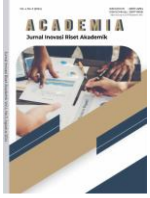

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 4, September-November 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

DIGITAL EDUCATIONAL GAMES FOR ENHANCING GEOMETRY PROBLEM-SOLVING SKILLS: A SYSTEMATIC LITERATURE REVIEW

Elna Mar'atussholihah[1], Rika Mulyati Mustika Sari[2]
[12]Universitas Singaperbangsa Karawang, Indonesia
Email : 2510632050008@student.unsika.ac.id , rika.mulyatimustika@fkip.unsika.ac.id

Diterima:14*/6/2026*; Direvisi: *31/8/2026*; Diterbitkan: *7/9/2026*

ABSTRAK

Geometri merupakan ranah matematika yang menuntut dan membutuhkan visualisasi spasial, penalaran abstrak, serta strategi kognitif yang terstruktur. Tinjauan pustaka sistematis kualitatif (*qualitative systematic literature review*) ini mengkaji bukti empiris mengenai implementasi permainan edukasi digital (*digital educational games*) untuk meningkatkan keterampilan pemecahan masalah (*problem-solving skills*) geometri siswa. Mengikuti kerangka kerja *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA), studi-studi *peer-reviewed* relevan yang diterbitkan antara tahun 2015 dan 2025 dikumpulkan dari basis data akademik utama menggunakan kata kunci yang ditargetkan. Sebanyak empat belas artikel empiris memenuhi kriteria inklusi dan dianalisis berdasarkan genre permainan, desain pedagogis, serta capaian pembelajaran. Sintesis ini mengungkapkan bahwa platform interaktif, perangkat lunak pemodelan visual, dan aplikasi edukasi seluler mendorong kemahiran pemecahan masalah dengan mendukung manipulasi spasial dinamis, penalaran algoritmik, ketekunan tugas, dan inkuiri kolaboratif. Mekanika permainan berbasis tantangan (*challenge-driven game mechanics*) memitigasi beban kognitif berlebih (*cognitive overload*) dengan menerjemahkan prinsip-prinsip geometri abstrak ke dalam ruang eksplorasi yang intuitif. Akibatnya, pembelajaran berbasis permainan (*game-based learning*) berfungsi sebagai metodologi instruksional yang efektif untuk memajukan kompetensi pemecahan masalah geometris. Penelitian pendidikan di masa depan harus mengeksplorasi arsitektur pembelajaran adaptif (*adaptive learning architectures*), integrasi kecerdasan buatan (*artificial intelligence*), dan mekanika *scaffolding* yang disesuaikan untuk mengatasi keragaman bakat siswa di seluruh ranah spasial serta perkembangan matematika longitudinal.

Kata Kunci: *digital educational games*, *game-based learning*, *geometry learning*, *mathematics education*, *problem-solving skills*

ABSTRACT

Geometry represents a demanding mathematical domain requiring spatial visualization, abstract reasoning, and structured cognitive strategies. This qualitative systematic literature review examines empirical evidence regarding digital educational game implementations for enhancing students' geometry problem-solving skills. Following the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (*PRISMA*) framework, relevant peer-reviewed studies published between 2015 and 2025 were retrieved from major academic databases using targeted keywords. Fourteen empirical articles satisfied the inclusion criteria and were analyzed across game genres, pedagogical designs, and learning outcomes. The synthesis reveals that interactive platforms, visual modeling software, and mobile educational applications foster problem-solving proficiency by supporting dynamic spatial manipulation, algorithmic reasoning, task persistence, and collaborative inquiry. Challenge-driven game mechanics mitigate cognitive overload by translating abstract geometric principles into intuitive

https://doi.org/10.51878/academia.v6i4.12444

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 4, September-November 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

exploratory spaces. Consequently, game-based learning serves as an effective instructional methodology for advancing geometric problem-solving competencies. Future educational research must explore adaptive learning architectures, artificial intelligence integration, and tailored scaffolding mechanics to address diverse student aptitudes across spatial domains and longitudinal mathematical development.
Keywords: *digital educational games*, *game-based learning*, *geometry learning*, *mathematics education*, *problem-solving skills*

INTRODUCTION

Geometry plays a fundamental role in school curricula by cultivating spatial orientation, structural reasoning, and visual-spatial competence. Despite its recognized necessity, learners consistently encounter severe cognitive hurdles when interpreting abstract shapes, coordinate systems, and formal multi-step proofs (Sari & Roesdiana, 2019). Traditional instructional practices often rely heavily on static textbook figures and rote formula memorization, which leaves students ill-equipped to deconstruct intricate geometric tasks. Consequently, many learners fail to formulate mathematical models, identify viable transformation strategies, or verify their geometric deductions systematically. Addressing these persistent comprehension barriers requires interactive instructional interventions that make abstract spatial configurations accessible.

Recent advancements in educational technology offer promising multimedia tools designed to foster conceptual clarity and cognitive engagement across mathematical disciplines (Haleem et al., 2022). Among modern innovations, digital game-based learning has emerged as a potent instructional approach that merges formal curricular objectives with exploratory problem scenarios. Digital learning environments provide immediate feedback mechanisms, dynamic spatial manipulation, and visual scaffolding that stimulate mathematical inquiry (All et al., 2021). These game features lower affective barriers, turning challenging problem-solving exercises into gamified investigations. Integrating game-based platforms into classroom environments addresses core pedagogical needs for interactive geometric visualization.

A substantial body of empirical research confirms that gamified interventions promote mathematical achievement, procedural fluency, and analytical reasoning (Calder, 2018; Dai et al., 2023; Grizioti & Kynigos, 2021). Interactive digital tasks encourage learners to test conjectures, observe geometric invariants, evaluate transformations, and refine problem-solving strategies through iterative experimentation. These exploratory experiences align closely with constructivist learning theories, wherein students actively construct mathematical knowledge rather than passively receiving information. Furthermore, gamified problem scenarios nurture higher-order thinking skills by requiring continuous reflection and tactical planning during mathematical tasks. Such cognitive engagements make game environments suitable for mastering intricate geometric principles.

Despite expanding scholarship on game-based educational technology, existing literature syntheses primarily examine broad mathematical performance rather than targeted spatial problem-solving competencies. Prior review articles frequently aggregate various mathematical topics together, obscuring the distinct instructional mechanisms through which digital games impact geometric visualization and proof construction. Furthermore, previous overviews rarely investigate how different interactive environments—such as visual block programming, dynamic geometry software, and mobile game engines—scaffold problem-solving phases differently. This absence of focused synthesis creates a critical research gap concerning the specific pedagogical contributions of distinct digital games to geometry

https://doi.org/10.51878/academia.v6i4.12444

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 4, September-November 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

learning. Addressing this literature deficit is vital for establishing targeted instructional frameworks in geometry education.

The purpose of this qualitative study is to systematically review empirical literature on the integration of digital educational games into geometry instruction. This review evaluates the instructional mechanisms through which game platforms improve students' geometric problem-solving proficiencies. By identifying specific game types, instructional contexts, and reported learning outcomes, this synthesis provides evidence-based guidance for educators and instructional designers. The findings elucidate how digital interactive environments can be utilized to overcome spatial reasoning difficulties in geometry curricula. Ultimately, this systematic synthesis establishes structured insights into the pedagogical efficacy of digital game-based mathematics interventions.

METHODS

This qualitative study implemented a *Systematic Literature Review* (*SLR*) guided strictly by the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (*PRISMA*) framework (Page et al., 2021). Academic literature searches were conducted across digital databases, specifically *Google Scholar*, *Semantic Scholar*, and *Scopus*, using boolean search combinations such as "digital games" *AND* "geometry" *AND* "problem-solving skills". Specific inclusion criteria required peer-reviewed empirical studies published in English or Indonesian between 2015 and 2025 that examined digital game implementations within geometry education and directly evaluated student problem-solving competencies. Publications such as editor notes, non-peer-reviewed conference abstracts, instructional essays, book chapters, and studies unrelated to geometric problem-solving were excluded. Data evaluation followed systematic qualitative synthesis techniques to assess methodological rigor, educational contexts, software genres, and instructional mechanisms documented across the selected primary literature (Xiao & Watson, 2019). The qualitative synthesis centered on categorizing pedagogical patterns and cognitive transformations without altering the qualitative review framework.

The methodological synthesis protocol categorized qualitative data points across each eligible empirical document to ensure structured thematic organization and analytical consistency (Miles et al., 2014). The qualitative extraction process recorded digital game classifications, sample demographics, geometric concepts addressed, problem-solving rubrics, and reported pedagogical constraints across educational settings. Each reviewed study was examined for thematic patterns regarding spatial visualization scaffolding, algorithmic construction, intrinsic motivation, and collaborative inquiry. Qualitative content analysis enabled the contextual cross-comparison of distinct software environments ranging from dynamic geometry systems to block-coding platforms and interactive game modules. Data matrices were constructed to systematically cross-reference theoretical frameworks against documented problem-solving developments. Through iterative qualitative coding, the gathered evidence was organized to establish structural themes regarding cognitive development and instructional affordances in digital geometry learning environments.

RESULTS AND DISCUSSION

Results

The systematic screening and eligibility assessment yielded empirical studies that matched all qualitative synthesis criteria. The synthesis identified digital game interventions and their documented contributions to student geometric problem-solving competencies.

https://doi.org/10.51878/academia.v6i4.12444

Table 1. Digital Educational Games and Their Contributions to Problem-Solving Skills

No	Author(s) & Year	Digital Tool / Environment	Geometric Topic / Context	Key Pedagogical Impact on Problem-Solving
1	Amir & Ihamuddin (2021)	*Cabri 3D*	Three-dimensional solids and spatial transformations	Enhanced spatial visualization, conjecturing, and geometric problem-solving through dynamic 3D manipulation.
2	Calder (2018)	*Scratch*	Plane geometry, coordinate systems, and angles	Fostered logical reasoning, problem deconstruction, and visual algorithmic problem-solving.
3	Dai et al. (2023)	*Digital Math Game*	Coordinate geometry and spatial navigation	Enhanced task persistence, strategic reflection, and structured problem-solving execution.
4	Grizioti & Kynigos (2021)	*MaLT2*	3D dynamic geometry and spatial modeling	Supported computational thinking, spatial modeling, and reflective geometric problem-solving.
5	Handayani et al. (2023)	*FlipaClip*	Two-dimensional shapes and dynamic geometry	Improved conceptual retention, visualization, and autonomous problem-solving performance.
6	Hilda & Prasetyaningtyas (2024)	*Baamboozle*	Flat geometric shapes and perimeter-area properties	Increased learning engagement, fast recall, and collaborative mathematical problem-solving.
7	Koroh et al. (2024)	*DPBL E-Module*	Geometric transformations and coordinate systems	Elevated technological problem-solving competence, algorithmic modeling, and structured problem analysis.
8	Maheswari et al. (2023)	*MathCityMap*	Ethnomathematics and outdoor contextual geometry	Strengthened contextual reasoning, authentic spatial modeling, and contextual problem-solving skills.

https://doi.org/10.51878/academia.v6i4.12444

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 4, September-November 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

9	Rosyid et al. (2020)	*N-Ram Digital Game*	Geometric proofs and angles	Enhanced geometric exploration, spatial deduction, and self-directed problem-solving strategies.
10	Wahyuni et al. (2021)	*Scratch-Based Media*	Spatial relations and geometric transformations	Improved structured reasoning, spatial analysis, and mathematical problem-solving accuracy.

The synthesis table 1 reveals that digital educational games enhance geometric problem-solving across three instructional dimensions: dynamic spatial modeling, algorithmic problem deconstruction, and contextual task engagement. Tools like *Cabri 3D* and *FlipaClip* provide real-time geometric manipulation, transforming abstract spatial definitions into interactive representations that simplify complex cognitive deductions. Meanwhile, block-coding environments such as *Scratch* and *MaLT2* require learners to deconstruct complex geometric figures into precise algorithmic instructions. Finally, contextual platforms like *MathCityMap* and gamified systems like *Baamboozle* bridge the gap between theoretical geometry and real-world spatial reasoning through structured collaborative challenges.

Discussion

The qualitative synthesis indicates that digital educational games provide dynamic exploratory environments that support spatial modeling, cognitive reflection, and structured problem-solving execution in geometry. By transforming abstract geometric objects into manipulative visual entities, digital game platforms bridge the cognitive gap between intuitive spatial reasoning and formal geometric deductions (Amir & Ihamuddin, 2021). Learners who interact with dynamic geometry tools develop stronger spatial transformation proficiencies than those instructed through conventional static diagrams. These visual affordances allow students to observe geometric invariants directly during manipulation, generating clear mental schemas that guide problem deconstruction (Dwirahayu et al., 2025; Ng et al., 2020; Sigalingging et al., 2026). The reviewed literature demonstrates that interactive game mechanics directly assist learners in forming mathematical conjectures and executing multi-step solutions. Consequently, digital games serve as an effective cognitive bridge that clarifies complex geometric proofs and structural relationships (Hui & Mahmud, 2023; Wardat et al., 2022; Yulianto et al., 2025).

Block-programming environments such as *Scratch* and *MaLT2* foster geometric problem-solving by connecting formal geometric constructions directly with algorithmic logic and computational thinking frameworks (Calder, 2018; Grizioti & Kynigos, 2021). When constructing geometric figures using programmable code, students must analyze angles, coordinates, and edge relationships as explicit mathematical parameters. This constructionist learning process encourages students to deconstruct complex geometric problems into structured computational sub-tasks, test hypotheses through trial-and-error, and debug errors immediately (Wahyuni et al., 2021). Rather than memorizing static formulas, learners actively operationalize mathematical theorems to control game entities and achieve visual objectives. This interactive problem-solving cycle reinforces deep understanding of foundational concepts like congruence, coordinates, and symmetry. Integrating programming with geometric tasks nurtures structured spatial problem-solving habits that extend beyond conventional paper-and-pencil exercises (Aslan et al., 2024; Crisci et al., 2024; Wheeler et al., 2024; Xu, 2025).

https://doi.org/10.51878/academia.v6i4.12444

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 4, September-November 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

These findings align closely with Paivio's dual-coding theory and constructivist learning principles, which posit that combining verbal and non-verbal representations strengthens conceptual schemas and reduces cognitive overload (All et al., 2021). Dynamic spatial environments like *Cabri 3D* and *FlipaClip* enable learners to visualize complex three-dimensional relationships that are difficult to portray using traditional blackboard sketches (Handayani et al., 2023). Previous research by Dai et al. (2023) similarly observed that responsive digital environments provide externalized scaffolding that supports strategic planning during demanding problem-solving tasks. By offloading mechanical computation and static visualization demands to interactive software, learners can focus cognitive resources on higher-order deduction, strategic exploration, and structural evaluation. This theoretical alignment explains why digital game interventions consistently produce superior problem-solving gains in geometric domains (Abrahamson et al., 2020; Gui et al., 2023; Hsieh, 2025; Huber et al., 2024).

Contextual and gamified platforms, such as *MathCityMap* and *Baamboozle*, further enhance problem-solving by grounding abstract geometric concepts in collaborative, real-world exploration (Hilda & Prasetyaningtyas, 2024; Maheswari et al., 2023). Contextual game platforms anchor mathematical tasks in local environments, prompting students to apply geometric theorems to authentic structural problems outside classroom walls. Furthermore, gamified problem elements provide intrinsic motivation, goal orientation, and immediate feedback, which collectively encourage task persistence during complex mathematical investigations (Koroh et al., 2024; Rosyid et al., 2020). Students who experience game-based mathematics report higher self-efficacy, reduced math anxiety, and greater willingness to tackle challenging spatial puzzles. This heightened affective engagement leads to sustained cognitive involvement during multi-step geometric modeling. Consequently, game-based learning environments cultivate both cognitive abilities and positive dispositions toward mathematical problem-solving.

Despite documented pedagogical strengths, digital game implementations in geometry face several practical and theoretical challenges across current educational environments. Many empirical studies rely on short-term experimental interventions, leaving the long-term cognitive durability of game-based problem-solving skills insufficiently examined (All et al., 2021; Haleem et al., 2022). Furthermore, many classroom implementations lack personalized scaffolding, which can cause struggling learners to experience disorientation while advanced students complete challenges too quickly (Dai et al., 2023). Emerging technologies, such as intelligent tutoring systems, adaptive learning paths, and artificial intelligence models, remain rarely integrated into standard geometry game platforms. Addressing these technical and instructional gaps is critical for designing adaptive digital game environments that cater to diverse student aptitudes. Resolving these challenges will ensure the effective integration of game-based learning into mainstream geometry curricula.

CONCLUSION

This systematic literature review answers the primary research objective by demonstrating that digital educational games enhance students' geometric problem-solving competencies. The qualitative evidence confirms that interactive platforms such as dynamic visual modelers, block-coding software, and gamified mobile applications support spatial reasoning, algorithmic deconstruction, and structured mathematical deduction. By offering real-time visual feedback and interactive spatial manipulation, digital educational games demystify abstract geometric definitions and promote autonomous cognitive exploration.

https://doi.org/10.51878/academia.v6i4.12444

Furthermore, gamified problem environments increase student engagement and task persistence, enabling learners to tackle multi-step geometric proofs with greater confidence. The synthesis confirms that game-based learning serves as a sound, constructivist instructional methodology for improving student problem-solving skills in geometry.

These findings suggest that educational institutions and curriculum developers should systematically integrate digital educational games into mainstream mathematics instruction rather than treating them as supplementary activities. Teachers require specialized professional development to combine game mechanics with formal geometric pedagogy, ensuring that gamified tasks translate into rigorous mathematical reasoning. Future research should prioritize designing adaptive game-based environments powered by artificial intelligence and real-time learning analytics. Such technological enhancements will allow games to adjust spatial problem complexities to individual student proficiencies dynamically. Additionally, longitudinal empirical investigations are needed to evaluate the lasting impact of game-based interventions on advanced geometric thinking throughout secondary and tertiary education.

REFERENCES

Abrahamson, D., Nathan, M. J., Williams, C., Walkington, C., Ottmar, E., Soto, H., & Alibali, M. W. (2020). The future of embodied design for mathematics teaching and learning. *Frontiers in Education*, 5, Article 147. https://doi.org/10.3389/feduc.2020.00147

All, A., Castellar, E. N. P., & Van Looy, J. (2021). Digital game-based learning effectiveness assessment: Reflections on study design. *Computers & Education*, 167, Article 104160. https://doi.org/10.1016/j.compedu.2021.104160

Amir, A., & Ihamuddin, I. (2021). Cabri 3D software technology: Students' problem-solving skills with problem-based instruction model approach. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 10(4), 2237–2253. https://doi.org/10.24127/ajpm.v10i4.4326

Aslan, D., Dağaynası, S., & Ceylan, M. (2024). Technology and geometry: Fostering young children's geometrical concepts through a research-based robotic coding program. *Education and Information Technologies*, 29(17), 22699–22721. https://doi.org/10.1007/s10639-024-12747-3

Calder, N. (2018). Using Scratch to facilitate mathematical thinking. *Waikato Journal of Education*, 23(2), 43–58. https://doi.org/10.15663/wje.v23i2.658

Crisci, R., Iacono, U. D., & Dentice, E. F. (2024). Axial symmetry in primary school through a milieu based on visual programming. *Digital Experiences in Mathematics Education*. https://doi.org/10.1007/s40751-024-00146-9

Dai, C. P., Ke, F., Pan, Y., & Liu, Y. (2023). Exploring students' learning support use in digital game-based math learning. *Computers & Education*, 194, Article 104698. https://doi.org/10.1016/j.compedu.2022.104698

Dwirahayu, G., Satriawati, G., Sobiruddin, D., Martadiputra, B. A. P., & Harnum, T. S. (2025). Mapping the mind: Exploring students' visual-spatial thinking in transformation geometry. *Journal of General Education and Humanities*, 4(2), 535–548. https://doi.org/10.58421/gehu.v4i2.434

Grizioti, M., & Kynigos, C. (2021). Code the mime: A 3D programmable charades game for computational thinking in MaLT2. *British Journal of Educational Technology*, 52(3), 1004–1023. https://doi.org/10.1111/bjet.13075

https://doi.org/10.51878/academia.v6i4.12444

Gui, Y., Cai, Z., Yang, Y., Kong, L., Fan, X., & Tai, R. H. (2023). Effectiveness of digital educational game and game design in STEM learning: A meta-analytic review. *International Journal of STEM Education*, 10(1), Article 24. https://doi.org/10.1186/s40594-023-00424-9

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education. *Sustainable Operations and Computers*, 3, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Handayani, T., Sutiarso, S., & Firdaus, R. (2023). Pengaruh media pembelajaran berbasis FlipaClip terhadap kemampuan pemecahan masalah matematis. *Histogram: Jurnal Pendidikan Matematika*, 7(1), 350–366. https://doi.org/10.31100/histogram.v7i1.2464

Hilda, H., & Prasetyaningtyas, F. D. (2024). The effectiveness of Baamboozle game as a learning media for flat geometry. *Journal for Lesson and Learning Studies*, 7(3), 524–532. https://doi.org/10.23887/jlls.v7i3.78423

Hsieh, P. (2025). ML-based validation of experimental randomization in learning games. *Frontiers in Artificial Intelligence*, 8, Article 1541087. https://doi.org/10.3389/frai.2025.1541087

Huber, S. E., Kiili, K., Nebel, S., Ryan, R. M., Sailer, M., & Ninaus, M. (2024). Leveraging the potential of large language models in education through playful and game-based learning. *Educational Psychology Review*, 36(1), Article 4. https://doi.org/10.1007/s10648-024-09868-z

Hui, H. B., & Mahmud, M. S. (2023). Influence of game-based learning in mathematics education on the students' cognitive and affective domain: A systematic review. *Frontiers in Psychology*, 14, Article 1105806. https://doi.org/10.3389/fpsyg.2023.1105806

Koroh, T. R., Arifin, S., & Suban, A. (2024). Problem-solving skills on prospective teachers: Digital problem-based learning in geometry. *QALAMUNA: Jurnal Pendidikan, Sosial, dan Agama*, 16(2), 1411–1424. https://doi.org/10.37680/qalamuna.v16i2.5182

Maheswari, G. A., Saraswati, E., & Rudhito, M. A. (2023). Pengembangan media pembelajaran menggunakan MathCityMap dalam kemampuan pemecahan masalah berbasis etnomatematika. *Jurnal Pendidikan Matematika*, 9(2), 187–198. https://doi.org/10.33474/jpm.v9i2.19632

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (edisi ke-3). SAGE Publications.

Ng, O., Shi, L., & Ting, F. S. T. (2020). Exploring differences in primary students' geometry learning outcomes in two technology-enhanced environments: Dynamic geometry and 3D printing. *International Journal of STEM Education*, 7(1), Article 33. https://doi.org/10.1186/s40594-020-00244-1

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, Article n71. https://doi.org/10.1136/bmj.n71

https://doi.org/10.51878/academia.v6i4.12444

Rosyid, A., Harmini, T., & Nugroho, P. A. (2020). Designing N-Ram digital game for geometry learning media. *Journal of Mathematics Education*, 9(1), 55–66. https://doi.org/10.22460/jurnal_jpm.v9i1.p55-66

Sari, R. M. M., & Roesdiana, L. (2019). Analisis kemampuan pemecahan masalah matematis siswa SMP pada materi geometri. *Jurnal Analisa*, 5(2), 143–152. https://doi.org/10.15575/ja.v5i2.5489

Sigalingging, A., Purba, E. R., Shakila, M. K., Sianipar, T. G., & Siregar, B. H. (2026). Application of quadratic blocks and gafurat media to improve understanding of quadratic functions in class XI students at SMA. *SCIENCE: Jurnal Inovasi Pendidikan Matematika dan IPA*, 6(1), 520–529. https://doi.org/10.51878/science.v6i1.9486

Wahyuni, S., Novitasari, A., & Kusuma, D. (2021). Implementation of Scratch-based media to improve mathematical problem-solving ability in geometry. *International Journal of Educational Studies in Mathematics*, 8(2), 112–123. https://doi.org/10.5152/ijesm.2021.82112

Wardat, Y., Jarrah, A. M., Almassri, H., & Johnson, J. D. (2022). Assessing the impact of digital games-based learning on students' performance in learning fractions using (ABACUS) software application. *Eurasia Journal of Mathematics, Science and Technology Education*, 18(10), Article em2162. https://doi.org/10.29333/ejmste/12421

Wheeler, A., Barrera, H., & Cooley, S. (2024). Unlocking the use of coding to understand geometric concepts. *Ohio Journal of School Mathematics*, 97(1). https://doi.org/10.18061/ojsm.4169

Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, 39(1), 93–112. https://doi.org/10.1177/0739456X17723971

Xu, C. (2025). Improving mathematical skills of mathematics education students through integrated use of graphing software and programming techniques. *International Journal of Education and Humanities*, 5(1), 13–24. https://doi.org/10.58557/(ijeh).v5i1.277

Yulianto, D., Situmeang, M. S., Anwar, S., & Puspitasari, N. (2025). Revisiting digital game-based mathematics learning: Global insights into thinking and attitudes from a PRISMA-guided review. *KALAMATIKA: Jurnal Pendidikan Matematika*, 10(2), 94–116. https://doi.org/10.22236/kalamatika.vol10no2.2025pp94-116

https://doi.org/10.51878/academia.v6i4.12444