JOELI: Journal of Educational and Learning Innovation
Vol. 2, No. 2, November 2025 pp. 81 – 87
ISSN: 3063-3966 ***(online)***

The Effect of Problem Based Learning Assisted by Genially Interactive Media on Students' Critical Thinking and Mathematical Communication Skills

Fira Surmawati Moh. Saleh[1], Shoffan Shoffa[2], Endang Suprapti[3], Febriana Kristanti[4]

[1,2,3,4] Department of Mathematics Education, Universitas Muhammadiyah Surabaya, East Java, Indonesia

Article Info

Artikel History
Received : 8 January 2026
Reviewed : 24 January 2026
Accepted : 27 January 2026

Keywords:
Critical thinking
Genially
Mathematical communication
Problem Based Learning

ABSTRACT

This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design to examine the effect of the Problem-Based Learning (PBL) model assisted by Genially interactive media on students' critical thinking and mathematical communication skills. The participants were 19 seventh-grade students of SMP Muhammadiyah 3 Surabaya in the 2024/2025 academic year. Data was collected through tests, observations, and questionnaires, and analyzed using a paired sample t-test and N-gain analysis. The results revealed a significant improvement in students' abilities after the implementation of PBL assisted by Genially, with $t(18) = 20.042$, $p < .001$. The average N-gain score was 0.541, categorized as moderate. Student activity reached 99.75% (very good category), and student responses indicated a very positive perception (93%). These findings indicate that the integration of PBL and Genially interactive media effectively enhances students' critical thinking and mathematical communication skills.

Please cite this article APA style as:
Surmawati Moh. Saleh, F., Shoffa, S., & Suprapti, E. (2026). The Effect of Problem Based Learning Assisted by Genially Interactive Media on Students' Critical Thinking and Mathematical Communication Skills. *JOELI: Journal of Educational and Learning Innovation*., 2(2), pp. 81-87.

Corresponding Author:
Fira Surmawati Moh. Saleh
Department of Second Author, University of Second Author, State of Second Author
**Email Correspondence: FirasurmawatiMS@fkip.um-surabaya.ac.id*

1. Introduction

Mathematics learning at the junior secondary school level not only emphasizes the mastery of concepts and procedures but also focuses on the development of higher order thinking skills, particularly critical thinking and mathematical communication. These two abilities are essential components of 21st-century skills

that students must possess to solve problems logically, systematically, and communicatively across various life contexts (Trilling & Fadel, 2009; NCTM, 2014).

Nevertheless, numerous studies indicate that the critical thinking and mathematical communication skills of junior high school students in Indonesia remain relatively low. Students tend to experience difficulties in analyzing problems, connecting mathematical concepts to contextual situations, and communicating ideas or solution strategies coherently, both orally and in written form (Hendriana, Rohaeti, & Sumarmo, 2017; Putri & Zulkardi, 2020). This condition is closely related to learning practices that are still predominantly conventional, teacher-centered, and provide limited opportunities for students to actively explore and construct knowledge.

One instructional model considered effective in developing critical thinking and mathematical communication skills is Problem-Based Learning (PBL). PBL positions contextual problems as the starting point of learning, thereby encouraging students to think critically, collaborate, and communicate their ideas and solutions in an argumentative manner (Hmelo-Silver, 2004; Arends, 2012). Several studies have reported that the implementation of PBL can significantly improve students' critical thinking and mathematical communication skills (Zahrotin et al., 2020; Saputri, Widodo, & Kartono, 2023).

However, the implementation of PBL in classroom settings often faces challenges, including limited instructional media that can facilitate attractive and interactive problem visualization, as well as low student engagement during the learning process. Along with the rapid development of digital technology, the use of interactive learning media has emerged as an alternative solution to enhance student engagement and learning motivation (Mayer, 2020). Interactive and visual digital media are considered effective in supporting students' understanding of abstract mathematical concepts and promoting higher order thinking processes.

One interactive digital medium that has gained increasing attention in educational practice is Genially. Genially is a web-based platform that enables teachers to develop interactive, visual, and game-based learning media. Several studies have shown that the use of Genially based media can enhance students' motivation, participation, and conceptual understanding (Pérez & Salinas, 2022; Kurniawan & Prasetyo, 2023). However, studies that specifically integrate the PBL model with Genially media to simultaneously develop students' critical thinking and mathematical communication skills remain relatively limited, particularly in the context of basic statistics learning at the junior secondary school level.

Most previous studies tend to examine PBL or digital media separately, without emphasizing the synergy between problem-based instructional approaches and interactive, game-based digital media. In fact, the integration of both has the potential to create a more meaningful, contextual, and challenging learning environment for students, thereby optimizing the development of critical thinking and mathematical communication skills (Hmelo-Silver et al., 2015; Anggraini et al., 2015; Mayer, 2020).

Based on the foregoing discussion, this study offers novelty in the implementation of a Problem-Based Learning model assisted by Genially based interactive game media to enhance junior high school students' critical thinking and mathematical communication skills. This study not only examines improvements

in learning outcomes quantitatively but also highlights student engagement and responses to interactive digital learning. Therefore, this research is expected to contribute both theoretically and practically to the development of innovative mathematics learning approaches that are aligned with the demands of 21st-century education.

2. Method

This study employed a quantitative approach using a pre-experimental one-group pretest–posttest design. This design was selected to identify changes in students' critical thinking and mathematical communication skills before and after the implementation of the Problem-Based Learning (PBL) model assisted by the interactive digital media Genially. The design is considered appropriate for an initial or limited experimental study aimed at examining the effectiveness of an instructional innovation within an authentic classroom context (Creswell & Creswell, 2018).

The study was conducted at SMP Muhammadiyah 3 Surabaya during the even semester of the 2024/2025 academic year. The research participants consisted of 19 students from class VII-A, selected using purposive sampling. This selection was based on the suitability of the class characteristics to the research objectives, as well as the readiness of both teachers and students to participate in digital-based learning. The relatively small sample size is deemed appropriate for a pre-experimental design that emphasizes intra-subject change analysis (Fraenkel, Wallen, & Hyun, 2019).

The research procedure was carried out in three main stages:

1. Preparation stage, which included the development of PBL-based instructional materials, the design of interactive Genially media, and the construction and validation of research instruments.
2. Implementation stage, which involved administering the pretest, conducting PBL-assisted learning using Genially over several instructional sessions, and administering the posttest. During this stage, students were presented with contextual problems delivered interactively through Genially to promote analysis, discussion, and mathematical communication.
3. Evaluation stage, which included the analysis of pretest and posttest results, observation of student activities, and the collection of student responses to the implemented learning model.

The instruments used in this study consisted of:

1. A test of critical thinking and mathematical communication skills in the form of essay questions developed based on indicators of students' critical thinking and mathematical communication abilities.
2. An observation sheet of student activities, used to monitor student engagement during the PBL-assisted learning process with Genially.
3. A student response questionnaire, used to measure students' perceptions and attitudes toward the implemented learning approach.

The test instruments underwent content validity assessment through expert judgment, while instrument reliability was analysed using appropriate reliability coefficients based on the characteristics of the data (Sugiyono, 2021).

The data analysis technique employed inferential statistics. Prior to hypothesis testing, normality tests were conducted to ensure that statistical assumptions were

met. Differences in students' abilities before and after the intervention were then analysed using a paired sample *t*-test, as the data were obtained from the same group with two different measurements (Field, 2018).

To determine the level of improvement in students' critical thinking and mathematical communication skills, N-gain analysis was applied and classified into low, moderate, and high categories (Hake, 1998). Observation data and student response questionnaire results were analyzed descriptively using quantitative methods to complement the main findings of the study.

This research was conducted in accordance with educational research ethics principles, including obtaining approval from the school, ensuring the confidentiality of participants' identities, and using the data solely for academic purposes.

3. Results and Discussion

Results

Before conducting hypothesis testing, the data were first examined through prerequisite tests, namely normality and homogeneity tests. The results of the normality test using the Shapiro–Wilk test indicated that both the pretest and posttest data were normally distributed. The significance value for the pretest was 0.135 and for the posttest was 0.356, both of which exceeded the 0.05 significance level. Therefore, the assumption of normality was satisfied.

The homogeneity of variance test using Levene's test yielded a significance value of 0.527 (> 0.05), indicating that the data were homogeneous and suitable for further parametric statistical analysis. Effect of Problem-Based Learning Assisted by Genially on Critical Thinking and Mathematical Communication Skills Hypothesis testing was conducted using a paired sample *t*-test to determine differences in students' abilities before and after the intervention. The analysis results showed a *t*-value of 20.042 with 18 degrees of freedom ($df = 18$) and a significance value of $p < 0.001$. These results indicate that $t_{count} > t_{table}$ (20.042 > 1.740), leading to the rejection of H_0 and acceptance of H_1. This finding demonstrates that the implementation of the Problem-Based Learning model assisted by the Genially application has a significant effect on students' critical thinking and mathematical communication skills. To determine the level of improvement in students' skills, an N-gain analysis was conducted. The results indicated that the average N-gain score was 0.5410, with a minimum value of 0.42 and a maximum value of 0.76. According to the criteria proposed by Hake (1998), this level of improvement is classified as moderate.

The observation results indicated that students' learning activities during the instructional process were categorized as very good, with an average activity percentage of 99.75%. The dominant activity observed was students' involvement in the *snakes and ladders* game assisted by the Genially application, accounting for 23.85% of the total activities. In contrast, irrelevant activities were minimal, comprising only 2.38%.

In addition, the results of the student response questionnaire revealed a very positive perception of the implemented learning approach. The percentage of agreement (strongly agree and agree) reached 93%, indicating that students perceived the learning activities as engaging, enjoyable, and supportive of their understanding of the subject matter.

Discussion

The results of this study indicate that the implementation of the Problem-Based Learning model assisted by the Genially application significantly improved students' critical thinking and mathematical communication skills. The very high *t*-value (20.042) suggests that the improvement in students' abilities after the intervention was not merely a statistical coincidence, but rather a substantial effect of the applied instructional intervention.

This improvement is further supported by the N-gain analysis, which yielded a moderate category score (0.5410). This finding indicates that the learning process was not only statistically effective but also pedagogically meaningful. The PBL approach encourages students to analyze problems, evaluate problem-solving strategies, and draw conclusions key indicators of critical thinking skills (Facione, 1990; Ennis, 2016).

The integration of Genially media through the *snakes and ladders* game played an important role in enhancing students' mathematical communication skills. The visual and interactive features of the media supported students in expressing mathematical ideas more confidently, both orally and in written form. This was reflected in the improvement of students' verbal and written mathematical communication abilities, as well as the high levels of presentation and group discussion activities. These findings are consistent with Mayer's (2020) multimedia learning theory, which emphasizes that visualization and interactivity strengthen conceptual understanding.

Compared to previous studies that examined PBL or digital media separately, this study demonstrates that the synergy between Problem-Based Learning and Genially creates a more active, collaborative, and communicative learning environment. This synergy constitutes the main novelty of the study, particularly in the context of junior high school mathematics learning on data and graphical representation topics.

4. Conclusions

Based on the results and discussion, it can be concluded that the implementation of the Problem-Based Learning (PBL) model assisted by the Genially application has a significant positive effect on students' critical thinking and mathematical communication skills. The findings indicate a statistically significant difference between students' pretest and posttest scores, confirming that the applied learning intervention effectively improved higher order thinking and communication abilities.

The moderate N-gain value demonstrates that the improvement achieved is pedagogically meaningful, reflecting students' enhanced ability to analyze problems, construct arguments, and communicate mathematical ideas both orally and in written form. Furthermore, the very high level of student activity and the highly positive student responses indicate that the integration of PBL with interactive digital media fosters active engagement, collaboration, and learning motivation.

Overall, the synergy between Problem-Based Learning and Genially based interactive media creates a more meaningful, contextual, and student-centered learning environment. This study provides empirical evidence that integrating problem-based instructional strategies with digital interactive media is an effective

approach to developing critical thinking and mathematical communication skills at the junior secondary school level.

5. Acknowledgment

The authors would like to express their sincere gratitude to SMP Muhammadiyah 3 Surabaya for granting permission and providing support during the implementation of this research. The authors also gratefully acknowledge the support of the Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surabaya, for academic guidance and facilitation throughout the research process. Special thanks are extended to the mathematics teacher and the seventh-grade students of class VII-A for their active participation and cooperation. Appreciation is also conveyed to all parties who contributed to the successful completion of this study.

6. References

Anggraini, V. D., Suryaningtyas, W., & Shoffa, S. (2015). Pengaruh keterampilan metakognitif terhadap hasil belajar siswa melalui model *Problem-Based Learning* (PBL). *Jurnal Pendidikan Matematika*, 7(1), 7–28.

Arends, R. I. (2012). *Learning to teach* (9th ed.). New York, NY: McGraw-Hill.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Thousand Oaks, CA: Sage Publications.

Facione, P. A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction*. Millbrae, CA: The California Academic Press. *(Jika sudah dikutip di naskah, silakan pastikan ini ada; jika belum, bisa dihapus)*

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). London: Sage Publications.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2019). *How to design and evaluate research in education* (10th ed.). New York, NY: McGraw-Hill Education.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data. *American Journal of Physics, 66*(1), 64–74.

Hendriana, H., Rohaeti, E. E., & Sumarmo, U. (2017). *Hard skills dan soft skills matematik siswa*. Bandung: Refika Aditama.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2015). Scaffolding and achievement in problem-based and inquiry learning. *Educational Psychologist, 42*(2), 99–107.

Kurniawan, D., & Prasetyo, Z. K. (2023). Pengaruh media pembelajaran interaktif berbasis Genially terhadap motivasi dan hasil belajar siswa. *Jurnal Inovasi Pendidikan, 15*(2), 134–145.

Mayer, R. E. (2020). *Multimedia learning* (3rd ed.). Cambridge: Cambridge University Press.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. Reston, VA: Author.

Pérez, M. J., & Salinas, J. (2022). Interactive digital content and student engagement: The use of Genially in education. *International Journal of Educational Technology in Higher Education, 19*(1), 1–15.

Putri, R. I. I., & Zulkardi. (2020). Pengembangan kemampuan komunikasi matematis siswa melalui pembelajaran kontekstual. *Jurnal Didaktik Matematika, 7*(1), 1–12.

Saputri, A. D., Widodo, S. A., & Kartono. (2023). Problem-Based Learning dalam meningkatkan kemampuan berpikir kritis matematika siswa SMP. *Jurnal Pendidikan Matematika, 17*(2), 85–97.

Sugiyono. (2021). *Metode penelitian pendidikan*. Bandung: Alfabeta.

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Francisco, CA: Jossey-Bass.

Zahrotin, S., Sari, R. P., & Lestari, I. (2020). Pengaruh model Problem-Based Learning terhadap kemampuan komunikasi matematis siswa. *Jurnal Pendidikan Matematika, 14*(1), 45–56.