



The 4D Model in Developing Nearpod-Based Interactive Media for Reflection Material

Nuniek Noermala^{1,*}, Iyan Rosita Dewi Nur²

^{1,2}Universitas Singaperbangsa, Karawang, Indonesia

*Corresponding Authors: iyan.rosita@fkip.unsika.ac.id

<i>Submitted: 22-10-2025</i>	<i>Revised: 06-04-2026</i>	<i>Accepted: 22-04-2026</i>	<i>Published: 05-06-2026</i>
------------------------------	----------------------------	-----------------------------	------------------------------

ABSTRACT

Mathematics plays an important role in developing logical, critical, creative, and systematic thinking skills, but is often considered difficult and boring, thus requiring innovative learning media. One of the most challenging topics is reflection because of its abstract nature and requires visualization skills. This study aims to develop Nearpod-based interactive media that is valid, practical, and effective. The method used is Research and Development (R&D) with the 4D model (Define, Design, Develop, Disseminate) and the research subjects were 35 students in grade XI at Karawang State Senior High School 6, who were selected using purposive sampling. Data were obtained through validation questionnaires and practicality questionnaires. Effectiveness was not carried out, so no pretest and posttest scores were obtained. Data analysis was carried out quantitatively. The results show that Nearpod media is considered very feasible by media experts, with an overall average score of 3.90. This media is also considered very feasible by subject matter experts, with an overall average score of 3.80, and by students, with an overall average score of 3.80. In terms of practicality, based on the teacher questionnaire assessment results, Nearpod is categorized as very feasible with an overall average score of 3.60, while based on the student questionnaire assessment, Nearpod is categorized as feasible with an overall average score of 3.44. Thus, Nearpod is proven to be valid and practical for use in reflection materials.

Keywords: interactive media; model 4D; Nearpod; Reflection

INTRODUCTION

Mathematics education plays a crucial role in developing students' logical, critical, and creative thinking skills, while also supporting problem-solving skills in various contexts (Sukendra & Sumandya, 2020; Gusteti & Neviyarni, 2022). However, field practice shows that mathematics learning still faces various challenges, particularly low student motivation and engagement due to the perception that mathematics is a difficult subject (Manik et al., 2022). This situation results in limited conceptual understanding among students and a tendency to memorize procedures without grasping their meaning. One of the topics that often causes difficulty is geometric transformations. Based on observations and interviews with students and teachers, it was found that most students still struggle to understand the prerequisite algebraic concepts. One 11th-grade student also mentioned that he had trouble understanding the geometric transformations material because he was only looking at static images on paper. This not only led the student to make mistakes in applying the formulas but also caused misconceptions due to an inability to visualize the spatial changes in the figures' positions.

On the other hand, observations and interviews also indicate that students have a habit of using cell phones in their daily activities. This habit presents an opportunity for the

development of interactive and easily accessible technology-based learning media. Furthermore, students stated that they prefer learning that utilizes technology because it is considered more engaging and helps them understand the material. This indicates a need for innovative learning media that not only presents concepts in a dynamic visual manner but also enables active interaction, thereby potentially improving learning outcomes regarding geometric transformations.

Several studies indicate that a significant number of students hold misconceptions regarding translation, rotation, reflection, and dilation (Lestari et al., 2022). Many students struggle to visualize changes in the spatial positions of figures, thereby limiting their conceptual understanding (Maulani & Zanthi, 2020). Wahyuni's (2023) research confirms that students still struggle to visualize the position of the image after reflection, particularly in accurately determining the axis of reflection. These errors are generally influenced by weak visual representations and limited student engagement in learning (Sanita et al., 2024).

On the other hand, technological advancements offer opportunities to create more interactive learning experiences. Various studies indicate that technology-based interactive learning tools have become an urgent necessity in schools (Rohendi, 2025). Mubarok's (2025) research findings indicate that the use of interactive media helps students think logically, analytically, and critically when understanding mathematical concepts. One such platform is Nearpod, which enables the integration of visual materials, interactive activities, and immediate feedback into the learning process. Several studies report that Nearpod effectively improves mathematics learning outcomes across various educational levels and strengthens student participation and critical thinking skills (Pramesti et al., 2023; Djumardi & Andika, 2024; Putri & Hidayanto, 2025; Widiawati et al., 2024). Globally, Nearpod's interactive features have also been shown to increase student participation (Paramita, 2023) and support the gamification of mathematics learning (Caroy, 2023).

Nevertheless, studies specifically examining the development and effectiveness of Nearpod as a medium for reflective learning materials remain limited. In fact, the abstract nature of reflective learning materials and their need for dynamic visualization require the use of a medium capable of optimally facilitating interaction and visual representation. Consequently, there is a research gap in the form of a lack of Nearpod-based interactive media specifically designed to improve student learning outcomes in reflective material at the high school level. Based on this gap, the research questions in this study are: (1) what is the validity of Nearpod-based interactive learning media for reflective learning materials, and (2) how practical is its use in learning? Accordingly, this study aims to develop Nearpod-based interactive learning media that is valid, practical, and effective for reflective learning materials.

RESEARCH METHODS

This study is a Research and Development (R&D) study using the 4D model (Define, Design, Develop, Disseminate) adapted from Thiagarajan, Semmel, & Semmel (1974). The define stage was carried out by analyzing the curriculum, student needs, and learning difficulties in reflection material. The design stage involved designing interactive learning

media based on Nearpod, which contained material, practice questions, and collaborative activities. The develop stage included validation by media experts and subject matter experts (teachers), as well as practical testing through teacher and student response questionnaires.

The disseminate stage was disseminated through Focus Group Discussions (FGD) in study groups at Karawang 6 Public High School, and effectiveness testing was not conducted in this study, so no pretest or posttest scores were obtained.

The research subjects were 35 students in grade XI at Karawang State Senior High School 6, selected using purposive sampling, which is the selection of subjects based on specific considerations in accordance with the research objectives (Sugiyono, 2020). Data collection techniques included: (1) validation sheets by media experts, subject matter experts, and student questionnaires to assess the quality of the developed learning media, in order to produce learning media that met the validity criteria. The validation sheets contained assessments of content, construction, and language, which were used as an initial evaluation of the developed learning products (Effendi et al., 2018); and (2) a practicality questionnaire given to teachers and students after using the media. The results obtained are then adjusted to the research objectives and instruments in accordance with the indicators for collecting practicality data, which contains information about the usefulness, attractiveness, and ease of use of the product (Effendi, 2019). Data analysis was conducted quantitatively, namely validation assessed by subject matter experts, media experts, and student questionnaires. Practicality was obtained from teacher and student response questionnaires processed using a 1–4 semantic differential scale (Osgood, 1957), and effectiveness was not assessed, so no pretest or posttest scores were obtained.

RESULTS AND DISCUSSION

This study employs the 4D development model (Define, Design, Develop, Disseminate), adapted from Thiagarajan, Semmel, & Semmel (1974). The primary focus of this study is to develop Nearpod-based interactive learning media to support mathematics instruction on the topic of reflection.

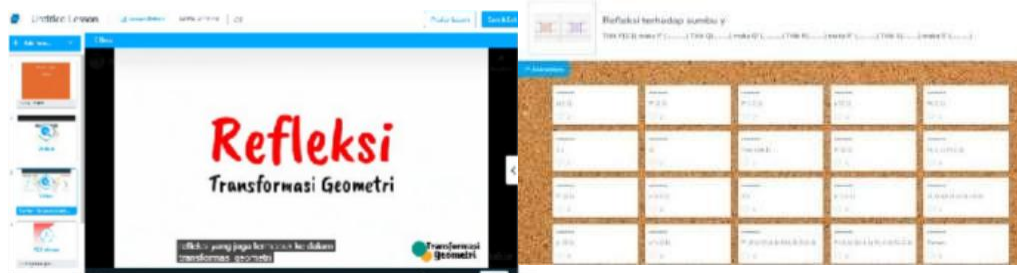
Define Stage

The define stage is the initial step in the development process, which aims to identify and analyze learning needs in depth. At this stage, researchers analyze the applicable curriculum, specifically the basic competencies and learning outcomes related to reflection in mathematics. Furthermore, researchers also analyze student characteristics and the difficulties they often experience in understanding the concept of reflection, such as difficulty visualizing the shadow of a figure or understanding the geometric transformation process in the Cartesian coordinate plane. This information is obtained through literature studies, analysis of learning documents, and field observations. The results of the define stage serve as the basis for developing learning media that are targeted and meet student needs.

Design Stage

After identifying learning needs, the next step is designing interactive learning

media based on Nearpod. In this design phase, researchers begin to develop the material structure, media presentation, and types of activities to be presented to students. The



designed materials include an explanation of the concept of reflection.

Figure 1. Use of Nearpod in Reflection Material

Development Stage

The develop stage is the process of realizing the previously prepared design. At this stage, researchers began to directly develop Nearpod-based interactive learning media. The development process included creating interactive presentation slides, inserting videos, quizzes, polls, practice questions, and various other multimedia elements that support the understanding of reflection concepts. During the development process, researchers also held regular discussions with their supervisors to ensure that the content and interactive features developed were in line with academic standards and student needs. Once the media had been developed, it was validated by subject matter experts and media experts to evaluate the quality of the content, appearance, and suitability for use in learning, including an assessment of its practicality by teachers and students. Suggestions and input from experts and supervising lecturers were used to revise and refine the media to make it more effective, interesting, and easy to use for students. This stage ensured that the media developed was not only informative, but also interactive and easily accessible in the learning process.

Validity assessment was conducted by material experts, media experts, and student questionnaires to assess the quality of the developed learning media, in order to produce learning media that meet valid criteria. Practicality assessment was carried out through a practicality questionnaire given to teachers and students after using the media, the results obtained were then adjusted to the research objectives and instruments according to indicators for collecting practicality data. Effectiveness assessment was not carried out in this study, so no pretest and posttest scores were taken. Validity and practicality assessments used a semantic differential scale questionnaire 1–4 (Osgood, 1957). Assessment scores were assessed based on the following table:

Table 1. Semantic Differential Scale Scores

Score	Description
1	Highly Unacceptable
2	Unacceptable
3	Acceptable
4	Highly Acceptable

After obtaining the scores, the assessment is calculated using a scale calculation formula to determine the quantitative suitability of the media. The results are assessed

using a scale calculation formula to determine the suitability of the media.

$$\bar{X} = \frac{\sum X_i}{N}$$

- \bar{X} = average score
- X_i = score given by respondents (1–4)
- N = number of respondents

Media Expert Validity Assessment

The validity assessment of Nearpod interactive media was conducted by a media expert using a questionnaire instrument with assessment criteria based on Effendi (2018), which covers three main aspects, namely content, construction, and language. Through this assessment, it can be determined the extent to which the media meets the eligibility standards for use in mathematics learning, particularly in reflection material.

Table 2. Result of Media Expert Assessment

Aspect	Number of Items	Total Score	Average Item	Interpretation
Content	9	36	4.00	Very Appropriate
Construction	6	23	3.83	Very Appropriate
Language	7	27	3.85	Very Appropriate
Overall Average	22	86	3.90	Very Appropriate

Based on table 2 of media expert assessment, the content aspect received an average score of 4.00 with a very appropriate, indicating that the visual design and readability of the media were optimal. The construction aspect received an average score of 3.83 with a very appropriate, indicating that the flow of material presentation was appropriate but could still be improved. Furthermore, the linguistic aspect received an average score of 3.85 with a very appropriate, meaning that the language used is communicative and appropriate for the developmental level of the students. Overall, Nearpod media received an average score of 3.90 with a very appropriate, so it can be concluded that this media meets the validity standards in terms of appearance, presentation, and language for use in mathematics learning on reflection material.

Expert Material Validity Assessment

Validity testing was also conducted by subject teachers who acted as subject matter experts. The assessment focused on three aspects, namely content, construct, and language (Effendi, 2018). This assessment aimed to obtain an overview of the quality of the Nearpod media developed in terms of content suitability, language clarity, content integration and appeal, as well as alignment with the established learning objectives.

Table 3. Result of Material Expert Assessment

Aspect	Number of Items	Total Score	Average Item	Interpretation
Content	5	19	3.80	Very Appropriate
Construction	6	23	3.83	Very Appropriate
Language	4	15	3.75	Very Appropriate
Overall Average	15	55	3.80	Very Appropriate

Based on the table 3, it can be seen that the content aspect received an average score of 3.80, which falls into the “Very Appropriate” category. The construct aspect received an average score of 3.83, which falls into the “Very Appropriate” category, and the linguistic

aspect received an average score of 3.75, which also falls into the “Very Appropriate” category. This shows that the Nearpod media developed has met the content validity criteria from the material expert perspective. In detail, the content aspect shows that the media is interesting and comfortable to use; and the material is in accordance with learning outcomes; the presentation is structured, varied, and interactive; the language is clear, precise, and consistent. Overall, the average score of the three aspects is 3.80 with a very appropriate category, which confirms that the Nearpod-based learning media on reflection material is considered valid and can be used in the learning process from the perspective of teachers as material experts.

Student Response Questionnaire

Validity testing was also conducted through a questionnaire of student responses, who acted as assessors of the developed learning media. The assessment focused on two aspects: readability and clarity. This test aimed to obtain an overview of the quality of Nearpod media in terms of content suitability, language clarity, content integration and appeal, and alignment with the established learning objectives. Furthermore, student responses were used to determine the extent to which the media was able to increase their interest and engagement in the learning process.

Table 4. Student Response Assessment Result

Aspect	Number of Items	Total Score	Average Item	Interpretation
Legibility	4	15	3.75	Very Appropriate
Clarity	7	27	3.85	Very Appropriate
Overall Average	11	42	3.80	Very Appropriate

Based on the table 4, it can be seen that the readability aspect obtained an average score of 3.75 which is included in the “Very Appropriate” category. The clarity aspect obtained an average score of 3.85 which is included in the “Very Appropriate” category. These results indicate that the Nearpod media developed has met the validity criteria from the user side, namely students as respondents. Overall, the average score of the three aspects is 3.80 with the “Very Appropriate” category, which confirms that the Nearpod-based learning media on reflection material is considered valid and suitable for use in the learning process according to the results of the student response questionnaire.

This finding aligns with research by Handayani and Utami (2023), who also stated that the validity of digital media is determined by content integration, ease of navigation, and the media's ability to stimulate active student engagement. Research by Pratiwi, Rachman, & Sari (2024) showed that Nearpod-based media with interactive presentations can increase student motivation and conceptual understanding due to the integration of visual elements and hands-on exercises. Overall, this discussion confirms that Nearpod is valid for use as a learning medium.

Analytically, this high validity score can be explained by the integration of several key elements in media development, namely: (1) the suitability of the material to learning outcomes, (2) visual presentation that supports the representation of reflective concepts, and (3) the use of communicative language. This is in line with previous findings which stated that the quality of content and visual design contribute significantly to the effectiveness of digital learning media. However, there were several notes from the

validator, particularly on the construct aspect, which indicated that the presentation flow could still be optimized. This indicates that although the media is suitable for use, improvements are still needed to be more adaptive to variations in student abilities.

Teacher Practicality Assessment

Practicality was tested through a questionnaire given to subject teachers after they used the media in teaching reflection material. The questionnaire was based on three main indicators of practicality, namely usefulness, interest, and ease of use of the media (Effendi, 2019). The aspect of usefulness covers the extent to which Nearpod media helps teachers deliver material and facilitate understanding of reflection concepts. The interest aspect assesses the attractiveness of the media's appearance and interactivity, which can increase student motivation to learn. Meanwhile, the ease of use aspect focuses on the ease with which teachers can operate, manage, and adapt the media to the learning needs in the classroom.

Table 5. Result of Teacher Practicality Assessment

Aspect	Number of Items	Total Score	Average Item	Interpretation
Usefulness	7	26	3.71	Very Appropriate
Interest	7	25	3.57	Very Appropriate
Ease	6	21	3.50	Very Appropriate
Overall Average	20	7	3.60	Very Appropriate

Based on table 5, it can be seen that the usability aspect obtained an average score of 3.71 with the category "Very Appropriate". The interest aspect obtained an average score of 3.57 with the category "Very Appropriate", and the ease of use aspect obtained an average score of 3.50 which is also included in the category "Very Appropriate". These results indicate that the developed Nearpod media has met the criteria of practicality from the user's perspective, namely the subject teachers. From the teacher's perspective, a high score on the usability aspect indicates that Nearpod helps in delivering material more systematically and interactively. In addition, features such as quizzes and draw-it allow teachers to monitor student understanding directly. Overall, the average score for all three aspects was 3.60 with the category "Very Appropriate". This confirms that the Nearpod-based learning media for reflection material is considered practical and suitable for use in the learning process according to the results of the teacher practicality questionnaire.

Assessment of Student Practicality

A practicality test questionnaire was administered to 12 students after they used Nearpod media in learning reflection material. The questionnaire instrument was compiled based on three main indicators of practicality: usability, interest, and ease of use of the media (Effendi, 2019). The usability aspect assesses the extent to which Nearpod media helps students understand the concept of reflection and makes it easier for them to follow the learning process. The interest aspect focuses on the attractiveness of the display, interactivity, and the extent to which the media can foster students' interest and motivation to learn. Meanwhile, the ease aspect covers students' ease in operating the media, understanding instructions, and interacting with the available features. The results of the practicality test from students serve as a reference for assessing the extent to which the developed media is practical, interesting, and easy to use in learning activities, and provide

input for improving the media for more effective implementation in the classroom.

Table 6. Result of Student Practicality Assessment

Aspect	Number of Items	Average Item	Interpretation
Usefulness	7	3.50	Very Appropriate
Interest	7	3.50	Very Appropriate
Ease	6	3.33	Worthy
Overall Average	20	3.44	Worthy

Based on Table 6, it can be seen that the usability aspect obtained an average score of 3.50, categorized as Very Appropriate. This result indicates that students considered Nearpod media useful in helping them understand the concept of reflection and facilitating the process of learning mathematics. The interest aspect also obtained an average score of 3.50, categorized as Very Appropriate, which means the media's appearance and interactivity were considered interesting, enjoyable, and able to increase students' learning motivation. Meanwhile, the ease of use aspect obtained an average score of 3.33, categorized as Worthy. Overall, the average assessment of the three aspects was 3.44, categorized as Worthy. From the students' perspective, the high interest aspect indicates that the media was able to increase learning motivation through its visual display and interactivity.

These findings are in line with the research by Musthariani et al. (2024), which shows that Nearpod is effective in improving students' analytical thinking skills and is considered practical and easy to use by teachers. Thus, the results of this study reinforce the view that the practicality of Nearpod is not only supported by its technology but also by the suitability of the media to the needs of teachers and students. Prasetyo & Rahmawati (2023) found that Nearpod-based media makes it easier for teachers to manage digital classrooms and increases student participation. Additionally, Kusuma and Nuraini (2025) emphasize that ease of access and attractive visual displays make Nearpod effective for project-based mathematics learning. Overall, this discussion confirms that Nearpod is practical according to teachers and students.

More deeply, the differences in scores between teachers and students, particularly in the ease of use aspect, indicate technical challenges experienced by some students, such as adapting to features or device limitations. This indicates that the success of digital media implementation is determined not only by media design, but also by user readiness and supporting infrastructure.

Disseminate Stage

The dissemination stage is the final stage in the 4D model, which aims to disseminate the learning media that has been developed so that it can be used more widely by teachers and students. In the context of this study, the dissemination process was carried out through focus group discussions (FGD) in study groups at Karawang 6 Public High School. This stage provided an overview of the potential for the media to be implemented more widely in various learning contexts.

CONCLUSION

Based on the results of the study, Nearpod-based learning media for reflection material proved to be valid, practical, and effective. The validity of the media was deemed

highly acceptable in terms of content, construct, and language through assessments by media experts, subject matter experts, and students, with average totals of 3.90, 3.80, and 3.85 (highly acceptable), indicating that the visual design, presentation structure, and language were appropriate for supporting mathematics learning. In terms of practicality, teachers rated the media as easy to use (total average of 3.60), while students rated it as acceptable to very acceptable (total average of 3.44), indicating that this media is easy to operate, interesting, and suitable for learning needs, although the presentation of the material could still be slightly improved to make it more coherent.

REFERENCES

- Aryani, P. I., Patmawati, H., & Santika, S. (2023). Penerapan Nearpod sebagai media pembelajaran interaktif berbasis web. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 7(3), 2966–2976.
- Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Houghton Mifflin.
- Caroy, A. A. (2023). A technology report on Nearpod. *RELC Journal*, 54(2), 551–560.
- Departemen Pendidikan Nasional. (2008a). *Panduan pengembangan instrumen penilaian hasil belajar siswa*. Depdiknas.
- Departemen Pendidikan Nasional. (2008b). *Panduan pengembangan bahan ajar*. Direktorat Jenderal Manajemen Pendidikan Dasar dan Menengah.
- Djumardi, D., & Andika, A. (2024). Pemanfaatan Nearpod pada materi pengukuran luas di kelas IV sekolah dasar. *Jurnal Pendidikan Tambusai*, 8(2), 16294–16305
- Effendi, K. N. S., Putri, R. I. I., & Yaniawati, P. (2018). The development of mathematics student worksheets for the school literacy movement. *Journal of Physics: Conference Series*, 13(4), 723- 738.
- Effendi, K. N. S., Zulkardi, Z., Putri, R. I. I., & Yaniawati, P. (2019). Developing mathematics worksheets using a futsal context for the school literacy movement. *Journal on Mathematics Education*, 10(2), 203–214.
- Gusteti, M. U., & Neviyarni. (2022). Pembelajaran berdiferensiasi pada pembelajaran matematika di Kurikulum Merdeka. *Lebesgue: Jurnal Ilmiah Pendidikan Matematika, Matematika dan Statistika*, 3(3), 636–646. <https://doi.org/10.46306/lb.v3i3>
- Handayani, S., & Utami, D. R. (2023). Kelayakan dan validitas media pembelajaran digital interaktif berbasis LMS dalam pembelajaran matematika. *Jurnal Pendidikan dan Teknologi*, 8(2), 101–110.
- Jatmiko, D. D. H., Putra, A. M., Kristiana, A. I., Murtikusuma, R. P., & Adawiyah, R. (2025). Kemampuan berpikir logis siswa dalam menyelesaikan masalah peluang ditinjau dari self-regulated learning. *Jurnal Ilmiah Matematika (JIMAT)*, 6(1), 163–172.
- Kusuma, A. R., & Nuraini, L. (2025). Implementation of Nearpod-based interactive media in project-based mathematics learning: Practicality and effectiveness analysis. *Journal of Digital Pedagogy and Learning Innovation*, 4(2), 45–57.
- Lestari, A. O., Susanti, E., & Hartono, Y. (2022). Pengembangan digital worksheet pada materi transformasi geometri untuk melatih kemampuan berpikir matematis. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 11(4), 2915–2926. <https://doi.org/10.24127/ajpm.v11i4.6160>
- Manik, H., Sihite, A. C. B., Sianturi, F., Panjaitan, S., & Hutauruk, A. J. B. (2022). Tantangan menjadi guru matematika dengan Kurikulum Merdeka Belajar di masa pandemi Omicron Covid-19. *Jurnal Pendidikan Matematika*, 6(1), 45–53.

- Maulani, F. I., & Zanthly, L. S. (2020). Analisis kesulitan siswa dalam menyelesaikan soal materi transformasi geometri. *Jurnal Gammath*, 5(1), 16–22.
- Mubarrok, A., Dewi, N. R., Zaenuri, Z., Walid, W., Agoestanto, A., & Sugiman, S. (2025). Peran media pembelajaran interaktif terhadap kemampuan berpikir kritis siswa. In *Prosiding Seminar Nasional Matematika (PRISMA)* (pp. 51–63).
- Musthariani, M., Madawistama, S. T., & Natalliasari, I. N. (2024). Pengembangan bahan ajar berbantuan Nearpod pada materi bangun datar untuk meningkatkan kemampuan berpikir analitis. *Pedagogy: Jurnal Pendidikan Matematika*, 9(2), 163–175.
- Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning*. University of Illinois Press.
- Paramita, P. E. (2023). Exploring student perceptions and experiences of Nearpod: A qualitative study. *Journal on Education*, 5(4), 17560–17570.
- Powa, N. W., & Murniarti, E. (2022). The analysis of Nearpod use in mathematics online learning at vocational school. *Jurnal Dinamika Pendidikan*, 15(2), 83–89.
- Pramesti, A. D., Masfuah, S., & Ardianti, S. D. (2023). Media interaktif Nearpod guna meningkatkan hasil belajar siswa sekolah dasar. *Jurnal Educatio FKIP UNMA*, 9(1), 379–385. <https://doi.org/10.31949/educatio.v9i1.4578>
- Prasetyo, D., & Rahmawati, I. (2023). Teachers' and students' perceptions of Nearpod practicality in digital classroom environments. *Jurnal Inovasi Pembelajaran dan Teknologi Pendidikan*, 9(2), 81–90.
- Pratiwi, R., Rachman, D., & Sari, M. (2024). Enhancing students' conceptual understanding through interactive Nearpod-based learning media. *International Journal of Digital Education Research*, 5(1), 45–56.
- Putri, I. F., & Hidayanto, E. (2025). Pemanfaatan Nearpod sebagai media pembelajaran matematika berbasis gamifikasi. *Journal of Innovation and Teacher Professionalism*, 3(3), 511–518.
- Rohendi, D., et al. (2025). Enhancing students' interactivity and responses in learning geometry using augmented reality. *EURASIA Journal of Mathematics, Science and Technology Education*, 21(1).
- Sofiyah, K., Nasution, N. E., Amelia, A., & Hutagalung, L. A. (2025). Pengaruh kesadaran siswa terhadap pentingnya matematika dalam karir di era digital dan ekonomi berbasis pengetahuan. *Aliansi: Jurnal Hukum, Pendidikan dan Sosial Humaniora*, 2(1), 111–118
- Sugiyono. (2020). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.
- Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. University of Minnesota.
- Wahyuni, S. (2023). Analisis kesulitan siswa pada materi transformasi geometri. *Journal Mathematics Education Sigma*, 4(1), 55–62.
- Widiawati, Y., Nurmaningsih, N., & Haryadi, R. (2022). Penerapan problem based learning berbantuan Nearpod terhadap kemampuan pemecahan masalah matematis. *Jurnal Riset Matematika dan IPA*, 1(2), 12–25.
- Zhang, Q., Zhang, X., & Liu, J. (2021). A holistic review of authentic assessment in mathematics education. In *Authentic assessment and evaluation in a digital era* (pp. 95–115).
- Zulkardi, Z., Susanti, E., & Meryansumayeka, M. (2024). Desain pembelajaran refleksi geometri menggunakan pendekatan PMRI dengan konteks songket Prada Palembang. *Indiktika: Jurnal Inovasi Pendidikan Matematika*, 7(1), 246–260.