The Effect of Digital Learning Tools on Secondary Students' Achievement in Mathematics: A Systematic Literature Review

[1]Thilagam Karadan, [2]Jong Sing Liang & [3]Zamri Mahamod

[1]Sekolah Menengah Universal, 43300 Seri Kembangan, Selangor, Malaysia

[2]Sekolah Kebangsaan Ridan, 95900 Lubok Antu, Sarawak, Malaysia

[3]Fakulti Pendidikan, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

DOI: https://doi.org/10.51244/IJRSI.2026.1306000282

Received: 12 June 2026; Accepted: 17 June 2026; Published: 07 July 2026

ABSTRACT

The world education systems are compulsory and Mathematics can be significant in enabling the students to gain analytical and critical thinking profiles. However, there are many concerns regarding the performance of learners in Mathematics in the secondary schools in most countries and even in the global performance tests such as PISA and TIMSS, the gaps have been maintained. Increased rate of information and communication technology (ICT) development has resulted in integration of various digital learning tools to teaching and learning activities in Mathematics. Relying solely on conventional teaching methods is increasingly not considered a sufficient means of meeting the multiple and active learning requirements of 21st century learners. Thus, it is a Systematic Literature Review (SLR) research paper that explores deeper the effects of the use of digital learning tools on the achievement of Mathematics among the secondary students. The major aims of this paper are to identify the most common form(s) of digital learning tool(s) discussed in the literature, analyse the impact of digital learning tool(s) on student achievement and make recommendations and interventions to improve student achievement in Mathematics from low to high levels in secondary schools. This was done using PRISMA (Preferred Reporting Items of systematic Reviews and meta-Analyses) flow diagram methodology and carried out in Google Scholar, ERIC and Web of Science. One hundred and sixteen articles were analysed and 10 articles were selected by the selection criteria. The results of the study indicate that the digital learning tools have a generally positive impact on students' performance, especially when used in an active manner, with a good feedback system and with the support of the teacher. The critical moderating variables consist of the quality of technology access, digital competency of teachers, student motivation and the quality of instruction design. The proposed solutions to the holistic approach to the realization of Mathematics among high school students are numerous online teaching techniques and the participation of technology-savvy teachers and equal availability of technology as the key recommendations. One would hope that the findings of this study will contribute greatly towards the national education agenda of narrowing achievement gaps and enhancing quality of Mathematics teaching and learning in the secondary schools.

Keywords: Digital Learning Tools, Mathematics Achievement, Secondary School, Systematic Literature Review, Educational Technology

INTRODUCTION

Mathematics ranks among all as a portion of STEM (Science, Technology, Engineering, and Mathematics) education and is a central component of preparing students to work in 21 st century jobs and to become an active participant in nation building. Though, it is the most significant topic, Mathematics is not less than one of the most challenging topics amongst the secondary school students globally. Systematic and growing differences in Mathematics achievement by different regions, socioeconomic groups, and educational systems have consistently turned out to be clear in global exams such as PISA (Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) (OECD, 2023). Such

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

loopholes have increased the pressures to come up with new, evidence-based teaching techniques that will engage students more and learn mathematical concepts more conceptually.

Over the past decade, digital learning tools have become an educational practice that prompts use across the globe. They encompass a vast variety of technologies: educational software applications, gamification applications, interactive simulations, learning management systems (LMS), and artificial intelligence-based tutoring systems; they open up fresh possibilities into personalized, interactive and data-driven teaching. The COVID-19 pandemic that caused educational institutions worldwide to switch to online and hybrid methods of learning in the beginning of 2020 accelerated the pace of adoption of digital tools to the classroom like never before (Hodges et al., 2020). Despite the fact that schools have slowly returned to face-to-face learning during the post-pandemic period, the digital technology has infiltrated the majority of teaching practices of all levels of learning.

In spite of this being extensively and enormously exploited, the research data on effectiveness of digital learning tools in improving the accomplishment of secondary students in Mathematics is inclusive and disjointed. A large positive effect on student performance, student motivation, and conceptual understanding of mathematical material has been shown and so are studies that show a smaller or no effect or context-specific effects that cannot be generalized to other school contexts (Li and Ma, 2021). This difference in the findings accentuates the importance of the systematic review of the material in question allowing to identify the strong tendencies and the key moderating and mediating factors, the significant gaps in the study that need to be addressed with the assistance of other studies.

Systematic Literature Review (SLR) is particularly appropriate to this end as it offers a transparent, replicable, and rigorous means of synthesizing evidence that is gathered by multiple independent studies regarding the same topic (Hayrol Azril et al., 2021). Sarah Nur Nurja and Maslida (2022) also add that SLR studies can be used as a universal and trusted source of information both to practitioners and researchers, as well as provide opportunities to the future researchers to develop deeper and more focused studies based on the particular issues and themes that have been revealed during the course of the review. This is particularly necessary when it comes to educational technology, where new tools and pedagogical strategies appear fast and frequent, and the quality and relevance of evidence available are to be constantly reviewed and revised.

Other national education blueprints, strategic digital transformation agendas, international models like UNESCO ICT Competency Framework of Teachers have also facilitated the increasing integration of technology in education. Numerous nations have initiated ambitious programs to entrench ICT holistically in national education systems, expand digital infrastructure and connectivity in schools, and retrain teachers on digital pedagogy and technology-enhanced instruction. It is in this context that a systematic review of what the existing evidence base is telling us about the real effects of digital learning tools on quantifiable student outcomes, namely Mathematics achievement at the secondary school level, where the effects of continuing underachievement are felt most acutely in regard to future academic and career paths.

Research Objectives

The proposed SLR seeks to systematically review previous studies concerning the impact of digital learning tools on the achievements of secondary learners in Mathematics, and the strategies and interventions that have been discovered in the efforts to bridge achievement gaps. The particular study objectives are as follows:

1. To find out the kind of digital learning tools that have been studied in connection to the achievement of Mathematics amongst secondary students most often.

2. To investigate the impacts positive and negative of using digital learning tools on the achievement of Mathematics among secondary students according to the literature (2022025).

3. To suggest any improvement recommendations and interventions based on the results of studied papers to overcome the problem of low Mathematics achievement among secondary students.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

METHODOLOGY

The process of collecting, identifying, analyzing, summarizing and evaluating problems associated with the research topic in a systematic and organized manner is the Systematic Literature Review (SLR) studies, as stated by Ngien Hock Wuong, Murugan Rajoo and Noor Azah (2022) which can be used in the appropriate stage of the research using document analysis methods, both qualitative and quantitative in nature. Thus, a document analysis technique which is one of the types of PRISMA (Preferred Reporting Items in Systematic Reviews and Meta-Analyses) was used in this study to satisfy this SLR.

Some of the words were applied in a way to ensure that articles that were obtained were relevant to the title and research questions of this research. Due to the voluminous nature of the topic of Digital learning tools in Mathematics education, the researcher has tried to identify appropriate and well-chosen keywords, which could be used to find articles published in Mathematics journals oriented towards the theme of Digital learning tools and Mathematics success in the Secondary school. According to Li and Ma (2021), students who are not following up on mastering Mathematics are doing so due to a mixture of internal and external influences, which means that the mere existence of a specific keyword does not necessarily indicate all articles related to the topic of mathematics in general. Consequently, the researcher used the Boolean operators (AND, OR) to search and mix several keyword terms so as to ensure that the search results are as inclusive and relevant as possible.

Besides having been extensively utilized due to its excellence in making sure that SLR studies can be carried out methodically, PRISMA method also offers a step-by-step process that has the potential of managing huge amount of bibliographic information in an effective and transparent manner. This approach illustrates some of the fundamental aspects of transparency, methodological consistency, and high scholarly standards on generating research reports using selected and clear procedures. According to Karantzas (2019) PRISMA method has helped researchers to accurately select relevant literature works depending on the research objectives in four consecutive steps: identification (pengenalpastian), screening (saringan), eligibility (kelayakan), and inclusion (rangkuman). Thus, the PRISMA approach was utilized to help the researcher develop a high-quality SLR research that has a high level of transparency and reproducibility.

LITERATURE SEARCH PROCESS

The search strategy used in this SLR was modified to suit its intended goals and objectives, and the main focus was to determine the key types of digital learning tools that have been explored in the literature and measured impacts on the achievement in Mathematics among secondary students, as well as the recommendations or interventions offered by researchers that could correct gaps. First, the researcher accessed two primary academic databases as the key search sources due to the overall coverage, quality and consistency of the search outcomes, as well as highly developed search features relative to other possible databases suggested by Gusenbauer and Haddaway (2020): Google Scholar and Web of Science (WoS).

With its expansive and extensive coverage of interdisciplinary educational research, such as peer-reviewed journal articles, theses, dissertations and conference proceedings through a process of comprehensive indexing over a wide variety of publishers and institutions Google Scholar was used. Web of Science was chosen based on their strict standards in peer-review, coverage of high impact journals and citation analysis options which assisted in the identification of high cited and methodologically sound research in the area of educational technology and Mathematics education. The two databases mentioned above were complementary and covered the complete area of peer-reviewed literature on the topic of interest of this study such that there was no significant loss of breadth or depth in the overall search process.

Article Search Keywords

Some of the words were applied in a way to ensure that articles that were obtained were relevant to the title and research questions of this research. Due to the voluminous nature of the topic of Digital learning tools in Mathematics education, the researcher has tried to identify appropriate and well-chosen keywords, which could be used to find articles published in Mathematics journals oriented towards the theme of Digital learning

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

tools and Mathematics success in the Secondary school. According to Li and Ma (2021), students who are not following up on mastering Mathematics are doing so due to a mixture of internal and external influences, which means that the mere existence of a specific keyword does not necessarily indicate all articles related to the topic of mathematics in general. Consequently, the researcher used the Boolean operators (AND, OR) to search and mix several keyword terms so as to ensure that the search results are as inclusive and relevant as possible.

The keywords adopted in the search were based on the key concepts found in the titles of the articles and in their abstracts and the language was limited to English to get the international relevant literature in terms of secondary school Mathematics teaching. The predetermined keywords included: 'digital learning tools Mathematics achievement; educational technology secondary school Mathematics; GeoGebra student performance secondary; gamification Mathematics learning outcomes; interactive simulation Mathematics secondary; online learning Mathematics outcomes secondary school; ICT integration Mathematics achievement; learning management system secondary Mathematics; and AI tutoring system Mathematics secondary students. Following the screening and analysis of the articles that were found using these set keywords and combinations, 10 articles were established to satisfy all the selection criteria showed in Table 1.

Table 1: Databases and Examples of Search Strings

Database	Example of Search String
Google Scholar	● "Digital learning tools" AND "Mathematics achievement" AND "secondary school" ● "GeoGebra" AND "student performance" AND "secondary school" AND "Mathematics" ● "AI tutoring system" AND "Mathematics achievement" AND "secondary students"
ERIC	● ("digital learning tools" OR "educational technology" OR "ICT integration" OR "learning management system" OR "AI tutoring system" OR "GeoGebra" OR "gamification" OR "interactive simulation") AND ● ("Mathematics achievement" OR "student performance" OR "learning outcomes") AND ("secondary school" OR "middle school" OR "high school")
Web of Science (WoS)	● ("digital learning tools" OR "educational technology" OR "ICT integration" OR "learning management system" OR "AI tutoring system" OR "GeoGebra" OR "gamification" OR "interactive simulation" OR "online learning") AND ● ("Mathematics achievement" OR "student performance" OR "learning outcomes") AND ● ("secondary school" OR "middle school" OR "high school")

Instrument Criteria

The researcher has prepared TABLE 2 which includes the criteria that it uses to help it accept and reject articles based on the scope of this SLR study. These selection criteria included the year of publication, language, type of reference material and area of study as outlined in TABLE 2. The publication date requirement is within the last 3 years i.e. between 2023 and 2025. This time frame has been restricted because it was the timeframe where the research topic receives most attention and included the most recent empirical data on digital learning tools in Mathematics teaching, especially regarding the significant context of the post-COVID-19 transition to a technology-based approach of teaching.

In addition, the articles chosen to be part of this paper all pertain to English language and have been retrieved in the databases selected. It is restricted to peer-reviewed journal articles, PhD theses and dissertations, and conference proceedings, but will exclude textbooks, monographs and non-peer-reviewed grey literature like

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

blog posts, opinion pieces and opinion pieces. The reason is that journal articles, PhD theses, and conference proceedings are sources of reference material that undergoes a full, comprehensive, transparent, and reliable reporting process than any other source, hence guaranteeing the scholarly integrity.

Table 2: Inclusion and Exclusion Criteria for Article Selection

Criteria	Inclusion	Exclusion
Publication Year	2021–2025	Before year 2021
Document Type	• Peer-reviewed journal articles • PhD theses / dissertations • Conference proceedings (peer-reviewed)	• Non-peer-reviewed reports • Textbooks and monographs • Blog posts / opinion articles • Magazines and newspapers
Language	• English & Bahasa Melayu only	• Languages other than English & Bahasa Melayu
Field of Study	• Research in the field of education • Research focused on Mathematics subject • Research involving secondary school students (Grade 7–12 / Form 1–5) • Research related to digital learning tools / educational technology • Research reporting measurable student achievement or performance outcomes (at least one of the above criteria must be met)	• Research outside the field of education • Research on topics other than mathematics • Studies involving students in elementary, preschool, tertiary, or non-secondary education • Studies unrelated to digital learning resources • Studies that don't provide quantifiable results for student achievement
Study population	• Studies involving secondary school students and teachers in mathematics education contexts	• Studies involving university students, lecturers, or higher education (tertiary level) contexts
Index	• Journal that involving in Scopus, Google Scholar, Web of Sciences, ScienceDirect and ERIC	• Journal index that not recognized database.

Article Selection Process

Both the selection of articles used to conduct a systematic literature review and the literature search are guided by the PRISMA model, and Powers (2017) recommends defining the criteria to use to select these articles. The flow chart diagram of the article selection process in Table 3 is based on the standard PRISMA flow diagram. This SLR was developed based on several articles found in the two databases involved in the process of searching articles. Once identified, the articles were filtered with the accepted and rejected criteria considered fitting the subject of the articles being pursued by the researcher, and subsequently subjected to the eligibility phase where they undergo closer examination, more detailed and systematic full-text filtering and screening.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

Besides, the four other exclusion criteria are used prior to adding the articles to the SLR. The initial further criterion is that articles should include the secondary school students as the key researcher's population. The second criterion is that the theses should report about factors, impact, or recommendations, regarding the subject of digital learning tools and Mathematics achievement. The third other criterion to exclude articles is that the studies must not be related to the subject field of Mathematics. The fourth criterion is that papers that fail to meet basic research acceptance criteria i.e. that do not include the clearly identified name of the author, the year of publication as well as the name of the publisher and the articles that do not feature empirical data and articles assuming a non-systematic narrative review format are also not considered in this SLR.

To use other criteria of acceptance, the study includes in its analysis only articles that are directly related to the study context, and that document at least one of the following: type of the digital tool investigated, impact on the achievement in Mathematics, or recommendation to consider improvement. Upon a meticulous and methodical screening and examination of all downloaded articles in both the databases, a short-list of 10 articles was extracted. The 10 articles fit all the outlined selection criteria and were incorporated into the SLR to undergo an in-depth analysis. The next section suggests a breakdown of the found 10 articles by search engine and database and by the year of publication.

Table 3: Flow chart diagram of the article selection process

Phase	**Article Identified/Included**	**Article Excuded/Reason**
Identification	Articles identified from databases: • Google Scholar: (n = 78) • Web of Science: (n = 22) • Scopus: (n = 0) • ERIC: (n = 16) • MyJurnal: (n = 0) Total: n = 116	Articles excluded before screening: (n = 16) Reason: Not related to digital learning tools or Mathematics subject Records excluded before screening: (n = 10) Reason: Duplicate records removed prior to title and abstract screening
Screening	Articles screened by title & abstract: n = 90 Articles used (n = 47) Articles not used (n = 43)	Articles excluded: n = 43 Reason: Not involving secondary school students; not empirical research
Eligibility	Articles assessed for full-text eligibility: n = 32 Articles excluded (n = 22)	Articles excluded: n = 22 Reason: Incomplete reporting; not peer-reviewed; inaccessible full-text
Inclusion	Articles included for final analysis: n = 10	—

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

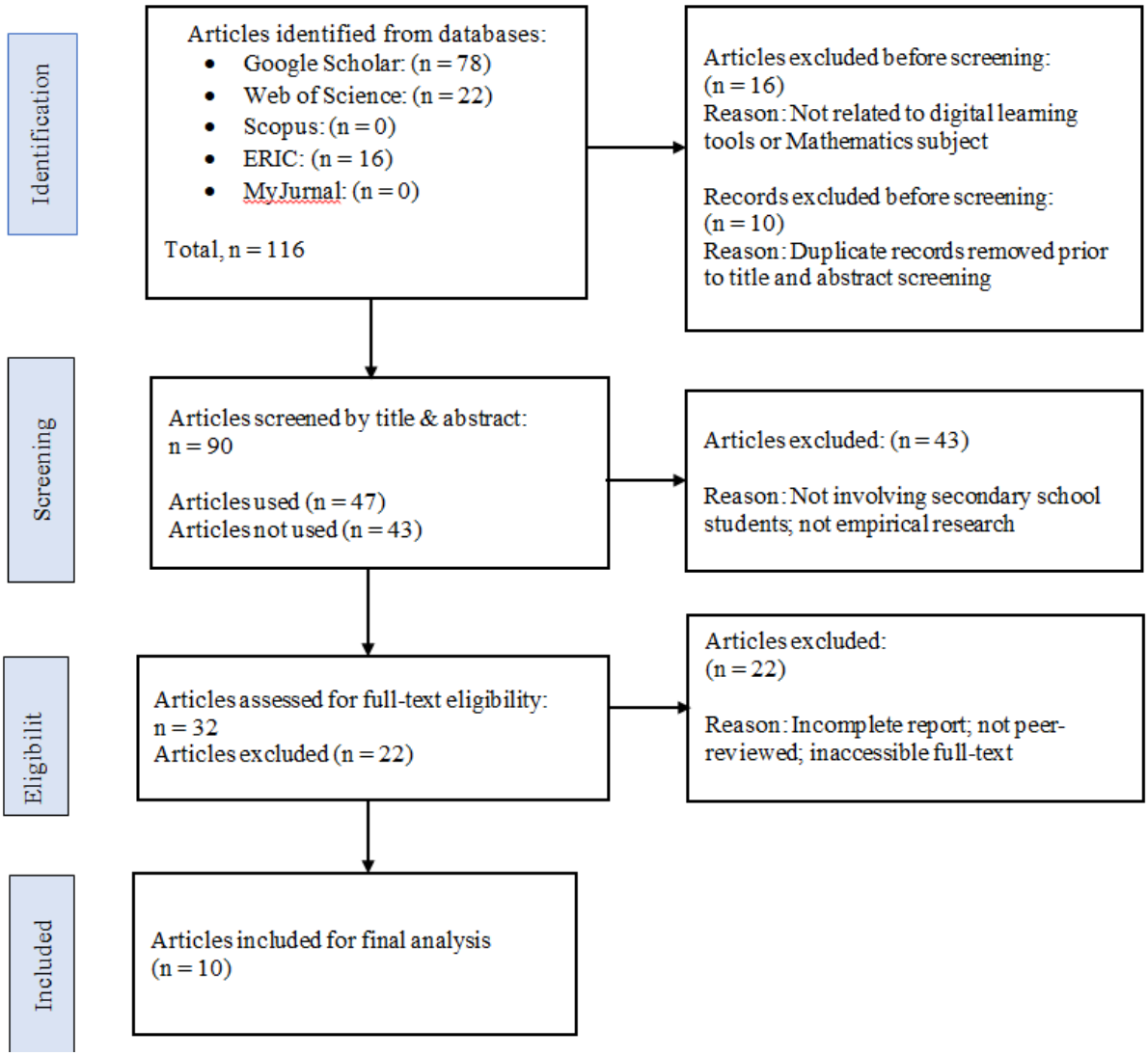

Figure 1.1: Flow chart diagram of the article selection process

Table 4 : Year of Article Publication

Year of Publication	**Number of Articles/Journals**
2023	2
2024	1
2025	7

Table 5: Article Search Engine / Database

Search Engine / Database	**Number of Articles/Journals**
Google Scholar	5
Web of Science	4
ERIC	1

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

Alongside the analysis provided by year of publication and search engine, the nature of the digital learning tools explored, what impacts have been reported on the achievement of the secondary students in Mathematics, what recommendations and interventions can be implemented to close the achievements gaps of the students have also been thoroughly examined on each of the 10 articles identified, as outlined in the Findings section using TABLE 5. With its thorough article-by-article synthesis, this study enables the development of a subtle and systematic appreciation of the evidence status quo on the digital tools in secondary Mathematics education.

The spread of the coverage of the included articles by the year of publication presents a fairly stable research production between 2023 and 2025 (n = 4), but the concentration will be the most significant in 2025. This surge aligns with the worldwide upsurge in remote and online learning at the beginning of the COVID-19 pandemic that suddenly and drastically increased the embrace of digital tools by teachers and students in the delivery of instruction. The small fall in subsequent publications since 2024 could be due to stabilization and solidification of interest in the research as education practices have solidified in the aftermath of the pandemic. Nonetheless, the output of research in the field continues to develop and increase and this indicates that the area has been of interest to the educational technology research community.

Most of the included articles were obtained in Google Scholar (n = 5), indicating its significantly broader indexing epistemology of the multidisciplinary educational research field and its global accessibility to researchers. Web of Science added 4 higher average citation impact articles and more methodological rigour articles as a centerpiece of empirical foundation of this review. The inclusion of the two databases also makes sure that the studies included fully capture a spectrum of studies in different educational settings as well as enough deep coverage of quality of scholarly life and thus enhances overall validity, quality, and informativeness of this systematic review.

Table 5: Studies that used digital tool from different countries together with their study design

Article	Methodology	Educational Challenges Identified	Impact of Digital Learning Tools on Mathematics Achievement	Measurement & Variables	Digital Learning Tool Implemented	Primary Limitations/ Rigor Rating	Recommendations
A1: Abu Bakar, D. N. N. P., et al. (2023). **Digital Escape Game and Students'** **Learning Outcomes in Mathematics : Experience From Brunei.** *SAGE Open*, 13(4), 1–14.	1. Type: Mixed methods quasi-experimental design. 2. Sample: 32 Year 9 secondary students in Brunei. 3. Instruments: Pre-test/post-test (10 items) and a 30-item perception questionnaire.	1. Mathematics is perceived as a challenging subject. 2. Students struggle specifically with index laws and zero/negative exponents. 3. National PISA scores are historically below the international average.	1. Substantial improvement in mathematics performance across all ability levels. 2. Reinforced student interest, enjoyment, and motivation. 3. Enhanced collaborative learning and communication skills.	1. Digital escape game performance vs. Math achievement	1. Digital Escape Game revision tool implemented via Google Forms, Quizizz, and WhatsApp.	1. Small sample size; lack of an isolated control group. 2. Research evaluated a mostly localized group within a single school in Brunei.	1. Harness gamification to supplement conventional revision. 2. Improve duration and clarity of in-game instructions.
A2: Alakayleh, A. S. (2025). **The Effect of**	1. Type: Quasi-experimental with pre- and	1. Overcrowded classrooms and high teacher-	1. Statistically significant improvements in mathematics	1. AI-personalized paths vs.	1. AI-supported personalized instruction	1. Lack of Longitudinal Tracking. 2. This	1. Formulate national policies for ethical AI

AI-Personalized Education on Achievement Among Students at the Secondary Stage in Jordan: A Future Vision. *The International Journal of Educational and Childhood Studies (IJECS)*, 1(1), 164-184.	post-tests. 2. Sample: 410 male secondary students in Jordan (stratified random sampling). 3. Instruments: Achievement tests and engagement surveys.	student ratios. 2. Resource disparities between urban and rural areas. 3. Loss of student interest due to a lack of individualized support.	achievement and problem-solving. 2. Reduced achievement gaps between student groups. 3. Fostered student engagement and academic persistence	Academic achievement	utilizing an adaptive learning platform and data analytics.	study captures immediate, short-term academic performance differences following the AI intervention but fails to track whether these learning gains persist over a longer duration for academic years.	integration. 2. Provide continuous teacher professional development in AI pedagogy. 3. Improve digital infrastructure and internet connectivity.
A3: Chan, J. Y.-C., et al. (2023). **Keep DRAGging ON: Is solving more problems in DragonBox 12+ associated with higher mathematical performance during the COVID-19 pandemic?** *British Journal of Educational Technology*, 54(4), 1310-1333.	1. Type: Randomized Controlled Trial (RCT) data analysis. 2. Sample: 253 seventh-graders in the USA. 3. Instruments: Algebraic knowledge assessments (10 items) and state standardised scores.	1. Learning loss and decreased progress caused by the COVID-19 pandemic. 2. Foundational struggles with algebraic principles and procedures. 3. Lower student engagement in online learning environments.	1. Higher in-game progress was related to higher algebraic performance after intervention. 2. Solving more problems mitigated the general decrease in math achievement scores. 3. Positive effects were strongest among students with lower prior achievement.	1. DragonBox 12+ problems solved vs. Math test scores	1. Game-based learning through the DragonBox 12+ application focused on algebraic equation solving.	1. Confounding variables due to remote learning environments. 2. Data was gathered entirely during unexpected COVID-19 remote learning periods, external factors like parental involvement, differing home internet speeds, and varied screen times could not be strictly standardized.	1. Dedicate specific school time for game-based revision. 2. Tailor gameplay duration based on the prior performance levels of students.
A4: Hetmanenko, L., & Khoruzha, L. (2025). **Leveraging Artificial Intelligence to Enhance Mathematics Education and**	1. Type: Quasi-experimental mixed-methods design. 2. Sample: 100 secondary school students in Kyiv,	1. Difficulty in solving complex didactic tasks. 2. A lack of practical skills in students despite theoretical focus. 3. Lack	1. Statistically significant improvement in math performance ($p < 0.001$). 2. 82% of students reported increased motivation.3. 90% stated the	1. AI instructional challenges vs. Curricular mitigation	1. Integration of the AI-powered Photomath application for step-by-step problem solving under teacher supervision	1. Lack of empirical data/experimental testing. 2. The study relies on theoretical structuring and existing literature review rather than introducing raw	1. Adapt curricula and methodologies to meet digital environment demands. 2. Support integration with proper teacher training and pedagogical

Overcome Instructional Challenges. *Innovaciencia*, 13(1), e5075.	Ukraine. 3. Instruments: Pre- and post-tests and a student perception survey.	of individual instructional support in traditional settings.	tool facilitated their learning effectiveness.		.		frameworks.
A5: Holman, K., et al. (2025). **Artificial Intelligence Interventions in Mathematics Education:** **A Systematic Literature Review**. *Insights into Learning Disabilities*, 22(1), 65-91.	1. Type: Systematic Literature Review (SLR) of 14 empirical studies (2020-2024). 2. Design: Methodological analysis following the PRISMA protocol.	1. Significant decline in national math scores post-pandemic. 2. Traditional methods failing to support students with disabilities. 3. Low proficiency rates in foundational skills (e.g., arithmetic, fractions).	1. AI interventions significantly improve academic performance, engagement, and personalization. 2. ITS and adaptive platforms lead to moderate-to-large improvements. 3. AI tools help bridge achievement gaps for diverse learners.	1. AI interventions vs. Efficacy for learning disabilities	1. Intelligent Tutoring Systems (ITS), adaptive platforms (ALEKS), and AI educational apps (Photomath, ChatGPT).	1. Subject to publication bias within indexed databases. 2. Despite structured filtering, the review is constrained by its database selection and language restriction.	1. Ensure thoughtful integration with traditional methods and teacher involvement. 2. Focus on ethical implementation, data privacy, and algorithmic fairness.
A6: Mollakuqe, V., & Mollakuqe, E. (2025). **A matrix-based analysis of pedagogical efficacy compared to traditional instructional approaches integrating GeoGebra in mathematics education.** *International Electronic Journal of Mathematics Education*, 20(2), em0821.	1. Type: Matrix-based efficacy analysis. 2. Sample: 112 high school students (aged 15-18). 3. Instruments: Pre- and post-tests and engagement surveys.	1. Abstract nature of geometry (circles) makes it difficult to grasp through static diagrams. 2. Varied learning paces and high cognitive load in traditional instruction. 3. The digital divide in technology access.	1. Experimental group scores improved by 46.6% compared to 23.3% for the control. 2. 82% active participation and 78% enthusiasm reported in the experimental group. 3. Interactive visualizations made complex concepts easier to understand.	1. GeoGebra dynamic visualization vs. Circle geometry scores	1. Integration of GeoGebra software for dynamic visual exploration of geometric figures and circle properties.	1. Strict Tool Specificity. 2. The mathematical matrices focus exclusively on GeoGebra's specific user interface and functionality	1. Digital tools should be utilized as complements to foundational methods. 2. Provide adequate teacher training to overcome software learning curves.
A7: Mosia, M., & Egara, F. O. (2025).	1. Type: Quasi-experimental with pretest-posttest non-	1. Weak and boring traditional instructional	1. Experimental group significantly outperformed control in both	1. Digital storytelling vs. Geometry	1. Digital Storytelling (using Canva,	1. Topic Isolation 2. The study focuses	1. Mathematics educators should incorporate

Enhancing achievement and retention in circle geometry through digital storytelling for senior secondary learners. *Education and Information Technologies*, 30, 25081–25111.	equivalent group design. 2. Sample: 132 SSS 1 learners from four public schools in Nsukka, Nigeria. 3. Instruments: Geometry Achievement Test (GAT) with 30 items (KR-20 = 0.83).	methods. 2. Mathematics anxiety associated with abstract geometric concepts. 3. Low achievement and knowledge retention rates globally.	achievement and long-term retention. 2. Increased student engagement and curiosity. 3. Digital stories reduced cognitive load and made abstract theorems concrete.	retention scores	Sway, and GeoGebra) to ground abstract theorems in real-world narratives (e.g. soccer).	exclusively on circle geometry, which leaves it unclear whether digital storytelling would prove equally effective for more abstract or algorithmic mathematical fields like calculus or algebra.	digital storytelling as a regular pedagogical approach. 2. Train teachers to design and implement engaging digital narratives. 3. Equip schools with projectors, tablets, and software.
A8: Plodkaew, K., et al. (2025). **Development of Interactive Multimedia to Enhance National Educational Test Results at the Basic Level in Mathematics for Educational Opportunity Expansion Schools in Lampang Province.** *Higher Education Studies*, 15(4), 154-168.	1. Type: Experimental (One-Group Pretest-Posttest). 2. Sample: 52 teachers and 308 Grade 9 students in Thailand. 3. Instruments: 12 multimedia learning modules and a 30-item achievement test.	1. National test (O-NET) scores consistently lower than national averages. 2. Teachers' qualifications mismatched to content and a lack of teaching diversity. 3. Boring, lecture-centric traditional methods.	1. Students' academic achievement increased significantly (Pre: 40.92%, Post: 70.34%). 2. Teachers' multimedia usage competency scores improved significantly. 3. Increased learner curiosity and attention through integrated visual/auditory elements.	1. Interactive multimedia vs. National Exam scores	1. Interactive Multimedia modules (12 units) based on ADDIE and Active Learning, utilizing ClassPoint and PowerPoint.	1. Contextual and Regional Isolation. Developed explicitly for "Educational Opportunity Expansion Schools" in Lampang Province	1. Provide comprehensive practical training to improve teacher multimedia competency. 2. Emphasize Active Learning where students take responsibility for their own knowledge construction.
A9: Putri, A. D., et al. (2025). **Blended Learning and Math Achievement: A Meta-Analytic Review Highlighting the Effectiveness and Heterogeneity.** *Electronic*	1. Type: Meta-analysis synthesizing 34 empirical studies (2014-2023). 2. Sample: 2,996 students globally. 3. Analysis: Z-test and Cochrane's Q test via CMA	1. Significant 15-point decline in global average mathematics performance (PISA 2022). 2. Insufficient teacher training in modern pedagogical methods. 3. Student disinterest	1. Blended learning has a significantly positive and robust effect on achievement (g = 1.090). 2. Improved student engagement through interactive activities and real-time	1. Blended learning vs. Traditional math achievement	1. Blended Learning models (Rotation, Flex) merging in-person instruction with digital tools like GeoGebra and Google Classroom.	1. Small Study Sample and Missing Demographics. Out of a massive initial search, only 34 studies met the strict statistical inclusion criteria.	1. Educators and policymakers should incorporate digital tools into the mathematics curriculum more strategically. 2. Provide affordable digital tools to bridge geographical

Journal of e-Learning, 23(1), 113-128.	software.	and frustration with traditional classroom approaches.	feedback. 3. Highest impact observed at the primary school level.				and socioeconomic gaps.
A10: Mohamad Ikram Zakaria, Wong Wai San Carol, Mohd Fadzil Abdul Hanid, Mohd Fahmi Adnan, Nur Fatihah Raimi, & Syarifah Maryam Syed Azman. (2024). **Integrating Geometrical Design with GeoGebra: Effects on Motivation and Academic Performance Among Secondary Students**. *Mathematics Teaching Research Journal*, 16(5), 186-217.	1. Type: Quasi-experimental with an unequal-group design. 2. Sample: 64 Form Three students in Johor Bharu, Malaysia. 3. Instruments: Motivation questionnaires (18 items) and academic performance tests.	1. Passive learning environments in secondary schools where students are listeners. 2. Abstract nature of transformation geometry is difficult to visualize. 3. Lack of direct impact studies specifically on geometry motivation.	1. Substantial enhancements in both intrinsic motivation and academic performance. 2. Increased level of student appreciation for the beauty of mathematics. 3. Fostered critical thinking and problem-solving skills through hands-on exploration.	1. GeoGebra geometric design vs. Motivation /Performance	1. Integration of Geometrical Design (Islamic mosque patterns) using GeoGebra software over a 7-week period.	1. Self-Report Bias on Motivation. While academic test scores were objective, the motivational and affective data relied heavily on student self-reporting surveys,	1. Emphasize mathematics' relevance by integrating cultural art and technology. 2. Encourage the regular use of dynamic software like GeoGebra to enhance instruction 3. Conduct longitudinal studies to assess long-term impacts.

FINDINGS

The search resulted in 10 articles that were deemed as related directly to the effect of digital learning tools on the achievement of Mathematics of secondary students. In detail the 10 identified articles have been discussed and they show, to various degrees, the type of digital tools investigated, the effects reported, the interventions used and recommendations on how to address issues related to achievements in secondary Mathematics education. Results of this review are organized depending on the three research objectives that were set at the beginning of the research study.

Objective 1: Types of Digital Learning Tools Investigated in Relation to

Secondary Students' Mathematics Achievement

The systematic analysis performed by the SLR has helped the researcher to identify that there are five key types of digital learning tools that have been most extensively studied in the context of Mathematics achievement of secondary students in the 10 articles reviewed. These are: (1) interactive mathematics software, including GeoGebra and Desmos; (2) gamification, including Kahoot!, Quizlet, Classcraft, and Gimkit; (3) a

learning management system (LMS) like Google Classroom, Moodle, Schoology, and Canvas; (4) an intelligent tutoring system (ITS) and (5) AI-assisted tools, such as Khan Academy and Dream.

The category that was most studied was interactive learning platforms (n = 10 articles) and then technology-based mathematics instruction (n = 10 articles). The 6 articles covered visual and dynamic learning tools whereas the 4 articles covered intelligent tutoring systems. The least studied type of interactive simulation/ multimedia tool and digital storytelling applications had cases in 1 article each. This distribution is indicative of the increased prior interest held by researchers in active, game-based and visualization-oriented online-based tools as key agents of enhancing student engagement and quantitative measure of achievement in mathematical training in high schools. Interactive software and gamification tools predominance in the literature reviewed can also be connected to the bigger pedagogical trends of fostering learning through the focus on student-centered and technology-mediated pedagogies in the post-pandemic educational environment. These ten types of digital learning tools are further analyzed in more detail in TABLE 6 in the next section of the 10 articles analyzed.

Table 6: Analysis articles of Types of Digital Learning Tools Investigated in Relation to Secondary Students' Mathematics Achievement

Types of Digital Learning Tools	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
● Interactive Mathematics Software (GeoGebra, Desmos)	-	/	/	/	/	-	-	-	-	-
● Gamification Tools (Kahoot!, Quizlet, Classcraft, Gimkit)	-	-	-	-	-	-	/	-	/	-
● Intelligent Tutoring System (ITS)	/	-	-	-	-	-	-	/	-	-
● AI-Assisted Tools (Khan Academy, Dream)	/	-	-	-	-	-	-	/	-	-
● Digital Storytelling Applications	-	-	-	-	-	/	-	-	-	-
● Interactive Multimedia	-	-	-	-	-	-	-	-	-	/
● Interactive Learning Platforms	/	/	/	/	/	/	/	/	/	/
● Mobile Learning Applications	/	-	-	-	-	-	/	/	-	-
● Technology-Based Mathematics Instruction	/	/	/	/	/	/	/	/	/	/
● Visual and Dynamic Learning Tools	-	/	/	/	/	/	-	-	-	/

Objective 2: Effects of Digital Learning Tools on Secondary Students'

Mathematics Achievement

The SLR analysis has determined six primary levels of identified effects in the literature testing the influence on the achievement in Mathematics as reported by secondary students using digital learning tools. These include: better conceptual knowledge and procedural fluency in Mathematics; better student engagement, interest, and intrinsic motivation; better performance in both formative and summative Mathematics assessment; better self-regulation, metacognitive awareness, and independent learning behaviours; less Mathematics anxiety and higher academic self-efficacy; student-centred learning approach improvement in Mathematical conceptual understanding; use of interactive technology in Mathematics and enhanced collaborative learning; improvement in Mathematics learning retention; and enhanced collaborative learning and peer interaction in Mathematics tasks.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

Enhanced students conceptual understanding and procedural fluency, students' improvement in formative and summative Mathematics performance, student-centred learning approach, improvement in Mathematical conceptual understanding and use of interactive technology in Mathematics (n = 10 articles, 100%), were the five most frequently reported effects in the 10 analyzed articles. Other than that, better student engagement, interest, and intrinsic motivation was found in 9 articles (90%) and increased self-regulation and metacognition were found in 6 articles (60%). The 6 articles that indicated reduced Mathematics anxiety were 60 percent and the 9 articles that showed improved collaborative learning were 90 percent. Finally, 8 articles that showed improvement in Mathematics learning retention equal to 80%. These results have made it clear that the effects of digital learning tools implemented in an efficient and properly pedagogically supported manner have a wide and generally beneficial effect on many aspects of the secondary pupils' experience of learning Mathematics and the resultant achievement measures. These six prevailing effects are further analyzed in more detail in Table 7 in the next section of the 10 articles analyzed.

Table 7: Analysis of Effects of Digital Learning Tools

Effects of Digital Learning Tools / Articles	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
● Improvement in Conceptual Knowledge and Procedural Fluency	/	/	/	/	/	/	/	/	/	/
● Enhancement of Student Engagement, Interest, and Intrinsic Motivation	/	/	/	/	/	-	/	/	/	/
● Improvement in Formative and Summative Mathematics Performance	/	/	/	/	/	/	/	/	/	/
● Enhancement of Self-Regulation, Metacognitive Awareness, and Independent Learning	/	-	-	/	/	-	/	/	-	/
● Reduction of Mathematics Anxiety and Improvement of Academic Self-Efficacy	/	-	/	/	/	-	/	/	-	-
● Enhancement of Collaborative Learning and Peer Interaction	/	/	/	/	/	-	/	/	/	/
● Student-Centred Learning Approach	/	/	/	/	/	/	/	/	/	/
● Improvement in Mathematical Conceptual Understanding	/	/	/	/	/	/	/	/	/	/
● Use of Interactive Technology in Mathematics	/	/	/	/	/	/	/	/	/	/
● Improvement in Mathematics Learning Retention	/	-	/	/	/	/	/	/	-	/

Objective 3: Recommendations and Interventions to Improve Secondary Students'

Mathematics Achievement

The consolidation of the 10 chosen papers also brought to light some critical suggestions as well as practical interventions that can enhance the achievement of Mathematics by secondary students by efficiently applying

digital learning tools. In the literature, the theme that has been stressed on repeatedly is that digital tool integration demands access to technology, as well as effective pedagogical and institutional support.

The recommendations with the most frequent suggestions are offering teachers ongoing professional development to gain digital competency and the ability to design instruction, and to ensure that teachers can successfully implement digital tools in Mathematics teaching. Also, enhancement of fair access to the digital infrastructure, including reliable internet network and access to gadgets is identified as a key requirement to minimize the achievement gap between pupils.

Moreover, numerous research works suggest that blended learning models should be utilized, meaning integrating digital learning resources with the face-to-face training to obtain the best possible results in terms of comprehending the concepts and student interaction. It also gives a high emphasis on the importance of interactive and student-centered approach of instruction which may comprise gamification, problem based learning, and adaptive learning systems.

Initially on the student level, where motivation and self-regulated learning are encouraged with the help of personalized feedback systems and AI-assisted learning platforms, this approach is often proposed to be a successful intervention. In addition, limited research suggested to works on integration of GeoGebra in Mathematics instruction to improve students' understanding, participation and achievement. The most common use of GeoGebra to allow students to visualize abstract mathematical concepts dynamically through interactive graphs, geometric constructions and simulations. Supporting self-paced and independent learning using digital technologies also highlighted by some studies. Articles such A1, A7, A8 and A10 mentioned the technologies including artificial intelligence systems AI, educational games like Blooket, Kahoot!, and Quizizz, and interactive multimedia can promote autonomous learning by providing immediate feedback, adaptive activities, and flexible access to learning resources. Finally, curriculum designers can not only promote the integration of digital tools and Mathematics learning outcomes but also make sure that this activity is meaningful and they are not using technology in a superficial manner.

On the whole, the results indicate that the improvement of the potential of digital learning tools in enhancing the Mathematics performance among the secondary students depends on improving both the pedagogical and infrastructural factors. Recommendations and interventions to improve secondary students' Mathematics achievement analyzed in more detail in TABLE 8 in the next section of the 10 articles analyzed.

Table 8: Analysis Recommendations and Interventions to Improve Secondary Students' Mathematics Achievement

Recommendations and Interventions to Improve Secondary Students' Mathematics Achievement	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
● Offering teachers ongoing professional development to gain digital competency and the ability to design instruction	/	-	/	/	-	-		/	-	/
● Enhancement of fair access to the digital infrastructure, including reliable internet network and access to gadgets	-	-	-	-	-	-	/	/	-	/
● Blended learning models	/	-	/	/	/	/	/	/	/	/
● Student motivation through technology-integrated learning	-	-	-	-	/	-	/	-	/	-
● Addressing instructional challenges through	/	-	-	-	-	-	-	/	-	-

AI-assisted Mathematics education										
● Curriculum designers must merge with digital technologies into Mathematics curriculum planning and instructional design	/	-	/	/	/	/	/	/	/	/
● Improvement of academic performance through digital learning interventions	/	-	/	/	/	/	/	/	/	/
● Encouraging active student participation using interactive digital tools	-	-	/	/	/	-	/	-	/	/
● Integration of GeoGebra in Mathematics instruction	-	-	/	/	/	-	-	-	-	-
● Supporting self-paced and independent learning using digital technologies	/	-	-	-	-	-	/	/	-	/

DISCUSSION

This part showed a detailed analysis of the research findings by connecting the synthesized empirical evidence directly to the three primary research objectives. By anchoring these findings within established educational frameworks, the discussion explores how digital tools affect secondary mathematics performance and outlines practical, real-world interventions to lift struggling learners out of low math achievement.

Digital Learning Tools Most Frequently Studied

The first research goal in this research was to identify what kinds of digital learning tools have been most commonly evaluated in the literature in the last few years related to mathematics achievement in secondary education. The insights between 2023 and 2025 indicate that research is taking place at the intersection of three main technological pillars. This is away from static and passive computer programs and towards highly interactive, intelligent and visual ecosystems.

The field of secondary mathematics research is still in its early stages and currently, AI tools are primarily classified into two functional categories: Intelligent Tutoring Systems (ITS) and AI-Powered Homework Assistants. Intelligent Tutoring Systems are large-scale software systems that can trace personalized learning paths using the data produced in real time from a student's performance (Alakayleh, 2025; Holman et al., 2025). On the other hand, AI-Powered Homework Assistants are mobile applications like Photomath that use computer vision to solve intricate algebraic and arithmetic problems in a step-by-step and guided manner (Hetmanenko & Khoruzha, 2025).

GeoGebra is the most specialized of the math software, and is the most closely reviewed digital tool in recent literature worldwide (Mollakuqe & Mollakuqe, 2025; Zakaria et al., 2024). GeoGebra is used by researchers due to its open access availability and the fact that it enables the link between abstract algebraic equations with real-time visual changes of the geometric objects. Besides, GeoGebra has a special pedagogical value; abstract algebraic equations can be conceptually understood through dynamic real-time visualization of the geometric aspect, affording students the ability to explore complex mathematical relationships dynamically (Mollakuqe & Mollakuqe, 2025; Sianturi & Ningsih, 2025; Zakaria et al., 2024).

A key challenge in the field of education is the issue of student disengagement in math, with researchers exploring the promise of immersive digital environments, which fall into three modes. The first type of gamified applications, like DragonBox 12+ and customized Digital Escape Games, combine essential game features (points, unlocks, story-based puzzles) with intensive problem-solving tasks (Abu Bakar et al., 2023; Chan et al., 2023). Second, digital storytelling is a technology that leverages multimedia storytelling to make

the abstract geometric properties more relevant and real to a story line (Mosia & Egara, 2025). Lastly, interactive multimedia is a software package that is designed to be tailored and localized to prepare learners for high-stakes national standardized tests (Plodkaew, 2025).

Positive and Negative Impacts of Digital Learning Tools on Mathematics Achievement

The second research objective aimed to unpack both the positive breakthroughs and the hidden limitations of these digital tools on secondary students' mathematics achievement.

a) Positive Impacts: Visual Clarity and Mental Relief

The information from all 10 sources, when taken together, strongly and clearly indicates that, where well-designed, digital interventions are likely to have more consistent impact than paper-based interventions. From a macro-structural perspective and at the level of thousands of learners, the meta-analysis of Putri et al. (2025) has found that these digital tools have a large positive effect ($g = 1.090$) as part of a blended learning approach (where they are used in class and digitally).

Furthermore, in geometry, dynamic software is the most graphical. Mollakuqe and Mollakuqe (2025) showed that the students who were taught by using GeoGebra had a conceptual increase of 46.6% and the conceptual increase of the students who were taught by the classical lecture method was 23.3% in the same empirical tests. These tools will reduce the mental effort required, by converting abstract lines to interactive images, allowing students to focus more on problem solving, rather than on geometry.

Lastly, for Nigeria, gamified platforms and digital storytelling (with an extremely high EES of) mask the very rigorous mathematical activities as low threat games (Mosia and Egara, 2025). This is a great equaliser: gender focussed analysis showed that there were no differences in performance between male and female students in the use of digital storytelling or AI tools, suggesting that technology can be used to create an equitable learning environment.

b) Negative and Neutral Nuances: The Limits of Digital Integration

The findings of this empirical research are positive, but when further research is done on the literature, there is evidence that technology is not the answer. First, there is the abstract transfer issue – sometimes, a student's performance on a traditional exam is not a reflection of whether or not he or she has improved in a learning game. The mathematics achievement in DragonBox 12+ was shown to be positively predicted by in-game progression, which did not appear to be a significant predictor of the formal algebra test scores, in Chan et al.'s (2023) study. Therefore, it implies that it is not a symmetrical transfer of learning: not every representation of learning that is intuitive (gamified) becomes a representation of learning in a traditional testing situation.

In addition, digital tools can also be a better safety net than an accelerator. The results from gamified platforms and AI homework helpers are better among students who have low achievements, which does not necessarily hold true for the other student groups (Chan et al., 2023). That's a good thing for equalizing the playing field in education, but it also implies that such tools are less and less productive for students who are already quite adept in basic mathematics.

Last but not least, time and developmental considerations are crucial to AI and digital platform success. The impact of the short-term digital exposures is low, since it takes weeks to months of exposure to the "ecosystem" of a software for students to become familiar with it (Holman et al., 2025). Furthermore, the findings of the meta-analysis suggest that in the primary and lower secondary education, blended learning has strong power especially when using media which are interactive and sensory because it was used heavily, while for students at the senior-secondary level, the level of abstraction in mathematics required to be mastered, the effect of using blended learning in this level may be a little reduced.

Actionable Interventions and Recommendations to Overcome Low Mathematics Achievement

To resolve the ongoing issue of low mathematics achievement among secondary school students, educational systems must move past unstructured, ad-hoc technology use. Based on the empirical findings of the reviewed research, four systematic interventions are recommended.

a) Institutionalizing the Blended Learning and TPACK Frameworks

Technology should not be treated as a complete replacement for human instruction; rather, the literature demonstrates that AI and digital tools reach peak efficacy when operating as an instructional "partner" rather than a standalone teacher. To operationalize this synergy, school districts should adopt a dual-structured classroom model where educators lead foundational conceptual anchoring sessions, which are immediately followed by digital lab sessions leveraging GeoGebra or AI tutoring software for active, personalized application (Bozkurt & Ruthven, 2018; Son, 2024). Grounded in the frameworks of Mohd Yatim et al. (2022) and Chytas et al. (2024), this sequence enables students to build conceptual understanding under teacher guidance before progressing to technology-supported exploratory and individualized learning activities.

Furthermore, to achieving this systemic shift requires that teacher training programs be fundamentally redesigned using the Technological Pedagogical Content Knowledge (TPACK) framework. As demonstrated by Thailand’s localized training initiatives (Plodkaew et al., 2025), professional development must transcend basic technical literacy. Programs must explicitly instruct educators on how to actively weave interactive multimedia into existing curricular goals, ensuring that digital tools serve as cognitive catalysts rather than solely expensive digital notebooks.

b) Targeted Use of Gamification and Narratives for Remedial Cohorts

Such specialized tools, which are aimed at making mathematics more enjoyable to learn, should be employed as focused intervention techniques to prevent 'math phobia' and 'blocks' among struggling students, who have strict and abstract mathematical notation. For secondary-level students working below grade level in mathematics, schools should start using narrative-based programs - such as a digital storytelling program or digital escape room - for mathematical concepts that need to be understood on a more complex level, like circle geometry, trigonometry, and for the introduction of simple algebraic equations. This will allow for abstract notation to be delayed and build spatial intuition and intuition about the concepts in a low stakes, collaborative environment (Barkley & Cross, 2021; Segrist, 2023).

c) Sustained, Long-Term AI Integration Over Short-Term Novelty

For short-term digital interventions often suffer from a short-lived "novelty effect," the implementation of intelligent tutoring platforms must be structural and sustained. To move past superficial engagement, curriculum designers must embed AI-personalized tools directly into students' daily homework, in-class assignments, and formative assessment ecosystems for extended durations spanning entire school terms. Rather than deploying these tools as occasional novelty activities, this long-term approach provides AI algorithms with the continuous data streams necessary to accurately map, adapt to, and systematically remediate individual learning gaps over time (Agostini et al., 2024; Jiali, 2024).

d) Designing for Equity: Curricular Alignment and Low-Tech Alternatives

Educational interventions must be highly accessible and relevant to the context, and must not inadvertently expand the digital divide when using digital tools. In particular, the implementation of AI and multimedia software should be purposefully designed and adapted to incorporate national curricula and to be localized based on the student population's cultural and linguistic needs. In addition, in resource-limited or rural context settings where high-speed internet and advanced hardware infrastructure do not exist, institutions could use low-tech alternatives to digital resources. Digital narratives, offline-ready multimedia and comic-strip versions of digital stories are useful tools to facilitate digital integration, but can also be implemented without leaving out the most marginalized learners (Agostini et al., 2024; Jiali, 2024).

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

Implication Of Study

From the ten empirical articles (2023-2025) used to develop this dataset, it was clear that the introduction of digital tools into secondary mathematics classrooms is more than just about the incorporation of technology into a lesson plan; it has far-reaching consequences for how mathematics is taught, how institutions function, and how social gaps are addressed.

Changing the Way We Teach (Pedagogical Implications)

The numbers tell one story: lectures, as usual, don't work very well with a very abstract topic such as geometry and algebra—and especially when many students feel very uncomfortable with math and are overwhelmed by it. Dynamic visual tools such as GeoGebra or a real-life story structure completely redefine the situation when teachers introduce them: by making intimidating formulas real and tangible, they become visual realities (Alakayleh, 2025; Mohamad Ikram Zakaria et al., 2024; Mollakuqe & Mollakuqe, 2025; Mosia & Egara, 2025).

Moreover, gamified platforms like DragonBox 12+ or Quizizz are not simply superficial activities or meaningless rewards in the aftermath of the pandemic. They serve as cognitive buffers that can proactively mitigate learning losses caused by the pandemic, from the role of an info-provider to a learning coach (Chan et al., 2023; Abu Bakar et al., 2023; Holman et al., 2025). The implementation of a grounding approach using a relatable story provides evidence that student learning is very much dependent on genuine emotional and cultural connection, whether in the form of sports mechanics or local cultural art patterns (Mohamad Ikram Zakaria et al., 2024; Mosia & Egara, 2025).

Overhauling Policies and Teacher Training (Institutional Implications)

It is essential for organizational and policy reforms to be implemented at the national and school levels if these digital ecosystems are to be created. Adding artificial intelligence tools or high-tech multimedia to a classroom is not enough – if teachers are not tech competent, the tech-fatigue is immense. The education ministry needs to focus on more than just providing hardware, and must prioritize continuous and hands-on professional development (Alakayleh, 2025; Hetmanenko & Khoruzha, 2025; Plodkaew et al., 2025).

This is especially suitable for the present-day policy such as Malaysia's Rancangan Pendidikan Malaysia (RPM) 2026 – 2035 (Kementerian Pendidikan Malaysia, 2026) which highlights curriculum flexibility (Keluwesan) and smart resource distribution (Ketersediaan Sumber) to seamlessly integrate adaptive tech into a standard school environment. In parallel, as AI-based personalized learning and intelligent tutoring systems provide massive boosts in student performance, policymakers have a pressing need to develop enforceable data privacy laws and ethical principles to safeguard student data (Alakayleh, 2025; Holman et al., 2025).

Bridging or Widening the Academic Divide (Social Equity Implications)

Ultimately, the success of these technologies will be judged on whether they will exacerbate or diminish current social inequalities. Significantly, several studies point out that the biggest winners in game-based and AI-adaptive learning are actually struggling students and learners with disabilities, positioning ed-tech as a genuine driver for upward social mobility (Alakayleh, 2025; Chan et al., 2023; Holman et al., 2025). However, there is a major catch. Because blended learning frameworks and AI applications inherently depend on stable Wi-Fi and reliable device access, their true impact is completely bottlenecked by geographic and economic realities (Alakayleh, 2025; Mollakuqe & Mollakuqe, 2025; Putri et al., 2025).

CONCLUSION

This Systematic Literature Review (SLR) aimed to investigate the effects of digital learning tools on the performance of secondary students in Mathematics, the most commonly investigated tools, and how to mitigate the ongoing achievement gaps. According to the review of 10 chosen articles (published between

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

2020 and 2025), the results unambiguously show that digital learning tools contribute to the improvement of Mathematics learning outcomes at the secondary school level in a generally positive and transformative way.

It was found that the most common tools as the focus of the review were interactive mathematics software and gamification platforms, then learning management systems, interactive learning platforms, visual and dynamic learning tools and AI-based tutoring systems. These tools have been evidenced to enhance major areas of learning, especially; student engagement, conceptual and performance in assessment. Moreover, when backed up by efficient pedagogy, digital tools are seen to aid in the process of building self-regulated learning, Mathematics anxiety, and foster collaborative learning environments.

Nonetheless, not all of such tools are equally effective and depend on a variety of moderating variables, such as access to technology, teacher digital competence, student motivation, and the quality of the instruction design. This indicates that technology cannot successfully be used without the help of technology; it is only through its application in the teaching practice that it can be successful. It also implies the overall movement towards student-friendly and technology-supported education, which is being amplified during the COVID-19 pandemic.

To sum up, there are high possibilities that digital learning tools can enhance Mathematics achievement among secondary students, but they need to be put in place in a strategic, inclusive, and pedagogical manner. This directly aligns with the strategic vision of Rancangan Pendidikan Malaysia (RPM) 2026 – 2035 (Kementerian Pendidikan Malaysia, 2026), which emphasizes equitable access to digital tools, curriculum flexibility, and tech-driven infrastructure as non-negotiable outcomes for holistic student development. Moving forward, the long-term effects, applications in specific contexts, and how to mitigate equity problems must be deeply considered in future studies so that digital innovation in education may truly be beneficial to all students.

Future Research Directions

Despite providing valuable insights into the impact of digital learning tools on secondary students' mathematics achievement, this review has several limitations that should be acknowledged. The review included only 10 studies that met the established inclusion criteria, which may limit the breadth and generalizability of the findings across different educational settings and student populations. Future systematic reviews should consider incorporating a larger pool of eligible studies from a wider range of databases and geographical contexts to provide a more comprehensive understanding of the topic. In addition, a detailed quality appraisal of the selected studies should be conducted to assess methodological rigor and strengthen the credibility and reliability of the synthesized evidence.

Future researchers should also categorize digital learning tools according to their specific functions, such as gamification platforms, artificial intelligence-based systems, learning management systems, interactive mathematics software, and multimedia applications. Such categorization would allow for more meaningful comparisons of their effectiveness across different mathematics topics, including algebra, geometry, statistics, and calculus, as well as across diverse educational contexts. Furthermore, meta-analytic techniques could be employed to quantify the overall effect size of digital learning interventions on mathematics achievement, providing stronger empirical evidence regarding their effectiveness and enabling comparisons between different intervention types.

Additionally, future studies should move beyond the sole examination of academic achievement and explore a broader range of educational outcomes. These may include critical thinking skills, problem-solving ability, learner engagement, motivation, self-regulated learning, collaboration, and long-term knowledge retention. Investigating these factors would provide a more holistic understanding of how digital learning tools influence students' learning experiences and development. Future research may also examine the long-term sustainability of digital learning interventions and the moderating effects of factors such as teacher digital competence, technology accessibility, socioeconomic background, and instructional design. Such efforts would contribute to the development of more effective, equitable, and evidence-based approaches to technology-enhanced mathematics education.

REFERENCES

1. Agostini, D., Lazareva, A. & Picasso, F. 2024. Advancements in technology-enhanced assessment in tertiary education. Australasian Journal of Educational Technology, 40(1): 1–15. https://doi.org/10.14742/ajet.10122
2. Alakayleh, A. S. (2025). The effect of AI-personalized education on achievement among students at the secondary stage in Jordan: A future vision. International Journal of Educational Science and Computing (IJESC). https://doi.org/10.21608/ijesc.2025.435740.1005
3. Barkley, E. F. & Cross, K. P. 2021. Interactive learning environments in secondary mathematics. San Francisco: Jossey-Bass.
4. Bozkurt, G. & Ruthven, K. 2018. The activity structure of technology-based mathematics lessons: A case study of three teachers in English secondary schools. Research in Mathematics Education 20(3): 254–272.
5. Chan, J. Y.-C., Byrne, C., Jerusal, J., Liu, A. S., Roberts, J., & Ottmar, E. (2023). Keep DRAGging ON: Is solving more problems in DragonBox 12+ associated with higher mathematical performance during the COVID-19 pandemic? British Journal of Educational Technology, pp. 1–24. https://doi.org/10.1111/bjet.13304
6. Chytas, C., van Borkulo, S.P., Drijvers, P., Barendsen, E. & Tolboom, J.L.J. 2024. Computational thinking in secondary mathematics education with GeoGebra: Insights from an intervention in calculus lessons. Digital Experiences in Mathematics Education 10: 228–259.
7. Fabian, K., Topping, K. J., & Barron, I. (2022). Mobile technology and mathematics: Effects on students' attitudes, engagement and achievement. Journal of Computers in Education, 9(2), 165-186. https://doi.org/10.1007/s40692-021-00214-0
8. Guldaray Akhmetzhanova, Syrym Zhanzhigitov, Botagoz Bermukhambetova, Serikkhan Zhuzeyev & Manat Zhailauova. 2025. Assessing the role of online mathematics tools in enhancing student learning and engagement. International Journal of Information and Education Technology 2025(1): 67–85. https://doi.org/10.55056/etq.874
9. Gusenbauer, M. & Haddaway, N. R. 2020. Which academic search systems are suitable for systematic reviews? Evaluating retrieval qualities of Google Scholar, PubMed, and Web of Science. Research Synthesis Methods 11(2): 181–217.
10. Hayrol Azril, M. S. et al. 2021. Systematic literature review in educational research: Methodological perspectives and applications. Journal of Educational Research and Practice 11(1): 1–15.
11. Hetmanenko, L., & Khoruzha, L. (2025). Leveraging artificial intelligence to enhance mathematics education and overcome instructional challenges. Innovaciencia, 13(1), e5075. https://doi.org/10.15649/2346075X.5075
12. Hetmanenko, L., & Khoruzha, L. (2025). Leveraging artificial intelligence to enhance mathematics education and overcome instructional challenges. Innovaciencia, 13(1), e5075. https://doi.org/10.15649/2346075X.5075
13. Hodges, C., Moore, S., Lockee, B., Trust, T. & Bond, A. 2020. The difference between emergency remote teaching and online learning. Educause Review 27.
14. Holman, K., Marino, M., Vasquez, T., Taub, M., Hunt, J. & Tazi, Y. (2025). Artificial intelligence interventions in mathematics education: A systematic literature review. Insights into Learning Disabilities, 22(1), 65–91.
15. Ion, T.-C., & Popescu, E. 2025. An innovative distance learning platform for mathematics education in secondary schools: Design, development and preliminary studies. Education and Information Technologies 30(5): 5529–5560. https://doi.org/10.1007/s10639-024-13040-z
16. Jayalekshmi Janardhanan & M. Aron Antony Charles. 2024. Exploring the role of innovation in enhancing mathematics achievement in higher secondary students. Edelweiss Applied Science and Technology 8(6): 5659–5671. https://doi.org/10.55214/25768484.v8i6.3237
17. Jiali, S. 2024. The impact of artificial intelligence on personalized learning in education: A systematic review. Pakistan Journal of Life and Social Sciences (PJLSS), 22(2): 7412–7428. https://doi.org/10.57239/pjlss-2024-22.2.00560
18. Karantzas, G. C. 2019. Enhancing the rigor of systematic reviews: Applications of PRISMA framework. Educational Research Review 26: 100–110.

19. Kementerian Pendidikan Malaysia. (2026). Rancangan Pendidikan Malaysia (RPM) 2026–2035. Putrajaya: Kementerian Pendidikan Malaysia. https://www.moe.gov.my
20. Li, Q. & Ma, X. 2021. A meta-analysis of the effects of computer technology on school students' mathematics learning. Educational Psychology Review 33(1): 1–27.
21. Ministry of Education Malaysia. (2022). Laporan tahunan 2022: Malaysia Education Blueprint 2013-2025. MOE Malaysia.
22. Mohd Yatim, S.S.K., Saleh, S., Zulnaidi, H., Yew, W.T. & Yatim, S.A.M. 2022. Effects of Brain-Based Teaching Approach Integrated with GeoGebra (BGeo Module) on students' conceptual understanding. International Journal of Instruction 15(1): 327–346.
23. Mollakuqe, V., & Mollakuqe, E. (2025). A matrix-based analysis of pedagogical efficacy compared to traditional instructional approaches integrating GeoGebra in mathematics education. International Electronic Journal of Mathematics Education, 20(2), em0821. https://doi.org/10.29333/iejme/15936
24. Mosia, M., & Egara, F. O. (2025). Enhancing achievement and retention in circle geometry through digital storytelling for senior secondary learners. Education and Information Technologies, 30, pp. 25081–25111. https://doi.org/10.1007/s10639-025-13702-6
25. Ngien Hock Wuong, Murugan Rajoo & Noor Azah. 2022. Application of systematic literature review in educational research: A practical guide. International Journal of Academic Research in Education 8(2): 45–60.
26. OECD. 2023. PISA 2022 Results: Learning Outcomes and Trends in Global Education. Paris: OECD Publishing.
27. Pg Abu Bakar, D. N. N., Shahrill, M., & Zakariya, Y. F. (2023). Digital escape game and students' learning outcomes in mathematics: Experience from Brunei. SAGE Open, October-December 2023, pp. 1–14. https://doi.org/10.1177/21582440231216838
28. Plodkaew, K., Pankaew, K., Suwanreung, C., & Komat, C. (2025). Development of interactive multimedia to enhance national educational test results at the basic level in mathematics for educational opportunity expansion schools in Lampang Province. Higher Education Studies, 15(4), 154. https://doi.org/10.5539/hes.v15n4p154
29. Powers, K. 2017. Selecting and reviewing research articles: A guide for systematic literature reviews. Journal of Research Practice 13(2): 1–10.
30. Putri, A. D., Juandi, D., Turmudi & Suparman (2025). Blended learning and math achievement: A meta-analytic review highlighting the effectiveness and heterogeneity. Electronic Journal of e-Learning, 23(1), 113–128. https://doi.org/10.34190/ejel.23.1.3781
31. Sarah Nur Nurja & Maslida, Y. 2022. The role of systematic literature review in educational research development. Malaysian Journal of Education 47(1): 15–25.
32. Segrist, J. A. 2023. Gamification and narrative intervention strategies for low-achieving math students. Journal of Mathematical Pedagogies, 15(3): 112–128. https://doi.org/10.1016/j.jmp.2023.03.004
33. Son, T. 2024. Intelligent tutoring systems in mathematics education: A systematic literature review using the substitution, augmentation, modification, redefinition model. Computers 13(10): 270.
34. Tengku Farahnorfadhilah Engku Azman & Norah Md Noor. 2023. Tahap kemahiran penggunaan alat teknologi pendidikan dalam kalangan guru sains dan matematik di sekolah menengah. Innovative Teaching and Learning Journal 7(1): 90–105. https://doi.org/10.11113/itlj.v7.127
35. Zakaria, M. I., Carol, W. W. S., Hanid, M. F. A., Adnan, M. F., Raimi, N. F., & Azman, S. M. S. (2024). Integrating geometrical design with GeoGebra: Effects on motivation and academic performance among secondary students. Mathematics Teaching Research Journal, 16(5), pp. 186-217.