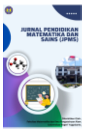

Available online at: http://journal.uny.ac.id/index.php/jpms

Jurnal Pendidikan Matematika dan Sains, 14 (2), 2026, 717–726

Students' Interest in Learning Mathematics Following GeoGebra-Assisted Learning on Quadratic Functions

Ni Komang Emi Supriani*, Alfisyahra, Akhyar H.M. Tawil, Sutji Rochaminah
Mathematics Education, Universitas Tadulako, Indonesia
*Corresponding Author. E-mail: komangemi2004@gmail.com

Abstract

This study aimed to analyze the improvement of students' mathematics learning interest through GeoGebra-assisted learning on quadratic functions. The study employed a quantitative approach with a pre-experimental one-group pre-test post-test design. The sample consisted of 30 students from one public senior high school in Palu. Data were collected using a questionnaire measuring students' mathematics learning interest across four aspects: enjoyment, interest, engagement, and perseverance and discipline in learning. The final instrument consisted of 24 valid items with adequate reliability. The data were analyzed using descriptive statistics, the Shapiro–Wilk test, a paired-samples t-test, and Cohen's d. The results showed that the mean mathematics learning-interest score increased from 73.67 on the pre-test to 76.20 on the post-test. The paired-samples t-test indicated a statistically significant increase in mathematics learning-interest scores after GeoGebra-assisted learning, $t(29) = 5.706$, $p < 0.0005$, with a large effect size (Cohen's $d = 1.042$). Analysis by aspect showed that the largest change occurred in interest, followed by enjoyment, engagement, and perseverance and discipline. These findings indicate a positive change in students' mathematics learning interest following GeoGebra-assisted learning, particularly in affective aspects directly related to the learning experience. The more limited changes in engagement, perseverance, and discipline suggest the need for greater attention to structured learning activities and sustained instructional support.

Keywords: *GeoGebra, Mathematics learning interest, Quadratic functions*

How to Cite: Supriani, N. K. E., Alfisyahra, A., Tawil, A. H. M., & Rochaminah, S. (2026). Students' interest in learning mathematics following geogebra assisted learning on quadratic functions. *Jurnal Pendidikan Matematika dan Sains*, *14*(2), 717–726. https://doi.org/10.21831/jpms.v14i2.100826

DOI: https://doi.org/10.21831/jpms.v14i2.100826

INTRODUCTION

The development of information and communication technology provides opportunities to improve the quality of mathematics learning through the use of innovative instructional media. This is important because mathematics is still often perceived as difficult and boring, resulting in low student interest in learning mathematics (Ayu et al., 2021) and reluctance to actively engage in the learning process (Kholil & Safianti, 2019). Therefore, mathematics learning requires learning environments that encourage students to participate actively and interactively.

Student engagement is particularly important because mathematics learning involves not only mastering concepts and procedures but also understanding mathematical meaning, connecting concepts, using multiple representations, and developing conceptual understanding through active learning activities (Papageorgiou et al., 2025). The importance of improving mathematics learning is also reflected in Indonesia's performance in the Programme for International Student Assessment (PISA) 2022. Indonesian students obtained a mathematics score of 366, below the OECD average of 472, and only 18% reached Level 2 or higher compared with 69% across OECD countries (OECD, 2023). These findings indicate the need for learning experiences that support not only cognitive achievement but also students' active engagement.

Student engagement is closely related to affective and motivational processes that encourage students to initiate, sustain, and direct their learning activities. A recent systematic review indicates that motivation is an important factor associated with student engagement, achievement, and the development of mathematical understanding, while research on mathematics learning motivation continues to employ diverse theoretical frameworks and measurement instruments (Radišić et al., 2026). One important motivational aspect related to engagement is learning interest. Learning interest refers to a tendency to feel pleased and enthusiastic, pay attention to something, and pursue particular goals (Isnaini et al., 2023). It is a multidimensional construct influenced by internal and external factors and students with greater interest tend to make greater efforts to achieve their learning goals (Ahmad et al., 2020).

Students' learning interest is influenced by internal factors, such as curiosity, motivation, and physical conditions, as well as external factors, including family, school, and community environments (Pratama & Rohaeti, 2023). In mathematics learning, interest is associated with students' engagement, participation, and persistence when facing mathematical tasks or challenges (Wang et al., 2021). Learning interest can also be reflected through enjoyment, interest, attention, and engagement during learning activities (Pratama et al., 2024). Accordingly, the present study conceptualizes learning interest not merely as liking mathematics but as students' positive feelings, interest in learning materials, engagement in learning activities, and persistence and discipline. Therefore, learning interest is examined through four aspects: enjoyment, interest, engagement, and persistence and discipline in learning.

These issues are relevant to the mathematics learning conditions at the research site. Initial observations showed that mathematics learning was still dominated by lectures and whiteboard use. Interviews with the mathematics teacher indicated that most students had difficulty understanding changes in graph shapes resulting from changes in the coefficients of quadratic functions. Only approximately 6–8 students actively asked questions, while most students primarily took notes on the teacher's explanations. Thus, the problem concerns not only students' understanding of quadratic functions but also limited opportunities for active engagement. A learning environment that promotes interaction, exploration, and interest in mathematical concepts is therefore needed.

This need is particularly relevant to quadratic functions, which involve variables, parameters, nonlinear changes, and functional relationships. Understanding quadratic functions requires not only symbolic manipulation but also coordination between algebraic and visual reasoning (Wilkie, 2024). The connection between symbolic and graphical representations is important because different representations reveal different aspects of mathematical concepts and can support meaningful understanding when their connections are made explicit (Dreher et al., 2024). Nevertheless, students may experience various difficulties when representing quadratic functions using paper-and-pencil methods (Arnal-Palacián et al., 2022). Consequently, learning quadratic functions requires an approach that enables students to connect algebraic and graphical representations while directly observing changes in graphs. One potential medium is GeoGebra.

GeoGebra supports mathematical learning through visualization and interactive activities (Azis & Rohaeti, 2025). In quadratic functions, it enables students to connect algebraic and graphical representations interactively (Ermilia et al., 2024). Students can observe how graphs change when function values or forms are modified, making relationships between representations more explicit. Thus, GeoGebra functions not only as a graphing tool but also as a medium for observing and exploring mathematical concepts interactively (Chytas et al., 2024).

The use of GeoGebra can be explained through constructivist theory, which views learning as an active process in which students construct understanding through experience, interaction, and information processing. In GeoGebra-assisted learning, students can explore mathematical objects, manipulate them, observe changes, and establish relationships based on their observations (Juandi et al., 2025; Yunianto et al., 2024). Such activities allow students to explore changes in quadratic function graphs directly and develop conceptual understanding through active learning. Furthermore, the Cognitive Theory of Multimedia Learning states that information presented through visual and verbal modes can be processed more effectively in working memory than text-only presentations (Mayer, 2024). Therefore, GeoGebra can support both the visualization of mathematical concepts and students' engagement in learning.

The relationship between GeoGebra-assisted learning and learning interest can also be viewed through the ARCS Motivation Model, which consists of Attention, Relevance, Confidence, and Satisfaction. This model has been applied in various educational contexts, including technology-based learning, and has been shown to support student motivation (Li & Keller, 2018; Goksu & Bolat, 2021). In

GeoGebra-assisted learning, dynamic visualization and mathematical manipulation can attract attention, connections between algebraic and graphical representations can enhance relevance, opportunities for exploration can strengthen confidence, and successful learning experiences can foster satisfaction. Thus, the ARCS model provides a motivational framework for explaining how GeoGebra may support students' engagement and interest in mathematics.

These theoretical perspectives complement one another in explaining the potential of GeoGebra-assisted learning. Constructivism emphasizes active knowledge construction through exploration and manipulation, while the Cognitive Theory of Multimedia Learning explains how visual and verbal representations support the selection, organization, and integration of information (Mayer, 2024). Meanwhile, the ARCS model explains how learning environments can attract attention, establish relevance, build confidence, and provide satisfaction (Li & Keller, 2018). Accordingly, GeoGebra can be viewed not merely as a graphing tool but as an interactive learning environment that supports mathematical exploration, engagement, and interest.

Previous studies have reported the potential of GeoGebra to support affective aspects and student engagement in mathematics learning. Lidu et al. (2023), and Maisari & Usman (2024) reported students' positive responses or increases in learning interest in mathematics learning involving GeoGebra. More specifically, Melissa et al. (2023) examined students' learning interest in quadratic functions using GeoGebra. These findings suggest that the relationship between GeoGebra and learning interest has been investigated, including in quadratic functions. However, previous studies differ in context, research design, and the operationalization of learning interest. Further research is therefore needed to examine changes in students' learning interest following GeoGebra-assisted learning using clearly defined indicators and supported by constructivism, the Cognitive Theory of Multimedia Learning, and the ARCS Motivation Model.

Based on this gap, the present study examines the improvement of students' mathematics learning interest through GeoGebra-assisted learning on quadratic functions, focusing on four aspects: enjoyment, interest, engagement, and persistence and discipline in learning. GeoGebra is positioned not merely as a tool for generating graphs but as an interactive learning environment that enables students to explore relationships between algebraic and graphical representations dynamically. The interpretation of its relationship with learning interest is further strengthened by the perspectives of constructivism, the Cognitive Theory of Multimedia Learning, and the ARCS Motivation Model. This study is expected to provide empirical evidence of changes in students' learning interest following GeoGebra-assisted learning of quadratic functions and contribute a theoretical basis for understanding learning experiences that support student engagement.

METHOD

This study employed a quantitative approach using a pre-experimental method. The research design used was a one-group pre-test post-test design. The pre-test was conducted to determine the students' baseline level of mathematics learning interest. The students were then provided with GeoGebra-assisted learning on quadratic functions, followed by a post-test to determine changes in learning interest after the learning process. The study was conducted at one of the public senior high schools in Palu City.

The study population comprised all Grade 10 students. Using probability sampling with the cluster random sampling technique, one class consisting of 30 students was selected as the single experimental class sample. Primary data were obtained directly from students' responses to a learning interest questionnaire, which covered the indicators of enjoyment, interest, engagement, and persistence.

The instrument used to measure students' mathematics learning interest was a learning interest questionnaire. The questionnaire was developed based on four indicators: enjoyment, student interest, student engagement, and persistence and discipline in learning. The initial instrument consisted of 30 statements, including both positive and negative statements. The questionnaire used a Likert scale with four response alternatives in checklist format. The blueprint of the learning interest questionnaire is presented in Table 1.

Table 1. Blueprint of the questionnaire instrument

Aspect	Indicator	Number of Items
Enjoyment	I feel happy when mathematics lessons use technology-based media	8
Student interest	I am more focused when the teacher explains mathematics material using technology-based visual media	7
Student engagement	I am directly involved in mathematics learning activities that use technology-based media	7
Persistence and discipline in	I do not complete mathematics assignments on time even when technology-based media are used	8

Before the questionnaire was tested to the research sample, the instrument was first subjected to a validation process. Content validity was assessed by expert lecturers to ensure the alignment of the statement items with the learning interest indicators being measured. Subsequently, construct validation was conducted with 51 respondents. The data obtained from the tryout were used to assess the empirical validity and reliability of the instrument.

Empirical validity was assessed by comparing the calculated r value with the critical r value. With 51 respondents participating in the instrument tryout, the critical r value used was 0.276. A statement item was considered valid if its calculated r value was greater than the critical r value. The results of the validity analysis showed that, for the pre-test questionnaire, 27 of the 30 statement items were valid, while 3 items were invalid. Similarly, the post-test questionnaire contained 27 valid items and 3 invalid items. To ensure measurement consistency and avoid bias in the measurement results between the pre-test and post-test, the invalid statement items were eliminated. Invalid items identified through validity testing should be excluded from the analysis to avoid compromising the construct validity of the instrument (Sugiyono, 2019). Therefore, 24 statement items that were demonstrated to be valid in both instruments were retained for the study. The invalid items in both instruments were considered discarded and were not used in subsequent data analysis.

A reliability test was conducted to determine the internal consistency of the instrument in measuring students' mathematics learning interest. The reliability of the instrument was assessed using Cronbach's Alpha. Cronbach's Alpha is one of the coefficients commonly used to evaluate the internal consistency of a research instrument or scale (Taber, 2018). The reliability test results showed Cronbach's Alpha values of 0.877 for the pre-test questionnaire and 0.839 for the post-test questionnaire, indicating that the instruments were considered reliable based on the criteria applied.

At the initial stage, students completed a pre-test questionnaire to obtain data on their mathematics learning interest before participating in GeoGebra-assisted learning. Subsequently, the students participated in mathematics learning on quadratic functions using the GeoGebra application as the research treatment. GeoGebra-assisted learning was implemented in accordance with the prepared instructional materials. After the entire learning process was completed, the students were completed a post-test questionnaire using the instrument items selected based on the results of the validity test. The pre-test and post-test scores were then compared to determine the improvement in students' mathematics learning interest after participating in GeoGebra-assisted learning. The analysis was also conducted based on four indicators of learning interest: enjoyment, student interest, student engagement, and persistence and discipline in learning.

Data analysis was conducted using descriptive and inferential statistics. Descriptive statistics were used to describe the characteristics of the research data, whereas inferential statistics were used to examine differences in scores between the two measurements (Cohen et al., 2018). In this study, descriptive statistics were used to describe students' learning interest scores before and after the use of GeoGebra based on the mean, standard deviation, minimum, and maximum values. Subsequently, inferential statistics were used to examine differences in students' learning interest scores between the pre-test and post-test.

Before hypothesis testing was conducted, the data were first tested for normality using the Shapiro–Wilk test. Normality was assessed for the pre-test and post-test scores as a basis for using the paired-samples t-test. The data were considered to meet the assumption of normality if the significance value was greater than 0.05. After the assumption of normality was met, hypothesis testing was conducted using a paired-samples t-test to determine whether there was a significant improvement in students' mathematics learning interest after participating in GeoGebra-assisted learning on quadratic functions. The test was conducted using a significance level of 0.05.

In addition to statistical significance, the effect size was calculated using Cohen's d to determine the magnitude of the improvement in learning interest after the learning intervention. The magnitude of the change in learning interest scores was also described by comparing the mean pre-test and post-test scores. An indicator-based analysis was conducted to provide an overview of the aspects of learning interest that changed following GeoGebra-assisted learning.

Decision-making criteria:

H_0: There is no significant improvement in students' mathematics learning interest after participating in GeoGebra-assisted learning on quadratic functions.

H_1: There is a significant improvement in students' mathematics learning interest after participating in GeoGebra-assisted learning on quadratic functions.

This study obtained permission from the educational institution and the school authorities before data collection was conducted. The participants were provided with an explanation of the study's objectives, procedures, and the use of research data. Students' participation in completing the instrument was voluntary and free from coercion. The principles of voluntariness and adequate information are important considerations in research involving students as participants because the relationship between researchers and participants may affect participants' freedom to make decisions about whether to participate (Siipi & Uusitalo, 2024).

RESULTS AND DISCUSSION

Following six sessions of GeoGebra-assisted mathematics learning on quadratic functions, students' mathematics learning interest was assessed using pre-test and post-test questionnaires. The analysis examined changes in overall learning interest as well as four aspects: enjoyment, interest, engagement, and persistence and discipline in learning. The descriptive statistics of the pre-test and post-test scores are presented in Table 2.

Table 2. Descriptive statistics

Measurement	n	Mean	Std. Dev
Pre-test	30	73.67	4.985
Post-test	30	76.20	4.722

Based on Table 2, learning interest tended to increase following GeoGebra-assisted learning. The mean represented the central tendency of the scores, while the standard deviation indicated their dispersion around the mean (Harahap et al., 2025). The increase was reflected in higher mean and minimum scores, while the maximum score remained at the upper limit of the measurement scale. This indicates that the improvement occurred not only in the overall tendency but also among students with relatively lower scores. However, descriptive changes alone are insufficient to determine the practical magnitude of the improvement and therefore require inferential analysis and effect size estimation. Before hypothesis testing, the Shapiro–Wilk test was conducted to assess the normality of the learning interest scores as a prerequisite for parametric analysis. The results are presented in Table 3.

Table 3. Normality test result

Data	Shapiro-Wilk	df	Sig.
Pre-test	0.972	30	0.586
Post-test	0.946	30	0.130

Before hypothesis testing, the Shapiro–Wilk test was conducted to assess the normality of the learning interest scores as a prerequisite for parametric analysis, with the results presented in Table 3. Both pre-test and post-test data were normally distributed. Accordingly, a paired-samples t-test was conducted because the measurements involved the same students before and after learning, and a one-tailed test was applied because the hypothesis was directional. Effect size was also calculated to assess the magnitude of the change.

Table 4. Hypothesis testing and effect size result

Mean	Std. Dev.	df	t	Sig.	p	Cohen's d
2.533	2.431	29	5.706	<0.001	<0.0005	1.042

The results presented in Table 4 showed that the change in learning interest was in the direction consistent with the research hypothesis and met the established significance criterion. Thus, there was statistical evidence supporting an improvement in learning interest following GeoGebra-assisted learning in the group under study. The effect size indicated a large magnitude of change, suggesting that the findings demonstrated not only a statistically significant difference but also a relatively substantial change in the group under study. Nevertheless, these findings should be interpreted within the context of the one-group pre-test–post-test design, which did not include a control group.

The subsequent analysis examined each indicator of learning interest to identify patterns of change across aspects, as presented in Table 5. The analysis showed that changes in learning interest were not uniform across the four indicators.

Table 5. Analysis of changes in learning interest by aspect

Aspect	Cohen's d	Interpretation
Enjoyment	0.558	Moderate
Student Interest	0.817	Large
Student Engagement	0.242	Small
Persistence and Discipline in Learning	0.032	Very small

The analysis results showed that changes in learning interest were not uniform across all indicators. The interest aspect showed the most pronounced change, followed by enjoyment. In contrast, engagement showed a more limited change, whereas persistence and discipline were the aspects that showed the smallest changes. This pattern suggests that GeoGebra-assisted learning may be more responsive to affective aspects that are directly related to the learning experience than to behavioral aspects of learning that require consistency and habituation.

In learning quadratic functions, students can observe changes in graphs when the form or coefficients of a function are manipulated. This experience provides students with opportunities to directly observe the relationship between algebraic forms and graphical representations. The use of connected algebraic and graphical representations can help students develop a more meaningful understanding of mathematical concepts (Arnal-Palacián et al., 2022; Ermilia et al., 2024). These interactive characteristics can also create a learning experience that differs from the presentation of concepts in a purely static manner, thereby supporting students' interest in learning.

These findings can be explained from a constructivist perspective. GeoGebra-assisted learning provides students with opportunities to explore mathematical objects, manipulate parameters, observe changes, and establish relationships based on the results of their exploration. These activities position students as active participants in the process of constructing knowledge rather than merely as recipients of information. This explanation is consistent with the study by Juandi et al. (2025), which demonstrated the potential of GeoGebra-based learning to support conceptual understanding, as well as with the constructionist approach, which emphasizes knowledge construction through students' activities in mathematics learning (Yunianto et al., 2024).

From the perspective of the Cognitive Theory of Multimedia Learning, the use of visual representations in GeoGebra can complement the symbolic and verbal information received by students during learning. In quadratic functions, visual changes in the graph can help students connect symbolic forms with their graphical consequences. When these representations are presented in a guided manner and integrated with teacher explanations and student activities, the processes of selecting, organizing, and integrating information can occur more meaningfully (Mayer, 2024). This helps explain why GeoGebra-assisted learning experiences elicited stronger responses particularly in the aspects of interest and enjoyment.

However, the visual and interactive characteristics of GeoGebra do not automatically ensure that all aspects of learning interest will develop to the same extent. From the perspective of Cognitive Load Theory, the amount of information, features, or visual changes that must be processed simultaneously may increase cognitive load if they are not appropriately guided. Under such conditions, students' attention may be directed more toward the technological features than toward the mathematical relationships that are the intended learning objectives. Therefore, the use of GeoGebra should be accompanied by gradual instructions, a focus on relevant information, and activities that are appropriate to students' processing capacity so that the technology does not impose unnecessary cognitive load.

The more limited change in the engagement aspect indicates that interest in the media does not automatically result in consistent active engagement. Engagement requires students to continuously engage in learning activities, such as asking questions, trying strategies, completing tasks, explaining their observations, and maintaining attention throughout the learning process. Therefore, the use of GeoGebra needs to be combined with activities that deliberately require students to participate. Guiding questions, exploratory tasks, discussions, and feedback can be used to ensure that students' interaction with GeoGebra does not remain limited to observing visualizations.

The persistence and discipline aspect showed the most limited change. This condition can be understood because persistence and discipline are learning behaviors that require habituation and consistent support. The appeal of the media may help generate attention and interest at the beginning of the learning process, but it may not be sufficient to change habits related to completing assignments, sustaining effort, and managing learning time. Therefore, developing these aspects requires more structured learning strategies, such as setting learning targets, dividing tasks into clear stages, monitoring progress, and providing continuous feedback.

The pattern of changes across the indicators can also be understood through the ARCS Motivation Model. The dynamic characteristics of GeoGebra can attract students' attention, while the relationship between changes in parameters and changes in graphs can help demonstrate the relevance of the learning material. Opportunities to try, obtain results, and improve their understanding can support students' confidence, while successfully completing learning activities can provide positive experiences that support learning satisfaction. However, these experiences need to be designed sustainably so that attention and interest can develop into engagement and consistent learning effort. This explanation is consistent with the review by Li & Keller (2018) and the meta-analysis by Goksu & Bolat (2021) on the use of the ARCS model in learning

The findings of this study are consistent with several previous studies indicating that GeoGebra has the potential to support students' interest and motivation in mathematics learning. Jabnabillah & Reza (2022) found a positive relationship between the use of GeoGebra and learning interest, while Lidu et al. (2023) and Maisari & Usman (2024) reported positive findings in GeoGebra-assisted mathematics learning. In a more specific context, Melissa et al. (2023) examined students' learning interest in quadratic functions using GeoGebra. These similarities suggest that the visual and interactive characteristics of GeoGebra can support a more engaging learning experience. However, this study shows that changes in learning interest were not uniform across all indicators. These findings suggest that the presence of engaging media needs to be accompanied by activity designs that can sustain students' engagement and persistence.

Theoretically, the findings of this study suggest that the relationship between the use of educational technology and learning interest can be understood as the result of interactions among the learning environment, student activities, cognitive processes, and motivational conditions. The constructivist perspective emphasizes the importance of exploration and direct experience; the Cognitive Theory of Multimedia Learning explains the role of visual representations in information processing; Cognitive Load Theory emphasizes the importance of managing information and activities to avoid overloading students; while the ARCS model explains how attention, relevance, confidence, and satisfaction can support motivation. Thus, the theoretical contribution of this study lies in understanding

GeoGebra not merely as a tool for generating graphs, but as part of a learning environment that integrates exploratory experiences, visual representations, and motivational experiences.

The practical implication of the findings is that GeoGebra should be used as part of the instructional design rather than merely as a tool for drawing graphs. Teachers can design activities that require students to predict changes in graphs, manipulate parameters, compare results, explain relationships between representations, and draw conclusions. Such activities can connect the visual and interactive advantages of GeoGebra with students' cognitive engagement. To strengthen engagement as well as persistence and discipline, the use of the media should be combined with structured tasks, time management, guiding questions, feedback, and monitoring of students' learning progress.

This study has several limitations. First, the one-group pre-test post-test design without a control group means that the observed changes cannot be fully separated from the influence of other factors that may have occurred during the implementation of the study. Second, the study was conducted in a single class at one school and focused on quadratic functions; therefore, the findings cannot be broadly generalized to all students, schools, or other mathematics topics. Third, learning interest was measured using a questionnaire, meaning that the results primarily represent students' responses to the instrument items and do not fully capture all engagement behaviors during the learning process. Fourth, the study did not explore in depth the individual factors and characteristics of learning activities that may have contributed to differences in change across the indicators.

Considering the research design and context, GeoGebra-assisted learning showed a positive change in the learning interest of the students studied, particularly in the aspects of interest and enjoyment, whereas engagement, persistence, and discipline require more structured learning support. Therefore, GeoGebra may be considered as an alternative visual and interactive learning environment for mathematics learning; however, these findings cannot be used to claim that GeoGebra is generally effective in increasing learning interest among all students. The conclusion is limited to the characteristics of the students, school, quadratic function material, and learning conditions that constituted the context of the study.

CONCLUSION

GeoGebra-assisted learning in quadratic functions demonstrated a positive change in the mathematics learning interest of the students studied. The change was not uniform across all aspects of learning interest, with more pronounced changes in interest and enjoyment than in engagement, persistence, and discipline. These findings indicate that the use of GeoGebra in learning quadratic functions provides a learning experience that enables students to explore the relationship between algebraic and graphical representations dynamically. In the context of the group studied, these visual and interactive characteristics were more evident in aspects of learning interest related to students' affective experiences during learning.

REFERENCES

Ahmad, N., Ilato, R., & Payu, B. R. (2020). Pengaruh pemanfaatan teknologi informasi terhadap minat belajar siswa. *Jambura Economic Education Journal*, *2*(2), 70–79. https://doi.org/10.37479/jeej.v2i2.5464

Arnal-Palacián, M., Baeza, M. Á., & Claros-Mellado, J. (2022). Quadratic functions representation: Pencil and paper vs. GeoGebra. *International Journal for Technology in Mathematics Education, 29*(3), 165–178. https://doi.org/10.1564/tme_v29.3.04

Ayu, S., Ardianti, S. D., & Wanabuliandari, S. (2021). Analisis faktor penyebab kesulitan belajar matematika. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 10*(3), 1611–1622. https://doi.org/10.24127/ajpm.v10i3.3824

Azis, Y. M., & Rohaeti, E. (2025). A systematic literature review on implementation of GeoGebra: Benefits and challenges in mathematics education. *Infinity Journal, 14*(3), 655–672. https://doi.org/10.22460/infinity.v14i3.p655-672

Chytas, C., van Borkulo, S. P., Drijvers, P., Barendsen, E., & Tolboom, J. L. J. (2024). Computational thinking in secondary mathematics education with GeoGebra: Insights from an intervention in calculus lessons. *Digital Experiences in Mathematics Education, 10*(2), 228–

259. https://doi.org/10.1007/s40751-024-00141-0
Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge.
Dreher, A., Wang, T. Y., Feltes, P., Hsieh, F. J., & Lindmeier, A. (2024). High-quality use of representations in the mathematics classroom – A matter of the cultural perspective? *ZDM–Mathematics Education, 56*(5), 965–980. https://doi.org/10.1007/s11858-024-01597-5
Ermilia, R., Fitriana, L., & Riyanti, V. (2024). GeoGebra dalam pembelajaran fungsi kuadrat dan pengaruhnya terhadap motivasi dan hasil belajar siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 13*(4), 1237–1251. https://doi.org/10.24127/ajpm.v13i4.9685
Goksu, I., & Bolat, Y. I. (2021). Does the ARCS motivational model affect students' achievement and motivation? A meta-analysis. *Review of Education, 9*(1), 27–52. https://doi.org/10.1002/rev3.3231
Harahap, Y. A., Nasution, R. P., & Amir, A. (2025). Peran ukuran pemusatan dan penyebaran data dalam analisis statistika. *Pendas: Jurnal Ilmiah Pendidikan Dasar, 10*(4), 332–350. https://doi.org/10.23969/jp.v10i04.38955
Isnaini, S. N., Firman, & Desyandari. (2023). Penggunaan media video pembelajaran dalam meningkatkan minat belajar matematika siswa di sekolah dasar. *ALPEN: Jurnal Pendidikan Dasar, 7*(1), 42–51 https://doi.org/10.24929/alpen.v7i1.183
Jabnabillah, F., & Reza, W. (2022). Pengaruh penggunaan aplikasi GeoGebra terhadap minat belajar siswa pada pembelajaran matematika. *Mathematics Education Journal, 5*(2), 94–100. https://doi.org/10.21067/pmej.v5i2.7468
Juandi, J., Sugiatno, S., & Noviani, E. (2025). Enhancing students' conceptual understanding of trigonometric functions through GeoGebra-based learning. *Al-Jabar: Jurnal Pendidikan Matematika, 16*(1), 55–70. https://doi.org/10.24042/ajpm.v16i1.25653
Kholil, M., & Safianti, O. (2019). Efektivitas pembelajaran penemuan terbimbing terhadap hasil belajar matematika siswa materi barisan dan deret. *Laplace: Jurnal Pendidikan Matematika, 2*(2), 89–98. https://doi.org/10.31537/laplace.v2i2.246
Li, K., & Keller, J. M. (2018). Use of the ARCS model in education: A literature review. *Computers & Education, 122,* 54–62. https://doi.org/10.1016/j.compedu.2018.03.019
Lidu, M., Simarmata, J. E., & Delvion, E. B. S. (2023). Analisis minat belajar siswa pada pembelajaran matematika berbantuan aplikasi GeoGebra. *Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS), 7*(3), 395–402. https://doi.org/10.33369/jp2ms.7.3.395-402
Maisari, N., & Usman, U. (2024). Pengaruh model discovery learning berbantuan GeoGebra terhadap minat belajar matematika. *Indiktika: Jurnal Inovasi Pendidikan Matematika, 6*(2), 316–324. https://doi.org/10.31851/indiktika.v6i2.14925
Mayer, R. E. (2024). The past, present, and future of the cognitive theory of multimedia learning. *Educational Psychology Review, 36*(8). https://doi.org/10.1007/s10648-023-09842-1
Melissa, M. M., Redianto, A., Wiwahanama, A. V., & Maturbongs, L. M. (2023). Students' learning interest in quadratic function topics using GeoGebra. *Edumatika: Jurnal Riset Pendidikan Matematika, 6*(1). https://doi.org/10.32939/ejrpm.v6i1.1716
Organisation for Economic Co-operation and Development. (2023). *PISA 2022 results (Volume I and II): Country notes – Indonesia*. OECD Publishing.
Papageorgiou, E., Wong, J., Liu, Q., Khalil, M., & Cabo, A. J. (2025). A systematic review on student engagement in undergraduate mathematics: Conceptualization, measurement, and learning outcomes. *Educational Psychology Review, 37*(3). https://doi.org/10.1007/s10648-025-10046-y

Pratama, F. I., & Rohaeti, E. (2023). Students' chemical literacy ability on hydrocarbon material: A case of toxic compounds in fried food. *Jurnal Penelitian Pendidikan IPA*, *9*(9), 6795–6802. https://doi.org/10.29303/jppipa.v9i9.4554

Pratama, F. I., Rohaeti, E., & Laksono, E. W. (2024). Empirical foundations for developing new learning models to improve chemical literacy, scientific habits of mind, and science process skills of chemistry education students. *Jurnal Penelitian Pendidikan IPA*, *10*(10), 8062–8069. https://doi.org/10.29303/jppipa.v10i10.8661

Radišić, J., Schukajlow, S., Rach, S., & Eccles, J. S. (2026). A situative perspective on motivation in mathematics education: A systematic review. *ZDM–Mathematics Education*, *58*(4), 539–559. https://doi.org/10.1007/s11858-026-01802-7

Siipi, H., & Uusitalo, S. (2024). Ethical challenge of student-participants using a research survey for giving course feedback. *Discover Education*, *3*(1). https://doi.org/10.1007/s44217-024-00254-z

Sugiyono. (2019). *Metode penelitian kuantitatif, kualitatif, dan R&D* (2nd ed.). Alfabeta.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Wang, M.-T., Binning, K. R., Del Toro, J., Qin, X., & Zepeda, C. D. (2021). Skill, thrill, and will: The role of metacognition, interest, and self-control in predicting student engagement in mathematics learning over time. *Child Development*, *92*(4), 1369–1387. https://doi.org/10.1111/cdev.13531

Wilkie, K. J. (2024). Coordinating visual and algebraic reasoning with quadratic functions. *Mathematics Education Research Journal*, *36*, 27–63. https://doi.org/10.1007/s13394-022-00426-w

Yunianto, W., El-Kasti, H., Lavicza, Z., & Prahmana, R. C. I. (2024). A constructionist approach to learning computational thinking in mathematics lessons. *Journal of Information Technology Education: Innovations in Practice*, *23*. https://doi.org/10.28945/5365

BIOGRAPHIES OF SUTHORS

Ni Komang Emi Supriani is an undergraduate student in the Mathematics Education Study Program with an interest in developing innovative learning media. The author is open to academic discussions and further research collaborations and can be contacted at komangemi2004@gmail.com.

Alfisyahra is a lecturer in the Mathematics Education Study Program at Tadulako University. The author's research interests are in the field of mathematics education. The author can be contacted at alfisyahra@untad.ac.id

Akhyar H.M. Tawil is a lecturer in the Mathematics Education Study Program at Tadulako University. The author's research interests are in the field of mathematics education. The author can be contacted at akhyarhmt@untad.ac.id

Sutji Rochaminah is a lecturer in the Mathematics Education Study Program at Tadulako University. The author's research interests are in the field of mathematics education. The author can be contacted at sucipalu@gmail.com