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Effectiveness of the ICARE Model Integrated with Desmos: Improving Mathematical Conceptual Understanding

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ABSTRACT

Purpose – This research compared students' understanding of mathematical concepts when taught through two different approaches: conventional instruction and the ICARE model (Introduction, Connect, Apply, Reflect, Extend) supported by the Desmos application in the topic of quadratic equations. Despite growing evidence on the individual benefits of the ICARE learning model and the Desmos application, limited empirical research has examined their systematic integration within each ICARE phase to improve secondary students' conceptual understanding of quadratic equations.

Methodology – The study adopted a quasi-experimental design with a posttest-only control group. A total of 45 ninth-grade students from SMP Manunggal Medan participated in the 2025/2026 academic year, comprising 23 in the control class and 22 in the experimental class. The instrument was a conceptual understanding test consisting of open-ended questions, validated by experts. Data were analyzed using an independent sample *t*-test.

Findings – The results showed a significant difference between the two groups ($p < 0.001$). The experimental class obtained an average score of 76.09, while the control class reached only 59.65. Distribution analysis also revealed that 86.4% of students in the experimental group were categorized as *good* to *very good*. In comparison, 78.2% of students in the control group were categorized as *poor* to *very poor*. These outcomes suggest that the ICARE model, combined with Desmos, is efficacious in improving students' conceptual understanding of mathematics and in narrowing individual achievement gaps.

Contribution –In practice, the findings underscore the importance of preparing teachers to integrate technology into their teaching practices, thereby making learning more interactive, collaborative, and student centered.

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INTRODUCTION

Mathematics education is fundamental to developing students' logical reasoning, analytical thinking, and problem-solving skills, which are essential competencies in the 21st century. According to Law No. 20 of 2003 on the National Education System, every learner has the right to access quality education that prepares them to face future challenges. Although mathematics is a compulsory subject at the junior high school level and serves as a foundation for advanced learning in science and technology, it is frequently perceived as abstract and complex, leading to low motivation and achievement (Surya Maulana et al., 2025). International evidence from the Programme for International Student Assessment (PISA) consistently shows that Indonesian students perform below the OECD average in mathematical literacy, particularly in tasks requiring conceptual understanding and reasoning. These results suggest systemic instructional issues, including an excessive focus on procedural practice and formula memorization, which limit students' ability to construct meaningful mathematical understanding and apply concepts in novel contexts.

This challenge is also evident at the classroom level. Preliminary observations at SMP Manunggal Medan indicated that the average score of ninth-grade students on quadratic equation assessments was 46.55, far below the Minimum Mastery Criteria of 70, highlighting substantial conceptual difficulties in a core algebraic topic. Previous studies identify the abstract nature of quadratic equations as a significant barrier when instruction relies on conventional, teacher-centered approaches with minimal visualization or interaction (Fajar et al., 2018). In contrast, contemporary research emphasizes the effectiveness of student-centered, technology-enhanced learning environments in fostering deeper conceptual understanding and engagement (Gunada et al., 2023; Daryanes et al., 2023). Therefore, pedagogical innovation is urgently needed to bridge the gap between curricular expectations and students' actual learning outcomes, positioning this study within the broader international discourse on improving the quality of mathematics education (Rahim et al., 2022).

To address these challenges, teachers need learning models that keep students engaged and provide clear visual cues. The ICARE model (Introduction, Connect, Apply, Reflect, Extend) offers a structured process that helps students build their understanding step by step (Sakdiah & Unaida, 2025). When this model is combined with Desmos, a digital graphing tool, students can experiment with quadratic equations more dynamically. They can observe directly how changing the coefficients affects the shape of a parabola (Isroil et al., 2022; Nisa et al., 2024). Previous studies have reported that using Desmos can enhance students' motivation and interest in learning mathematics. However, existing research remains limited in several important aspects. For instance, Astarina et al. (2024) focused primarily on the development of interactive learning media for elementary science content, emphasizing feasibility and user responses rather than students' conceptual understanding or learning processes in mathematics. Moreover, the study did not integrate Desmos within a structured pedagogical framework such as ICARE, nor did it investigate how each phase of the ICARE model (Introduction, Connection, Application, Reflection, and Extension) systematically supports students' engagement and understanding. As a result, empirical evidence explaining the instructional mechanism of Desmos-based learning within the ICARE framework, particularly in secondary-level mathematics instruction, remains scarce. This gap highlights the need for studies that not only employ Desmos as a technological tool but also embed it within a coherent instructional model to examine its impact on students' conceptual understanding and learning outcomes.

Despite the growing body of research on technology-enhanced mathematics learning and constructivist instructional models, there remains a clear research gap concerning how interactive digital tools such as Desmos function when systematically embedded within a structured pedagogical framework like ICARE, particularly in supporting specific indicators of students' conceptual understanding of quadratic equations at the secondary school level. Most previous studies have examined either the use of Desmos as a stand-alone technological aid or the effectiveness of ICARE as a general learning model, without analyzing their combined instructional mechanism across each ICARE phase. Addressing this gap, the present study offers a novel empirical investigation of the integrated implementation of the ICARE model and Desmos, focusing on how this combination enhances students' interpretation, representation, and application of mathematical concepts. The purpose of this study is therefore to compare students' conceptual understanding of quadratic equations under conventional instruction and ICARE-assisted Desmos learning. Theoretically, this research contributes to constructivist and technology-enhanced learning literature by demonstrating how digital tools can act as cognitive mediators within a structured learning model. Practically, the findings provide concrete pedagogical insights for mathematics teachers on designing interactive, student-centered instruction aligned with the demands of 21st-century education.

This study was designed to address that gap. It compares students' conceptual understanding of quadratic equations when taught with conventional instruction and when taught using the ICARE model assisted by Desmos. Theoretically, the study provides evidence for combining constructivist learning models with interactive technology. Practically, it offers teachers an alternative strategy that suits digital-native students and the learning demands of the 21st century.

METHODOLOGY

Research Design

This study employed a quantitative approach using a quasi-experimental design, specifically a posttest-only control group design, as recommended by Campbell and Stanley (1963) and Creswell (2014) for situations where random assignment and pretesting are not feasible. The design was selected because the student population was relatively homogeneous, as the school did not implement special, acceleration, or ability-based classes. Therefore, students were assumed to have comparable initial abilities. Moreover, the use of a pretest was intentionally avoided to minimize the potential testing effect, in which prior exposure to test items may influence posttest performance and threaten internal validity (Fajar et al., 2019).

Population and Sample

The study population consisted of all ninth-grade students at SMP Manunggal Medan in the 2025/2026 academic year, totaling 166 students. Two classes were selected using purposive sampling, based on academic similarity, schedule feasibility, and teacher recommendations. This technique is academically justifiable in quasi-experimental research when intact classes must be used, and randomization is impractical (Creswell, 2014). The sample comprised class IX-A (control group, 23 students) and class IX-B (experimental group, 22 students). The relatively small sample size is acknowledged as a limitation of the study and will be addressed further in the discussion section.

Data Collection

The intervention was carried out over four learning sessions, each lasting 2 × 40 minutes. The control group received conventional instruction through teacher-centered lectures, formula explanations, and routine practice exercises, without the support of interactive digital tools, an approach widely reported to emphasize procedural fluency rather than conceptual understanding (Fajar et al., 2018). In contrast, the experimental group was taught using the ICARE instructional model integrated with Desmos, with learning activities structured as follows: (1) Introduction, students were introduced to quadratic equations through contextual problems, while Desmos was used to present dynamic graphs of quadratic functions to stimulate curiosity and activate prior knowledge; (2) Connection, students explored relationships between algebraic expressions and graphical representations by manipulating coefficients (a, b, c) using Desmos sliders, enabling students to connect prior knowledge with new concepts; (3) Application, students solved quadratic equation problems and verified their solutions through real-time graph visualization in Desmos; (4) Reflection, students discussed their findings, interpreted changes in the graphs, and articulated conceptual understanding supported by visual feedback from Desmos; and (5) Extension, students completed enrichment tasks involving new or real-world problem contexts, using Desmos for further independent exploration. The integration of Desmos within a structured learning framework supports active knowledge construction and conceptual understanding, as suggested by prior studies on technology-enhanced and student-centered mathematics learning (Gunada et al., 2023; Astarina et al., 2024). At the end of the instructional intervention, both groups were administered a posttest to assess students' conceptual understanding of quadratic equations.

Instrument

The instrument used was a conceptual understanding test in the form of essay questions, developed based on indicators of quadratic equation concepts. The test measured students’ ability to interpret, classify, represent, and apply mathematical ideas. To ensure content validity, the instrument was reviewed by three experts: two mathematics education lecturers and one experienced mathematics teacher.

Table 1. Reliability Test Results

Variable	Cronbach’s Alpha	Number of Items	Reliability Category
All Variables	0.796	9	Acceptable / Reliable

Based on the table above, all statement variables show acceptable reliability, as indicated by a Cronbach’s Alpha value of 0.796, which is higher than the minimum acceptable threshold of 0.6. Therefore, the measurement instrument can be considered reliable for further analysis.

Data Analyisis

For data analysis, inferential statistics were applied. The procedures included: (1) testing normality with the Shapiro–Wilk test to check data distribution, (2) testing homogeneity with Levene’s test to confirm the equality of variances, and (3) hypothesis testing using an independent sample *t*-test to determine differences in students’ conceptual understanding between the two groups. The significance level was set at $\alpha = 0.05$. In addition to hypothesis testing, Cohen's d (Cohen, 1988) was calculated to assess the magnitude and practical significance of the ICARE model integrated with Desmos, with interpretation based on standard benchmarks for small, medium, and significant effects.

FINDINGS

A test of mathematical conceptual understanding was administered to both groups. The posttest outcomes revealed notable differences in achievement between the experimental and control groups. The descriptive statistics for the two groups are presented in Table 2.

Table 2. Descriptive Statistics of The Control and Experimental Groups

Group	Mean	SD	Median	Minimum	Maximum
Control	59.65	5.51	60.00	48	70
Experimental (ICARE + Desmos)	76.09	3.96	76.50	67	84

Based on Table 2, the control group obtained a mean score of 59.65 with a standard deviation of 5.507, indicating relatively high variability in students’ performance. The 95% confidence interval ranged from 57.27 to 62.03, with a minimum score of 48 and a maximum of 70, yielding a score range of 22. The median score of 60.00 indicates that half of the students scored below 60, while the other half scored above 60. The score distribution in the control group was approximately symmetric, with skewness of -0.288 (close to zero) and kurtosis of 0.031, indicating a distribution close to normal.

In contrast, the experimental group achieved a mean score of 76.09 with a standard deviation of 3.963, indicating lower variability in students' scores than in the control group. The 95% confidence interval ranged from 74.33 to 77.85, with a minimum score of 67 and a maximum score of 84, producing a score range of 17. The median score of 76.50 reflects the consistency of students' performance around the mean. The distribution of scores in the experimental group was also approximately symmetric, with skewness of -0.266 and kurtosis of 0.145, indicating a normal distribution.

Therefore, it can be inferred that students in the experimental group, who were taught using the ICARE model assisted by Desmos, achieved higher average performance and exhibited a more consistent score distribution than the control group, which was taught using conventional methods.

To enhance transparency and interpretability, students' conceptual understanding scores were classified into achievement categories based on score intervals. The categorization followed a criterion-referenced approach, adapted from commonly used educational assessment standards, in which score ranges correspond to levels of mastery. The categories were defined as follows: Very Good (80–100), Good (70–79), Fair (60–69), Poor (50–59), and Very Poor (<50). This classification was applied consistently to both the experimental and control groups to facilitate meaningful comparison of students' achievement levels.

Table 3. Distribution of Achievement Categories in the Experimental Group

Category		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Good	5	22.7	22.7	22.7
	Good	14	63.6	63.6	86.4
	Fair	3	13.6	13.6	100.0
	Total	22	100.0	100.0	

The distribution of achievement categories in the experimental group, presented in Table 2, illustrates the students' conceptual understanding of mathematics when taught using the ICARE model assisted by the Desmos application. Of the total 22 students, 5 (22.7%) were classified as outstanding, 14 (63.6%) as good, and 3 (13.6%) as fair. None of the students fell into the poor categories. Accordingly, 86.4% of the students in the experimental group were categorized as good to very good. This indicates that the implementation of the ICARE model, assisted by Desmos, effectively encouraged the majority of students to achieve a high level of conceptual understanding.

Table 4. Distribution of Achievement Categories in the Control Group

Category		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fair	5	21.7	21.7	21.7
	Poor	15	65.2	65.2	87.0
	Very Poor	3	13.0	13.0	100.0
	Total	23	100.0	100.0	

Table 4 illustrates the distribution of students' conceptual understanding of mathematics in the control group, which was taught using conventional methods. Of the 23 students, only 5 (21.7%) were categorized as fair, while the majority, 15 (65.2%), were classified as poor, and 3 (13.0%) as very poor. None of the students reached the good or very good categories. Consequently, 78.2% of the students in the control group fell into the lower categories (poor to very poor), indicating that conventional instruction was less effective in enabling students to achieve an optimal level of conceptual understanding in mathematics.

Based on the achievement results of both groups, it can be concluded that the distribution between the experimental and control groups is precise. The experimental group, which was taught using the ICARE model assisted by the Desmos application, was predominantly classified in the good-to-very-good category (86.4%). In contrast, the control group was mainly composed of people in low-income and very poor categories (78.2%). This reinforces the conclusion that the ICARE model, supported by Desmos, is significantly more effective than conventional instruction in enhancing students' conceptual understanding of mathematics and in shifting the overall distribution of achievement toward higher levels.

Inferential Statistical Analysis

Normality Test

Table 5. The Result of the Normality Test

Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Control	0.098	23	0.200*	0.977	23	0.856
Experiment	0.094	22	0.200*	0.983	22	0.957

*This is a lower bound of the true significance. a. Lilliefors Significance Correction

The results of the Shapiro–Wilk test presented in Table 5 indicate that the data from both groups were normally distributed, with p-values of 0.856 for the control group and 0.957 for the experimental group ($p > 0.05$). Therefore, hypothesis testing could proceed.

Homogeneity Test

Table 6. The Result of the Homogeneity Test

	Levene Statistic	df1	df2	Sig.
Based on Mean	1.636	1	43	0.208
Based on Median	1.550	1	43	0.220
Based on Median and with adjusted df	1.550	1	37.899	0.221
Based on the trimmed mean	1.620	1	43	0.210

The homogeneity test results in Table 6 show a p-value of 0.208 ($p > 0.05$), indicating that the variances of the two groups are homogeneous.

Hypothesis Testing (Independent T-Test Sample)

Table 7. The Result of the Independent t-Test Sample

	Levene's Test for Equality of Variances		t-Test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.636	0.208	-11.448	43	0.000	-16.439	1.436	-19.335	-13.543
Equal variances not assumed.			-11.531	39.99	0.000	-16.439	1.426	-19.320	-13.557

Table 7 presents the results of the independent-samples *t*-test examining differences in students' conceptual understanding of mathematics between the experimental and control groups. Based on Levene's Test for Equality of Variances, the significance value was 0.208 ($p > 0.05$), indicating that the variances of the two groups were homogeneous. Therefore, the *t*-test results were interpreted under the assumption of equal variances.

The independent-samples *t*-test produced a t value of -11.448 with df = 43 and a significance level of p = 0.000 ($p < 0.001$). These results indicate a clear and statistically significant difference between the experimental and control groups in their mathematical conceptual understanding. The mean difference of -16.439, with a 95% confidence interval ranging from -19.335 to -13.543, provides further evidence of a substantial gap in performance between the two groups. Based on these findings, it can be concluded that the students in the experimental group—taught using the ICARE model with the aid of the Desmos application—achieved much higher scores in conceptual understanding than those in the control group, who were taught with conventional methods.

Table 8. Effect Size of the ICARE Model Assisted by Desmos

Group	Mean	SD	Cohen's d	Effect Size
Control	59.65	5.51		
Experimental (ICARE + Desmos)	76.09	3.96	3.41	Very large

The effect size analysis using Cohen's d yielded a value of 3.41, indicating a considerable effect. This result demonstrates that the ICARE model, supported by Desmos, had a substantial and educationally meaningful impact on students' conceptual understanding compared to conventional instruction.

DISCUSSION

The findings of this study indicate that the ICARE model, supported by Desmos, significantly enhances students' conceptual understanding of quadratic equations. Rather than merely producing higher achievement levels, the combined approach appears to influence how students construct and internalize mathematical concepts. This suggests that the observed differences are not only quantitative outcomes but also reflect qualitative changes in students' learning processes.

From the perspective of conceptual understanding indicators, the use of ICARE, supported by Desmos, particularly strengthens students' abilities to represent and interpret concepts. During the Connect and Apply stages, students were encouraged to relate algebraic forms of quadratic equations to their graphical representations using Desmos. This dynamic visualization helped students interpret the meanings of coefficients, roots, and vertex positions, which are often sources of misconception in conventional instruction. Furthermore, the Reflect and Extend stages promoted deeper conceptual application, as students were guided to evaluate their reasoning and apply the concept of quadratic equations in varied problem contexts. These processes help explain why students demonstrated greater conceptual mastery than those in teacher-centered instruction.

Theoretically, these findings reinforce constructivist learning theory, which emphasizes that knowledge is actively constructed through interaction, reflection, and meaningful experiences. The ICARE model closely aligns with this framework by structuring learning activities that progress from prior knowledge activation to conceptual application and extension. When combined with Desmos as an interactive technological tool, the learning environment also reflects principles of technology-enhanced learning, where digital representations serve as cognitive tools that mediate understanding rather than merely as presentation media. This supports prior arguments that technology, when integrated within a sound pedagogical model, can function as a scaffold for conceptual construction rather than a superficial add-on (Isroil et al., 2022; Nisa et al., 2024).

In relation to previous studies, the results are consistent with findings that structured instructional models such as ICARE can enhance higher-order thinking and conceptual clarity (Sakdiah & Unaida, 2025). Similarly, earlier research has shown that Desmos facilitates visualization and engagement in algebra learning (Isroil et al., 2022; Nisa et al., 2024) and that integrating digital tools can improve motivation and learning outcomes (Astarina et al., 2024). This study extends the existing literature by providing empirical evidence on the synergistic effect of combining ICARE and Desmos, specifically in the context of conceptual understanding of quadratic equations, which has received relatively limited empirical attention.

From a practical standpoint, the findings imply that effective implementation of ICARE supported by Desmos requires more than general pedagogical awareness. Teachers need targeted training on how to design learning activities for each ICARE stage and how to integrate Desmos strategically, for example, by using graph manipulation tasks during the Connect stage or exploratory problem sets during the Apply stage. Professional development programs may therefore focus on lesson design workshops, hands-on training with Desmos, and collaborative lesson study to ensure that both pedagogical and technological competencies are developed in a balanced manner.

Despite its contributions, this study has several limitations that should be considered when interpreting the results. The short duration of the intervention and its focus on a single mathematical topic may have amplified short-term learning gains but did not fully capture long-term conceptual retention. The relatively small sample size and single-school context may also introduce contextual bias, limiting the generalizability of the findings. In addition, variations in students' access to and familiarity with technology could have influenced the effectiveness of Desmos integration.

Given these limitations, future research is encouraged to adopt longitudinal designs to examine the sustainability of conceptual understanding over time, to analyze the effectiveness of each ICARE stage in greater detail, and to compare the ICARE–Desmos combination with other innovative instructional models. Further studies could also explore its application across different mathematical topics and diverse educational settings to strengthen the external validity of the findings.

CONCLUSION

This study demonstrates that integrating the ICARE learning model with the Desmos application is significantly more effective than conventional instruction in enhancing students' conceptual understanding of quadratic equations, as evidenced by higher mean scores and more consistent performance among students in the experimental group. These findings theoretically support constructivist learning perspectives by showing how interactive digital tools can function as cognitive mediators when embedded within a structured instructional model. In practice, the results emphasize the importance of strengthening teachers' pedagogical and technological competencies to design student-centered, interactive mathematics learning environments aligned with 21st-century educational demands. Despite these positive outcomes, this study is limited by its relatively small sample size and short intervention period, suggesting that future research should involve larger, more diverse populations, extend the implementation duration, and explore the applicability of the ICARE–Desmos integration across different mathematical topics and technological contexts.

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REFERENCES

Ambarwat, A., & Ambarwati, U. (2025). *Enhancing Elementary Students' Understanding of Geometry Concepts through GeoGebra and Color Nets Integration*. *6*(1), 23–32.

Astarina, R., Bentri, A., & Zainil, M. (2024). Development of Interactive Learning Media Assisted by Google Sites in Building Materials for Elementary Schools Grade V. *Jurnal Penelitian Pendidikan IPA*, 10 (Special Issue), 226-233.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research. Houghton Mifflin*.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.).* SAGE Publications.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.)*. Lawrence Erlbaum Associates.

Dani, A., & Ashok, D. (2025). Exploring the Impact of DESMOS on Students' Understanding and Learning of Transformations. In *Proceedings of the HCT International General Education Conference (HCTIGEC 2024),* *Atlantis Highlights in Social Sciences, Education and Humanities* (Issue HCTIGEC 2024, pp. 71–87). Atlantis Press International BV. https://doi.org/10.2991/978-94-6463-660-4_6

Daryanes, F., Darmadi, D., Fikri, K., Sayuti, I., Rusandi, M. A., & Situmorang, D. D. B. (2023). The development of an articulate, interactive learning media based on case methods to train students' problem-solving abilities. *Heliyon*, 9(4).

Dhanti, F. N., & Azizah, R. W. N. (2025). Analyzing students' mathematical conceptual understanding of functions in senior high school. *Pasundan Journal of Mathematics Education : Jurnal Pendidikan Matematika*, *15*(Vol 15 No 1), 93–101. https://doi.org/10.23969/pjme.v15i1.20615

Ditasari, D. D., Ulya, H., & Wanabuliandari, S. (2022). Analisis Kemampuan Pemahaman Konsep Matematis Siswa Yang Menggunakan Model Pembelajaran Core. *JISIP (Jurnal Ilmu Sosial Dan Pendidikan)*, *6*(2), 2560–2566. https://doi.org/10.58258/jisip.v6i2.3180

Fajar, A. P., Kodirun, S., & Arapu, L. (2018). Analisis Kemampuan Pemahaman Konsep Matematis Siswa Kelas VIII SMP Negeri 17 Kendari. *Jurnal Pendidikan Matematika*, *9*(2).

Halimah, N., & Sari, A. ICARE: Development of Mathematics Student Worksheets on Sequences and Series Material. *Suska Journal of Mathematics Education*, 11(2), 161–172.'

Hanizar, E., Triwahyuni, E., & Pramana, A. (2024). The Feasibility of an Online Module with the ICARE Learning Model Flow Based on the Ubiquitous Learning Class. *International Journal of Social Learning (IJSL)*, *5*(1), 276–293. https://doi.org/10.47134/ijsl.v5i1.352

Harahap, R. D., Bangun, B., & Siregar, S. U. (2025). *The effectiveness of IMLO Biology media in enhancing students ' learning motivation under the Merdeka Curriculum*. *8*(2), 184–191. DOI : 10.30821/biolokus.v8i2.4796

Harahap, R. D., & Hasibuan, R. (2025). *Efektivitas Penggunaan Media Sosial Tiktok Untuk Pembelajaran Biologi di SMA Negeri 1 Rantau Utara*. *13*(2), 1200–1207.

Isroil, A., Khairul Umam, A., & Supriyanto, S. (2022). Aplikasi Desmos Dalam Penyelesaian Masalah Persamaan Trigonometri. *Karangan: Jurnal Bidang Kependidikan, Pembelajaran, dan Pengembangan*, *4*(1), 58–63. https://doi.org/10.55273/karangan.v4i1.171

Kobernyk, H. (2025). Innovative approaches to the formation of mathematical competence of future primary school teachers. *Scientific Bulletin of Mukachevo State University. Series "Pedagogy and Psychology," 0*, 71–81. https://doi.org/10.52534/msu-pp1.2025.71

Maciejewski, W. (2025). A Tale of Two Exams. *Canadian Journal of Science, Mathematics and Technology Education*, 25(1), 66-78.

Mediana Jr, N. L., & Dio, R. V. (2025). Systematic review on the efficacy of Desmos integration in mathematics education: unveiling impacts on learning outcomes and pedagogical strategies. *International Journal of Future Engineering Innovations*, 2(4), 104-15.

Nisa, L. C., Isnawati, A. R., Rachmawati, A. K., & Miasary, S. D. (2024). Pemanfaatan Desmos untuk Pembelajaran Matematika Interaktif bagi Guru Matematika SMK di Salatiga. *Nuansa Akademik: Jurnal Pembangunan Masyarakat*, *10*(1), 59–72. https://doi.org/10.47200/jnajpm.v10i1.2675

Nurtamam, M. E., & Jannah, A. N. (2025). A Systematic Qualitative Review of Teachers' Strategies in Enhancing Mathematical Reasoning in Elementary Schools. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *9*(2), 447–462. https://doi.org/10.31004/obsesi.v9i2.6189

Omoniyi, A. A., Johnston, S. J., & Jita, L. C. (2025). Quantifying the Impact of 8Ps Learning Model on Grade 12 Students' Performance in Stationary Points Differential Calculus. *Journal of Ecohumanism*, *4*(2). https://doi.org/10.62754/joe.v4i2.6553

Rahim, F. R., Nabila, P., Sari, S. Y., Suherman, D. S., & Riyasni, S. (2022). Interactive learning media for critical and creative thinking skills development. *Pillar of Physics Education*, 15(4), 235–244.

Sakdiah, H., & Unaida, R. (2021). Efektivitas Pendekatan Stem Dalam Meningkatkan Hasil Belajar IPA Siswa N 17 Lhoksmawe. *Journal of Education Research : Indonesian Institute For Corporate Learning And Studies (IICLS)*, *2*(2), 28–33.

Saputri, M., Elisa, E., & Nurlianti, S. (2022). Effectiveness of ICARE Learning Model in Improving Students' Critical Thinking Skills and Collaboration Skills. *Jurnal Penelitian Pendidikan IPA*, *8*(3), 1128–1134. https://doi.org/10.29303/jppipa.v8i3.1360

Shanmugam, R., Perumal, M. G., & Krishnamoorthy, U. M. (2025). Bridging Tradition and Innovation: A Thoughtful Approach to Future-Ready Education. *2025 ASEE North Central Section (NCS) Annual Conference Proceedings*. https://doi.org/10.18260/1-2--54652

Supiter, H. J. F., & Rabut, J. F. (2025). Application of the Desmos Graphing Calculator in the Context of Maguindanaon Learners in their Least Learned Competencies. *International Journal of Science, Architecture, Technology and Environment*, *02*(05), 909–925. https://doi.org/10.63680/ijsate052566.79

Surya Maulana, B., & Nur Cahyono, A. (2025). Studi Literatur: Teknologi 3D Printing sebagai Media Pembelajaran Matematika. *PRISMA, Prosiding Seminar Nasional Matematika*. *8*, 64–67.

Yusoff, M. S. B. (2019). ABC of Content Validation and Content Validity Index Calculation. *Education in Medicine Journal*, *11*(2), 49–54. https://doi.org/10.21315/eimj2019.11.2.6