

GeoGebra-Assisted Instruction and Learning Activity: Their Effects on Students' Geometry Learning Outcomes



Alfizah Ayu Indria Sari¹

¹Sekolah Tinggi Ekonomi Syariah Manna Wa Salwa Tanah Datar Sumatera Barat, Indonesia

Article Info

Corresponding Author:

Alfizah Ayu Indria Sari

✉ alfayundria@gmail.com

History:

Submitted: 13-11-2025

Revised: 25-11-2025

Accepted: 10-12-2025

Keyword:

GeoGebra, learning activity, learning outcomes, geometry, mathematics education

Kata Kunci:

GeoGebra, aktivitas belajar, hasil belajar, geometri, pendidikan matematika

Abstract

This study investigates the effect of GeoGebra-assisted instruction and students' learning activity on mathematics learning outcomes in circle topics. A quasi-experimental design with a non-equivalent control group was employed. The participants were eighth-grade students of SMP Nurul Ikhlas, divided into an experimental group taught using GeoGebra and a control group taught through conventional instruction. Data were collected using achievement tests and learning activity observation sheets, with all instruments confirmed to be valid and reliable. The results show that students in the experimental group achieved significantly higher post-test scores than those in the control group. Paired sample t-test analysis indicated a substantial improvement in learning outcomes in the experimental group, while the control group showed only a slight increase. Independent sample t-test results confirmed a significant difference between the two groups. Furthermore, regression analysis revealed that learning activity had a positive and significant effect on learning outcomes, contributing 21.3% to the variance. These findings indicate that GeoGebra-assisted learning effectively enhances students' understanding of geometry when integrated with activity-oriented instruction. This study emphasizes the importance of combining digital tools with active learning strategies to improve mathematics learning in contemporary educational settings.

Abstrak

Penelitian ini bertujuan untuk menganalisis pengaruh pemanfaatan GeoGebra dan aktivitas belajar siswa terhadap hasil belajar matematika pada materi lingkaran. Penelitian menggunakan desain kuasi-eksperimen dengan non-equivalent control group design. Subjek penelitian adalah siswa kelas VIII SMP Nurul Ikhlas yang terbagi ke dalam kelas eksperimen dengan pembelajaran berbantuan GeoGebra dan kelas kontrol dengan pembelajaran konvensional. Data dikumpulkan melalui tes hasil belajar dan lembar observasi aktivitas belajar, dengan instrumen yang telah memenuhi kriteria valid dan reliabel. Hasil penelitian menunjukkan bahwa kelas eksperimen mengalami peningkatan hasil belajar yang signifikan dibandingkan dengan kelas kontrol. Uji paired sample t-test menunjukkan peningkatan yang tinggi pada nilai posttest kelas eksperimen, sedangkan kelas kontrol hanya mengalami peningkatan yang relatif rendah. Hasil uji independent sample t-test menegaskan adanya perbedaan yang



Copyright © 2025 by
Multidisciplinary
Research of Education
Report

All writings published in this journal are personal views of the authors and do not represent the views of the Constitutional Court.

signifikan antara kedua kelompok. Selain itu, analisis regresi menunjukkan bahwa aktivitas belajar berpengaruh positif dan signifikan terhadap hasil belajar dengan kontribusi sebesar 21,3%. Temuan ini menegaskan bahwa pembelajaran berbantuan GeoGebra efektif meningkatkan pemahaman konsep geometri apabila diterapkan melalui pembelajaran yang berorientasi pada aktivitas siswa.

A. INTRODUCTION

Mathematics learning at the junior secondary school level continues to face substantial challenges, particularly in geometry topics that require students to integrate visualisation, spatial reasoning, and relational understanding of concepts. International educational reports consistently indicate that students' performance in geometry remains lower than in other mathematical domains, especially on tasks that demand conceptual understanding and higher-order reasoning. This condition suggests that geometry instruction has not yet fully supported the development of students' mathematical thinking processes in a meaningful way (OECD, 2019; OECD, 2023).

From a theoretical perspective, effective mathematics learning is grounded in constructivist views that regard learning as an active process of knowledge construction. Within this framework, Bruner's theory of representation emphasises that conceptual understanding develops through enactive, iconic, and symbolic stages. Learning experiences that allow students to interact with and manipulate mathematical objects before formal symbolisation are essential for building durable conceptual understanding. However, classroom practices often bypass these stages and move directly to symbolic representations, resulting in procedural learning that lacks conceptual depth (Ernest, 2018; Sullivan et al., 2020).

In classroom realities, mathematics instruction particularly in circle topics remains predominantly teacher-centred. Teachers act as the primary source of knowledge, while students tend to assume passive roles by following predetermined solution procedures. Instructional media are commonly static, relying on textbook illustrations or board drawings that fail to capture the dynamic nature of geometric relationships. This situation contrasts sharply with the characteristics of today's learners, who are accustomed to interactive and visual digital technologies in their everyday lives (Prensky, 2010; Schindler et al., 2017).

This mismatch indicates a lack of alignment between instructional practices and the learning characteristics required in twenty first century education. Numerous studies highlight that learning environments which fail to actively engage students tend to produce low participation and superficial understanding. Learning activity should not be interpreted merely as physical engagement, but as meaningful cognitive, social, and reflective involvement in the learning process. Empirical evidence suggests that students' learning activity is strongly associated with the quality of conceptual understanding and learning outcomes in mathematics (Chi & Wylie, 2014; Bond et al., 2020).

In geometry learning, students' learning activity becomes particularly critical due to the visual and relational nature of geometric concepts. Students need opportunities to observe changes, test conjectures, and draw conclusions based on direct learning experiences. Instruction that positions students as active knowledge constructors has been shown to be more effective in developing conceptual understanding than traditional lecture-based approaches (Freeman et al., 2014; Lazonder & Harmsen, 2016).

Advances in digital technology provide opportunities to address these challenges by fostering more contextualised and meaningful mathematics learning. One digital learning tool that aligns well with the nature of geometry is GeoGebra, a dynamic mathematics software that integrates visual, numerical, and symbolic representations. GeoGebra allows students to construct and manipulate geometric objects dynamically, enabling concepts to be understood not as static formulas, but as observable and testable relationships (Hohenwarter et al., 2018).

A growing body of research indicates that the use of GeoGebra in mathematics instruction can enhance students' conceptual understanding and learning outcomes. However, many of these studies treat GeoGebra as an isolated instructional variable, without explicitly examining how students' learning activity mediates its effectiveness. In reality, the impact of digital learning tools depends largely on how they facilitate students' engagement and active learning processes, rather than on technological sophistication alone (Rezat & Straesser, 2019; Crompton & Burke, 2018).

Conversely, studies on students' learning activity in mathematics education are often conducted independently of digital learning contexts. Learning activity is frequently analysed as a supporting or descriptive variable, rather than as an integral component of technology enhanced instructional design. As a result, the interrelationship between digital media use, learning activity, and learning outcomes remains insufficiently explained, particularly in junior secondary geometry instruction (Falloon, 2020; Bond et al., 2020).

These conditions reveal a relevant research gap aligned with contemporary educational needs: the necessity for empirical studies that integrate digital learning media and students' learning activity within a unified analytical framework. Such research is essential to explain the mechanisms through which technology-enhanced instruction influences learning outcomes, rather than merely demonstrating that technology use is effective.

Therefore, this study aims to examine the effects of GeoGebra utilisation and students' learning activity on mathematics learning outcomes in circle topics at SMP Nurul Ikhlas. This study is significant not only for evaluating the effectiveness of digital learning media, but also for emphasising students' learning activity as a key mechanism in technology-enhanced mathematics instruction. The findings are expected to contribute theoretically to the reinforcement of constructivist mathematics education and practically to the development of mathematics instruction that is responsive to digital transformation and the demands of twenty-first-century learning

B. METHOD

This study employed a quantitative approach using a quasi-experimental design with a non-equivalent control group. This design was selected to examine the causal effects of GeoGebra-assisted learning and students' learning activity on mathematics learning outcomes under authentic classroom conditions, where random assignment of participants was not feasible. The experimental design enabled a systematic comparison between students who learned through GeoGebra-assisted instruction and those who received conventional instruction. The study was conducted at SMP Nurul Ikhlas during the academic year in which the research took place. The participants consisted of Grade VIII students, selected through purposive sampling based on the equivalence of their academic characteristics and prior mathematics achievement. Two intact classes were involved: one class was assigned as the experimental group, which received GeoGebra-assisted instruction, and the other as the control group, which was taught using conventional teaching methods. This selection ensured comparability between groups while maintaining the natural classroom setting.

The study involved three main variables. The independent variable was the use of GeoGebra-assisted learning in mathematics instruction. The moderating/predictor variable was students' learning activity, which reflected students' cognitive, visual, and participatory engagement during the learning process. The dependent variable was mathematics learning outcomes, specifically students' achievement on circle topics. Instruction was carried out over several learning sessions covering circle topics, including elements of a circle, relationships among angles, arc length, and area of sectors. In the experimental group, learning activities were designed to integrate GeoGebra as a dynamic learning tool. Students actively constructed and manipulated geometric objects, explored relationships among circle elements, and discussed their findings under teacher facilitation. GeoGebra was used not merely as a demonstration tool, but as an interactive medium that supported students' exploration and conceptual construction. In contrast, the control group received conventional instruction through teacher explanations, textbook-based examples, and routine exercises. Although both groups were taught the same content and allocated equal instructional time, the learning experiences differed in terms of media use and student engagement.

Data were collected using two primary instruments. The first instrument was a mathematics learning outcomes test in the form of objective and structured items aligned with the learning indicators of circle topics. The test was administered as a post-test to measure students' conceptual understanding and procedural competence after the instructional intervention.

The second instrument was a learning activity observation sheet, developed to capture students' engagement during the learning process. The observation sheet included indicators of visual, verbal, mental, and collaborative activities. Observations were conducted systematically during the instructional sessions to ensure accurate representation of students' learning activity. Both instruments were subjected to

content validity evaluation by subject-matter experts and underwent reliability testing to ensure consistency and accuracy in data measurement.

Data collection was conducted in three stages. First, instructional implementation was carried out in both groups according to the predetermined lesson plans. Second, students' learning activity was observed and recorded during the learning process. Third, the learning outcomes test was administered at the end of the instructional period to both groups under equivalent conditions. These procedures ensured that the collected data reflected both the learning process and learning outcomes. Data analysis was performed using descriptive and inferential statistical techniques. Descriptive statistics were used to summarise students' learning outcomes and learning activity. Prior to hypothesis testing, data were examined for normality and homogeneity to ensure that the assumptions of parametric testing were met. Inferential analysis was conducted using regression analysis to examine the effects of GeoGebra-assisted learning and students' learning activity on mathematics learning outcomes. This analysis enabled the identification of both individual and combined contributions of the independent variables to the dependent variable. Statistical significance was determined at the conventional alpha level.

C. RESULT

Quality of Research Instruments

As designed in the methodology, the first stage of analysis focused on ensuring that the research instruments met psychometric quality standards. The learning outcomes test consisted of 20 objective items developed to measure students' understanding of circle topics. Item validity was examined using the product-moment correlation, with the critical value set at $r = 0.3291$. The results show that all 20 items demonstrated correlation coefficients exceeding the critical value, indicating that each item validly measured students' mathematics learning outcomes.

Table 1. Summary of Item Validity Test Results

Number of Items	Valid Items	Invalid Items
20	20	0

Reliability analysis was conducted using the Spearman-Brown formula, yielding a reliability coefficient of 0.846, which indicates a high level of internal consistency. This result confirms that the instrument produced stable and consistent measurements. Further analysis of item characteristics showed that 60% of the items were categorised as easy and 40% as moderate, suggesting that the test difficulty level was appropriate for the participants. In terms of discriminating power, 55% of the items demonstrated very good discrimination, while the remaining items were categorised as good. These findings indicate that the test items were capable of distinguishing between students with higher and lower levels of mathematical understanding. Overall, the results of the instrument analysis confirm that the learning outcomes test met the validity, reliability, difficulty, and discrimination criteria required for subsequent data analysis.

Description of Students' Learning Activity

In line with the research design, students' learning activity was measured during the implementation of GeoGebra-assisted instruction in the experimental group using a structured observation sheet. The observation focused on students' visual, cognitive, verbal, and collaborative engagement throughout the learning process. The results show that students' learning activity scores ranged from 71 to 87, with a mean score of 78.47. Based on this mean score, students were categorised into high and low learning activity groups.

Table 2. Distribution of Students' Learning Activity

Activity Level	Number of Students	Percentage
High	17	47.22%
Low	19	52.78%
Total	36	100%

As shown in Table 2, although slightly more than half of the students were categorised as having low learning activity, the difference between the two categories was relatively small. This indicates that GeoGebra-assisted instruction was generally able to engage students, while individual variations in participation and engagement remained evident.

Descriptive Analysis of Learning Outcomes

To examine changes in students' mathematics learning outcomes, pre-test and post-test data were collected from both the control and experimental groups as specified in the methodology.

Control Group

In the control group, which received conventional instruction, the mean pre-test score was 64.19, while the mean post-test score increased marginally to 65.27. This represents an improvement of 1.68%, indicating that conventional instruction resulted in minimal learning gains. Further analysis shows that only 37.84% of students demonstrated higher post-test scores compared to their pre-test scores, while more than half of the students showed no change. This pattern suggests that conventional instruction had limited impact on improving students' understanding of circle concepts.

Experimental Group

In contrast, the experimental group, which received GeoGebra-assisted instruction, showed a substantial improvement in learning outcomes. The mean pre-test score was 65.83, increasing to 79.31 in the post-test. This represents a gain of 20.48%, indicating a meaningful improvement in students' mathematical understanding. Notably, 91.67% of students in the experimental group achieved higher post-test scores than pre-test scores, demonstrating a consistent improvement across participants.

Table 3. Comparison of Pre-test and Post-test Scores

Group	Mean Pre-test	Mean Post-test	Gain (%)
Control	64.19	65.27	1.68
Experimental	65.83	79.31	20.48

The data in Table 3 illustrate a clear contrast between the two instructional approaches, highlighting the stronger learning gains achieved through GeoGebra-assisted instruction.

Assumption Testing

Before conducting inferential statistical analysis, assumption tests were performed as outlined in the methodology. The Kolmogorov–Smirnov test indicated that pre-test and post-test scores in both groups were normally distributed ($p > 0.05$). Additionally, the homogeneity of variance test confirmed that the variances between groups were homogeneous ($F = 2.708 < F_{table} = 3.126$). These results indicate that the data met the assumptions required for parametric statistical testing.

Effect of GeoGebra-Assisted Instruction on Learning Outcomes

An independent samples t-test was conducted to examine differences in post-test scores between the experimental and control groups. The analysis revealed a statistically significant difference between the two groups ($t = -7.002$, $df = 71$, $p < 0.05$). The mean post-test score of the experimental group (79.31) was substantially higher than that of the control group (65.27), confirming that GeoGebra-assisted instruction had a significant positive effect on students' mathematics learning outcomes.

Effect of Learning Activity on Learning Outcomes

To analyse the influence of students' learning activity on learning outcomes, a simple linear regression analysis was conducted using data from the experimental group. The regression results show that learning activity significantly predicted learning outcomes ($t = 3.304$, $p < 0.05$). The regression coefficient ($\beta = 0.718$) indicates that an increase of one unit in learning activity score resulted in an increase of 0.718 points in learning outcomes. The coefficient of determination ($R^2 = 0.213$) indicates that students' learning activity accounted for 21.3% of the variance in learning outcomes.

Table 4. Summary of Regression Analysis

Predictor	β	t	R^2
Learning Activity	0.718	3.304	0.213

These findings demonstrate that students' active engagement during GeoGebra-assisted instruction played a meaningful role in improving learning outcomes.

Taken together, the results demonstrate that GeoGebra-assisted instruction led to significantly higher learning outcomes compared to conventional instruction. Moreover, students' learning activity emerged as an important predictor of learning outcomes, indicating that the effectiveness of GeoGebra is closely related to the extent to which students actively engage in the learning process.

D. DISCUSSION

The findings of this study provide strong empirical evidence that GeoGebra-assisted instruction significantly improves students' mathematics learning outcomes on circle topics compared to conventional teaching methods. More importantly, the

results demonstrate that the effectiveness of GeoGebra is closely associated with students' learning activity, indicating that technology-enhanced instruction works optimally when it actively engages learners in the learning process.

GeoGebra-Assisted Learning and Conceptual Understanding

The substantial improvement in post-test scores in the experimental group confirms that GeoGebra plays an effective role in facilitating students' understanding of geometric concepts. This finding aligns with constructivist learning theory, which posits that knowledge is actively constructed through interaction with learning objects rather than passively received (Ernest, 2018). GeoGebra enables students to manipulate geometric objects dynamically, allowing abstract concepts related to circles such as central angles, arcs, and sector areas—to be explored visually and relationally.

From the perspective of Bruner's theory of representation, GeoGebra-assisted learning supports students' transition from iconic to symbolic representation by providing continuous visual feedback during exploration (Sullivan et al., 2020). Instead of memorising formulas, students observe patterns and relationships before formalising them symbolically. This process helps explain why the experimental group demonstrated a significantly higher learning gain than the control group, which relied on static representations and teacher explanations.

These results are consistent with previous studies reporting that dynamic geometry environments enhance conceptual understanding and reasoning skills in mathematics (Hohenwarter et al., 2018; Zengin et al., 2017). However, this study strengthens the existing literature by demonstrating that such gains are not merely a result of technology use, but of how technology facilitates meaningful learning experiences.

Limited Impact of Conventional Instruction

The minimal improvement observed in the control group reflects a broader issue in mathematics education, where conventional instruction often emphasises procedural fluency at the expense of conceptual understanding. Similar findings have been reported in large-scale assessments, which reveal that students struggle with non-routine and reasoning-based problems despite being able to perform routine calculations (OECD, 2019; OECD, 2023).

The results suggest that conventional instruction, even when delivered effectively, may be insufficient to address the cognitive demands of geometry learning in the digital era. This finding supports arguments that traditional, teacher-centred approaches are increasingly misaligned with the learning needs of contemporary students, who require interactive and exploratory learning environments (Schindler et al., 2017).

Role of Learning Activity in Technology-Enhanced Instruction

One of the most important contributions of this study lies in its examination of students' learning activity as a predictor of learning outcomes. The regression analysis shows that learning activity accounts for 21.3% of the variance in students' learning

outcomes, indicating a meaningful relationship between engagement and achievement.

This finding is consistent with the ICAP framework, which categorises learning activities into passive, active, constructive, and interactive modes, and argues that deeper learning occurs when students are actively and constructively engaged (Chi & Wylie, 2014). GeoGebra-assisted instruction in this study encouraged students to engage in observation, manipulation, discussion, and reflection—activities that correspond to higher levels of cognitive engagement.

Moreover, recent meta-analyses have confirmed that active learning strategies lead to significantly higher learning outcomes than traditional lecture-based approaches, particularly in STEM subjects (Freeman et al., 2014; Bond et al., 2020). The present findings reinforce this conclusion within the context of junior secondary geometry learning.

GeoGebra as a Cognitive Tool, Not a Mere Teaching Aid

The results of this study highlight the importance of positioning GeoGebra as a cognitive tool rather than a presentation medium. When used as a tool for exploration and problem-solving, GeoGebra supports students' metacognitive processes by allowing them to test hypotheses, receive immediate feedback, and revise their understanding.

This perspective aligns with contemporary views in educational technology, which emphasise that digital tools should be designed to support thinking and learning processes rather than simply deliver content (Rezat & Straesser, 2019; Falloon, 2020). The findings suggest that the effectiveness of GeoGebra is maximised when it is integrated into pedagogical designs that prioritise student activity and inquiry.

Relevance to Contemporary Educational Contexts

In the context of rapid digital transformation in education, this study is particularly relevant. Current educational policies emphasise the integration of digital technology to support student-centred learning and the development of higher-order thinking skills (Redecker, 2017; Voogt et al., 2018). The findings of this study provide empirical support for these policy directions by demonstrating that technology integration can enhance learning outcomes when accompanied by active learning strategies.

Furthermore, the post-pandemic educational landscape has intensified the need for flexible and interactive digital learning environments. GeoGebra, as an open-source and widely accessible tool, offers a practical solution for schools seeking to enhance mathematics instruction without substantial financial investment. However, this study also cautions that technology alone is insufficient; pedagogical design and student engagement remain central determinants of learning success.

Contribution and Implications

The findings of this study contribute to the literature in two key ways. First, they provide empirical evidence that GeoGebra-assisted instruction significantly improves mathematics learning outcomes at the junior secondary level. Second, and more

importantly, they demonstrate that students' learning activity plays a crucial role in mediating the effectiveness of technology-enhanced instruction.

Practically, these findings suggest that teachers should design GeoGebra-based lessons that explicitly promote student activity through exploration, discussion, and reflection. For policymakers and curriculum developers, the results underscore the importance of integrating digital tools within pedagogical frameworks that emphasise active learning rather than focusing solely on technological infrastructure.

E. CONCLUSION

This study concludes that the integration of GeoGebra in mathematics instruction significantly improves students' learning outcomes on circle topics compared to conventional teaching methods. Students in the experimental group demonstrated a substantial increase in post-test scores, while the control group showed only marginal improvement, indicating that traditional instruction alone is insufficient to foster meaningful conceptual understanding. The findings also confirm that students' learning activity has a positive and significant effect on learning outcomes. Higher levels of engagement during GeoGebra-assisted learning were associated with better achievement, highlighting that the effectiveness of digital tools depends not merely on their use, but on how they stimulate active and constructive learning processes.

Overall, this study provides empirical evidence that GeoGebra, when implemented within an activity-oriented pedagogical design, functions as an effective cognitive tool for enhancing students' understanding and achievement in mathematics. These results support the integration of dynamic digital tools in contemporary mathematics education to meet the learning demands of today's students.

BIBLIOGRAPHY

- Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2020). Emergency Remote Teaching In Higher Education: Mapping The First Global Online Semester. *International Journal Of Educational Technology In Higher Education*, 17(1), 1–24. <https://doi.org/10.1186/S41239-020-00232-0>
- Chi, M. T. H., & Wylie, R. (2014). The ICAP Framework: Linking Cognitive Engagement To Active Learning Outcomes. *Educational Psychologist*, 49(4), 219–243. <https://doi.org/10.1080/00461520.2014.965823>
- Crompton, H., & Burke, D. (2018). The Use Of Mobile Learning In Higher Education: A Systematic Review. *Computers & Education*, 123, 53–64. <https://doi.org/10.1016/J.Compedu.2018.04.007>
- Ernest, P. (2018). *The Philosophy Of Mathematics Education*. Routledge. <https://doi.org/10.4324/9781351007917>
- Falloon, G. (2020). From Digital Literacy To Digital Competence: The Teacher Digital Competency Framework. *Educational Technology Research And Development*, 68(5), 2449–2472. <https://doi.org/10.1007/S11423-020-09767-4>

- Freeman, S., Eddy, S. L., Mcdonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active Learning Increases Student Performance In Science, Engineering, And Mathematics. *Proceedings Of The National Academy Of Sciences*, 111(23), 8410–8415. <https://doi.org/10.1073/Pnas.1319030111>
- Hohenwarter, M., Jarvis, D., & Lavicza, Z. (2018). Linking Geometry, Algebra, And Mathematics Teachers: Geogebra Software And The Establishment Of The Geogebra Community. *International Journal For Technology In Mathematics Education*, 25(1), 27–38.
- Lazonder, A. W., & Harmsen, R. (2016). Meta-Analysis Of Inquiry-Based Learning: Effects Of Guidance. *Review Of Educational Research*, 86(3), 681–718. <https://doi.org/10.3102/0034654315627366>
- OECD. (2019). *PISA 2018 Results (Volume I): What Students Know And Can Do*. OECD Publishing. <https://doi.org/10.1787/5f07c754-en>
- OECD. (2023). *PISA 2022 Results (Volume I): The State Of Learning And Equity In Education*. OECD Publishing. <https://doi.org/10.1787/53f23881-en>
- Prensky, M. (2010). *Teaching Digital Natives: Partnering For Real Learning*. Corwin Press.
- Redecker, C. (2017). *European Framework For The Digital Competence Of Educators (Digcompedu)*. Publications Office Of The European Union. <https://doi.org/10.2760/159770>
- Rezat, S., & Straesser, R. (2019). From The Use Of Tools To Orchestration Of Learning Environments. *ZDM–Mathematics Education*, 51(6), 895–908. <https://doi.org/10.1007/S11858-019-01075-4>
- Schindler, L. A., Puls-Elvidge, S., Welzant, H., & Crawford, L. (2017). Computers In Education: A Meta-Analysis. *International Journal Of Educational Technology In Higher Education*, 14(1), 1–25. <https://doi.org/10.1186/S41239-017-0063-0>
- Sullivan, P., Clarke, D., & Clarke, B. (2020). Teaching With Tasks For Effective Mathematics Learning. *Journal Of Mathematics Teacher Education*, 23(2), 213–233. <https://doi.org/10.1007/S10857-018-09430-9>
- Voogt, J., Erstad, O., Dede, C., & Mishra, P. (2018). Challenges To Learning And Schooling In The Digital Networked World. *Journal Of Computer Assisted Learning*, 34(2), 111–124. <https://doi.org/10.1111/Jcal.12224>
- Zengin, Y., Furkan, H., & Kutluca, T. (2017). The Effect Of Dynamic Mathematics Software Geogebra On Student Achievement In Teaching Geometry. *Educational Sciences: Theory & Practice*, 17(2), 623–643. <https://doi.org/10.12738/Estp.2017.2.0221>