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ADLX Introflex-Based GeoGebra Learning Media for Triangle and Quadrilateral Congruence: Supporting Mathematical Problem Solving and Learning Independence

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Abstract

Students' mathematical problem-solving ability and learning independence in Integrated Islamic Junior High Schools (SMP IT) still need to be improved. In addition, the implementation of ADLX Introflex-based learning has not been fully supported by interactive learning media. This study aimed to develop learning media based on ADLX Introflex assisted by GeoGebra for the topic of triangle and quadrilateral congruence and to describe its quality in terms of validity, practicality, and effectiveness. This research employed the Research and Development (R&D) method using the ADDIE model, consisting of Analyze, Design, Develop, Implement, and Evaluate stages. A small-scale trial was conducted at SMPIT Iqro Nogosari, Boyolali, while a large-scale trial was conducted at SMPIT Nur Hidayah Surakarta, involving eighth-grade students. Data were collected through interviews, observations, questionnaires, mathematical problem-solving tests, and learning independence questionnaires. Data were analyzed descriptively and quantitatively to determine the validity and practicality of the media, while its effectiveness was analyzed using a normality test and the Wilcoxon Signed Rank Test on pretest and posttest results. The results showed that the media obtained mean scores of 4.79 from material experts and 4.82 from media experts, both categorized as highly valid. Teacher and student responses indicated that the media was highly practical. Statistical analysis also showed significant improvements in students' mathematical problem-solving ability and learning independence. Therefore, the developed media is valid, practical, and effective for mathematics learning.

Keywords: ADLX Introflex, GeoGebra, learning media development, learning independence, mathematical problem solving.

1. Introduction

Mathematics is an important subject in school education for developing students' thinking and problem-solving skills (Ding et al., 2024). Mathematical problem-solving ability is an essential

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competency because it involves understanding situations, determining strategies, carrying out solutions, and evaluating results (Polya, 1973). The National Council of Teachers of Mathematics (NCTM, 2000) also places problem solving as one of the main process standards in mathematics education. Therefore, mathematics learning needs to provide experiences that allow students not merely to receive solution procedures but also to engage actively in thinking, exploring, and developing solution strategies.

Mathematical problem-solving ability is also related to students' learning independence. In solving problems, students need to regulate their learning processes, determine the steps to be taken, monitor the solution process, and reflect on the results obtained (Zulfah et al., 2025). Zimmerman (2000) explains that learning independence is associated with students' ability to regulate their thoughts, feelings, and actions to achieve learning goals. Learning that provides opportunities for students to explore, make decisions, and reflect has the potential to support the development of both problem-solving ability and learning independence (Knowles, 1975).

Rifai et al. (2025) investigated the implementation of an open-ended approach to improve vocational high school students' learning independence in mathematics. Their findings showed that the open-ended approach resulted in greater improvement in learning independence than the conventional approach. This study highlights the importance of providing students with opportunities to explore multiple solution strategies and take greater responsibility for their learning. Nevertheless, it did not specifically examine the integration of GeoGebra-based interactive media with the ADLX Introflex framework or its combined contribution to mathematical problem-solving skills and learning independence.

Preliminary observations at SMP Islam Terpadu Iqro Nogosari, Boyolali, indicated that some students experienced difficulties in solving mathematical problems that required reasoning. These difficulties included determining appropriate solution strategies and explaining the reasoning behind their answers. Some students also tended to rely on teachers' explanations and had limited opportunities to explore mathematical concepts independently. These conditions highlight the need for learning media that support both mathematical problem-solving skills and learning independence.

These conditions indicate the need to increase students' involvement in the learning process. One approach that is consistent with these characteristics is Active Deep Learner eXperience (ADLX) Introflex, which consists of individualization, interaction, observation, and reflection. ADLX Introflex emphasizes learning experiences through individualization, interaction, observation, and reflection integrated with the principles of Sajikan, Internalisasikan, and Terapkan (JSIT Indonesia, 2023; Diyanah et al., 2024). These characteristics provide opportunities for students to engage in active and deep learning experiences (Bahgat, 2018).

The implementation of student-oriented learning requires appropriate learning media to support the learning process (Smaldino et al., 2012). The use of digital technology can be an alternative to address this need. In mathematics education, technology can help present abstract concepts through visual representations and interactive activities (Hadi & Faradillah, 2022). One medium with these characteristics is GeoGebra. GeoGebra allows students to manipulate geometric objects, observe changes dynamically, test conjectures, and explore relationships among objects (Juandi et al., 2021;

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Triet & Loc, 2024; Gurmu et al., 2024). These characteristics are consistent with learning that positions students as active participants and provides opportunities for exploration and reflection.
Astuti et al. (2025) developed a GeoGebra-assisted electronic worksheet using a problem-based learning approach to improve junior high school students' numeracy literacy and learning activeness. Their findings indicated that the developed worksheet met the criteria for validity, practicality, and effectiveness. This study demonstrates the potential of integrating GeoGebra into digital mathematics learning materials to support students' active engagement and mathematical learning outcomes. However, the study focused on numeracy literacy and learning activeness rather than mathematical problem-solving skills and learning independence within an ADLX Introflex framework.
Triangle and quadrilateral congruence is a geometry topic that is relevant to the use of GeoGebra. Understanding congruence requires not only the ability to recall congruence criteria but also the ability to visualize relationships among geometric figures and identify corresponding sides and angles. Putri et al. (2019) reported the use of GeoGebra in teaching triangle congruence to eighth-grade students through learning activities designed to explore different cases of congruence. GeoGebra provides learning experiences through movable and manipulable geometric objects, allowing students to directly observe relationships among geometric elements.
Several studies have demonstrated the potential of ADLX Introflex to support active and reflective learning (Kontesa et al., 2023; Diyanah et al., 2024; Nurgenti & Wahyudi, 2025). Meanwhile, studies on GeoGebra have shown that the software can support mathematics learning through dynamic visualization and manipulation of objects (Juandi et al., 2021; Triet & Loc, 2024; Gurmu et al., 2024). However, studies integrating the characteristics of ADLX Introflex with GeoGebra in mathematics learning, particularly to facilitate students' mathematical problem-solving ability and learning independence in the context of Integrated Islamic Schools, remain limited. This gap provides an opportunity to develop learning media that not only utilize technology to visualize mathematical concepts but are also deliberately designed around individualization, interaction, observation, and reflection as components of students' learning experiences.
This study developed mathematics learning media based on ADLX Introflex assisted by GeoGebra for teaching triangle and quadrilateral congruence to eighth-grade students at an Integrated Islamic Junior High School. The novelty of this study lies in integrating the characteristics of ADLX Introflex into digital learning media assisted by GeoGebra, so that geometric exploration activities are not conducted independently but are directed toward active, deep, interactive, and reflective learning experiences. The developed media is also oriented toward supporting students' mathematical problem-solving ability and learning independence.
Although previous studies have demonstrated the potential of GeoGebra-based learning materials to support mathematics learning and the effectiveness of innovative learning approaches in promoting learning independence, further research is needed to integrate these aspects within a coherent instructional framework. The present study addresses this gap by developing GeoGebra-assisted mathematics learning media based on ADLX Introflex for triangle and quadrilateral congruence. Its distinctive contribution lies in translating the four Introflex components—Individualization, Interaction, Observation, and Reflection—into concrete learning activities

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designed to support both mathematical problem-solving skills and learning independence among eighth-grade students in Islamic integrated junior high schools.
This development study aimed to produce ADLX Introflex-based mathematics learning media assisted by GeoGebra that meets the criteria of validity, practicality, and effectiveness and is oriented toward students' mathematical problem-solving ability and learning independence in triangle and quadrilateral congruence.

2. Methods

This study employed a research and development (R&D) design aimed at producing ADLX Introflex-based mathematics learning media assisted by GeoGebra for teaching triangle and quadrilateral congruence. The developed media was oriented toward students' mathematical problem-solving ability and learning independence.
The development model used was the ADDIE model, which provides a systematic development process from needs analysis to product evaluation (Branch, 2009). In the Analyze stage, an analysis of needs, curriculum, learning materials, and available resources was conducted. The needs analysis involved observations and interviews with a mathematics teacher to identify problems encountered in the learning process. In the Design stage, the learning media was designed based on the results of the analysis. The design included the learning sequence, interactive activities, research instruments, and learning strategies based on ADLX Introflex. In the Development stage, the design was realized into interactive learning media. The media was then validated by material and media experts and revised based on their feedback.
In the Implementation stage, the revised product was used in the learning process. Implementation consisted of a limited trial and a field trial to obtain data regarding the practicality and effectiveness of the media. In the Evaluation stage, formative and summative evaluations were conducted. Formative evaluation was used to improve the product based on validation and trial results, whereas summative evaluation was conducted to determine the effectiveness of the media after its implementation in learning.
The effectiveness evaluation employed a one-group pretest–posttest design involving 30 eighth-grade students. Students' mathematical problem-solving ability and learning independence were measured before and after the implementation of the ADLX Introflex-based GeoGebra learning media. The pretest and posttest scores were analyzed using the Wilcoxon signed-rank test to examine differences between the two measurements. Because the evaluation did not include a comparison group, the findings were interpreted as evidence of changes following implementation rather than definitive evidence that the learning media alone caused the improvements.
ADLX Introflex was integrated into the media through activities that encouraged students to explore geometric objects, reflect on the results of their exploration, and strengthen their conceptual understanding. GeoGebra served as an interactive environment that enabled students to manipulate geometric objects and directly observe geometric relationships.
The limited trial involved 10 eighth-grade students from SMPIT Iqro Nogosari who were selected purposively. This trial aimed to obtain initial information regarding the readability, ease of use,

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and implementation of the media. The field trial was conducted in one eighth-grade class at SMPIT Nur Hidayah Surakarta involving 30 students. The participants were selected purposively based on student characteristics and recommendations from the mathematics teacher.
Data were collected using expert validation sheets, teacher and student response questionnaires, learning implementation observation sheets, mathematical problem-solving ability tests, and learning independence questionnaires. Each instrument was used to obtain data related to the corresponding aspects of product quality.
The validation sheets were used to determine the validity of the media. The response questionnaires and observation sheets were used to determine its practicality, while the mathematical problem-solving ability test and learning independence questionnaire were used to determine its effectiveness.
The data were analyzed quantitatively and qualitatively. Quantitative data consisting of validation scores, user responses, learning implementation scores, test results, and learning independence scores were analyzed descriptively and inferentially. Product validity was determined based on the average scores provided by the experts. Practicality was determined based on the percentages of teacher and student responses and learning implementation, referring to predetermined criteria (Tarwana, 2018).
The effectiveness of the media was assessed based on improvements in students' mathematical problem-solving ability and learning independence. Effectiveness was also determined based on the achievement of classical learning mastery. The effectiveness analysis began with a normality test. Normally distributed data were analyzed using a *paired-samples t-test*, whereas non-normally distributed data were analyzed using the *Wilcoxon signed-rank test* (Walpole, 2012). A proportion test was used to determine the achievement of classical learning mastery. Qualitative data in the form of comments and suggestions from validators, teachers, and students were analyzed descriptively and used as a basis for improving the developed media.

3. Result and Discussion

3.1 Development of ADLX Introflex-Assisted GeoGebra Learning Media

The development of the learning media was conducted using the ADDIE model, consisting of the Analyze, Design, Development, Implementation, and Evaluation stages. The analysis stage identified the need for interactive learning media that could facilitate active, meaningful, and independent learning while supporting students' mathematical problem-solving abilities. The analysis of curriculum and learning materials showed that triangle and quadrilateral congruence was appropriate for development using GeoGebra because geometric concepts can be visualized and manipulated dynamically.
The media was designed by integrating the principles of Active Learning, Deep Learning, and Learner Experience within the ADLX framework and the Individualization, Interaction, Observation, and Reflection principles of Introflex. The learning activities were also organized through the Terpadu approach consisting of Telaah, Eksplorasi, Rumuskan, Presentasikan,

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Aplikasikan, Duniawi, and Ukhrowi. These principles were implemented through interactive exploration, guiding questions, discussions, problem-solving activities, feedback, and reflection.

Figur 1. Geogebra Book display



The developed product was presented as a GeoGebra Book containing learning objectives, an introduction, triangle and quadrilateral congruence materials, interactive GeoGebra activities, problem-solving exercises, and reflection activities. Students could manipulate geometric objects through translation, reflection, and rotation to observe the relationships between corresponding sides, angles, shapes, and positions. For triangle congruence, the media included SSS, SAS, ASA, and AAS conditions. The media was also equipped with a *Check My Answer* feature and activities that supported independent learning by allowing students to explore concepts, monitor their answers, and reflect on their learning.

3.2 Product Validity and Practicality

The validity of the developed media was evaluated by material and media experts. The material validation obtained an average score of 4.79 and was categorized as very valid. The media validation obtained an average score of 4.82 and was also categorized as very valid. These results indicate that the developed media met the criteria of content suitability, mathematical accuracy, language clarity, visual presentation, interactivity, navigation, and compatibility with the ADLX Introflex framework.

Table 1. Validity Results of the Developed Media

Aspect	Average Score	Category
Material validity	4.79	Very valid
Media validity	4.82	Very valid

Source : Research results

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Following expert validation, several revisions were conducted, including improvements to the guidebook cover, consistency of transformation terminology, explicit presentation of Individualization, Interaction, Observation, and Reflection activities, and clarification of instructions for the GeoGebra exploration activities.
The practicality of the media was assessed through teacher and student responses. The teacher response obtained a percentage of 92.3%, categorized as very practical, while the student response obtained 93.31%, also categorized as very practical. These findings indicate that the media was considered easy to use, clearly presented, attractive, useful, and supportive of mathematics learning activities. The small-scale trial involving 10 students was conducted to identify readability, usability, and clarity of instructions before the product was implemented in the larger-scale trial.

Table 2. Practicality Results of the Developed Media

Respondent	Percentage	Category
Teacher	92.30%	Very practical
Students	93.31%	Very practical

Source : Research results

3.3 Effectiveness of the Media on Mathematical Problem-Solving Ability

The effectiveness of the media in improving students' mathematical problem-solving ability was examined through pretest and posttest scores involving 30 students. The data were analyzed using the Wilcoxon Signed Rank Test because the Shapiro-Wilk normality test indicated that both pretest and posttest data were not normally distributed.

Table 3. Descriptive Statistics of Mathematical Problem-Solving Scores

Statistic	Pretest	Posttest
Mean	62.97	76.10
Median	65.50	75.00
Standard deviation	7.72	8.39
Minimum	40	50
Maximum	75	95

Source : Research results

The Wilcoxon test resulted in a Z value of −4.789 with an Asymp. Sig. (2-tailed) value of 0.000 ($p < 0.05$). The results showed 30 positive ranks, with no negative ranks and no ties, indicating that all students obtained higher posttest scores than pretest scores. Therefore, there was a statistically significant difference between students' mathematical problem-solving ability before and after using the developed media.

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Table 4. Effectiveness Results for Mathematical Problem-Solving Ability

Indicator	Result
Sample	30 students
Positive ranks	30
Negative ranks	0
Ties	0
Wilcoxon Z	−4.789
Sig. (2-tailed)	0.000
Classical mastery	86.67%
Mastery criterion	>70%

Source : Research results

The effectiveness was also examined through classical mastery. A total of 26 out of 30 students achieved the predetermined mastery criterion of 75, resulting in a classical mastery percentage of 86.67%. The one-sample proportion test showed that this proportion was significantly higher than the predetermined criterion of 70%. Thus, the developed media met the effectiveness criterion in terms of students' mathematical problem-solving ability.

3.4 Effectiveness of the Media on Students' Learning Independence

The effectiveness of the media in supporting students' learning independence was also analyzed using pretest and posttest scores. Because the data did not meet the normality assumption, the Wilcoxon Signed Rank Test was applied.

Table 5. Descriptive Statistics of Students' Learning Independence Scores

Statistic	Pretest	Posttest
Mean	60.24	77.63
Median	59.20	79.20
Standard deviation	3.93	5.22
Minimum	55.20	64.00
Maximum	67.20	84.80

Source : Research results

The analysis resulted in a Z value of −4.785 with an Asymp. Sig. (2-tailed) value of 0.000 ($p < 0.05$). The results showed 30 positive ranks, no negative ranks, and no ties, indicating that all students experienced an increase in their learning independence scores after using the developed media.

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Table 6. Effectiveness Results for Students' Learning Independence

Indicator	Result
Sample	30 students
Positive ranks	30
Negative ranks	0
Ties	0
Wilcoxon Z	−4.785
Sig. (2-tailed)	0.000
Classical mastery	90%
Mastery criterion	>70%

Source : Research results

The classical mastery analysis showed that 27 of 30 students achieved the predetermined criterion, resulting in a percentage of 90%. The one-sample proportion test indicated that the proportion was significantly higher than 70%. Therefore, the developed media fulfilled the effectiveness criterion in terms of students' learning independence.

3.5 Discussion

The findings indicate that the developed ADLX Introflex-assisted GeoGebra learning media fulfilled the criteria of validity, practicality, and effectiveness. The high validity scores demonstrate that the media was appropriate in terms of content, presentation, visual design, and learning characteristics. The practicality results indicate that both teachers and students were able to use the media effectively during learning activities.

The effectiveness of the media can be attributed to the integration of dynamic GeoGebra visualization and ADLX Introflex learning activities. GeoGebra allowed students to directly manipulate geometric objects and observe changes in position and orientation while maintaining their shape and size. Such activities provided opportunities for students to explore, test conjectures, identify relationships, and construct an understanding of congruence before applying the concepts to mathematical problems.

The results of the present study also relate to the research conducted by Khotimah et al. (2026), which examined digital learning media assisted by GeoGebra Classroom within a project-based learning approach. Both studies highlight the potential of GeoGebra-supported digital media in mathematics education. However, the present study differs in its instructional framework, mathematical topic, and learning outcomes. Rather than focusing on project-based learning and mathematics learning outcomes in trigonometry, the present study integrates ADLX Introflex into learning activities on triangle and quadrilateral congruence, with particular attention to mathematical problem-solving skills and learning independence.

The integration of Individualization, Interaction, Observation, and Reflection also supported students' learning independence. Individualization allowed students to learn according to their own pace, while Interaction encouraged communication and discussion during learning activities.

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Observation was facilitated through dynamic visualization of geometric objects, and Reflection was supported through guiding questions, *Check My Answer*, problem-solving activities, and learning reflection. These characteristics provided students with opportunities to monitor and evaluate their own learning processes.

The significant improvement in mathematical problem-solving ability is consistent with previous findings regarding the use of GeoGebra in mathematics learning. The results also support the ADLX perspective that active and meaningful learning experiences can facilitate deeper understanding. The novelty of this study lies in the integration of ADLX Introflex principles with GeoGebra within a single learning media specifically developed for triangle and quadrilateral congruence. The integration not only facilitates visualization of geometric concepts but also provides structured learning experiences aimed at developing mathematical problem-solving ability and learning independence.

The improvement in students' learning independence observed in the present study can also be discussed in relation to the findings of Rifai et al. (2025), who reported that an open-ended learning approach led to greater improvement in vocational high school students' learning independence than the conventional approach. Both studies emphasize the importance of learning experiences that encourage students to take an active role in their learning. However, the present study approaches this goal through GeoGebra-assisted media based on ADLX Introflex, which incorporates individualization, interaction, observation, and reflection into mathematics learning activities.

Nevertheless, this study has several limitations. The developed media was limited to triangle and quadrilateral congruence for Grade VIII students. Some students did not have personal devices and therefore had to use shared devices or school facilities. The relatively short research period also limited repeated and more extensive trials. In addition, the large-scale trial involved only one class, so the findings should be interpreted within the context of the research participants and cannot yet be generalized to a wider population.

4. Conclusion

Based on the results of the research and development, a mathematics learning media based on ADLX Introflex and assisted by GeoGebra was developed for teaching triangle and quadrilateral congruence to eighth-grade students at an integrated Islamic junior high school (SMPIT). The media integrates the principles of *Active Learning, Deep Learning,* and *Learner Experience*, as well as the components of individualization, interaction, observation, and reflection through GeoGebra exploration activities, guiding questions, *Check My Answer* features, problem-solving exercises, and evaluation activities.

The developed media met the criteria of very valid, very practical, and effective. Its validity was demonstrated by the average scores of 4.79 from the material experts and 4.82 from the media experts. Its practicality was indicated by a teacher response rate of 92.3%, a student response rate of 93.31%, and the implementation of learning activities in the very good category. Its effectiveness was demonstrated by a significant difference between the pretest and posttest results in students'

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mathematical problem-solving skills and learning independence, as well as the achievement of learning mastery by more than 70% of the students.
The media can be utilized by teachers as an alternative for interactive mathematics instruction and by students to support concept exploration, problem solving, and independent learning. Schools are expected to support the use of digital learning media by providing adequate facilities and infrastructure. Future researchers may develop ADLX Introflex-based learning media assisted by GeoGebra for different topics and educational levels, while incorporating more adaptive features, such as automated feedback and difficulty-level adjustment.

5. References

Bahgat, Mohamed, Ashraf Elsafty, Ashraf Shaarawy, dan Tamer Said. (2018). *First Framework Design and Facilitate Active Deep Learner experience*. Journal of Education and Training Studies 6 (8): 123. https://doi.org/10.11114/jets.v6i8.3337

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer. https://doi.org/10.1007/978-0-387-09506-6

Ding, Y., Klapp, A., & Yang Hansen, K. (2024). *The importance of mathematics self-concept and self-efficacy for mathematics achievement: A comparison between public and independent schools in Sweden.* Educational Psychology. https://eric.ed.gov/?id=EJ1447112

Diyanah, Rif'atud, Kusumawati, Endah Tri, & Lestari, Yayuk Sri. 2024. *Penerapan Pembelajaran Berbasis ADLX Terpadu Berdiferensiasi untuk Meningkatkan Hasil Belajar Algoritma Pemrograman Scratch Siswa*. 5(1), 14-27.

Dyana Astuti, Yumiati, & Sudirman. (2025). Development of Problem-Based E-Worksheet Assisted by GeoGebra to Improve Numeracy Literacy and Student Learning Activeness in Junior High School. *EduMatSains : Jurnal Pendidikan, Matematika Dan Sains*, *10*(1), 419–430. https://doi.org/10.33541/edumatsains.v10i1.6944

Gurmu, F., Tuge, C., & Hunde, A. B. (2024). *Effects of GeoGebra-assisted instructional methods on students' conceptual understanding of geometry*. *Cogent Education, 11*(1), 2379745. https://doi.org/10.1080/2331186X.2024.2379745

Hadi, W., & Faradillah, A. (2022). *Implementation of GeoGebra online based on guided inquiry to increase problem solving ability and student learning independence*. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 11*(2), 882–890. https://doi.org/10.24127/ajpm.v11i2.5000

Husnul Khotimah, Amin Harahap, & Lily Rohanita Hasibuan. (2026). The Effectiveness of Digital Learning Media Based on Project Based Learning Assisted by Geogebra Classroom on Mathematics Learning Outcomes of Vocational High School Students. *EduMatSains : Jurnal Pendidikan, Matematika Dan Sains*, *10*(4), 349–359. https://doi.org/10.33541/edumatsains.v10i4.8082

JSIT Indonesia. (2023). Standar Mutu Kekhasan Sekolah Islam Terpadu. Harlis Kurniawan (Ed). JSIT Indonesia Publishing.

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Juandi, D., Kusumah, Y. S., Tamur, M., Perbowo, K. S., & Wijaya, T. T. (2021). *A meta-analysis of GeoGebra software decade of assisted mathematics learning: What to learn and where to go? Heliyon, 7*(6), e06953. https://doi.org/10.1016/j.heliyon.2021.e06953

Knowles, M. S. (1975). *Self-directed learning: A guide for learners and teachers*. New York: Association Press.

Kontesa, D. A., Minsih, & Fuadi, D. (2023). *Penerapan pendekatan pembelajaran Active Deep Learner Experience dalam membangun kemandirian belajar siswa sekolah dasar*. *Jurnal Elementaria Edukasia, 6*(3), 1416–1427. https://doi.org/10.31949/jee.v6i3.6638

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics.* Reston, VA: NCTM.

Nurgenti, S., & Wahyudi, A. (2025). *Implementasi pembelajaran PAI berbasis ADLX Introflex di SMAIT Ishlahul Ummah Prabumulih*. Muaddib: Jurnal Studi Kependidikan dan Keislaman, *7*(2), 1–10. https://doi.org/10.46773/muaddib.v7i2.1798

Polya, G. (1973). *How to solve it: A new aspect of mathematical method.* Princeton University Press.

Putri, N. A. S., Faradiba, S. S., & Khairunnisa, G. F. (2024). *Students' mathematical problem-solving ability of class-VIII through the GeoGebra-assisted POGIL learning model*. *International Journal on Emerging Mathematics Education, 8*(2), 111–118. https://doi.org/10.12928/ijeme.v8i2.26585

Rifai, R., Turmudi, Jarnawi Afgani Dahlan, & Suhendra. (2025). Implementation of Open-Ended Approach in Mathematics Learning to Improve Learning Independence of Vocational High School Students. *EduMatSains : Jurnal Pendidikan, Matematika Dan Sains*, *10*(1), 88–97. https://doi.org/10.33541/edumatsains.v10i1.6710

Smaldino, S. E., Lowther, D. L., & Russell, J. D. (2012). *Instructional technology and media for learning* (9th ed.). Boston, MA: Pearson

Tarwana, B. (2018). Efektivitas dan kepraktisan pengembangan media pembelajaran. *Jurnal Ilmiah Pendidikan Teknik Elektro*, 3(1), 1–10.

Triet, L. V. M., Loc, N. P., & Ngan, N. N. T. (2024). *Effect of GeoGebra–supported 5E learning model on students' understanding of the area of a trapezium: A quasi-experimental study*. Mathematics Teaching Research Journal, 16(6), 190-213. Retrieved from https://files.eric.ed.gov/fulltext/EJ1464255.pdf

Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (2012). *Probability and statistics for engineers and scientists* (9th ed.). Pearson.

Zimmerman, B. J. (2000). *Self-efficacy: An essential motive to learn*. *Contemporary Educational Psychology, 25*(1), 82–91. https://doi.org/10.1006/ceps.1999.1016

Zulfah, E., Fauzan, A., & Arnawa, I. M. (2025). *Pengembangan local instructional theory topik segi empat berbasis RME untuk meningkatkan kemampuan pemecahan masalah matematis.* AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 14(2), 381–393. https://doi.org/10.24127/ajpm.v14i2.10285

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