Indonesian Language Education and Applied Linguistics Reviews
Volume 2, Issue 1, 2026, 14-22
https://doi.org/10.66272/619w2e03

MEDIA AKADEMIKA PUBLISHER
ISSN 3110-3480

Available online at:
https://journal.mediaakademika.id/index.php/informs/article/view/75

Improving Creative Thinking Skills Through the Application of Student Worksheets Based on Project Based Learning in Basic Physics 1 Course on Motion Dynamics Material

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ARTICLE INFO

Received:
18 August 2025

Revised:
31 December 2025

Accepted:
15 March 2026

Keywords:
Worksheets, Project Based Leraning, ability, creative thinking

ABSTRACT

Student worksheets (LKM) are one of the alternatives to support the optimization of the implementation of learning activities. LKM based on project based learning (PjBL) as one of the efforts to improve students' creative thinking skills in post-pandemic learning. Creative thinking skills can produce new ideas, solutions or concepts in solving problems, especially those related to everyday life. This study aims to analyze the improvement of students' creative thinking skills through LKM based on PjBL in post-pandemic learning. The test subjects in this study were 39 first-semester students of the Chemical Engineering Study Program, University of Jambi. Data were collected through observation sheets on the implementation of PjBL activities and the achievement of creative thinking skills in learning. Based on the observation data obtained and the description of the implementation of LKM PjBL, it is known that the application of LKM in Basic Physics learning can improve students' creative thinking skills, with a clearer increase if applied continuously.

How to Cite: Amnie, E., & Sirait, J. V. (2026). Improving Creative Thinking Skills Through the Application of Student Worksheets Based on Project Based Learning in Basic Physics 1 Course on Motion Dynamics Material. *Indonesian Journal of Pedagogy and Research Development, 2*(1), 14-22. https://doi.org/10.66272/619w2e03

Published by:
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1. INTRODUCTION

Education lies at the heart of a nation's advancement. In recent years, global conditions have shifted, moving from a period of normalcy to the pandemic, and now into the post-pandemic "new normal." These changes have profoundly impacted every aspect of life, including education and learning. Globally, including in Indonesia, the educational landscape has transitioned from a focus on in-person instruction to blended learning models.

Education during the pandemic required educators, education observers, and education-related institutions to develop appropriate learning models and methods to ensure the effective implementation of the teaching and learning process (Winata et al., 2021). This policy impacted the transformation process for students, educators, and parents alike (Widad & Bakar, 2021). The COVID-19 pandemic shifted the education system from in-person classroom instruction to a "learning at home" (BDR) model. This approach served as a robust solution, allowing education to continue even while the world was gripped by the pandemic outbreak (BDR).

Online learning serves as a solution for delivering education in Indonesia during the COVID-19 pandemic, enabling the educational process to proceed effectively and achieve its intended learning objectives (Nafrin & Hudaidah, 2021). It offers an effective way to keep classes active despite school closures, addressing the risks associated with time and location constraints during the pandemic (Ndasung, 2021). Optimal learning outcomes are achieved when interactions between teachers and students leverage information technology—specifically, internet connectivity (Yudi Firmansyah & Fani Kardina, 2020).

Achieving learning objectives requires paying close attention to all the factors that influence the process. One such factor involves the obstacles associated with conducting education during the pandemic. These challenges include parents' lack of technological proficiency, issues with internet access, difficulty grasping the material, and students struggling with lethargy and concentration. According to Oktavia et al. (2021), these obstacles can be overcome by developing online learning media, maintaining communication with parents or guardians, creating lesson summaries, and assigning tasks that encourage active student participation.

The implementation of online learning during the pandemic has exposed various educational issues in the country. Furthermore, it has highlighted the unequal state of educational development in Indonesia and the need for an in-depth evaluation (Rionga & Alwi, 2021). One aspect requiring evaluation is how students' learning outcomes—spanning knowledge, skills, and attitudes—shifted during online learning. The transition of learning back to a normal state is also a subject worthy of close examination (Nur, 2022). The emergence of the "new normal" has required society to adapt to this new way of life. This new normal era has brought about numerous changes, including significant shifts in the field of education (Malau, 2021).

To re-establish pre-COVID-19 habits—such as the routine of studying—innovations must be developed for the post-pandemic era. Naturally, creating such innovations entails overcoming various challenges (Arum et al., 2022). The learning process has evolved alongside the shifting landscape of the pandemic that gripped the world. The pandemic influenced learning patterns, shifting them from purely online formats toward a transition back to in-person or hybrid (semi-online) instruction. This is because learning in the "new normal" era has not been able to fully restore the study habits that existed prior to the pandemic's widespread impact. In fact, some learning arrangements still lean heavily toward online delivery, even when certain sessions are conducted face-to-face.

The phenomenon of adapting to learning is also experienced during the higher education learning process. As members of the academic community, students are central to the implementation of learning activities. The adaptation process required of university students does not differ significantly from the learning adaptation undertaken by students at the primary and secondary levels. University students require a learning approach that fosters greater engagement on their part in every activity; this represents one of the challenges within the higher education learning process.

The emergence of challenges and obstacles in the learning process necessitates solutions that create an enjoyable learning experience and restore the true essence of education by prioritizing the learner (student-centered approach). One practical solution involves utilizing specific instructional models to help students re-accustom themselves to direct learning patterns. Several models can be employed to support the post-pandemic learning process, one of which is project-based learning.

Project-based learning is a comprehensive approach to the design of learning environments (Krajcik, Czerniak, & Berger, 2003). The project-based learning model can stimulate motivation and learning processes, as well as enhance student achievement, by utilizing real-world problems related to specific subjects (Mulyana et al., 2022). Project-Based Learning (PjBL) is crucial for improving the quality of student activities and encompasses various distinct learning processes (Astuti et al., 2019). PjBL serves as a learning model capable of guiding students in realigning learning processes and objectives during the post-pandemic return to in-person instruction. Through PjBL, students can develop a wide range of skills in alignment with desired learning outcomes.

One method that can enhance learners' skills—particularly creative thinking skills—and foster greater active participation in the learning process is the implementation of the project-based learning model (Asri & P, 2022). The National Education Association (NEA) has identified the "4C" skills as essential 21st-century skills (Sheppard, 2022), with creativity (creative thinking skills) being one of them.

Through creative thinking, learners can generate new ideas or concepts to solve problems, particularly those encountered in daily life (Haryanti & Saputra, 2019). In almost every domain,

creativity is viewed as a key contributor to development and prosperity (Jausovec & Jausovec, 2011).

PjBL activities can also offer an alternative solution for enhancing learning-related skills in higher education. Research conducted by Safriana (2018) and Hartono & Asiyah (2018) indicates that PjBL is capable of improving various student skills. Through PjBL projects, students are given the opportunity to boost their creativity by developing media to convey their ideas (Safriana, 2018).

Given the shift from pandemic-era online learning to the predominantly offline learning environment of the post-pandemic period—a transition also experienced by university students—this study examines student learning activities through the implementation of Project-Based Learning (PjBL). The application of PjBL in this context aims to revitalize students' creative thinking skills by incorporating group projects into their coursework. The study primarily focuses on describing the implementation of PjBL as a means to enhance students' creative thinking abilities during the Basic Physics course through group project assignments.

Group assignments are carried out using student worksheets to guide the targeted project activities. Students' creative thinking skills can be enhanced through the use of project-based student worksheets (Sari & Wulanda, 2019). These worksheets serve as an alternative learning medium that supports the optimization of learning outcomes, such as creative thinking. Understanding the role of collaborative principles can lead to the identification of effective strategies for improving the quality of class discussions (Kuntarto & Gafar, 2016). This approach benefits not only lecturers in designing and managing more effective class discussions but also students in developing communication skills essential for their academic and professional success.

2. METHODS

The implementation of the research focused on group project activities by students. This research used a qualitative descriptive research method. Qualitative description can be understood as a comprehensive description, which attempts to provide a detailed account of findings that are more likely to result in consensus among observers (Seixas et al., 2018). Pure qualitative descriptive research is derived directly from data, where codes are generated from the data during the research process and is generally characterized by simultaneous data collection and analysis (Lambert & Lambert, 2013).

Qualitative research aims to describe, explain, and interpret the collected data (Leal Filho & Kovaleva, 2015). The methodological data in this qualitative descriptive study were obtained by collecting qualitative information alongside a descriptive explanation of what occurred in the field. The data obtained in this study came from observations during the learning process by applying project-based learning (PjBL) student worksheets (LKM) to improve students' creative thinking skills.

The subjects in this study were 39 first-semester students in the Chemical Engineering study program enrolled in the Basic Physics I course for the 2023/2024 Academic Year. The project activities were carried out in groups, with each group consisting of five students. This research was conducted from September to November 2022. The data collection process was carried out through direct interaction to obtain data on the application of project-based learning in an effort to improve students' creative thinking skills. The data collection techniques used were observation methods, interview methods, and documentation methods.

The observation method was conducted during the implementation process of the simple water rocket-making project. The interview method was used to obtain information regarding student responses to the application of project-based learning, and c) the documentation method was used to obtain data regarding the implementation of the project-based learning activities carried out by students in the form of photos and videos. The obtained data were then analyzed descriptively by identifying the data, presenting the data, drawing conclusions, and verifying those conclusions.

3. RESULTS

The implementation process of PjBL in this study began with the preparation of an Outcome-Based Education (OBE) Semester Lesson Plan (RPS). The learning implementation took place with predominantly face-to-face (offline) activities, where during the group project phase, students were given student worksheets (LKM) with a predetermined theme: the application of the laws of motion dynamics in everyday life. Guruh, Anjarwati, and Prayitno (2018) state that delivering learning materials linked to everyday life can develop students' thinking skills. Students are expected to increasingly understand phenomena or problems related to motion dynamics that are so closely tied to daily life. The LKM was designed to make it easier for students to carry out the project activities step-by-step through to completion, as well as to facilitate lecturers in ensuring that each stage was executed properly.

The lecturer provided mentoring and directed students to solve tasks during the completion of the group project. The lecturer gave an explanation of the knowledge related to the project before the group project tasks were carried out. The lecturer set the direction of the implemented learning objectives and designed the learning atmosphere, which included dividing the students into several groups and designing the activity topics.

The lecturer structured the stages of the students' group project activities, such as creating a workflow for project completion, properly collecting data, and reporting the project results. This was outlined in the LKM. Students were also directed to take an active role in the process of designing the group project. They were asked to discuss the problem formulation, project completion steps, and the tools and materials to be used. Students were given the opportunity to present their project designs to be discussed together with other groups and the lecturer in a single learning session. The project stages were carried out based on these compiled designs.

In the first meeting, the lecturer explained motion dynamics and several of its applications closely related to everyday life. The lecturer also provided an opportunity for students to express their opinions regarding related problems in everyday life. While the learning was taking place, some students were active in the discussion session, while others tended to just listen. In the second meeting, students began to analyze the real-world application of the concept of motion dynamics in life. Students were directed to design and discuss the projects they were creating.

Figure 1. Discussion Activity on Choosing Projects for Each Group

In the third meeting, a presentation session for the students' project designs was held. In this session, each group could provide feedback on the plans presented by other groups. The lecturer observed the discussion activities carried out by the students, paying close attention to the components of creative thinking skills during each group's presentation. After the presentations, the students began preparing for the execution of the project, including preparing the necessary tools and materials. By the fourth meeting, every group visibly began the process of completing the implementation stages of their project activities.

Figure 2. Presentation Activity of Each Group

The completion of the project was also accompanied by the finalization of a paper and a short video regarding the resulting project. Students were given guidance on preparing material concepts based on the produced project. This was also supported by literature reviews from reference books as well as supporting journal articles, enabling students to explain the concepts of their projects well.

In the video, each group presented the project they had produced. The resulting video became one of the main focuses of the final observation regarding students' creative thinking skills. In the fifth meeting, students were asked to present and discuss with each other the results of the projects designed in groups. During the implementation of learning, students were observed during presentation activities and while assessing their project results. In this activity, each student's creative thinking skills were observed when providing explanations about the project related to the application of motion dynamics. During the discussion session, the lecturer paid attention to the narratives and arguments provided by each group regarding the four aspects included in the indicators of creative thinking skills, namely fluency, flexibility, originality, and elaboration.

The indicators and scoring guidelines used for the observation of creative thinking skill activities are listed in Table 1.

Table. 1. Creative Thinking Indicator, Scoring Guidelines, and Descriptor

Creative Thinking Indicator	Assessment Indicator	Score	Descriptor
Fluency	Fluency of opinion in explaining motion dynamics concepts related to the project task	4	Students are very fluent in explaining motion dynamics concepts related to the project task in terms of both content and language.
		3	Students are fluent in explaining motion dynamics concepts related to the project task in terms of both content and language.
		2	Students are moderately fluent in explaining motion dynamics concepts related to the project task in terms of both content and language.
		1	Students are less fluent in explaining motion dynamics concepts related to the project task in terms of both content and language.
Flexibility	Flexibility of opinion in presenting an understanding of motion dynamics concepts related to the project task	4	Students are very flexible in presenting their understanding of motion dynamics concepts related to the project task in terms of both content and language.
		3	Students are flexible in presenting their understanding of motion dynamics concepts related to the project task in terms of both content and language.
		2	Students are moderately flexible in presenting their understanding of motion dynamics concepts related to the project task in terms of both content and language.
		1	Students are less flexible in presenting their understanding of motion dynamics concepts related to the project task in terms of both content and language.

Creative Thinking Indicator	Assessment Indicator	Score	Descriptor
Originality	Originality in explaining the relationship between motion dynamics concepts related to the project task	4	Students very clearly explain the relationship between motion dynamics concepts related to the project task, which is not done by others, in terms of both content and language.
		3	Students explain the relationship between motion dynamics concepts related to the project task, which is not done by others in terms of content, but in terms of language is slightly done by others.
		2	Students moderately explain the relationship between motion dynamics concepts related to the project task, which is not done by others in terms of content, but in terms of language is frequently done by others.
		1	Students poorly explain the relationship between motion dynamics concepts related to the project task, which is done by others in terms of both content and language.
Elaboration	Elaboration of opinion in explaining the relationship between motion dynamics concepts and phenomena that appear in everyday life	4	Students always want to modify ideas in terms of both content and language when explaining the relationship between motion dynamics concepts and phenomena that appear in everyday life.
		3	Students want to modify ideas in terms of both content and language when explaining the relationship between motion dynamics concepts and phenomena that appear in everyday life.
		2	Students sometimes modify ideas in terms of both content and language when explaining the relationship between motion dynamics concepts and phenomena that appear in everyday life.
		1	Students do not modify ideas in terms of both content and language when explaining the relationship between motion dynamics concepts and phenomena that appear in everyday life.

(Haryanti & Saputra, 2019)

The PjBL student worksheets (LKM) were applied in the Basic Physics course with the consideration that this LKM could direct students to broaden their thinking and develop creative thinking skills in their learning activities. During the pandemic, students were more often involved as listeners and spectators when lecturers presented lecture materials. This contributed to students feeling bored with learning activities that dominantly involved sitting still and listening attentively. Several learning activities attempted to be project-based during the pandemic, but the main weakness lay in the minimal interaction between students and lecturers for mentoring and the evaluation process. As a result, the project activities carried out during the pandemic certainly did not run optimally. This was because students did not feel directly involved in learning. In this study, learning using the PjBL LKM enabled lecturers to guide students through the project completion process.

During the pandemic, students faced challenges in demonstrating their innate creative thinking skills. The predominantly online learning during the pandemic prevented students from displaying their abilities and skills optimally. This occurred due to the truncation of learning interaction flows and mentoring processes typically experienced by educators and learners, which in this context is between lecturers and students. The shift in learning patterns from the pandemic era to the post-pandemic era certainly requires a process that is not brief. In this study, students were directed to involve themselves in learning activities that also guided them to reactivate their creative thinking skills through the group project completion process. Starting from the activities of designing and discussing, students were directed to build the concept of dynamic fluids using phenomena that appear in everyday life through group project assignments. The average acquisition of observation data on creative thinking skills obtained in each assigned project group is as follows.

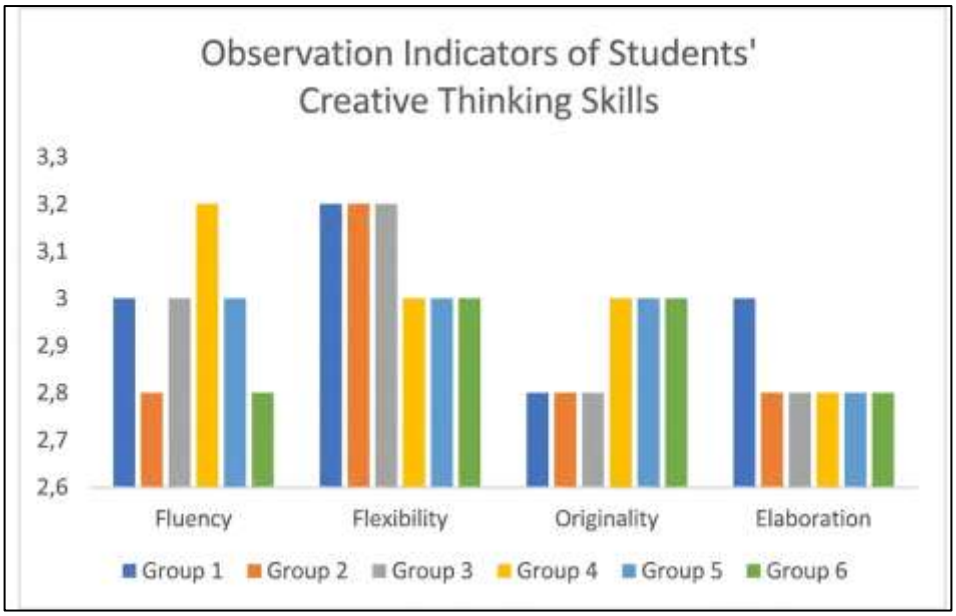

Figure 3. Graph of Students' Creative Thinking Skill Observation Results

Based on Figure 3, it is known that the process of fostering students' creative thinking skills in post-pandemic learning using the PjBL LKM is still in a stage that requires more time. This is because most indicators of students' creative thinking skills are still not optimally visible. The consideration of the learning adaptation process from online classes to predominantly face-to-face classes provides an important note that efforts are still needed to improve students' creative thinking skills in learning. When presenting the concept of the designed project tasks, some students were fluent in explaining the dynamic fluid concepts related to the project tasks, both in terms of content and language. However, it was found that some students were not yet able to articulate the dynamic fluid concepts well. This was also evident in some of the short videos created by the students.

Meanwhile, the flexibility indicator was an aspect that students already possessed well. Students showed good flexibility in presenting their understanding of the dynamic fluid concepts related to the project tasks in terms of both content and language. The majority of students were even able to provide arguments regarding the concepts of their group's project tasks with a clear and precise flow.

Based on the previous description, the application of the PjBL LKM provides an opportunity for students to increase their participation in learning and also brings out their innate creative thinking skills. This is in line with research conducted by Sari (2019), which shows that in learning with project-based LKM, students become more interested in participating actively in learning, so their interest increases, they understand the material more deeply, and their creative thinking skills improve.

4. CONCLUSION

Based on the observation data obtained and the description of the implementation of the PjBL LKM, it was found that the application of LKM in Basic Physics learning can improve students' creative thinking skills, and this improvement will be clearly evident if carried out continuously. This can be seen from the average value of the observation data on students' creative thinking skills, using creative thinking skill indicators in every related project completion process. This research is expected to be continued using different variables in learning achievement for students, both within the 4C criteria and other ability or skill criteria.

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