Jurnal Gantang *11*(1) (2026): 127 - 136

JURNAL GANTANG

e-ISSN: 2548-5547
p-ISSN: 2503-0671

http://ojs.umrah.ac.id/index.php/gantang/index

Validity of a computational thinking and artificial intelligence-based electronic student worksheet in the context of deforestation

Farah Nabilah Tampubolon, Hapizah*, Meryansumayeka

Universitas Sriwijaya, Palembang, Sumatera Selatan, 30139, Indonesia
*Corresponding Author: hapizah@fkip.unsri.ac.id

Submission: November 16th 2025; Accepted: May 24th 2026; Published: May 31st 2026
DOI: https://doi.org/10.31629/jg.v11i1.7914

Abstract

Indonesian students' mathematical literacy remains below the OECD average, with international assessments indicating persistent difficulty in translating contextual problems into systematic mathematical reasoning, a gap that Computational Thinking (CT) is theorized to help close. This study examines the validity of a Computational Thinking-based electronic student worksheet (E-LKPD), supported by Artificial Intelligence (AI), in the context of deforestation on the topic of Linear Equation System in Two Variables (SPLDV). The research addresses the need for valid learning tools that strengthen students' mathematical problem-solving skills while promoting environmental awareness, examining how CT skills and environmental issues can be meaningfully integrated, with AI assisting the algorithmic stage of CT through automated feedback, solution-strategy hints, and adaptive task difficulty. The method used is design research with a development studies approach, focusing on preliminary research and prototyping. Validation involved expert review by subject-matter, media, and education experts, together with one-to-one student evaluations, to assess content, construct, language, and visual aspects. Results show that the CT-based E-LKPD with AI support meets the established validity criteria for content accuracy, presentation, and media quality. The developed E-LKPD is thus feasible for use as a learning tool integrating computational thinking, artificial intelligence, and environmental awareness.

Keywords: computational thinking; deforestation; E-LKPD; SPLDV; validity

How to cite: Tampubolon, F. N., Hapizah, & Meryansumayeka. (2026). Validity of a computational thinking and artificial intelligence-based electronic student worksheet in the context of deforestation. *Jurnal Gantang, 11*(1), 127 – 136. https://doi.org/10.31629/jg.v11i1.7914

I. Introduction

In the 21st century, education has undergone significant transformation, emphasizing digital competence, problem-solving, and the integration of technology into learning (Muliardi, 2023). Mathematics education plays a crucial role in developing students' higher-order thinking skills and preparing them to solve real-world problems (Sukendra & Sumandya, 2020). However, international assessments such as the Programme for International Student Assessment (PISA) consistently show that Indonesian students' mathematical literacy remains below the OECD average, indicating weaknesses in applying mathematical reasoning to contextual problems (Al Husna, Amir & Vebrianto, 2021).

JURNAL GANTANG. May 2026; *11*(1): 127 - 136
p-ISSN. 2503-0671
e-ISSN. 2548-5547

Context-based learning is one strategy that can help address this issue by connecting mathematical concepts with authentic real-world phenomena (Senoaji, Hidayat & Iskandarl, 2020). Among the many available real-world contexts, environmental issues are particularly suitable: they are locally observable, data-rich, and pedagogically aligned with global sustainability agendas, which makes them an effective vehicle for constructing authentic mathematical tasks. Deforestation is a pressing and quantifiable environmental issue in Indonesia that provides rich numerical data, such as annual forest-loss figures across regions, suitable for constructing SPLDV word problems, while simultaneously fostering environmental awareness (Mutia, Muslih& Basri, 2023; Zulkarnain, Hidayanto & Riza, 2021). This integration aligns with Sustainable Development Goal 15 (Life on Land) by linking mathematics education to real environmental challenges (Annisa, Suanto & Maimunah, 2023; Azma, Hapizah, & Darmawijoyo, 2024).

At the same time, Computational Thinking (CT) has emerged as an essential 21st-century skill, enabling students to solve problems systematically through decomposition, pattern recognition, abstraction, and algorithmic thinking (Cahdriyana & Richardo, 2020). Internationally, CT is increasingly framed as a fundamental, transferable problem-solving skill in mathematics teaching, closely related to, yet distinct from, the use of AI as a computational aid (Carvalho e Silva, 2025; Pinheiro & Santos, 2025). Integrating CT into mathematics learning helps students organize information logically, analyze relationships, and construct models that support reasoning and problem-solving (Ramadoni, Aima & Mardiyah, 2024; Sarman Suastika & Murniasih, 2023).

Despite this potential, empirical studies indicate that CT remains difficult to operationalize in Indonesian mathematics classrooms: students continue to struggle, particularly with the abstraction and algorithmic-thinking stages, when solving contextual problems related to the System of Linear Equations in Two Variables (SPLDV) (Al Husna et al., 2021). Ostian, Hapizah and Mulyonol (2023) further found that even when CT stages were embedded in a locally contextualized e-worksheet, students still required considerable scaffolding to complete the decomposition and algorithm-design steps independently. Together, these findings indicate that successfully integrating CT into a worksheet depends not merely on labeling activities with CT-stage names, but on how much structured, stage-specific support, such as adaptive feedback, is provided to guide students through each stage. This is precisely the gap in structured support that motivates the use of AI in the present study.

Recent advances in Artificial Intelligence (AI) have created new opportunities to enhance digital learning by providing exactly this kind of adaptive and personalized support (Pratiwi & Silalahi, 2021; Ahmad, Rahmat, Mubarik, Alam, & Hyder, 2021). AI can analyze student responses, generate instant feedback, and tailor learning experiences to individual needs (Fahrudin, Sollikhin & Masruroh, 2024; Ahmad, Rahmat, Mubarik, Alam & Hyder, 2021; Koe, Kustandi & Siregar, 2025), making it an effective tool for creating intelligent and interactive learning environments that respond to the specific CT stages where students are known to struggle (Korkmaz, Boran, & Yildiz, 2024).

The integration of CT and AI into digital learning tools such as Electronic Student Worksheets (E-LKPD, an Indonesian term for a digital "Lembar Kerja Peserta Didik," or student activity sheet) aligns with modern pedagogical principles that emphasize independence, interactivity, and contextual understanding. However, previous E-LKPD studies (Istiqomah, Arigiyati, Wijayanti & Widodo, 2021; Nabilla, Edy & Khikmiyah, 2022; Ananda & Soro, 2023) have primarily focused on improving cognitive outcomes through general interactivity features, without embedding a structured computational-thinking framework or an environmental problem context. Closely related work by Ostian et al.

(2023) developed a CT-based interactive e-worksheet situated in a South Sumatran traditional-game context and reported strong validity, demonstrating that CT stages can feasibly be scaffolded within a digital worksheet; however, that study did not incorporate an environmental theme or AI-based adaptive support. Building on this line of work, the present study proposes a combination that, to our knowledge, has not been previously tested: embedding the four CT stages within an authentic deforestation context while using AI to provide stage-specific adaptive feedback, thereby extending both the contextual scope (from cultural to environmental) and the technological scope (from static to AI-adaptive) of existing CT-based e-worksheets.

Therefore, this study aims to develop and validate an E-LKPD based on Computational Thinking and Artificial Intelligence in the context of deforestation, focusing on the validity aspects of content, construct, and language. This research contributes to the advancement of technology-integrated and sustainability-oriented mathematics learning in secondary education (Bakker & Korthagen, 2019).

II. Research Method

This study adopts a Research and Development (R&D) approach utilizing the Design Research methodology (Bakker & Korthagen, 2019). The purpose of this research is to design, develop, and validate an E-LKPD that integrates Computational Thinking (CT) and Artificial Intelligence (AI) within the context of deforestation. The study focuses on examining the validity of the developed E-LKPD, which includes content validity, construct validity, and language validity. The development process consists of three main stages.

The AI technology integrated into the e-LKPD was ChatGPT, which functioned as a learning assistant during the algorithmic-thinking stage of the Computational Thinking (CT) process. ChatGPT provided guidance, explanations, automated feedback on students' solutions, and hints toward appropriate problem-solving strategies. Rather than replacing students' reasoning, ChatGPT was designed to scaffold their computational thinking by encouraging reflection and independent problem solving.

The deforestation context was deliberately scoped to Indonesian forest-cover-loss data obtained from published statistics of the Indonesian Ministry of Environment and Forestry (KLHK). These statistics were adapted into narrative scenarios and simplified numerical values to construct contextual Systems of Linear Equations in Two Variables (SPLDV) problems. The numerical values served solely as authentic learning contexts for mathematics instruction, enabling students to formulate and solve SPLDV problems in a meaningful real-world setting. The data were not analyzed scientifically, nor were they intended to draw conclusions about deforestation trends or environmental conditions.

The Preliminary Research stage involves problem identification, literature review, needs analysis, and the design of the E-LKPD framework incorporating the CT components and AI-based support described above. The Prototyping Phase includes self-evaluation of the initial prototype, expert review by content, media, and language experts, and one-to-one evaluation with three students to assess clarity and usability. The Assessment Phase consists of collecting data from expert validation and small-scale testing, followed by analyzing the E-LKPD's validity scores.

The research subjects consisted of two groups. The first group comprised three experts: a mathematics content expert, a media expert, and a language expert who evaluated the E-LKPD using the validation instrument. The second group consisted of three ninth grade students of SMP Negeri 32 Palembang, selected purposively in consultation with the class teacher to represent high, medium, and low levels of mathematics achievement, who took part in the one-to-one evaluation to assess the clarity, readability, and usability of the E-LKPD from a learner's perspective.

JURNAL GANTANG. May 2026; *11*(1): 127 - 136
p-ISSN. 2503-0671
e-ISSN. 2548-5547

The expert validation sheet was structured around the three validity dimensions, each broken down into specific indicators: (1) content validity alignment of worksheet tasks with the SPLDV curriculum, accuracy of the deforestation data used, and clarity of each CT stage (decomposition, pattern recognition, abstraction, algorithmic thinking) as presented in the tasks; (2) construct validity logical sequencing of activities, consistency of layout, and appropriateness of the AI-based feedback placement within the CT workflow; and (3) language validity clarity, grammatical correctness, and age-appropriateness of the instructional language. Observation sheets and interview guides were used in parallel to gather qualitative feedback from the one-to-one student evaluation.

Data were collected using a 4-point Likert scale (1 = invalid, 2 = fairly valid, 3 = valid, 4 = very valid) and analyzed descriptively using the following formula (Akbar, 2013):

$$Validity = \frac{Total\ score\ obtained}{Maximun\ score} \times 100\% \quad (1)$$

Following this formula, the product is categorized as very valid (81–100%), valid (61–80%), fairly valid (41–60%), or less valid (0-40%) (Akbar, 2013). Before use, the validation instrument was reviewed for content adequacy by the three experts, and inter-rater consistency among the three validators was qualitatively assessed to ensure that the scores reasonably converged before averaging. The study was conducted at SMP Negeri 32 Palembang during the 2025/2026 academic year.

III. Results and Discussion

Before presenting the validity results, this section first describes the developed product. The E-LKPD is a digital student worksheet designed around the four stages of Computational Thinking (CT), using the context of deforestation to learn Systems of Linear Equations in Two Variables (SPLDV). The worksheet consists of a cover page, learning objectives, instructions for use, contextual problems, CT-based learning activities, reflection questions, and evaluation tasks.

The learning activities are organized according to the four stages of Computational Thinking. (1) Decomposition: students identify the known and unknown information from the contextual problem and determine the variables that will be used in the SPLDV model. (2) Pattern Recognition: students identify relationships among the given numerical information and formulate two linear equations representing the problem situation. (3) Abstraction: students simplify the contextual problem by expressing it as a mathematical model in the form of an SPLDV while focusing only on the relevant variables and relationships. (4) Algorithmic Thinking: students solve the resulting system of linear equations using a systematic procedure. At this stage, ChatGPT serves as a learning assistant, providing explanations, guidance, feedback on students' solution steps, and hints as needed, while students remain responsible for completing the solution independently. The numerical values presented in the contextual problems were adapted solely to construct authentic SPLDV learning tasks and were not intended for scientific analysis of deforestation.

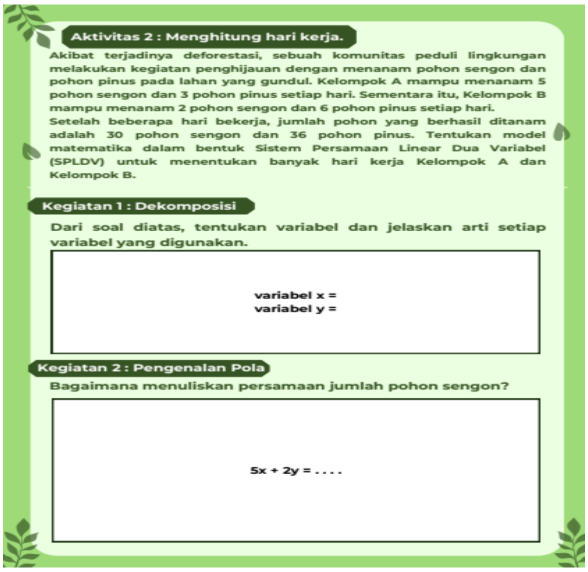


Figure 1. Example of a CT stage activity page (decomposition and pattern recognition) in the E-LKPD.

Figure 2. The algorithmic thinking stage, where the AI (ChatGPT) feature is integrated to provide guidance and feedback.

The validity test was conducted by three experts: a content expert, a media expert, and a language expert. Each expert assessed the E-LKPD using a 4-point Likert scale (1 = invalid, 2 = fairly valid, 3 = valid, 4 = very valid), covering the three aspects above: content, construct, and language. The goal of the validation process was to assess the degree of content relevance, construct appropriateness, and linguistic clarity of the E-LKPD before implementation. The validation results are shown in Table 1.

Table 1. Validation result

Aspect	Mean Score	Percentage (%)	Category
Content	3.85	96.00	Very Valid
Construct	3.80	95.00	Very Valid
Language	3.90	97.50	Very Valid
Average	3.85	96.25	Very Valid

Note. Percentages are computed per aspect as (total score obtained / maximum possible score) × 100%. The Average row is calculated from the mean of the three aspects' raw scores (3.85/4 × 100% = 96.25%), not from averaging the three percentages above it (96.00% + 95.00% + 97.50%) / 3 = 96.17%, which would differ slightly due to rounding.

Table 1 shows that the overall mean score of 3.85 (96.25%) falls under the very valid category. This indicates that the E-LKPD meets expert criteria for content alignment, construct design, and language use. The language aspect scored the highest (97.50%), demonstrating that the language used in the E-LKPD was clear, communicative, and appropriate for students' comprehension levels. The content aspect also showed very high validity (96.00%), indicating that the learning materials, questions, and computational thinking components were well aligned with the learning objectives. The construct aspect likewise showed high validity (95.00%), suggesting that the design and structure of the E-LKPD were logically organized and pedagogically sound.

The high validity score demonstrates that the developed E-LKPD fulfills the criteria for a valid learning instrument. This finding supports the claim that E-LKPDs integrating CT and AI can be effectively designed for mathematics learning in contextual topics such as deforestation and is consistent with Pinheiro and Santos (2025), who argue that combining CT and AI within a single learning pathway strengthens both the algorithmic and adaptive dimensions of mathematics instruction.

The content validity results confirm that the E-LKPD materials align with the mathematics curriculum and emphasize problem-solving through the CT processes of decomposition, pattern recognition, abstraction, and algorithmic thinking (Cahdriyana & Richardo, 2020). The contextual approach, using deforestation data, encourages students to connect mathematical concepts to real-world sustainability issues, thereby supporting SDG 15: Life on Land (Annisa et al., 2023). This linkage is not only thematic, as the SPLDV tasks are built directly from real deforestation figures; correctly solving the mathematical problem requires students to engage with the same quantitative trends that underlie environmental policy discussions, which is why the validators rated the content dimension as highly aligned with both the curriculum and the sustainability agenda. Compared with Ostian et al.

(2023), who validated a CT-based e-worksheet in a traditional-game context and reported a similarly high level of validity, the present result indicates that CT stages can be scaffolded with comparable success regardless of whether the surrounding context is cultural or environmental. This pattern also stands out against E-LKPD development studies that do not structure their content around explicit CT stages: Sarman et al. (2023), for example, reported a considerably lower material-validity score of 78.67% for a problem-solving-oriented E-LKPD without a CT framework. While this comparison cannot isolate the causal contribution of CT scaffolding, given differences in topic, instrument, and validators across studies, it is consistent with the possibility that explicit CT structuring, alongside the chosen context, contributes meaningfully to content validity.

The construct validity indicates that the learning flow, layout, and AI-assisted interactions were well designed and consistent with the instructional design principles proposed by Bakker and Korthagen (2019). AI elements such as interactive hints and adaptive question sequencing made the E-LKPD more engaging and individualized (Pratiwi & Silalahi, 2021; Fahrudin et al., 2024). The reason this design choice raised construct validity rather than simply adding a visual feature is that the adaptive hints were placed specifically at the algorithmic-thinking stage identified as the most error-prone step in prior CT research (Ostian et al., 2023); by targeting support to the stage where students are known to struggle, the worksheet's structure directly reflects, rather than merely follows, Bakker and Korthagen's (2019) design-research principle that instructional scaffolding should be responsive to documented learning obstacles. This is also consistent with Carvalho e Silva (2025), who contends that CT and AI serve complementary rather than interchangeable roles: CT structures the algorithmic dimension of a task, while AI adapts the level of support a student receives as they work through it.

The language validity findings also support earlier studies (Septiana, Hapizah, & Mulyono., 2024), emphasizing the importance of communicative and age-appropriate language to help students comprehend digital learning content. Overall, the E-LKPD is categorized as very valid and ready to proceed to the next research stage, which includes practicality testing (one-to-one and small-group trials) and effectiveness analysis to measure its impact on students' problem-solving abilities.

Based on expert feedback, several revisions were made to improve the clarity, aesthetics, and usability of the E-LKPD. The main improvements are summarized in Table 2.

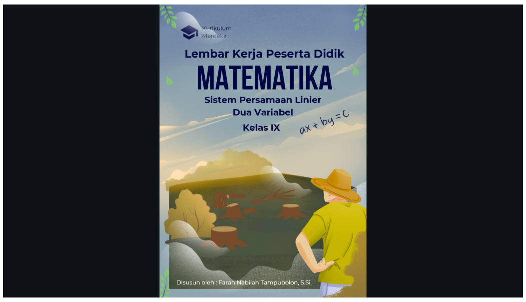
Table 2. Product revision based on expert feedback

Revised Aspect	Validator Feedback	Revision Result
E-LKPD Design	The illustration of deforestation on the cover and several content pages was not detailed or contextual enough.	The illustrations on the cover and several content pages were replaced with more representative visuals depicting the condition of deforestation.
Layout	Inconsistent layout across pages.	Standardized font sizes, heading styles, and CT step icons.
Page Order	Description and work instructions were swapped.	The description page is placed first, followed by the instructions.
Language and Problem Statements	The wording of the pattern-recognition items should use the term "mathematical model" when referring to the number of rubber and acacia trees.	The wording of the pattern-recognition questions and instructions was revised to consistently use the term "mathematical model" to refer to the number of rubber trees and acacia trees in the SPLDV problems.

The revisions included improving clarity, enhancing visual design, adjusting instructional flow, and strengthening the integration of CT and AI components. These revisions enhanced the visual appeal, accessibility, and pedagogical effectiveness of the E-LKPD.

The cover revision results are presented in Table 3. These revisions were made to ensure that the cover design aligns with the theme of deforestation and more clearly reflects the learning media's identity.

Table 3. Cover revision (before / after)

Before	After
	

The cover revisions shown in Table 3 illustrate the adjustments made in response to validator feedback. The revisions include refining the title and adjusting the illustration to better reflect the context of deforestation. All suggestions have been accommodated, making the final cover more informative, attractive, and consistent with the overall learning media.

After implementing the revisions, the experts reconfirmed that the E-LKPD was highly valid and ready for the practicality phase. These improvements enhanced the visual design, pedagogical flow, and interactive AI components, making the E-LKPD more engaging, accessible, and contextually relevant for students.

In addition to the expert validation, a one-to-one evaluation was conducted with three ninth-grade students of SMP Negeri 32 Palembang, representing high, medium, and low levels of mathematics achievement, to examine the clarity, readability, and usability of the E-LKPD from a learner’s perspective. Each student accessed and used the AI-assisted E-LKPD individually while the researcher observed their interaction with the worksheet and gathered responses through brief interviews. The observation results revealed three main findings. First, several students had difficulty following the Computational Thinking stages because the instructions for decomposition, pattern recognition, abstraction, and algorithmic thinking were not displayed sequentially and were still merged with the general usage instructions. Second, some students did not immediately notice the AI feature because the AI button was not clearly visible during the learning activity. Third, some students began working on the problems directly without first watching the instructional video, as no clear direction was given to do so before starting the activity.

Based on these findings, the E-LKPD was revised by reorganizing the Computational Thinking instructions so that the four stages were displayed sequentially, repositioning the AI button closer to the problem-solving activity to make it easier to locate, and adding a clearer instruction directing students to watch the instructional video before beginning the tasks. Despite these initial obstacles, students generally responded positively to the E-LKPD, reporting that its appearance was attractive, the learning activities were easy to follow, and the deforestation context made the learning experience more meaningful. These one-to-one results indicate that, following minor revisions, the E-LKPD is sufficiently clear and usable for classroom use, complementing the strong validity scores from the expert review and further supporting the E-LKPD's readiness for subsequent small-group and effectiveness testing.

Compared with Ostian et al. (2023), whose CT-based e-worksheet in a traditional-game context achieved a similarly high validity level, and with Septiana et al. (2024), who likewise reported valid outcomes for a CT-oriented worksheet situated in a different South Sumatran local context, the present findings suggest that expert validators consistently rate CT-structured worksheets as valid across a range of real-world contexts, provided the CT stages are explicitly scaffolded. Among these three CT-structured worksheets, however, the present E-LKPD is distinguished by its construct validity being additionally supported by AI-based adaptive feedback, a feature absent from both comparison studies, suggesting that adaptivity may offer an incremental, though not yet directly measured, benefit over static scaffolding. This comparison implies that future studies should move beyond validity testing toward practicality and effectiveness testing that directly compare AI-adaptive and static CT scaffolds to determine whether the adaptivity feature translates into measurable learning gains rather than only into higher expert ratings of design quality.

The findings highlight that combining CT and AI within contextual mathematics learning strengthens students' engagement and conceptual understanding. The validation and revision process proved that expert-based iterative improvement ensures product readiness and educational quality (Azma et al., 2024).

In summary, the developed E-LKPD is very valid in terms of content, construct, and language, and the one-to-one evaluation further confirmed that, following minor revisions, the worksheet is clear and usable for students. This strong validation result provides a solid foundation for the next stages of small-group and effectiveness testing to assess the E-LKPD's impact on students' mathematical problem-solving and environmental awareness.

IV. Conclusion

This study aimed to develop a valid E-LKPD grounded in Computational Thinking and Artificial Intelligence in the context of deforestation. The expert validation results show that the E-LKPD meets the criteria of content quality, design clarity, structural coherence, and computational integration. Overall, the product falls into the very valid category and is considered suitable for use in the next stages of testing. Therefore, this E-LKPD provides a strong foundation for subsequent evaluations of its practicality and effectiveness in enhancing students' mathematical problem-solving skills.

Reference

Akbar, S. (2013). *Instrumen perangkat pembelajaran*. Bandung: PT Remaja Rosdakarya.

Ahmad, S. F., Rahmat, M. K., Mubarik, M. S., Alam, M. M., & Hyder, S. I. (2021). Artificial intelligence and its role in education. Sustainability, 13(22), Article 12902. https://doi.org/10.3390/su132212902

Al Husna, L., Amir MZ, Z., & Vebrianto, R. (2021). Studi eksploratif problematika pembelajaran matematika di Sekolah Dasar di Tanah Datar. *Mathline: Jurnal Matematika dan Pendidikan Matematika*, 6(1), 1–12. https://doi.org/10.31943/mathline.v6i1.159

Ananda, R. W., & Soro, S. (2023). Pengaruh penggunaan lembar kerja peserta didik elektronik (E-LKPD) terhadap hasil belajar matematika di SMA Hang Tuah 1 Jakarta. *Jurnal Lebesgue: Jurnal Ilmiah Pendidikan Matematika, Matematika dan Statistika*. https://doi.org/10.46306/lb.v4i2.329

Annisa, R., Suanto, E., & Maimunah. (2023). Pengembangan E-LKPD materi aritmetika sosial berbasis pendekatan kontekstual untuk memfasilitasi kemampuan pemecahan masalah matematis. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 12(2), 1504–1517. https://doi.org/10.24127/ajpm.v12i2.6955

Azma, T. R., Hapizah, & Darmawijoyo, S. (2024). Innovative electronic worksheets to foster computational thinking in arithmetic sequences and series. *Al-Jabar: Pendidikan Matematika*, 15(02):623–43. https://dx.doi.org/10.24042/ajpm.v15i2.24603

Bakker, A., & Korthagen, F. (2019). *Design research in education: A practical guide for early career researchers.* London: Routledge.

Cahdriyana, R. A., & Richardo, R. (2020). Berpikir komputasi dalam pembelajaran matematika. *LITERASI (Jurnal Ilmu Pendidikan),* 11(1), 50–56. https://doi.org/10.21927/literasi.2020.11(1).50-56

Carvalho e Silva, J. (2025). Computational thinking versus artificial intelligence in mathematics teaching. *International Journal of Mathematical Education in Science and Technology*, 56(8), 1426–1437. https://doi.org/10.1080/0020739X.2025.2496695

Fahrudin, R., Sollikhin, R., & Masruroh, A. (2024). Inovasi pembelajaran pendidikan agama islam melalui teknologi artificial intelligence untuk meningkatkan interaksi siswa. *Mauriduna: Journal of Islamic Studies.* https://doi.org/10.37274/mauriduna.v5i1.1298

Istiqomah, N., Arigiyati, T. A., Wijayanti, A., & Widodo, S. A. (2021). Validitas lembar kerja peserta didik berbentuk elektronik berbasis Tri-N pada pokok bahasan bentuk aljabar. *Wacana Akademika: Majalah Ilmiah Kependidikan*, 5(2), 113–120. https://doi.org/10.26499/wacana.v5i2.11334.

Koe, L. S., Kustandi, C., & Siregar, E. (2025). AI-driven feedback system: Implementing advanced NLP and OpenAI for online learning. *Jurnal Inovasi dan Teknologi Pembelajaran*. https://doi.org/10.17977/um031v11i32024p137

Korkmaz Guler, N., Dertli, Z. G., Boran, E., & Yildiz, B. (2024). An artificial intelligence application in mathematics education: Evaluating ChatGPT's academic achievement in a mathematics exam. Pedagogical Research, 9(2), Article em0188. https://doi.org/10.29333/pr/14145

Muliardi, M. (2023). Mengembangkan kreativitas dan karakter bangsa melalui Kurikulum Merdeka di Madrasah. *Takuana: Jurnal Pendidikan, Sains, dan Humaniora*. https://doi.org/10.56113/takuana.v2i1.68

Mutia, L., Muslih, A. M., & Basri, H. (2023). Nilai ekonomi objek wisata alam di Air Terjun Suhom Desa Tunong Krueng Kala, Kecamatan Lhoong, Kabupaten Aceh Besar dengan metode biaya perjalanan. *Jurnal Ilmiah Mahasiswa Pertanian*, 8(1), 507–513. https://doi.org/10.17969/jimfp.v8i1.22815

Nabilla, N., Edy, S., & Khikmiyah, F. (2022). Pengembangan E-LKPD matematika interaktif berbasis literasi digital. *JPMI – Jurnal Pembelajaran Matematika Inovatif*, 5(6), 1581–1594. https://doi.org/10.22460/jpmi.v5i6.12530

Ostian, D., Hapizah, H., & Mulyono, B. (2023). An interactive e-student worksheet based on computational thinking with the South Sumatera traditional game context. *Jurnal Pendidikan Matematika RAFA*, 9(2), 101–122. https://doi.org/10.19109/jpmrafa.v9i2.20339

Pinheiro, M. M., & Santos, V. (2025). Integrating computational thinking and artificial intelligence into mathematics education: A pathway for the 21st century. In A. Reis et al. (Eds.), Technology and Innovation in Learning, Teaching and Education (TECH-EDU 2024), *Communications in Computer and Information Science*, vol. 2479. *Springer, Cham.* https://doi.org/10.1007/978-3-032-02675-0_7

Pratiwi, I. R., & Silalahi, P. (2021). Pengembangan media pembelajaran matematika model blended learning berbasis MOODLE. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 10(1), 206–218. https://doi.org/10.24127/ajpm.v10i1.3240

Ramadoni, R., Aima, Z., & Mardiyah, A. (2024). Innovating electronic worksheets for students using a project-based flipped classroom in math learning. *Mosharafa: Jurnal Pendidikan Matematika*. https://doi.org/10.31980/mosharafa.v13i2.1946

Sarman, A. A., Suastika, I. K., & Murniasih, T. R. (2023). Pengembangan E-LKPD untuk meningkatkan kemampuan pemecahan masalah matematis peserta didik pada materi bangun ruang sisi lengkung. *Jurnal Tadris Matematika*, 6(1), 49–66. https://doi.org/10.21274/jtm.2023.6.1.49-66

Senoaji, G., Hidayat, M. F., & Iskandar, I. (2020). Resolusi konflik tenurial pemanfaatan kawasan hutan di hutan Lindung Rimbo Donok Kabupaten Kepahiang. *Jurnal Manusia dan Lingkungan*, 26(1), 28–35. https://doi.org/10.22146/JML.29250

Septiana, D., Hapizah, & Mulyono, B. (2024). Pengembangan LKPD untuk pembelajaran berdiferensiasi dengan konteks brengkes tempoyak Sumatera Selatan yang berorientasi computational thinking. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 13(1), 34–47. https://doi.org/10.24127/ajpm.v13i1.8332

Sukendra, I. K., & Sumandya, I. W. (2020). Analisis problematika dan alternatif pemecahan masalah pembelajaran matematika di SMP. *EMASAINS: Jurnal Edukasi Matematika dan Sains*, 9(2). https://doi.org/10.5281/zenodo.4299433

Zulkarnain, I., Hidayanto, T., & Riza, M. (2021). Pengembangan media simulatif "travel game" konteks lingkungan lahan basah untuk pembelajaran matematika. *EDUMAT: Jurnal Pendidikan Matematika*, 9(1), 91–98. https://doi.org/10.20527/EDUMAT.V9I1.9784