to discuss with friends in Google Classroom." – Roni.

In addition, Google Classroom makes it easy for students to collaborate with friends by utilizing its features. This is revealed in the following interview answers:

> "The use of Google Classroom is straightforward because we can discuss there, we can also exchange ideas through the comments column in the discussion forum." – Rara

The combination of the problem-based learning model and Google Classroom differs from the learning the teacher has done in the previous material. Students felt that physics, especially Newton's law, was closer to everyday phenomena and related to the earlier material. The learning situation is described as more active, not dull, with group cooperation, and can build understanding. One of the learning situations is described in the following interview excerpt:

> "In my opinion, the perceived learning is much more effective than what the teacher used to use. First, it made me more actively involved in the learning process. When given real problems to solve, I feel more challenged to think critically and find solutions independently or in groups. For example, when learning about Newton's Laws, I was faced with a real situation, such as how to calculate the force needed to move an object, and we had to find the answer. Secondly,

> I could better understand the application of the theory in everyday life. Theories taught through lectures often feel far from reality and are difficult to understand. Therefore, I can more easily relate the material learned to things I encounter daily." – Roni.

After learning, students feel they have a deeper understanding of Newton's law. Students understand that learning Newton's law means that force affects the motion of objects, Newton's law is related to everyday phenomena, and Newton's law is interrelated with physics principles for practical problems. Here is one of the interview excerpts:

> "After completing this lesson, I feel that my understanding of Newton's laws is deeper. Before, I only knew about the laws theoretically, but now I can better understand how they apply in everyday life. For example, I understand Newton's first law of inertia better, especially when my body is pushed forward when a vehicle stops suddenly. I also understand better how forces work with Newton's second law, especially in calculating force and acceleration on objects. In addition, Newton's third law, which talks about action and reaction, became clearer with practical examples such as jumping off a boat or pushing a hand against a wall. It also helped me see how these laws are interrelated and how to use physics principles to solve practical problems. So, I understand and can apply Newton's Laws better now." - Rini.

Likewise, students feel the impact of solving problems. According to students' opinions, students are more able to think systematically and critically in analyzing issues, and team discussions for various solutions viewpoints, making it easier to experiment. This is revealed in the following interview excerpt:

> Regarding problem solving, I became more accustomed to thinking systematically. Usually, we have to analyze the problem, find the necessary data, and find the right way to solve it. Sometimes, if there is a complex problem, we discuss it with each other to find a solution, which helps me see the problem from various points of view." - Rara.

Students also experienced difficulties when working on problems that they thought required in-depth analysis, as in the following interview answers:

> "I have difficulties working on problems, especially those requiring deeper analysis or more complicated calculations. For example, in problems involving many forces acting on an object, I am sometimes confused about calculating the total force that affects the movement." -Rini.

The construction is shown in Figure 4 below, based on students' perceptions of the situation and the impact of PBL-GC learning on Newton's law material.

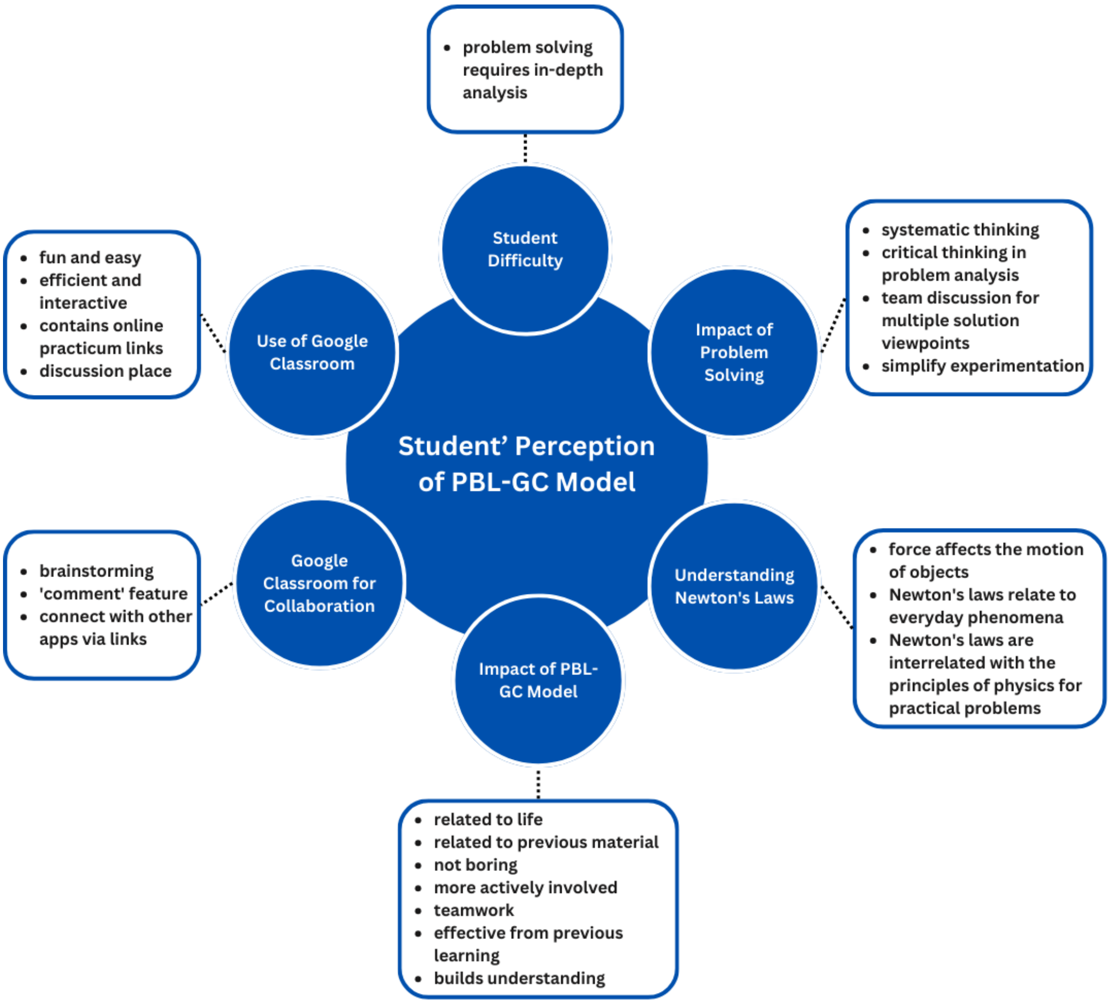

Figure 4. Construction of Students' Perceptions based on Interview Results

DISCUSSION

The improvement in students' problem-solving skills that occurred is in line with previous studies (Argaw et al., 2017; Hita et al., 2024; Lestari & Jatmiko, 2023; Usman et al., 2024; Yanto et al., 2021). This improvement is shown in the N-gain value and effect size. Although these results indicate the effectiveness of PBL-GC, the increase in problem-solving skills in the medium category (N-gain of 0.395) is lower than the research described in the literature review by Lestari and Jatmiko (2023) Which reported an increase in problem-solving skills in the high category with a PBL approach and an open-ended approach. One possible cause is Newton's Law material, which is difficult, especially when carrying out the plan and looking back at the indicators. In addition, interviews showed that some students needed additional information, such as the mass of the motor or the coefficient of friction, to answer the problem more accurately. This supports the findings that students often need more detailed context to maximize their analytical ability during problem-based learning (Budianti, 2021; Hita et al., 2024). The results of this study reinforce previous findings regarding the effectiveness of PBL in improving problem-solving skills and contribute by showing how the Google Classroom-assisted PBL model can help students overcome difficulties during the learning process.

The interview results show that learning Newton's law with the PBL-GC model provides a positive learning experience for students. Students' perceptions of this learning include the use of Google Classroom, Google Classroom for collaboration, the impact of PBL-GC, understanding of

Newton's law, the effect of solving problems, and the difficulties experienced by students. This finding is different from the research by Amalia et al. (2024). This states that students' perceptions of PBL are still low, but concerning interview findings, it supports the research results, which state that students have a high perception of the benefits of PBL. Ramadhani et al (2019) and Sindh (2022), which state that Google Classroom helps improve efficiency in managing learning, are also in line with the results of the interview answers by students. In addition, this finding is relevant to the results of research by Sulaiman (2010), who found that PBL helps students understand that physics concepts are related to life and daily activities. However, the interview results still reveal the difficulties experienced by students on complex questions, which is in line with Nesi et al. (2022). This reveals that students have difficulty understanding the meaning and basic concepts in the questions. Research by Jaeger and Adair (2014) showed that supporting students' interests seems to increase their perception of learning facilitator support, and ensuring students' ability to succeed in PBL seems to increase students' awareness of their responsibility.

Improving students' problem-solving skills through PBL-GC can be explained strongly by Contextual and Experiential Learning theories. Contextual Learning was implemented at stage 1 of the learning process, namely, orienting students to the problem, where the problem was adopted from students' daily activities. Students need experience (experiential learning) that they have done, and then synchronize it with learning materials to solve the problem. This can make students more critical and logical in solving problems, since they learn through real issues close to their lives. In addition, the basis of PBL learning is constructivist theory, which holds that learners are active participants in constructing their knowledge, significantly affecting the construction process and how people create meaning out of experience (Arends, 2012). Besides that, students actively experience, reflect, and apply Newton's concepts in relevant contexts. The PBL-GC model improves students' scores, as evidenced by the effect size of 1.62 (a strong category), and creates meaningful and sustainable learning.

CONCLUSION

The findings in this study indicate that implementing the PBL model assisted by Google Classroom (PBL-GC) can effectively improve students' problem-solving skills on Newton's law material. In-depth results showed that students are still trying to recognize the context of the problem so that information on the problem can be made more detailed and contextual. In addition to improving problem-solving skills, the PBL-GC model provides a positive response for students. Interactive tools such as Google Classroom greatly support students' interest in physics, especially Newton's law material. This research has theoretical implications to strengthen previous findings and theories, and practically, these findings support educators to provide problem-based learning with other supporting tools, so we hope that PBL with Moodle can be explored further. In addition, PBL GC can be improved by using more interactive demonstration videos. In addition, this study was only conducted at three meetings for its implementation due to time constraints. In addition to the future research that has been shown, future research can study it more deeply.

REFERENCES

Amalia, A. S., Desnita, Festiyed, & Putra, A. (2024). Persepsi Siswa tentang Keterlaksanaan Model Problem-Based Learning dalam Pembelajaran Fisika SMA di Kota Padang. *Jrunal Pendidikan Tambusai*, *8*.

Apriliasari, R. N., Jumadi, Wilujeng, I., & Kuswanto, H. (2019). The Effect of Web-Assisted Problem Based Learning Model Towards Physics Problem Solving Ability of Class X Students. *Journal of Physics: Conference Series*, *1233*(1). https://doi.org/10.1088/1742-6596/1233/1/012059

Arends, R. (2012). Learning to Tech. Tenth Edition. In *New York: McGraw-Hill Education*.

Argaw, A. S., Haile, B. B., Ayalew, B. T., & Kuma, S. G. (2017). The effect of problem based learning (PBL) instruction on students' motivation and problem solving skills of physics. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(3), 857–871. https://doi.org/10.12973/eurasia.2017.00647a

Ayumniyya, L., & Setyarsih, W. (2021). Profil Kemampuan Berpikir Tingkat Tinggi Siswa SMA dalam Pemecahan Masalah pada Materi Hukum Newton. *IPF: Inovasi Pendidikan Fisika*, *10*(1), 50–58.

Azizah, M. N. (2021). Development of Responsibility through Problem Based Learning Using Google Classroom on the Triangle Rules Materials. *Ideguru: Jurnal Karya Ilmiah Guru*, *6*(1). https://doi.org/10.51169/ideguru.v6i1.182

Bakri, F., Kusuma, K. F., & Permana, A. H. (2021). TPACK implementation in physics textbook: Practice problem-solving skill in Newton's law of motion for senior high school students. *Journal of Physics: Conference Series*, *2019*(1). https://doi.org/10.1088/1742-6596/2019/1/012057

Budianti, A. (2021). Penerapan Pembelajaran Berbasis Masalah untuk Meningkatkan Kemampuan Berpikir Kritis dan Hasil Belajar IPA Siswa MTsN 1 Bantul. *SECONDARY: Jurnal Inovasi Pendidikan Menengah*, *1*(1).

Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education, Sixth Edition*. London: Routledge.

Cresswell, J. W. (2015). Educational Research - Planning, Conducting, And Evaluating Quantitative and Qualitative Research - Fifth Edition (5th ed.). In *Pearson*.

Creswell, J. W., & Creswell, J. D. (2023). Research Design Qualitative, Quantitative, and Mixed Methods Approaches Sixth Edition. In *SAGE Publications*.

Ghinatri, N., Sari, I. M., & Saepuzaman, D. (2024). Development of New Todame Learning Media to Improve Problem-Solving Skills on Newton's Law for High School Students. *Jurnal Pendidikan Fisika Dan Teknologi*, *10*(2), 320–329. https://doi.org/10.29303/jpft.v10i2.7190

Gumisirizah, N., Muwonge, C. M., & Nzabahimana, J. (2023). Effect of Problem-based LLearning on Students' Problem-Solving Ability to Learn Physics. *Physics Education*.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1), 64–74. https://doi.org/10.1119/1.18809

Hermala, & Sapri, J. (2021). Penerapan Model Discovery Learning untuk Meningkatkan Kemampuan Memecahkan Masalah dan Prestasi Belajar. *DIADIK: Jurnal Ilmiah Teknologi Pendidikan*, *11*(1), 2021.

Hermawan, S., Sinaga, P., & Hikmat. (2022). Strategi Representasi Eksternal dalam Meningkatkan Keterampilan Kognitif Materi Hukum Newton Gerak Lurus. *Jurnal Pendidikan Nusantara*, *1*(2), 100–110. https://doi.org/10.55080/jpn.v1i2.16

Hijriani, & Hatibe, H. A. (2021). Analysis of Learning Difficulties in Physics Problem Solving on Newton's Law of Motion. *Jurnal Pendidikan Fisika Tadulako Online*, *9*(1), 45–49. http://jurnal.fkip.untad.ac.id/index.php/jpft

Hita, I. P. A. D., Dewi, K. A. K., & Pambayu, S. H. (2024). Efektivitas Model Pembelajaran Berbasis Masalah untuk Meningkatkan Kemampuan Gerak Passing Permainan Bola Basket. *Jurnal Pendidikan Olahraga*, *5*.

Hudha, M. N., Aji, S., & Rismawati, A. (2017). Pengembangan Modul Pembelajaran Fisika Berbasis Problem Based Learning untuk Meningkatkan Kemampuan Pemecahan Masalah Fisika. *SEJ (Science Education Journal)*, *1*(1), 36–51. https://doi.org/10.21070/sej.v1i1.830

Jaeger, M., & Adair, D. (2014). The Influence of Students' Interest, Ability and Personal Situation on Students' Perception of A Problem-based Learning Environment. *European Journal of Engineering Education*, *39*(1), 84–96. https://doi.org/10.1080/03043797.2013.833172

Januarifin, D., Parno, P., & Hidayat, A. (2018). Kesalahan Siswa SMA dalam Memecahkan Masalah pada Materi Hukum Newton. *Momentum: Physics Education Journal*, *2*, 47. https://doi.org/10.21067/mpej.v1i1.2292

Karmila, N., Wilujeng, I., & Sulaiman, H. (2021). The Effectiveness of Problem Based Learning (PBL) Assisted Google Classroom to Scientific Literacy in Physics Learning. *Proceedings of the 6th International Seminar on Science Education*.

Khoirunnisa, J. P. N., & Dwikoranto, D. (2021). Profil Keterampilan Berpikir Kritis Siswa Dalam Penyelesaian Masalah Materi Hukum Newton. *EDUKATIF : JURNAL ILMU PENDIDIKAN*, *3*(3), 806–816. https://doi.org/10.31004/edukatif.v3i3.429

Laila, S. I., & Anggaryani, M. (2021). The Use of STEM-Based Virtual Laboratory (PhET) of Newton's Law to Improve Students' Problem Solving Skills. *Jurnal Pendidikan Fisika*, *9*(2), 125–133. https://doi.org/10.26618/jpf.v9i2.5078

Lestari, S. A., & Jatmiko, B. (2023). Literature Study on Learning Physics with Problem-based Learning (PBL) Models to Improve Students' Problem-Solving Skills. *Inovasi Pendidikan Fisika*, *12*(2), 37.

Nesi, Y. M. D., Kusairi, S., & Nafisah, A. W. L. (2022). Analysis of Student Perceptions of Problem-solving Learning and Peer Assessment. *Momentum: Physics Education Journal*, 73–85. https://doi.org/10.21067/mpej.v6i1.6005

Nicholus, G., Muwonge, C. M., & Joseph, N. (2023). The Role of Problem-Based Learning Approach in Teaching and Learning Physics: A Systematic Literature Review. *F1000Research*, *12*, 951. https://doi.org/10.12688/f1000research.136339.1

Ningsih, S., Suana, W., Suana, W., Sesunan, F., & Sesunan, F. (2021). The Effect of Multi-Stage Discussion with Google Classroom and WhatsApp in Learning Physics on Problem Solving Ability. *Berkala Ilmiah Pendidikan Fisika*, *9*(3), 316. https://doi.org/10.20527/bipf.v9i3.11169

Pasaribu, A., Wiyono, K., Murniati, Saparini, & Sury, K. (2020). Analysis of Student's Higher-Order Thinking Skill in Newton's law. *4th Sriwijaya University Learning and Education International Conference (SULE-IC 2020)*, 761–766.

Putri, H. N. P. A., Wadilkh, S. F., Kusairi, S., & Hidayat, A. (2021). The Impact of Simulation Based Formative Assessment on Student Problem Solving Skill in Learning Newton Law. *International Joint Conference on Science and Engineering 2021 (IJCSE 2021)*. https://forms.gle/ez29znMPhFUqyFSk9

Ramadhani, R., Umam, R., Abdurrahman, A., & Syazali, M. (2019). The Effect of Flipped-Problem Based Learning Model Integrated with LMS-Google Classroom for Senior High School Students. *Journal for the Education of Gifted Young Scientists*, *7*(2), 137–158. https://doi.org/10.17478/jegys.548350

Retno, N. H. D., Sunarno, W., & Marzuki, A. (2019). Influence of Physics Problem-solving Ability through the Project Based Learning towards Vocational High School Students' Learning outcomes. *Journal of Physics: Conference Series*, *1307*(1). https://doi.org/10.1088/1742-6596/1307/1/012009

Sari, A. (2023). Pembelajaran Multi Representasi untuk Meningkatkan Kemampuan Pemecahan Masalah Siswa SMA pada Materi Hukum II Newton. *Jurnal Mahasiswa TARBAWI: Journal on Islamic Education*, *7*(1), 134–147. http://studentjournal.umpo.ac.id/index.php/tarbawi

Schreiber, J., & Asner-Self, K. (2011). Educational Research: Interrelationship Of Questions, Sampling, Design, and Analysis. In *USA: John Wiley & Sons, Inc.*

Selçuk, G. S., Çalışkan, S., & Erol, M. (2008). The Effects of Problem Solving Instruction on Physics Achievement, Problem Solving Performance and Strategy Use. *Latin-American Journal of Physics Education*, *2*(1). http://www.journal.lapen.org.mx

Setioningsih. (2021). Penerapan Model Pembelajaran Problem Based Learning (PBL) sebagai Upaya Meningkatkan Hasil Belajar Fisika Siswa pada Materi Hukum Newton. *SECONDARY : Jurnal Inovasi Pendidikan Menengah*, *1*(2), 27–34.

Siregar, R., Dewi, W. S., Putra, A., & Hidayati, H. (2023). Effect of Problem-Based Learning Model on Students' Physics Problem Solving Ability: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 2103–2109. https://doi.org/10.29303/jppipa.v9i4.3291

Suindhia, I. W. (2022). Penerapan Model Pembelajaran Problem Based Learning dengan Menggunakan Media Google Meet dan Google Classroom untuk Meningkatkan Hasil Belajar Fisika. *STRATEGY: Jurnal Inovasi Strategi Dan Model Pembelajaran*, *2*(4).

Sulaiman, F. (2010). Students' Perceptions of Implementing Problem-based Learning in A Physics Course. *Procedia - Social and Behavioral Sciences*, *7*, 355–362. https://doi.org/10.1016/j.sbspro.2010.10.048

Supeno, S., Subiki, S., & Rohma, L. W. (2018). Students' Ability In Solving Physics Problems on Newtons' Law of Motion. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *7*(1), 59–70. https://doi.org/10.24042/jipfalbiruni.v7i1.2247

Susiana, N., Yuliati, L., & Latifah, E. (2018). Pengaruh Interactive Demonstration terhadap Kemampuan Pemecahan Masalah Siswa Kelas X pada Materi Hukum Newton. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *3*(3), 312–315. https://doi.org/10.1103/PhysRevSTPER.7.020109

Usman, A. R., Khaeruddin, K., & Setiawan, T. (2024). Implementation of Problem-Based Learning Model to Improve High School Students' Problem-Solving Ability on Physics Materials. *Jurnal Pendidikan Fisika Dan Teknologi*, *10*(2), 250–256. https://doi.org/10.29303/jpft.v10i2.6902

Wahyuni, I. H., & Umam, K. (2020). Analysis of Collage Student Problem Solving Skills on Newton's Law Material. *Jurnal Ilmiah Pendidikan Fisika-COMPTON*, *7*(1).

Yanto, F., Festiyed, F., & Enjoni, E. (2021). Problem Based Learning Model For Increasing Problem Solving Skills In Physics Learning. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *6*(1), 53. https://doi.org/10.26737/jipf.v6i1.1870

Yunior Erlangga, S., Jumadi, Nadhiroh, N., & Wingsih, P. H. (2021). The Effect of Using Workbooks with Problem-Based Learning (PBL) Through Google Classrooms to Improve Critical Thinking Skills During the COVID-19 Pandemic. *Proceedings of the 6th International Seminar on Science Education*.