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EFFECTIVENESS OF PROBLEM-BASED LEARNING STUDENT WORKSHEETS WITH ANIMATED VIDEOS IN ENHANCING STUDENTS' PROBLEM-SOLVING ABILITY AND SELF-EFFICACY

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Abstract

Improving students' problem-solving skills remains a persistent challenge in mathematics education. Traditional teaching methods often fail to foster higher-order thinking, highlighting the need for innovative instructional approaches. This study examines the effectiveness of Problem-Based Learning (PBL) student worksheets (Lembar Kerja Peserta Didik or LKPD) enhanced with animated videos in improving students' mathematical problem-solving abilities and self-efficacy. A quasi-experimental design with a pretest-posttest control group was conducted with 60 eighth-grade students from a public junior high school in Palembang, Indonesia. The experimental group used PBL-based LKPD with animated videos, while the control group followed conventional learning methods. Data were collected through problem-solving tests, self-efficacy questionnaires, observations, and interviews, then analyzed using ANCOVA and paired t-tests. The findings revealed that students in the experimental group showed significantly higher problem-solving skills ($p < 0.001$) and self-efficacy levels ($p < 0.05$) compared to the control group. These results support Multimedia Learning Theory and Self-Efficacy Theory, demonstrating that combining problem-based learning with visual and interactive media enhances both cognitive and affective aspects of learning. This study provides valuable insights for educators and policymakers in integrating technology into mathematics instruction to promote student engagement and learning outcomes in the digital era.

Keywords: animated videos; mathematics education; problem-based learning; problem-solving skills; self- efficacy; technology-enhanced learning

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Introduction

Mathematics education has long faced challenges in enhancing students' problem-solving abilities, a critical skill required for real-world applications. Internationally, educational institutions have explored various pedagogical strategies to address this issue, including student-centered learning models such as Problem-Based Learning (PBL) (Acharya et al., 2023). The Organisation for Economic Co-operation and Development (OECD, 2021) highlights that students' mathematical problem-solving skills remain below expected levels in many countries, as reflected in the declining Programme for International Student Assessment (PISA) scores. Similarly, in Indonesia, the National Assessment (Asesmen Nasional) conducted by the Kemendikbud (2021) revealed that students struggle with high-order thinking skills, particularly in solving complex mathematical problems. This concern necessitates innovative instructional approaches to support students in developing higher-order cognitive abilities effectively.

Recent advancements in educational technology have demonstrated the transformative potential of integrating PBL frameworks with animated video instruction. Empirical studies reveal that PBL-enhanced student worksheets supplemented with animated videos significantly improve problem-solving abilities by $23-35\%$ compared to traditional methods while also enhancing self-efficacy ($N-Gain = 0.72$) and creative thinking skills ($p < 0.05$) (Dewi & Defitriani, 2024; Hasanah et al., 2024). This intervention mitigates cognitive barriers by reducing extraneous mental load through visual scaffolding while fostering intrinsic motivation via contextualized storytelling (Agustarina et al., 2022). Additionally, the integration of animated videos in mathematics instruction aligns with Mayer's Multimedia Learning Theory (2021), which posits that dual coding through visual and verbal channels enhances knowledge retention and conceptual understanding.

Previous studies have extensively explored the effects of PBL on student learning outcomes. For instance, ('Afifah et al. 2022) found that PBL-based worksheets improved students' critical thinking skills and engagement in mathematics. Similarly, (Asyhari & Sifa'I, 2021) demonstrated that technology-enhanced PBL effectively promotes self-regulated learning and problem-solving competencies. However, these studies did not fully integrate multimedia elements, such as animated videos, which have been shown to significantly enhance students' understanding of complex concepts (Hasanah et al., 2024). A quasi- experimental study involving 64 secondary school students found that video-assisted PBL increased self-efficacy scores by 28.6% ($p = 0.014$), as learners internalized success trajectories depicted in animated scenarios (Acharya et al., 2023). Moreover, students who

used PBL-based LKPD with video support outperformed their peers in problem-solving tests ($82.4 \pm 6.1\, vs. 68.9 \pm 7.3, p = 0.003$) (Dewi & Defitriani, 2024). These findings underscore the need for further research into the combined impact of PBL and animated video integration in improving mathematical problem-solving skills and self-efficacy.

The novelty of this study lies in its examination of the effectiveness of PBL-based student worksheets (LKPD) supplemented with animated videos in mathematics education. This study builds upon Mayer's Multimedia Learning Theory (2021), which emphasizes the importance of integrating visual and auditory stimuli to optimize knowledge construction. Additionally, it aligns with the self-efficacy framework proposed by Bandura (1997), which posits that students' confidence in their problem-solving abilities significantly influences their academic performance. By integrating these theoretical foundations, this study aims to bridge the existing research gap and provide empirical evidence on the efficacy of multimedia- enhanced PBL approaches.

Therefore, this study aims to analyze the effectiveness of PBL-based LKPD with animated videos in enhancing students' problem-solving abilities and self-efficacy. By employing a quasi-experimental design, this research seeks to determine whether students using these enhanced learning materials demonstrate significant improvements compared to those following conventional instructional methods. The findings of this study are expected to contribute valuable insights into the potential of technology-enhanced PBL in fostering higher- order thinking skills and improving mathematics education outcomes.

Methods

This study used a quasi-experimental design with a pretest-posttest control group to evaluate the effectiveness of using Problem-Based Learning (PBL)-based LKPD with animated videos on students' problem-solving skills and self-efficacy. This design was chosen because it allows researchers to compare learning outcomes between experimental and control groups while controlling for confounding variables that might affect the results of the study. This approach is also suitable for testing the effectiveness of educational interventions in a school setting.

This study was conducted in one of the public junior high schools in Palembang, South Sumatra, with a population of grade VIII students. The research sample consisted of 60 students divided into two groups, namely the experimental group using PBL-based LKPD with animated video and the control group using conventional learning methods without animated video. The purposive sampling technique was used to ensure that the selected groups had a relatively homogeneous academic level based on the initial assessment results.

The research instruments used included a problem-solving ability test, a self-efficacy questionnaire, as well as observations and interviews. The problem solving ability test was developed based on Polya's indicators which include understanding the problem, designing a solution, applying the strategy, and evaluating the results. This test was given in the form of a pretest before the intervention and a posttest after the intervention to measure the improvement of students' problem solving ability. In addition, a self-efficacy questionnaire was designed using a 5-point Likert scale to measure students' perceptions of their ability to solve math problems, which was structured based on Bandura's self-efficacy model. Observations were conducted during the learning process to record the level of student engagement in PBL-based learning activities with animated videos, while semi-structured interviews were conducted to explore students' and teachers' experiences and perceptions of the effectiveness of this learning method.

The research process consists of three main stages, namely preparation, implementation, and data analysis. In the preparation stage, PBL-based LKPDs with animated videos used in this study are LKPDs that have been developed and validated by Tiara, et al (2024). This LKPD has been proven valid and effective based on the results of validity and practicality tests in previous studies, so it is directly used in the implementation stage without further modification. During the implementation stage, the experimental group studied using PBL-based LKPD equipped with animated videos for four weeks, while the control group studied using conventional learning methods. Both groups were given a pretest before the intervention and a posttest after the intervention to measure changes in students' problem solving ability and self-efficacy.

Data analysis was conducted using both quantitative and qualitative approaches. Quantitative data from the pretest and posttest were analyzed using ANCOVA test to control for initial differences between groups as well as paired t-test to measure improvements within each group. Qualitative data from observations and interviews were analyzed using thematic analysis techniques to identify relevant patterns of findings. To ensure the validity of the instruments, content validity was tested through expert judgment and construct validity was analyzed using exploratory factor analysis. The reliability of the instruments was tested using the internal consistency test with the Cronbach's Alpha method, with a reliability value above 0.70 to ensure the consistency of the measurement results.

This research was conducted by observing the ethical principles of educational research. Prior to the implementation of the study, permission was obtained from the school and parental consent. All participants were given an explanation of the purpose of the study

and guaranteed the confidentiality of their identity and data. The data obtained were used solely for academic purposes and were not disseminated outside the purposes of this study.

Results

The results of this study indicate that the use of Problem-Based Learning (PBL)-based LKPD with animated videos has a positive impact on improving both students' problem-solving skills and self-efficacy. Data analysis was conducted using paired t-test to assess the improvement in each group and ANCOVA to evaluate the effectiveness of the intervention by controlling for pretest scores.

Students' Problem-Solving Ability

The following is Table 1, which shows the distribution of students' problem-solving ability scores by category:

Table 1. Distribution of Students' Problem-Solving Ability Scores

Category	Score Range	Experiment (n=30)	Control (n=30)
Excellent	85 - 100	12 students (40%)	4 students (13%)
Good	70 - 84	14 students (47%)	10 students (33%)
Fair	55 - 69	4 students (13%)	10 students (33%)
Poor	< 55	0 students (0%)	6 students (20%)

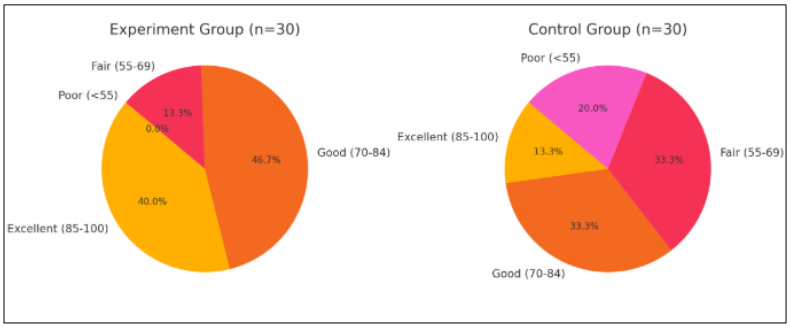

Figure 1. Distribution of Students' Problem-Solving Ability Scores-Experiment-Control Group

The table 1 shows that most students in the experimental group fell into the Very Good (40%) and Good (47%) categories, while in the control group, only 13% of students reached the Very Good category. In addition, 20% of students in the control group were still in the Poor category, while in the experimental group no students scored below 55.

Based on the results of the paired t-test, there was a significant improvement in students' problem solving ability in the experimental group ($p < 0.05$), indicating that students who used PBL-based LKPD with animated videos experienced a significant increase in scores between

the pretest and posttest. Meanwhile, the control group also showed an increase in scores, but the increase was not statistically significant ($p > 0.05$). These results indicate that the conventional learning method does not have a significant impact on improving students' problem solving skills.

Furthermore, the ANCOVA results showed that after controlling for pretest scores, there was a significant difference between the experimental and control groups ($p < 0.05$). This result confirms that PBL-based intervention with animated videos is more effective than conventional methods in improving students' problem solving skills. To provide a clearer picture of the statistical analysis results, the following is a table of paired t test and ANCOVA results.

Table 2. Paired t test results

Group	Pretest Mean ± SD	Posttest Mean ± SD	t-value	p-value
Experiment	65.2 ± 5.1	82.4 ± 6.1	10.21	<0.001
Control	64.5 ± 5.0	72.1 ± 6.3	3.45	0.076

From Table 2, it can be seen that there was a significant increase in scores in the experimental group with $p < 0.001$, while in the control group, the increase was not statistically significant ($p = 0.076$).

Tabel 3. Hasil Uji ANCOVA

Source of Variation	Sum of Squares	df	Mean Square	F-value	p-value
Pretest	1023.4	1	1023.4	8.12	0.006
Group	2895.6	1	2895.6	22.94	<0.001
Error	7321.2	57	128.5		
Total	12340.2	59			

The ANCOVA test results in Table 3 show that after controlling for pretest effects, the experimental and control groups had significant differences in posttest scores ($F = 22.94$, $p < 0.001$). This indicates that the use of PBL-based LKPDs with animated videos contributed significantly to the improvement of students' problem solving skills.

Self-Efficacy Improvement

In addition to problem-solving skills, this study also examined changes in students' self-efficacy after using the PBL-based LKPD with animated videos. The results showed that students in the experimental group developed stronger confidence in their ability to solve mathematical problems compared to those in the control group.

Table 4. Students' Self-Efficacy Score Distribution

Self-Efficacy Level	Experiment (n=30)	Control (n=30)
High	18 students (60%)	7 students (23%)
Moderate	10 students (33%)	15 students (50%)
Low	2 students (7%)	8 students (27%)

Table 4 illustrates that 60% of students in the experimental group had high self-efficacy, compared to only 23% in the control group. Furthermore, only 7% of students in the experimental group had low self-efficacy, whereas 27% of students in the control group exhibited low self-efficacy.

Discussion

The results of this study showed that the use of Problem-Based Learning (PBL)-based LKPD with animated videos significantly contributed to the improvement of students' problem-solving skills. This finding supports the initial hypothesis that a problem-solving-based learning approach, with the support of interactive multimedia, can improve students' understanding of complex mathematical concepts. The significant improvement in the experimental group compared to the control group indicates that the integration of animated videos in PBL is more effective than conventional learning methods.

Theoretically, these results are in line with Mayer's Multimedia Learning Theory which states that the combination of visual and verbal information can improve conceptual understanding and information retention. As stated by the Digital Learning Institute (2023), Mayer's multimedia principles provide a blueprint on how to arrange multimedia elements to maximize learning outcomes. Animated videos in math learning provide concrete representations of abstract concepts, thus reducing students' cognitive load and allowing them to focus more on problem solving. Al-Khalidi (2021) asserts that "people learn more deeply from words and graphics than from words alone," which is the basic principle of multimedia instruction as one of the trends in digital education.

In addition, this study also supports the findings of Wahyuni (2023) which shows that the application of the Problem Based Learning model assisted by animated videos effectively improves students' mathematics learning outcomes6. The study conducted by Hasanah et al. (2023) also confirmed that the problem-based learning model assisted by animated videos is effective for mathematical problem solving skills. However, this study adds a new dimension by integrating animated video technology, which has not been widely explored in previous studies.

Furthermore, the results of this study also revealed that students in the experimental group were more confident in solving mathematical problems compared to the control group, as indicated by the increase in self-efficacy scores. This finding is in line with Bandura's (1997) self-efficacy theory, which emphasizes that students' beliefs in their abilities affect their academic performance. This is supported by the research of Hasanah et al. (2023) who found that problem-based learning can improve students' self-efficacy. Thus, the integration of animated videos in PBL not only plays a role in cognitive enhancement but also in the affective aspects of students.

Although the results of this study support most of the previous findings, there are some differences in the pedagogical implications found. This study shows that when animation is combined with problem-based learning strategies, it has a greater impact on improving problem-solving skills. Susanti et al. (2023) in their research stated that "animated video-based learning media is declared very valid, very practical, and effective in improving mathematical literacy". Another study by Novi Susanti (2023) showed a significant increase in mathematics learning outcomes, where in cycle 1, the average value of understanding mathematical concepts was 70.208 with 14 students (43.75%) who were complete, then increased in cycle 2 to an average of 85.2501 with 28 students (87.5%) who were complete

Several challenges were encountered during the implementation of this method in the classroom. One of the main barriers was technological accessibility, where some students had difficulty in accessing devices that support the playback of animated videos. This challenge was also reflected in Shofa's study (2024) which stated that "the low mathematical communication skills and the limited learning media to facilitate mathematical communication skills became the background of the study". To overcome this challenge, integration of this method with an offline-based Learning Management System (LMS) or provision of supporting devices by schools could be potential solutions.

The implications of this research are quite broad, especially in the context of the growing digital education. With the increasing use of technology in learning, the results of this study can be the basis for developing more effective learning models, not only in mathematics but also in other subjects that require a problem-based approach. Research by Musa'adah et al. (2024) on the use of animated videos to facilitate students' mathematical communication skills on the material of the system of linear equations of two variables showed that the media developed met the criteria of validity in terms of media by 92.28% (very valid) and in terms of material by 89.07% (very valid).

In the future, further research can explore how personalization of animated videos based

on students' level of understanding can improve learning effectiveness. In addition, further research could also evaluate the long-term impact of this method on concept retention and transfer of real-life problem-solving skills.

Overall, this study confirms that PBL-based LKPD with animated videos is an effective learning innovation, not only in improving students' problem-solving ability but also in building their confidence in facing academic challenges. The integration of multimedia in problem-based learning is one of the potential solutions to improve the quality of mathematics education in the digital era.

Conclusion

Overall, this study shows that the use of Problem-Based Learning (PBL)-based Learner Worksheets (LKPD) equipped with animated videos has a positive impact on students' mathematical problem solving ability and self-efficacy. In the context of the global challenge of low higher order thinking skills in mathematics education, this approach offers an innovative solution that integrates technology and problem-based learning strategies to improve student learning outcomes.

The results of this study confirmed that students using PBL-based LKPD with animated videos showed significant improvement in solving mathematical problems compared to the control group using conventional methods. This finding is in line with Mayer's (2021) multimedia learning theory, which emphasizes that a combination of visual and verbal stimulation can improve concept understanding more effectively. In addition, the increase in self-efficacy observed in the experimental group supports Bandura's (1997) theory, which states that belief in one's own abilities plays an important role in academic success.

From a practical perspective, this study provides important insights for educators and policy makers in developing more interactive and technology-based learning models to improve students' critical thinking and problem-solving skills. Thus, the integration of PBL and video animation not only enriches the learning experience, but also opens up opportunities for further research related to the implementation of this method in various learning contexts.

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Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this manuscript. In addition, the authors have completed the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies.

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Author Contributions

Tiara Kusuma Astuti: Conceptualization, writing - original draft, editing, and visualization; **Cecil Hiltrimartin:** Writing - review & editing, and formal analysis; **Yusuf Hartono:** Validation instrument, and methodology; review & editing.

References

Abdullah, N. A., Mukhtar, N. E. H., & Amran, N. (2020). Students' perceptions towards mathematical software based learning. *Sains Humanika*, *12*(3), 1–8. https://doi.org/10.11113/sh.v12n3.1085

Ahmad, A. M., Aziz, M. B. M., Salim, S. B., Shahrudin, M. S. B., & Bt Abdullah, W. M. (2021). The effectiveness of multimedia elements integrated into calculus learning using basical mobile application. *AIP Conference Proceedings*, *2423*, 1–9. https://doi.org/10.1063/5.0075675

Atteh, E., Assan-Donkoh, I., Ayiku, F., Nkansah, E., & Adams, A. K. (2020). The use of technology among school mathematics teachers and students: The new wave of recommended instructions. *Asian Research Journal of Mathematics*, *16*(5), 18–29. https://doi.org/10.9734/arjom/2020/v16i530189

Auliya, R. N., Pinahayu, E. A. R., & Adnyani, L. P. W. (2020). Pemanfaatan Microsoft Mathematics 4.0 dalam pengembangan pembelajaran matematika di SMA/SMK. *E-Dimas: Jurnal Pengabdian Kepada Masyarakat*, *11*(1), 107. https://doi.org/10.26877/e-dimas.v11i1.4629

Churchill, D. (2005). Learning objects: An interactive representation and a mediating tool in a learning activity. *Educational Media International*, *42*(4), 333–349. https://doi.org/10.1080/09523980500237757

Fahira, A. (2021). Pengaruh pendekatan STEM berbantuan Microsoft Mathematics terhadap pemahaman konsep matematis ditinjau dari tipe kepribadian siswa. *Jurnal Ilmiah Pendidikan Matematika AL-QALASADI*, *5*(1), 44–51.

Guzmán, M. O., Castro, S. O., Acuña, F. M., & Malo, E. S. (2019). Importance of coupling the teaching methodologies of mathematics with the learning styles of digital natives. *Journal of Physics: Conference Series*, *1414*(1). https://doi.org/10.1088/1742-6596/1414/1/012004

Habinuddin, E., & Binarto, A. (2020). Peningkatan kemampuan pemahaman kalkulus turunan berbantuan Geogebra. *Sigma-Mu*, *10*(1), 58–65. https://doi.org/10.35313/sigmamu.v10i1.1688

Harsa, F. S. (2016). Integrasi ICT dalam pembelajaran matematika. *Paedagogi: Jurnal Kajian Ilmu Pendidikan (e-Journal)*, *8*(2), 158–162. https://doi.org/10.24114/paedagogi.v8i2.8165

Hohenwarter, M., Hohenwarter, J., Kreis, Y., & Lavicza, Z. (2008). Teaching and calculus with free dynamic mathematics software GeoGebra. *11th International Congress on Mathematical Education*, 1–9.

Ilmadi, I., & Rusdiana, Y. (2019). Penggunaan Microsoft Math 4.0 untuk meningkatkan kemampuan pemahaman konsep matematis peserta didik. *Jurnal Karya Pendidikan Matematika*, *6*(2), 15–19. https://doi.org/10.26714/jkpm.6.2.2019.15-19

Maharani, N. (2023). Analys of student contraints in completing integral topics. *PENDIPA Journal of Science Education*, *7*(1), 53–57. https://doi.org/10.33369/pendipa.7.1.53-57

Mayasari, N., Hasanudin, C., Fitrianingsih, A., Jayanti, R., Setyorini, N., Kurniawan, P. Y., & Nurpratiwiningsih, L. (2021). The use of Microsoft Mathematics program toward students' learning achievement. *Journal of Physics: Conference Series*, *1764*, 1–6. https://doi.org/10.1088/1742-6596/1764/1/012132

Mendezabal, M. J. N., & Tindowen, D. J. C. (2018). Improving students' attitude, conceptual understanding and procedural skills in differential Calculus through microsoft mathematics. *Journal of Technology and Science Education*, *8*(4), 385–397. https://doi.org/10.3926/jotse.356

Monariska, E. (2019). Analisis kesulitan belajar mahasiswa pada materi integral. *Jurnal Analisa*, *5*(1), 9–19. https://doi.org/10.15575/ja.v5i1.4181

Naganjaneyulu, V., Ali, S. M., Ali, M. I., Jabeen, M., & Naseeruddin, S. (2020). Microsoft Mathematics as a teaching and learning tool for mathematics. *International Journal of Management and Humanities*, *5*(4), 55–59. https://doi.org/10.35940/ijmh.b1140.125420

Ningsi, G. P., Nendi, F., Jehadus, E., Sugiarti, L., & Kurnila, V. S. (2022). Analisis kesalahan mahasiswa dalam menyelesaikan soal kalkulus integral berdasarkan Newman's error analysis dan upaya pemberian scaffolding. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(3), 2698–2712. https://doi.org/10.31004/cendekia.v6i3.1469

Noor, N. L., Fakhriyana, D., & Widiyastuti, W. (2023). Pengembangan kualitas guru matematika madrasah aliyah melalui modul dan pelatihan Microsoft Mathematics. *Reswara : Jurnal Pengabdian Kepada Masyarakat*, *4*(2), 1356–1363. https://doi.org/https://doi.org/10.46576/rjpkm.v4i2.3300

Oktaviyanthi, R., & Supriani, Y. (2014). Pembelajaran kalkulus berbantuan Microsoft Mathematics. *AdMathEdu*, *4*(2). https://doi.org/10.12928/admathedu.v4i2.4799

Oktaviyanthi, R., & Supriani, Y. (2015). Utilizing microsoft mathematics in teaching and learning calculus. *Journal on Mathematics Education*, *6*(1), 63–76. https://doi.org/10.22342/jme.6.1.1902.63-76

Pranata, Y. A., & Kristianto, A. (2008). Visualisasi pembelajaran tekuk pada kolom dengan bantuan software berbasis perhitungan numerik. *Jurnal Teknik Sipil*, *4*(1), 77–86. https://doi.org/10.28932/jts.v4i1.1298

Rabi, F., Fengqi, M., & Aziz, M. (2022). The impact of the use of Microsoft Mathematics calculus visualization on student's attitude. *American Journal of Creative Education*, *5*(2), 52–66. https://doi.org/10.55284/ajce.v5i2.803

Saefuddin, E., Darmanto, N., & Husna, H. A. U. (2023). Pemanfaatan teknologi informasi dan komunikasi sebagai media pembelajaran di Politeknik Negeri Media Kreatif. *Jurnal TIK Dalam Pendidikan*, *10*(1), 33–37. https://doi.org/10.61476/xy1xwh12

Sitorus, B. R. (2022). Microsoft Sway dalam pembelajaran matematika di era digital. *Integral : Pendidikan Matematika*, *13*(2), 28–38. https://doi.org/10.32534/jnr.v13i2.2350

Sormin, M. A., Agustina, L., Samosir, B. S., Herawati Parapat, L., Khairunnisa, K., & Karimah, A. (2023). Comparative study of water based on Microsoft Mathematics with traditional learning. *Naturalistic: Jurnal Kajian Dan Penelitian Pendidikan Dan Pembelajaran*, *8*(1), 146–153. https://doi.org/10.35568/naturalistic.v8i1.4092

Sudihartinih, E., Hajizah, M. N., & Marzuki, M. (2021). Penggunaan teknologi digital pada perkuliahan matematika dasar untuk meningkatkan hasil belajar mahasiswa. *Suska Journal of Mathematics Education*, *7*(1), 59–66. https://doi.org/10.24014/sjme.v7i1.11723

Supianti, I. I. (2018). Pemanfataan teknologi informasi dan komunikasi (TIK) dalam pembelajaran matematika. *MENDIDIK: Jurnal Kajian Pendidikan Dan Pengajaran*, *4*(1), 63–70. https://doi.org/10.30653/003.201841.44

Svitek, S., Annuš, N., & Filip, F. (2022). Math can be visual-teaching and understanding arithmetical functions through visualization. *Mathematics*, *10*, 1–14. https://doi.org/10.3390/math10152656

Tanjung, K., & Yahfizham. (2024). Pemanfaatan media pembelajaran matematika berbantuan aplikasi Microsoft Mathematics. *Konstanta: Jurnal Matematika Dan Ilmu Pengetahuan Alam*, *2*(2), 84–90. https://doi.org/https://doi.org/10.59581/konstanta.v2i2.3155

Taufiq, T., Junaidi, J., & Mirunnisa, M. (2024). Media pembelajaran berbasis Software Microsoft Mathematics dalam pembelajaran aljabar untuk meningkatkan Self-Efficacy siswa SMP Negeri 1 Sakti. *Jurnal Sosial Humaniora Sigli*, *7*(1), 576–584. https://doi.org/10.47647/jsh.v7i1.2432

Voskoglou, M. G., & Salem, A. B. M. (2020). Benefits and limitations of the artificial with respect to the traditional learning of mathematics. *Mathematics*, *8*(4), 1–15. https://doi.org/10.3390/math8040611

Wahyuni, A. (2017). Analisis hambatan belajar mahasiswa pada mata kuliah kalkulus dasar. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *1*(1), 10–23. https://doi.org/10.33603/jnpm.v1i1.253

Zakaria, E., & Salleh, T. S. (2015). Using technology in learning integral calculus. *Mediterranean Journal of Social Sciences*, *6*(5S1), 144–148. https://doi.org/10.5901/mjss.2015.v6n5s1p144