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Evaluation of the Application of Genially Assisted Problem-Based Learning, and Critical Thinking Profiles of Junior High School Students

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A B S T R A K

Critical thinking is an essential competency in 21st-century science learning. Problem-Based Learning (PBL), supported by interactive digital media such as Genially, can provide opportunities for students to engage with contextual problems, investigate information, discuss alternatives, and evaluate solutions. This study aimed to evaluate the implementation of Genially-assisted PBL in temperature and heat learning and to describe students' critical thinking profiles based on five Ennis indicators. A sequential explanatory mixed-methods design was employed, with descriptive quantitative data as the primary strand and semi-structured interviews as supporting qualitative data. The participants were 30 seventh-grade students at SMP Muhammadiyah Batudaa, comprising 16 students in the PBL–Genially class (VII-A) and 14 students in the regular class (VII-B). Data were collected using a 10-item essay test administered as a pretest and posttest and a 25-question semi-structured interview. The intervention was conducted over three meetings, each lasting 2 × 40 minutes. Quantitative data were analyzed descriptively, while interview data were analyzed thematically and integrated with test results through triangulation. The mean critical thinking score in the PBL–Genially class increased from 4.50 to 22.93, whereas the regular class increased from 2.35 to 8.28. Interview findings indicated that students benefited from visual and interactive learning experiences but still struggled to provide evidence-based explanations, draw conclusions, connect concepts with scientific mechanisms, and select appropriate problem-solving strategies. The findings suggest that Genially-assisted PBL can support critical thinking development when accompanied by systematic scaffolding, guided questioning, argumentation practice, and feedback. These results highlight the importance of structured instructional support during implementation.

INTRODUCTION

Critical thinking skills are one of the main competencies that students must have in the 21st century. This competency is needed so that students are able to analyze information objectively, evaluate various alternative problem solving, formulate arguments based on evidence, and make rational decisions. In learning Natural Sciences (IPA), the ability to think critically has an important role because students are not only required to master concepts, but also be able to explain natural phenomena through scientific processes. Therefore, the development of critical thinking skills is one of the main goals of science learning in secondary school (Maryani et al., 2021; Bajawa, 2024).

Various studies show that the critical thinking skills of students in Indonesia are still in the category that needs to be improved. Learning that is still dominated by the delivery of material by teachers causes students to memorize more concepts than build scientific reasoning. This condition

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causes students to experience difficulties when faced with problems that require analysis, reasoning, drawing conclusions, and solving contextual problems (Ayunda et al., 2023; Dhamayanti, 2022). The results of the initial observation at Muhammadiyah Batudaa Junior High School also showed that most students had difficulty identifying important information in the questions, choosing the appropriate concepts, and connecting the concepts of temperature and heat with the phenomena encountered in daily life. This condition shows the need for the application of learning that not only conveys concepts, but also provides opportunities for students to identify problems, conduct investigations, provide reasons based on available information, draw conclusions, and determine problem-solving strategies.

Previous research shows that Problem Based Learning (PBL) can provide opportunities for students to develop critical thinking skills through problem-solving, investigation, discussion, and solution evaluation activities (Dharma et al., 2019; Ghazali et al., 2021; Rauf et al., 2022; Busyairi & Kusuma, 2023). Meanwhile, research on Genially shows its use as an interactive learning medium that supports students' interest, involvement, and understanding through the presentation of material visually and interactively (Khoirun & Hermiati, 2022; Tri et al., 2025; Zulaichah et al., 2025). Although both approaches have been widely studied, research on the application of *Problem Based Learning* that is oriented towards critical thinking skills in temperature and heat materials is still developing. Saparina (2022), for example, developed E-LKPD based on Problem Based Learning on temperature and heat materials and showed an improvement in students' critical thinking skills. However, research that evaluates the application of Genially-assisted PBL specifically on temperature and heat materials by mapping critical thinking skills based on five Ennis indicators and integrating test results with students' experiences and difficulties through interviews is still limited. In addition, previous research has not integrated the results of the critical thinking ability test with the students' experiences and difficulties obtained through interviews to provide a more detailed picture of the development of each indicator.

Based on these gaps, the novelty of this research lies in the evaluation of the application of Genially-assisted PBL which integrates three aspects, namely the learning model, interactive media, and the Ennis critical thinking indicator framework. PBL is used as a learning framework to provide a problem-solving experience, Genially is used as a supporting medium to present problems and concepts in a visual-interactive way, while Ennis' five indicators are used to map students' ability to provide simple explanations, build basic skills, make inferences, provide further explanations, and determine strategies and tactics (Ennis, 2011). The integration of test results and subsequent interviews is used to identify not only changes in critical thinking ability, but also students' learning difficulties and needs on each indicator.

One of the learning models that is considered to be able to develop critical thinking skills is *Problem Based Learning* (PBL). This model places contextual problems as the starting point of learning so that students are encouraged to identify problems, gather information, develop alternative solutions, and evaluate the results obtained. Through this process, students have the opportunity to actively build knowledge and develop higher-level thinking skills (Ghazali et al., 2021; Estarini, 2023).

The application of PBL can be supported by the use of interactive learning media that help students understand the problems and concepts learned. One of the media that can be used is Genially, which is digital media that allows the presentation of material through text, images, animations, videos, quizzes, and various interactive elements. Visual and interactive presentation of material can help students obtain information, understand phenomena, and increase engagement during the learning process (Khoirun & Hermiati, 2022; Tri et al., 2025; Zulaichah et al., 2025).

Theoretically, PBL, Genially, and Ennis' critical thinking indicators are related to the learning process. PBL serves as a learning framework that provides opportunities for students to face

problems, identify information, conduct investigations, discuss alternative solutions, and evaluate results. These activities can facilitate Ennis' critical thinking indicators, namely providing simple explanations, building basic skills, making inferences, providing further explanations, and determining strategies and tactics. Genially acts as a supporting media that helps present problems, information, and concepts visually and interactively during the PBL stage. Thus, PBL provides learning activities, Genially supports presentation and interaction with the material, while the Ennis indicator becomes a framework to identify critical thinking skills that arise during the learning process.

Although various studies have reported on the effectiveness of PBL and Genially media on learning outcomes and critical thinking skills, most studies still focus on testing the influence through statistical analysis. Research that evaluates the process of implementing learning by integrating the results of critical thinking skills tests and student interview data is still relatively limited. In fact, the evaluation of the learning process is needed to obtain a more comprehensive picture of the development of critical thinking skills and the difficulties that students still experience while participating in learning.

The novelty of this study lies in the evaluation of the application *of Problem Based Learning* assisted by Genially through the integration of quantitative data in the form of critical thinking ability test results and qualitative data in the form of interviews based on five indicators of Ennis' critical thinking. This approach allows the research not only to describe changes in critical thinking ability scores, but also to explain the thinking process, learning strategies, and obstacles experienced by students during learning.

Based on this description, this study aims to evaluate the application of Genially-assisted *Problem Based Learning* on temperature and heat materials and describe the profile of students' critical thinking skills based on five Ennis indicators as a basis for formulating recommendations for improving science learning.

METHODS

This study uses an explanatory sequential mixed methods design with a quantitative data collection and analysis sequence followed by qualitative data (Creswell & Guetterman, 2019). The quantitative stage is used to describe changes in students' critical thinking skills based on the results of the pretest and posttest after the implementation of Genially-assisted Problem Based Learning (PBL). Furthermore, the qualitative stage is carried out through interviews to obtain a more in-depth explanation of the learning experience, strategies used, and students' difficulties in each indicator of critical thinking ability. Quantitative and qualitative data were integrated at the interpretation stage by comparing the pattern of changes in test scores with the findings of interviews (Patton, 2015**).** The results of the interviews were used to explain and enrich the interpretation of the score change, especially to identify indicators of critical thinking skills that have developed, are still experiencing difficulties, as well as learning factors that support or hinder these developments.

The research was carried out at Muhammadiyah Batuda'a Junior High School, Gorontalo Regency, in the odd semester of the 2025/2026 Academic Year. The research subjects amounted to 30 grade VII students consisting of 16 grade VII-A students as a class that applied Genially assisted Problem Based Learning and 14 grade VII-B students who participated in regular learning using package books. Data from regular classes are used as contextual comparisons to describe patterns of changes in critical thinking skills, rather than as a basis for drawing causal conclusions.

The research instrument consisted of a critical thinking ability test and semi-structured interview guidelines. The critical thinking ability test is in the form of 10 essay questions on temperature and heat material which are compiled based on Ennis' critical thinking indicators. Before

being used in learning, learning instruments and tools, which include teaching modules, student worksheets, learning materials, and critical thinking tests, are reviewed by academic advisors and subject matter experts to assess their suitability for use in learning. The available research records document the expert validation process and its interpretation criteria, but do not list numerical reliability coefficients. Therefore, this article does not list reliability values that are not supported by the research data.

Each student's answer to the essay question is assessed based on the scoring criteria that have been set according to the measured critical thinking ability indicator. The scores of the 10 questions are then calculated and converted into a percentage to describe the students' achievements on each indicator. The same scoring procedure is applied to the pretest and posttest results so that changes in students' abilities can be described consistently.

The implementation of learning is carried out in three meetings with a time allocation of 2 × 40 minutes at each meeting. The first meeting was used for the implementation of the pretest, the second to fourth meetings were used for the application of Genially assisted Problem Based Learning learning on temperature and heat materials, while the fifth meeting was used for the implementation of posttests. The learning stages follow the syntax of Problem Based Learning, which is student orientation to the problem, organizing students to learn, guiding investigations, developing and presenting results, and analyzing and evaluating the problem-solving process.

The interview was conducted after the entire series of learning and posttests were completed. The interviews involved 30 students using semi-structured interview guidelines. Interview questions are used to explore students' understanding of the material, reasons for solving problems, the ability to draw conclusions, the ability to connect concepts with phenomena in daily life, and strategies used in solving problems. Interview data is used as qualitative data to provide a more in-depth explanation of the results of the critical thinking ability test.

Data integration is carried out at the interpretation stage by linking the results of quantitative and qualitative analysis. Pretest and posttest results were used to identify changes in students' critical thinking skills quantitatively on each Ennis indicator. Furthermore, the results of the interviews were used to explain the findings by identifying the students' experiences, reasons, and difficulties in solving problems. The two types of data were then compared to see the match between the change in scores and the information students submitted. Thus, quantitative results provide an overview of changes in critical thinking skills, while qualitative results provide an explanation of experiences and difficulties related to these changes. The integration of the two data results in a more comprehensive picture of the implementation of Genially-assisted PBL and the profile of students' critical thinking skills.

The learning process in the experimental class is carried out following the syntax of Problem Based Learning, namely student orientation to the problem, student organization to learn, investigation, presentation of results, and analysis and evaluation of the problem-solving process. Genially media is used as a supporting medium to present contextual phenomena, animations, illustrations of temperature and heat concepts, interactive quizzes, and activities that support discussion and problem-solving. Meanwhile, the comparison class followed regular learning through the use of package books and teacher explanations in accordance with the learning practices that apply in schools.

Quantitative data was analyzed descriptively through the calculation of the average pretest and posttest scores as well as score changes to describe the development of students' critical thinking skills in each indicator. Interview data was analyzed thematically through the stages of data reduction, coding, thematic grouping based on Ennis' five critical thinking indicators, data presentation, and drawing conclusions (Miles et al. 2020). Furthermore, the results of quantitative and qualitative

analysis were integrated at the interpretation stage by comparing changes in critical thinking ability scores with interview findings. The results of the interviews were used to describe the students' experiences, strategies, and difficulties related to the change in abilities on each indicator. Thus, the integration of the two types of data provides a more comprehensive picture of the development of students' critical thinking skills during the implementation of Genially-assisted Problem Based Learning.

RESULTS AND DISCUSSION

Research Results

The results of the study are presented based on a descriptive analysis of changes in students' critical thinking skills after the application of *Genially-assisted Problem Based Learning* (PBL) on temperature and heat materials. Quantitative data was obtained through the results of pretest and posttest, while qualitative data was obtained through interviews that referred to five indicators of critical thinking ability, according to Ennis. The presentation of the results was carried out to provide an overview of the development of students' critical thinking skills as well as evaluate the learning process that has been implemented. The average change in students' critical thinking skills after learning is presented in

Table 1.Table 1. Description of Average Critical Thinking Score

Learning Context	Pretest	Posttest	Changes
Genially assisted PBL (n = 16)	4,50	22,93	18,43
Regular learning (n = 14)	2,35	8,28	5,93

Based on Table 1, the average critical thinking ability in the class that applied Genially-assisted PBL increased from 4.50 to 22.93 or an increase of 18.43 points. Meanwhile, regular learning classes increased from 2.35 to 8.28 or by 5.93 points. These findings show that during the learning process there is a greater development of critical thinking skills in classes that use Genially-assisted PBL.

The improvement is related to activities on the PBL syntax that provide opportunities for students to understand problems, conduct investigations, discuss, deliver results, and evaluate solutions. The results of the interviews show that students begin to identify important information and discuss in solving problems. This shows that PBL activities provide space for students to develop critical thinking skills through problem-solving experiences. However, the results of this study are not intended to prove the cause-effect relationship because the study uses an evaluative descriptive approach. Therefore, the interpretation of the results is more directed at the pattern of development of critical thinking skills during the learning process.

These results are in line with the research of Ananda and Fauziah (2022), Dharma et al. (2019), Cahyani and Ahmad (2024), and Anggaraini et al. (2025) which shows that the application of Problem Based Learning supported by learning tools or media can help improve students' critical thinking skills through student-oriented problem-solving and learning activities. The findings reinforce the results of this study that PBL activities provide opportunities for students to understand problems, conduct investigations, discuss alternative solutions, and evaluate the results of problem solving.

Analysis of interviews shows that students' critical thinking skills still vary on each Ennis indicator. A summary of the evaluation results is presented in Table 2.

Table 2. Summary of Evaluation of Critical Thinking Skills Based on Ennis Indicators

Indicator	Dominant Findings	Follow-up Needs

Elementary clarification	Most students do not immediately understand the meaning of the problem, especially about the story, calculations, and questions that ask for excuses.	Train students to identify important information, keywords, and the core of the problem.
Basic support	Students still have difficulty giving reasons based on scientific concepts and evidence.	Provide argumentation exercises using the framework of statements, evidence, and reasons.
Inference	Most students have not been able to draw conclusions independently based on the available data.	Practice drawing conclusions through the interpretation of data and observations.
Advanced clarification	Students are able to give examples in daily life, but have not been able to explain the scientific mechanism in full.	Develop learning that emphasizes the relationship of concepts to real phenomena.
Strategies and tactics	The learning strategy is still dominated by rereading the questions and remembering previous examples.	Train systematic problem-solving steps and reflect on the strategies used.

Based on Table 2, *the elementary clarification indicator* is an indicator that still needs attention. Most students state that they have to read the question over and over again before they understand the intent of the question. Difficulties mainly arise in questions in the form of stories, the use of scientific terms, and questions that require explanations of reasons. This condition shows that understanding the problem is the initial stage that still needs to be strengthened in learning.

In the *basic support indicator*, most students admitted that they still had difficulty explaining the reasons based on the concepts they had learned. The answers given tend to be short and have not been accompanied by scientific evidence. This shows that students are still used to remembering the final answer rather than building arguments based on concepts.

In the *inference indicator*, most students have not been able to draw complete conclusions based on the results of observations and available information. The conclusion conveyed is still in the form of repeating the content of the question without connecting the data with scientific concepts. Therefore, students need more intensive practice in interpreting the data before drawing conclusions.

Furthermore, in the *advanced clarification* indicator, most students are able to provide examples of temperature and heat phenomena in daily life, such as melting ice, boiling water, and spoons that get hot. However, students still have difficulty explaining the scientific process that causes the phenomenon to occur so that the relationship between concept and application is not fully understood.

In the *strategies and tactics* indicator, all students stated that they started solving the problem by reading the question first, then remembering the material they had studied or discussed with friends. The strategy shows an initial awareness of solving problems, but it is not accompanied by the ability to choose strategies that are in accordance with the characteristics of each problem.

If associated with the PBL syntax, students' difficulties in each indicator indicate that the critical thinking process still requires guidance at several stages of learning. The problem orientation stage is related to the ability to understand information, the investigation stage supports the reasoning and use of evidence, while the presentation and evaluation stage of results is related to the ability to draw conclusions and choose a solution strategy. Thus, the results of the interviews reinforce that PBL has provided an opportunity to practice critical thinking, even though students' abilities have not developed evenly.

Evaluation of the Application of Problem Based Learning Assisted by Genially

The implementation of learning was carried out in five meetings. The first meeting is used for the pretest, the second to fourth meeting is used for the implementation of Genially-assisted PBL, while the fifth meeting is used for the posttest. In three learning meetings, students take part in the

PBL stages which include orientation to problems, organizing students to learn, investigation, presentation of results, and analysis and evaluation of the problem-solving process.

The results of the interviews showed that the application of Genially-assisted Problem Based Learning provided a more active learning experience compared to regular learning. Most students stated that the display of images, animations, videos, and interactive quizzes on Genially media helped them understand temperature and heat material and increased interest in learning during the learning process.

Some students also revealed that they find it easier to remember the material through visualizations contained in Genially media. The media helps students connect abstract concepts with phenomena encountered in daily life so that the learning process becomes more interesting. These findings are in line with the research of Khoirun and Hermiati (2022), Tri et al. (2025), and Zulaichah et al. (2025) who stated that Genially is able to increase learning motivation, student involvement, and help understand concepts through the presentation of interactive materials.

If reviewed based on the learning stage, at the problem orientation stage, students gain experience in understanding phenomena through Genially visualization. In the investigation stage, students seek information and discuss to find solutions. Furthermore, at the stage of presenting results and evaluation, students convey the results of their thinking and review the problem-solving process. The results of the post-learning interviews showed that the experience helped students understand the material, identify information, and discuss, although students still had difficulty in giving scientific reasons, drawing conclusions, and determining strategies independently.

However, the results of the interviews also show that the use of interactive media has not been able to fully overcome students' difficulties in providing scientific reasons, drawing conclusions, and connecting concepts to problem solving. This shows that learning media functions as a support for the learning process, while the development of critical thinking skills still requires teacher guidance through the provision of guiding questions, directed discussions, argumentation exercises, and feedback during the learning process.

Overall, the interview findings showed that Genially supported the problem-orientation and investigation stages through visual and interactive presentations, while the process of discussion, presentation of results, and evaluation helped students develop reasoning on the problem. However, students still need *scaffolding* to be able to provide evidence-based reasons, draw conclusions, and determine strategies independently. These findings show that digital media serves as a support, while the development of critical thinking remains dependent on the learning process and teacher guidance.

Discussion

The results of the study showed that the application *of Genially-assisted Problem Based Learning* (PBL) provided greater development of critical thinking skills in PBL-Genially classes compared to regular learning classes. The average critical thinking ability score in the PBL-Genially class increased from 4.50 in the pretest to 22.93 in the posttest or changed by 18.43 points. Meanwhile, the regular class increased from 2.35 to 8.28 or by 5.93 points. The difference in improvement patterns shows that learning that involves students in understanding problems, investigating, discussing, presenting results, and evaluating solutions provides greater space for students to practice critical thinking skills. However, because this study uses an evaluative descriptive approach, the findings are understood as a description of the development of students' abilities during the learning process and not as evidence of cause-and-effect relationships.

The development of critical thinking skills is related to the characteristics of PBL which places problems as the starting point for learning. Through the PBL stage, students are directed to understand problems, identify relevant information, conduct investigations, discuss alternative solutions, present results, and evaluate the problem-solving process. This activity provides an

opportunity for students to use knowledge and reasoning in solving problems, not just receiving information from teachers. The results of the interviews support these findings because students begin to demonstrate the ability to identify important information and discuss with friends in solving problems. Thus, PBL activities provide a learning experience that can support students' critical thinking exercises.

The findings of this study are in line with the research of Ananda and Fauziah (2022), Dharma et al. (2019), Cahyani and Ahmad (2024), and Anggaraini et al. (2025) which shows that PBL supported by learning devices or media can help develop students' critical thinking skills. The similarity of these findings can be seen in learning activities that provide opportunities for students to understand problems, conduct investigations, discuss alternative solutions, and evaluate the results of problem solving. The results of this study reinforce previous findings that problem-solving oriented learning can provide students with the experience to use high-level thinking skills in understanding and solving learning problems.

The use of Genially provides support for the PBL process through the presentation of problems and materials in visual and interactive form. The results of the interviews show that the images, animations, videos, and interactive quizzes contained in Genially help students understand temperature and heat material and increase interest in learning. Some students also stated that visualization on Genially helps them remember the material and connect concepts with phenomena encountered in everyday life. Thus, Genially serves as a supporting medium that provides visual and interactive stimulus during the learning process. These findings are in line with the research of Khoirun and Hermiati (2022), Tri et al. (2025), and Zulaichah et al. (2025) which show that Genially can support student motivation, engagement, and understanding through the presentation of interactive materials.

Despite the increase in critical thinking skills, the results of the interviews show that student development has not been evenly distributed across all Ennis indicators. In the basic clarification indicator, most students still have to read the question repeatedly before understanding the meaning of the question, especially in questions in the form of stories, using scientific terms, or requiring an explanation of reason. On the basic support indicators, students still have difficulty giving reasons based on scientific concepts and evidence. This condition shows that students are beginning to be able to understand the problem, but are not fully able to develop the answer into an argumentation supported by evidence. Therefore, students need to practice argumentation gradually through questions that lead them to connect statements, evidence, and reason.

Students' difficulties are also seen in indicators of inference, further clarification, and strategies and tactics. On the inference indicator, most students have not been able to draw complete conclusions based on the available data and information. On the advanced clarification indicators, students have been able to provide examples of temperature and heat phenomena in daily life, such as melting ice, boiling water, and spoons getting hot, but still have difficulty explaining the scientific mechanisms that cause these phenomena. Meanwhile, in the strategy and tactics indicators, students tend to read questions first, remember the material they have learned, or discuss with friends, but are not always able to choose strategies that suit the characteristics of the problem. The findings suggest that students need more targeted practice in interpreting data, connecting concepts to phenomena, and choosing and evaluating problem-solving strategies.

Overall, the results of the study show that Genially is more appropriately positioned as a supporting medium in the implementation of PBL, while the development of critical thinking skills still requires a learning process and teacher guidance. Genially helps students gain a more visual and interactive learning experience, especially at the problem orientation and investigation stages. However, the use of interactive media has not been able to fully overcome students' difficulties in

providing scientific reasons, drawing conclusions, explaining the relationship between concepts and scientific mechanisms, and determining problem-solving strategies independently. Therefore, the implementation of Genially-assisted PBL needs to be accompanied by *scaffolding* in the form of guiding questions, directed discussions, argumentation exercises, drawing conclusions, and feedback. Thus, the integration of PBL and Genially can be more optimal in supporting the development of Ennis' five indicators of critical thinking ability.

Learning Implications

Based on the results of the research, the application of Problem-Based Learning assisted by Genially can be used as an alternative to science learning that is able to create an active and student-centered learning atmosphere. The integration of contextual problems with interactive media provides an opportunity for students to develop critical thinking skills through the process of observing, analyzing, discussing, and solving problems.

However, the implementation of PBL Genially still needs some improvements. Teachers are advised to provide *a framework in* the form of guiding questions, guide students in drafting evidence-based arguments, practice conclusion preparation, and provide step-by-step practice questions according to critical thinking skill indicators. Thus, the use of Genially not only increases students' interest in learning, but is also able to support the development of critical thinking skills more optimally.

Academic Contributions

The academic contribution of this research lies in integrating test and interview results to evaluate Genially-assisted PBL applications. The results of the study show that changes in critical thinking scores need to be understood along with the students' experiences during the PBL stage. Thus, this study provides an idea that PBL evaluation assisted by digital media not only needs to pay attention to test results, but also the reasoning process and students' difficulties in each critical thinking indicator.

CONCLUSION

The application *of Genially-assisted Problem Based Learning* (PBL) on temperature and heat materials showed positive results in supporting the development of critical thinking skills of grade VII students of SMP Muhammadiyah Batudaa. This is shown by the increase in the average critical thinking ability score in the class that applied Genially-assisted PBL from 4.50 to 22.93, while the comparison class increased from 2.35 to 8.28. The results of the interviews also showed that students began to apply learning strategies such as rereading questions, identifying important information, discussing with friends, and using Genially media as a visual reminder to understand the material. However, most students still have difficulty in providing scientific reasons that support concepts, drawing conclusions based on evidence, explaining the relationship between concepts and formulas, and determining problem-solving strategies independently. Therefore, the implementation of Genially-assisted PBL needs to be optimized through *scaffolding, gradual* reasoning exercises, the use of guiding questions, and feedback that refers to five indicators of critical thinking ability, according to Ennis. The results of this study provide an idea that PBL assisted by Genially has the potential to be an alternative to science learning that is able to create an active learning environment and support the development of critical thinking skills, although the research findings are still limited to the context of 30 students at SMP Muhammadiyah Batudaa so that further research with a wider scope of subjects and a more in-depth evaluation of the learning process is needed.

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