JIPSI: Jurnal Ilmu Pendidikan dan Sains Islam Interdisipiner
Vol. 5, No. 3, Agustus 2026, pp. 2195-2218
http://journal.amorfati.id/index.php/jipsi || ISSN 2962-9187

Interdisciplinary Scope of Science and Education, Islamic Education and Science, Integration of Science and Islam, Islamic Thought and Philosophy, Integration of Social Sciences, Humanities, and Islamic Studies, Islamic Economics and Business Studies, and Islamic Ethics in Science and Technology

The Effect of Game-Based Learning on Students' Learning Interest in Elementary School Science: A Systematic Literature Review (2021–2025)

Mila Dianur [1], Andi Thahir [2], Ayu Reza Ningrum [3]

[1,2,3] Program Studi Pendidikan Guru Madrsah Ibtidaiyah, Universitas Islam Negeri Raden Intan Lampung, Lampung, Indonesia

*[1] nurmiladia40@gmail.com, [2] andithahir@radenintan.ac.id, [3] ayurezaningrum@radenintan.ac.id

ARTICLE INFO

Article history
Received:
30-06-2026
Revised:
14-07-2026
Accepted:
02-08-2026

Keywords
Game-Based Learning, minat belajar, pembelajaran IPA, sekolah dasar, *Systematic Literature Review*.

ABSTRACT

This study aims to examine the effects of *Game-Based Learning* (GBL on elementary school students' learning interest in science education and to identify research trends and implementation factors during the 2021–2025 period. The study employed a Systematic Literature Review (SLR) following the PRISMA 2020 framework. The literature was retrieved from the Scopus and Google Scholar databases using the Publish or Perish (PoP) software. Article selection was conducted using Covidence AI to facilitate duplicate removal, title and abstract screening, and eligibility assessment in a more systematic and efficient manner. Of the 285 publications initially identified, 12 empirical studies met the inclusion criteria after the screening and eligibility assessment process. Data were analyzed using thematic qualitative analysis supported by Microsoft Excel**,** while VOSviewer was employed to visualize keyword co-occurrence and **co** authorship networks**.** The findings consistently demonstrate that GBL enhances students' learning interest by increasing motivation, learning engagement, attention, enjoyment, self-confidence, and scientific curiosity. Interactive digital platforms, including Kahoot, Quizizz, Scratch, Educandy, Baamboozle, and Wordwall**,** emerged as the most frequently implemented forms of GBL. The study concludes that GBL is an effective pedagogical approach for fostering students' affective engagement and promoting student-centered science learning in elementary schools. Furthermore, the findings provide important implications for the development of instructional design and future research on technology-enhanced learning.

INTRODUCTION

Science education in elementary schools plays a strategic role in establishing the foundations of scientific literacy from an early age. However, it continues to face numerous

challenges that affect the effectiveness of the learning process. In many schools, particularly in developing countries, science instruction remains predominantly teacher-centered, relying heavily on lecture-based approaches, while being constrained by limited laboratory facilities and a lack of contextual and meaningful learning media (Casanpitarch R.c, 2018; Timotheou et al., 2023; Wekerle et al., 2022). Furthermore, teachers often encounter difficulties in presenting abstract scientific concepts in ways that are accessible and comprehensible to students with diverse characteristics and varying learning abilities (Yaseen et al., 2025). These conditions have contributed to science being frequently perceived as a difficult, abstract, and unengaging subject, which in turn negatively affects students' learning interest, participation, and active engagement throughout the instructional process (Cheung, 2018; Nkomo et al., 2021; Zou et al., 2025). Therefore, there is a pressing need for instructional innovations capable of providing more interactive, contextualized, and student-centered science learning experiences.

Learning interest is a psychological construct that plays a pivotal role in determining the quality of both the learning process and learning outcomes in elementary science education. According to Renninger & Hidi, (2019), from the perspective of developmental theory, learning interest should not merely be understood as a student's liking for a particular subject, but rather as a psychological state that integrates focused attention, positive affect, personal value, and a sustained tendency to engage in learning activities. Interest develops progressively, beginning with *situational interest* triggered by specific learning experiences or stimuli and gradually evolving into a more stable *individual interest* through repeated and meaningful engagement. This developmental process is influenced by intrinsic factors, such as motivation and self-efficacy, as well as extrinsic factors, including the quality of learning media and the instructional strategies employed(Li & Xue, 2023; Utami et al., 2025). Within the context of science education, learning interest constitutes a prerequisite for fostering students' active engagement in observing phenomena, conducting investigations, and constructing conceptual understanding, while also demonstrating positive associations with student engagement and academic achievement(Barz et al., 2023; Sailer & Homner, 2020). Therefore, enhancing students' learning interest in elementary science education represents an educational imperative that cannot be overlooked and requires instructional approaches capable of creating learning experiences that are engaging, challenging, and relevant to students' needs and experiences.

One instructional approach that has been considered promising in addressing these challenges is *Game-Based Learning* (GBL). GBL refers to an instructional approach that integrates games as the primary medium for achieving learning objectives, allowing the acquisition of knowledge and skills to occur through structured, interactive, and competency-oriented gameplay experiences (Adipat et al., 2021; Casanpitarch R.c, 2018; Nadeem et al., 2023). Unlike conventional instructional approaches that position students as passive recipients of information, GBL places learners in active roles, enabling them to construct knowledge through exploration, decision-making, and problem-solving throughout the gameplay process. It is also important to emphasize that GBL is conceptually distinct from gamification. While GBL employs complete game experiences as the vehicle for learning, gamification merely incorporates game elements, such as points, badges, and leaderboards, into learning activities that are not inherently game-based(Sailer & Homner, 2020). The core characteristics of GBL, including clearly defined learning objectives, progressively challenging tasks, immediate feedback, and enjoyable learning

experiences, make it particularly well suited to fostering students' cognitive, emotional, and behavioral engagement simultaneously (Sanchez et al., 2023; Zhang & Yu, 2022).

The effectiveness of *Game-Based Learning* (GBL) as an instructional approach is grounded in several complementary theoretical perspectives and supported by a substantial body of empirical evidence. Constructivist theory and experiential learning emphasize that knowledge is actively constructed through meaningful, first-hand learning experiences. Furthermore, Flow Theory posits that an optimal balance between the level of challenge and learners' abilities during gameplay facilitates a state of complete immersion, thereby naturally enhancing intrinsic motivation (Larche & Dixon, 2020). In addition, Self-Determination Theory (SDT) argues that the fulfillment of learners' three fundamental psychological needs—competence, autonomy, and relatedness is essential for fostering sustained motivation and learning interest. Richard M. Ryan (2017), further demonstrated that game design elements supporting these psychological needs make a significant contribution to the development of long term motivation and learning interest(Hidayah et al., 2025; Pradani & Galuh, 2022).

These theoretical foundations have been consistently validated by numerous meta-analyses, which indicate that GBL is more effective than conventional instructional approaches in enhancing learning motivation, student engagement, learning satisfaction, and academic achievement(Susiloningsih et al., 2023). From an affective perspective, GBL has also been shown to enhance students' learning interest by providing appropriately challenging tasks, immediate feedback, and enjoyable learning experiences that promote active participation(Borit & Stangvaltaite-Mouhat, 2020; Dabbous et al., 2022). In the context of science education, GBL has been reported to outperform conventional teaching methods in improving conceptual understanding, knowledge retention, and learning outcomes, as it enables students to visualize abstract scientific concepts through authentic, inquiry oriented, experience-based learning activities (Rahmadina et al., 2024). Collectively, these findings suggest that Game-Based Learning (GBL) represents a promising technology enhanced pedagogical innovation for improving science learning at the elementary school level.

Nevertheless, empirical evidence regarding the effectiveness of *Game Based Learning* (GBL), particularly its influence on students' learning interest, remains mixed and not always consistent. Several meta-analyses have reported substantial heterogeneity in the findings, indicating that the magnitude of GBL effects varies according to learner characteristics, game design features, intervention duration, subject domains, and implementation contexts (Barz et al., 2023; Dabbous et al., 2022). This variability is further amplified by the diversity of GBL formats employed across studies, ranging from serious games and digital games to mobile games and game-based learning platforms, thereby making direct comparisons across studies inherently challenging (Vlachopoulos & Makri, 2017; Wiradarma et al., 2021). Moreover, the majority of existing studies have primarily focused on cognitive outcomes, such as academic achievement and conceptual understanding, whereas investigations examining the impact of GBL on learning interest an affective construct that plays a crucial role in educational success—remain relatively limited, particularly within the context of elementary science education. Existing evidence on this issue is also scattered across different subject areas and educational levels, limiting the generalizability of current conclusions to specific educational contexts(Halim & Manis, 2021; Rahmadina et al., 2024). Consequently, a fundamental question remains regarding the

extent to which GBL can consistently enhance students' learning interest within more specific educational settings.

To date, studies that specifically synthesize empirical evidence regarding the influence of Game-Based Learning (GBL) on students' learning interest in elementary science education remain scarce. Most previous reviews have examined GBL from a broader perspective, encompassing diverse subject areas, educational levels, and types of game-based media, and therefore have not provided a comprehensive and context-specific understanding of the effectiveness of GBL in elementary science learning, particularly with respect to the dimension of learning interest(Alotaibi, 2024; Hussein et al., 2019). Furthermore, the period from 2021 to 2025 has been characterized by a significant acceleration in the adoption of digital technologies in education following the COVID-19 pandemic. This transformation has stimulated the emergence of various innovative Game-Based Learning (GBL) media and platforms that have not yet been extensively documented in existing systematic reviews. This gap in the literature highlights the need for a synthesis that integrates recent empirical findings, identifies patterns in the effectiveness of GBL for enhancing students' learning interest, and explains the implementation characteristics that support successful application in elementary science education. Based on the identified research gaps, this study aims to systematically analyze the effects of GBL implementation on students' learning interest in elementary science education through a Systematic Literature Review (SLR) of articles published between 2021 and 2025. In addition to evaluating the impact of GBL on learning interest, this study seeks to map research trends, identify the GBL media and platforms employed in science instruction, and analyze the factors influencing the successful implementation of GBL in elementary science classrooms. To achieve these objectives, the study is guided by the following four research questions:

RQ1. What are the research trends in Game-Based Learning within elementary science education during the 2021–2025 period?

RQ2. What is the impact of Game-Based Learning on elementary school students' learning interest in science education?

RQ3. Which Game-Based Learning media and platforms are most frequently utilized in elementary science education?

RQ4. What factors influence the successful implementation of Game-Based Learning in enhancing students' learning interest?

RESEARCH METHODS

This study employed a Systematic Literature Review (SLR) approach to examine empirical findings concerning the effects of Game-Based Learning (GBL) on students' learning interest in elementary science education during the 2021–2025 period. This approach was selected because it enables a comprehensive and critical synthesis of previous studies, thereby facilitating the mapping of research trends, the identification of the effects of GBL on students' learning interest, the exploration of the pedagogical focuses developed in prior research, and the analysis of factors supporting successful learning outcomes reported across the literature. The review process was conducted in accordance with the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) 2020 guidelines

to ensure that the identification, screening, and selection of studies were carried out in a systematic and transparent manner (Apriani et al., 2025; Raharjo et al., 2024).

The literature search process was conducted using the Publish or Perish (PoP) software to retrieve articles from the Scopus and Google Scholar databases that were relevant to the research topic and published between 2021 and 2025. The initial identification stage yielded 285 articles that met the search criteria. Subsequently, the study selection process was performed using the Covidence platform, which supports the implementation of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. This enabled the stages of identification, screening, eligibility assessment, and study selection to be conducted systematically, transparently, and in accordance with the predefined inclusion and exclusion criteria (Coleman & Money, 2020; Gomez, 2022; Shabira et al., 2024). Following the screening and eligibility assessment stages, studies meeting the inclusion criteria were further examined using Mendeley to verify the completeness and accuracy of metadata and bibliographic information. The reference data were subsequently exported in RIS format and analyzed using VOSviewer to map keyword co-occurrence networks and patterns of co-authorship among researchers. Finally, the selected studies were extracted and synthesized using Microsoft Excel to categorize findings according to research trends, the effects of Game-Based Learning on students' learning interest, the pedagogical emphases developed in previous studies, and the factors influencing successful instructional implementation as reported in the literature.

Data Search Strategies

To ensure a systematic and focused literature search, the researcher employed a data s earch strategy tailored to the study (Lestari, 2025).

Table 1.Data Search Strategy

Filter	
Year	2021-2025
Subject	Education
Search String	"Game Based Learning" OR "GBL" AND "Science Education" OR "IPA" OR "Science Learning" AND "Elementary School" OR "Primary School"
Language	English/Indonesia
Document Type	Journal
Rang Type	Indexed Sinta 1-4, dan Scopus

Based on the search strategy conducted on 12 May 2026, a total of 285 articles were identified, comprising 3 articles retrieved from the Scopus database and 282 articles retrieved from Google Scholar using Publish or Perish (PoP) as the literature retrieval tool. All identified records were subsequently screened and selected following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, which represent the international standard for the identification, screening, eligibility assessment, and inclusion of studies in systematic literature reviews (Page et al., 2021). The screening process was conducted using Covidence and involved duplicate removal, title and abstract screening, keyword evaluation, and full-text assessment to identify studies

that satisfied the predefined inclusion criteria and were relevant to the objectives of the present review(Banff et al., 2011; Kwinram et al., 2022; Rusevska et al., 2024).

Inclusision and exclusion creteria

This study applied predefined inclusion and exclusion criteria to ensure the quality, relevance, and consistency of the articles included in the analysis. The selected studies comprised empirical research investigating the use of Game-Based Learning (GBL) in elementary science education published between 2021 and 2025 and indexed in either Scopus or SINTA (SINTA 1–4). To further ensure the quality and relevance of the evidence synthesized, the study established eligibility criteria encompassing topic relevance, publication year, publication type, field of study, research participants, article accessibility, and journal indexing status. These inclusion and exclusion criteria are presented in Table 2.

Table 2.Data Include and exclusion creteria

Criteria	Inclusion	Eksklusi
Article title and content	Relating to Game Based Learning in Elementary School Science Learning	Has an irrelevant title
Year of publication	2021-2025	In addition to 2021–2025
Publication type	Hanya artikel jurnal	Review, editor, non-empirical study, proceedings, articles irrelevant to the topic
Language	English and Indonesia	Journal
Article's field of study	Sains	Others
Participants	Students and teachers	Others
Accessibility	Full articles or open access only	Articles that require payment
Journal Index	Only articles indexed in Scopus and SINTA (SINTA 1–4)	Others

Data selection and analysis process

The articles retrieved through the literature search process were screened using the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) 2020 guidelines, supported by the Covidence software, to ensure that the selection procedure was conducted systematically and transparently(Anis et al., 2024). The screening process consisted of four sequential stages: identification, screening, eligibility assessment, and inclusion, as illustrated in Figure 1. During the identification stage, a total of 285 records were retrieved, comprising 282 articles from Google Scholar and 3 articles from the Scopus database. Subsequently, one duplicate record was identified and removed using Covidence, resulting in 284 unique articles eligible for the screening stage based on titles and abstracts. During the title and abstract screening stage, 173 articles were excluded because they did not align with the scope and objectives of the review. Consequently, 111 articles progressed to the full-text assessment stage, and all full-text articles were successfully retrieved and examined. In the eligibility assessment stage, 99 articles were excluded for several reasons: 5 studies addressed topics unrelated to the research focus, 39 articles had incomplete or inaccessible full texts, 19 studies did not meet the language criteria, 16 articles were published in journals that were neither indexed in Scopus nor accredited by SINTA, and 20 studies involved populations other than elementary school students.

Following the completion of all screening stages, 12 studies met the predefined inclusion criteria and were subsequently included in the final analysis. These findings indicate that although research on Game-Based Learning in elementary science education has grown substantially, only a limited number of studies satisfied the required standards of relevance, methodological quality, and alignment with the specific objectives of this review.

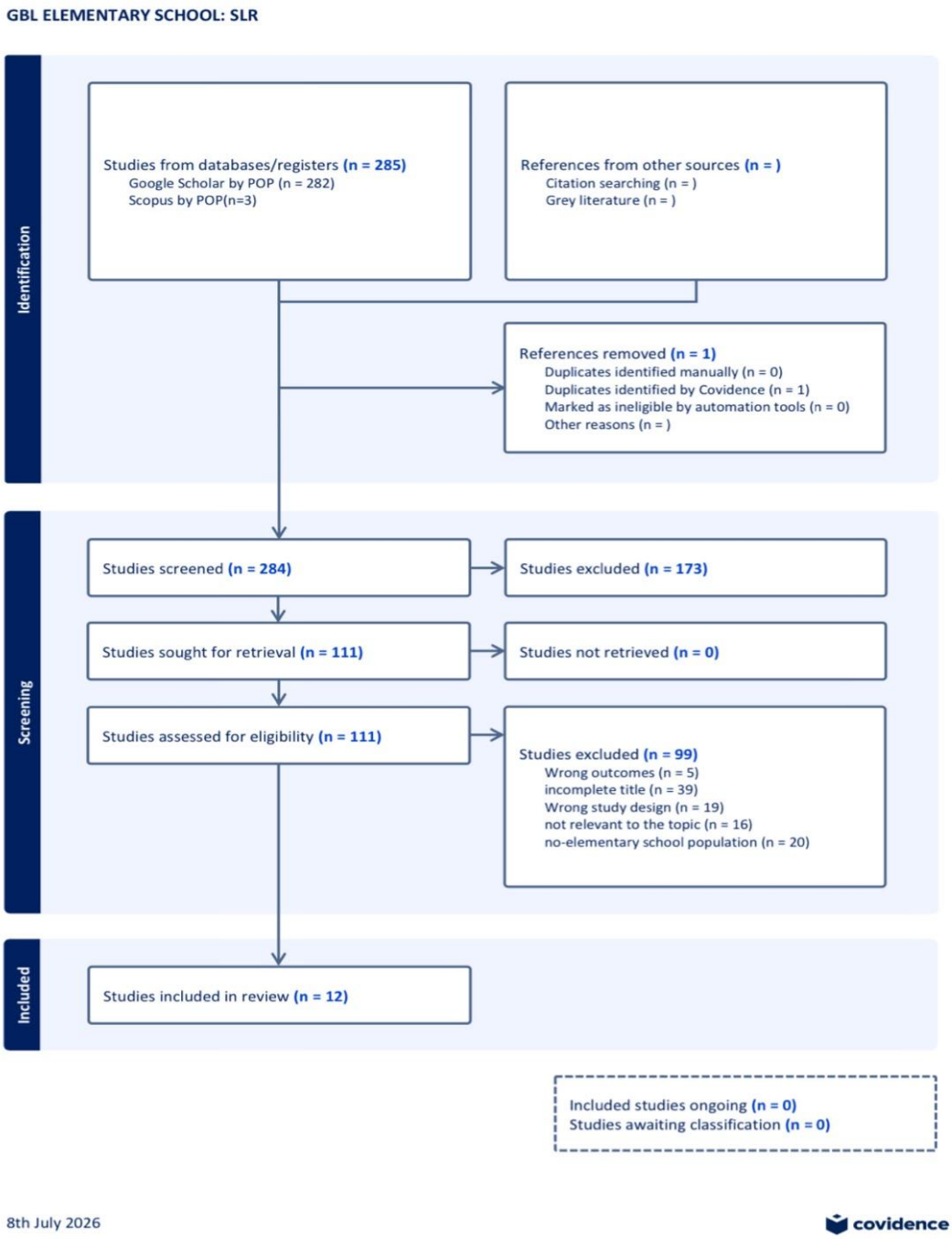

Figure 1. Diagram PRISMA 2020

Data were analyzed using thematic qualitative analysis supported by Microsoft Excel to categorize and synthesize research findings into several major themes, including

research trends, learning media focus, the effects of Game-Based Learning on students' learning interest, and the facilitating and inhibiting factors influencing the implementation of Game-Based Learning in elementary science education. In addition, bibliometric analysis was conducted using VOSviewer to visualize keyword co-occurrence patterns and author collaboration networks (co-authorship). This approach enabled a systematic and comprehensive mapping of research developments, thematic trends, and scholarly contributions related to the influence of Game-Based Learning on students' learning interest in elementary science education(Fitria et al., 2022).

RESULTS AND DISCUSSION

1. Trends in Research Publication and Distribution

This section presents an analysis of research trends concerning the effects of *Game Based Learning* on students' interest in learning in elementary science education, based on publication year and journal indexing status. The analysis aims to map the development of the research field and to examine the level of academic attention devoted to this topic.

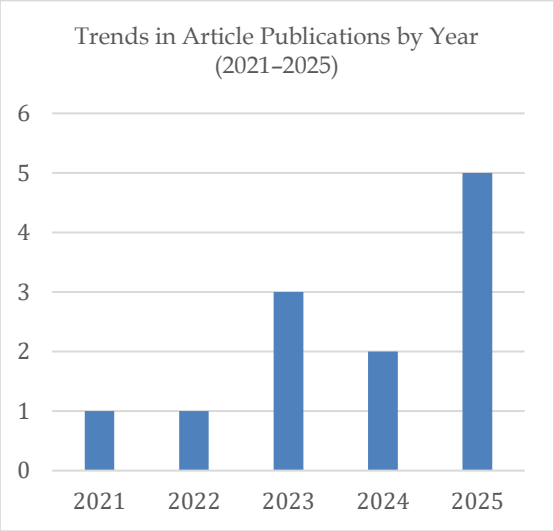

Figure 2. Publication Trends By year (2021-2025)

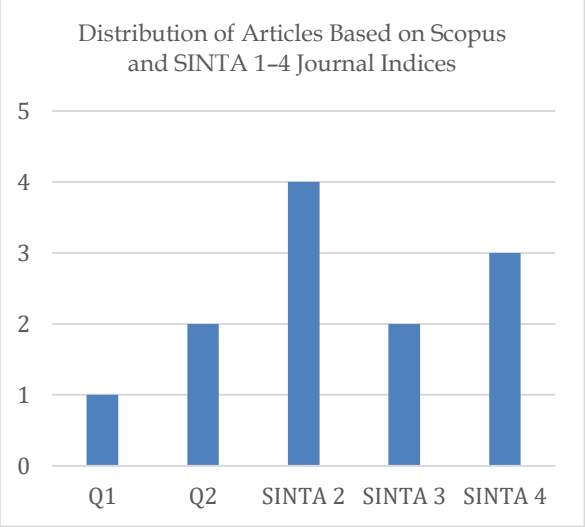

Figure 3. Distribution of article by journal index

a. **Publication Trends by Year (2021–2025)**

As illustrated in Figure 2, publications examining the effects of Game-Based Learning on students' interest in learning in elementary science education exhibited a publication trend during the 2021–2025 period. Overall, the number of studies investigating this topic demonstrated an increasing tendency over time. In 2021 and 2022, the number of publications remained relatively limited, with only one article published in each year, indicating that the topic was still in the early stages of research development. An upward trend emerged in 2023, with three articles published, although a slight decline was observed in 2024, when the number of publications decreased to two articles. Subsequently, 2025 recorded the most substantial increase, with a total of five published studies, making it the most productive year within the review period. This trend reflects the growing scholarly interest in the implementation of Game-Based Learning as an instructional innovation capable of enhancing students' interest in learning science at the elementary school level. The increasing attention to this topic is consistent with the expanding integration of digital technologies and

student-centered pedagogical approaches in twenty-first-century education(Kurupinar et al., 2022).

b. Distribution of articles by journal index

As illustrated in Figure 3, research publications on the effects of Game-Based Learning on students' interest in learning in elementary science education during the 2021–2025 period were predominantly published in nationally accredited Indonesian journals indexed in SINTA 2, accounting for four articles. This was followed by SINTA 4 journals with three articles and SINTA 3 journals with two articles. Meanwhile, three studies were published in internationally recognized journals indexed in Scopus, comprising one article in a Q1 journal from Portugal and two articles in Q2 journals from the United States. These findings suggest that research on Game-Based Learning in elementary science education has gained international scholarly attention, although the number of publications in high-impact international journals remains relatively limited. On the other hand, Indonesian researchers' contributions to this field continue to be concentrated in nationally accredited SINTA-indexed journals, particularly those categorized as SINTA 2 to SINTA 4. This pattern indicates that research on Game-Based Learning in elementary science education has developed considerably at the national level. Nevertheless, further improvements in methodological rigor, research novelty, and theoretical contributions are still required to enhance the competitiveness of Indonesian studies and increase their potential for publication in high-impact international journals. Increasing the number of publications in Scopus-indexed journals would not only broaden the dissemination of research findings but also strengthen Indonesia's contribution to the advancement of Game-Based Learning research in science education at the global level (Nyoman & Armini, 2025)

c. Visualization of author collaboration levels *(co-authorship)*

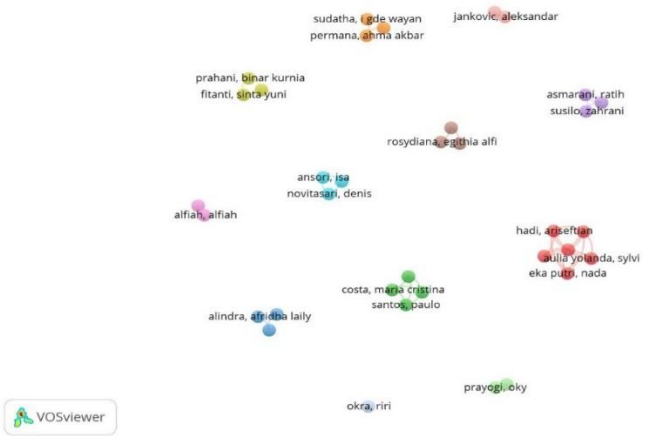

Figure 4. Visualization of author collaboration levels

As illustrated in Figure 4, the co-authorship visualization generated using VOSviewer comprised 35 authors from 12 journal articles, which were organized into several small collaboration clusters with limited interconnections among them. The network map indicates that research on the effects of Game-Based Learning on students' interest in learning in elementary science education during the 2021–2025 period has largely been characterized by relatively small and fragmented author collaborations. In the visualization, each color represents a distinct collaboration cluster, whereas the size of each

node reflects the level of contribution or frequency of an author's involvement in publications. Meanwhile, the distance between nodes represents the degree of collaborative proximity among authors. The co-authorship network reveals several isolated clusters, including those involving Sylvi Aulia Yolanda and colleagues, Maria Cristina Costa and Paulo Santos, Aleksandar Jankovic and Dragan Lambic, as well as Ahma Akbar Permana and I Gde Wawan Sudatha. This pattern suggests that research collaborations tend to occur within established research groups and have not yet developed into broader networks across researchers or institutions. Furthermore, the absence of a highly connected central node indicates that no individual researcher or institution has yet emerged as a major collaboration hub within this research domain. This finding reflects the relatively early stage of development of research on Game-Based Learning and students' interest in learning in elementary science education and highlights opportunities for strengthening inter-institutional and international research collaboration in future studies.

d. Keyword network visualization *(co-occurrence)*

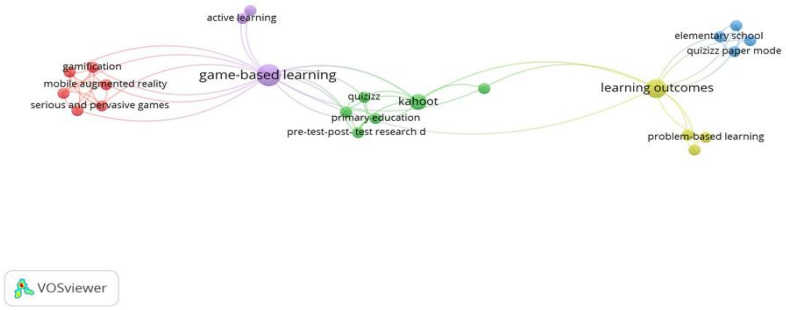

Figure 5. Keyword network visualization

Based on the keyword co-occurrence visualization generated using VOSviewer for studies investigating the effects of Game-Based Learning on students' interest in learning in elementary science education during the 2021–2025 period, the keyword *game-based learning* emerged as the central node with the highest degree of connectivity to other concepts, indicating that GBL constitutes the core research theme within this field. The keyword was linked to several major clusters. The first cluster represented technology and instructional innovation and included terms such as *gamification*, *mobile augmented reality*, and *serious and pervasive games*, reflecting the growing integration of digital and immersive technologies in science education. The second cluster was associated with digital learning platforms, including *Kahoot*, *Quizizz*, and *Quizizz Paper Mode*, suggesting that recent studies have increasingly employed interactive quiz-based platforms as practical implementations of Game-Based Learning in elementary schools. In addition, a strong relationship was identified between *game-based learning* and the keyword *learning outcomes*, indicating that most existing studies have focused primarily on the effects of GBL on students' academic achievement rather than on their interest in learning. The presence of keywords such as *primary education*, *elementary school*, *active learning*, and *problem-based learning* further suggests that the implementation of GBL in elementary education is commonly integrated with active and problem-oriented instructional approaches to enhance student engagement

in science learning. Interestingly, the keywords *learning interest* and *learning motivation* did not emerge as dominant nodes within the network, indicating that research examining the effects of GBL on students' interest in learning in elementary science education remains relatively limited. Consistent with this finding, Magpusao (2024) reported that keywords such as *primary education*, *gamification*, *learning*, and *motivation* demonstrated strong interconnections within the VOSviewer map, whereas studies specifically investigating students' interest in learning in elementary science contexts were comparatively scarce. These findings suggest that the current body of *Game Based Learning* research continues to be dominated by the assessment of cognitive outcomes, while investigations addressing affective dimensions, such as students' interest in learning, remain underrepresented in the literature.

2. Game Based Learning Media and Platforms Used in Science Learning in Elementary Schools

Table 3 presents the game-based learning media and platforms used in science instruction in primary schools, based on an analysis of articles that met the inclusion criteria.

Journal index	Study Code	Writer	Article title	Form of game based learning media
Q2	A1	Maria Cristina Costa, Paulo Santos ,Joao Manuel Patrício and AntónioManso(Costa et al., 2021)	An interactive information system that supports an augmented reality game in the context of *game based learning*	Augmented Reality (AR) location-based game
Q2	A2	Aleksandar Jankovic, Dragan Lambic(Jankovic & Lambic, 2022)	The effect of *game based learning* via Kahoot and Quizizz on the academic achievement of third grade primary school students	Kahoot dan Quizizz
SINTA 2	A3	Adrianus I Wayan Illia Yuda Sukmana, Ahma Akbar Permana, I Gde Wawan Sudatha(Sukmana et al., 2023)	*Game Based Learning* Interactive Multimedia in Improving Thematic Learning Achievement of Third Grade Students	Multimedia interaktif berbasis game
SINTA 2	A4	Egithia Alfi Rosydiana, Dwi Agus Sudjimat, Candra Utama(Rosydiana et al., 2023)	The effect of digital learning media using scratch *game based learning* on student problem solving skills	Scratch Game-Based Learning
SINTA 2	A5	Riri Okta(Okra, 2023)	The development of educational game-based learning media in natural science subject for elementary school students	Educational digital game
SINTA 2	A6	Zidan Ahmad Farhan, Fitri Nuraeni, Afridha Laily Alindra(Farhan et al., 2024)	Effectiveness of a Problem Based Learning Model with Quizizz Learning Media on Science Learning Outcomes	Quizizz Paper Mode
SINTA 4	A7	Anisa Nurlaila Larasati, Ratih Asmarani,dan Claudya Zahrani Susilo(Larasati et al., 2024)	Development of Educandy game-based interactive learning media in the Merdeka	Educandy

			curriculum for elementary school	
Q1	A8	Sinta Yuni Fitanti1, Binar Kurnia Prahani, Suryanti, Hanandita Veda Saphira(Fitanti et al., 2025)	Optimization of digital game media in *game based learning* to enhance critical thinking skills in science learning	Digital game dan board game
SINTA 3	A9	Alfiah Alfiah, Mar'atus Sholihah,(Alfiah & Sholihah, 2025)	Boosting elementary science engagement: A qualitative study of baamboozle *based game learning* in Indonesian classrooms	Baamboozle
SINTA 3	A10	Ni Kadek Eliyanti, I WayanSuastra, Ni Ketut Suarn(Wiradarma et al., 2021)	Interactive Edugame-Based Learning Media to Improve Science Learning Outcomes of Sixth-Grade Elementary School Students	Edugame interaktif
SINTA 4	A11	Oky Prayogi1, Ryan Dwi Puspita(Puspita & Prayogi, 2025)	Implementation of Constructivism-Based *Game Based Learning* Model in Science Learning for Grade IV	Wordwall dan game konstruktivistik
SINTA 4	A12	Sylvi Aulia Yolanda,Refnis Susanti, Rahmi Indah Cahyani, Ariseftian Hadi, Nada Eka Putri, Mutathahirin Mutathahirin(Aulia Yolanda et al., 2024)	*Game Based Learning*: A Solution for Improving the Quality of Learning Processes and Outcomes in Elementary Schools	Kahoot

Synthesis of Findings on the Use of Game-Based Learning Media and Platforms in Elementary School Science Education

Table 4 presents the results of the synthesis analysis regarding the Game-Based Learning media and platforms used in science instruction in elementary schools.

Learning media categories	Media format	Presentation characteristics	Inclusion Study
Media Digital Interaktif	Scratch Game, Educational Game, Digital Science Game.Kahoot, Quizizz, Quizizz Paper Mode.	A digital game featuring challenges, conceptual exploration, and problem-solving, as well as immediate feedback on students' answers..	A4, A5, A8.
			A2, A6, A12.
			A7, A9, A11.
	Educandy, Baamboozle, Wordwall.	Presentation of material through competition-based quizzes, scores, leaderboards, rewards, and real-time feedback.	A11
	Wordwall dan permainan eksploratif	Provides interactive game-based activities—such as matching exercises, quiz challenges, puzzles, and game-based	

		discussions—that are accessible online, including Wordwall and exploratory games.	
Media Imersif	Location-Based AR Game	Integrating virtual objects with the real environment so that students can explore science phenomena in a contextual and immersive way.	A1
Media Visual	Energy Expedition Board Game	Physical game activities based on group collaboration, discussion, and problem-solving related to science concepts.	A8

Based on the synthesis of the 12 selected studies, the implementation of Game-Based Learning in elementary science education was found to be predominantly characterized by the use of interactive digital media, such as *Kahoot*, *Quizizz*, *Scratch*, *Educandy*, *Baamboozle*, and *Wordwall*. This finding can be interpreted through the lens of Self-Determination Theory (SDT) developed by Haryandi et al (2024), which posits that students' intrinsic motivation increases when three fundamental psychological needs—competence, autonomy, and relatedness are fulfilled. Game elements embedded within GBL platforms, including challenges, scoring systems, leaderboards, rewards, and immediate feedback, have the potential to satisfy these psychological needs, thereby fostering students' intrinsic interest and engagement in learning activities. The predominance of interactive digital media can also be explained by Csikszentmihalyi's Flow Theory, which argues that learning experiences become more effective when the level of challenge is appropriately balanced with learners' abilities. Such conditions facilitate a state of flow characterized by intense concentration, enjoyment, and deep engagement in learning activities, ultimately enhancing students' interest in learning science(Farrell & Moffat, 2014). The findings of this synthesis are further supported by previous studies demonstrating that the implementation of Game-Based Learning and gamification consistently contributes to improvements in students' motivation, engagement, and interest in learning. Puspita & Prayogi (2025), argued that digital games possess strong motivational appeal because they effectively satisfy learners' needs for competence, autonomy, and social relatedness. These findings are consistent with the study conducted by Jankovic and Lambic (A2), which reported that the use of *Kahoot* and *Quizizz* enhanced motivation and engagement among elementary school students. Similarly, Costa et al. (A1) found that the implementation of a location-based augmented reality game increased students' enthusiasm and promoted more contextualized learning experiences in science education. Taken together, the predominance of interactive digital media in studies published between 2021 and 2025 indicates a shift in elementary science education toward learning experiences that are more participatory, immersive, and student-centered (Admiraal et al., 2011).

3. The Effect of Game-Based Learning on Students' Interest in Science Learning in Elementary School

Table 5 presents a summary of research findings regarding the effect of game-based learning on students' interest in learning science in elementary schools.

Study code	Types of Game-Based Learning	Influence on interest in learning	Evidence of Effectiveness
A1	Augmented Reality (AR) Game	Increasing motivation and enthusiasm for learning	Teachers and students demonstrated high enthusiasm during the implementation; there was a positive perception regarding the use of AR in science learning.
A2	Kahoot dan Quizizz	Increasing motivation and learning engagement	The ANOVA results show that the Kahoot group achieved a significant improvement compared to the control group; Kahoot was more effective than Quizizz in enhancing learning engagement.
A3	Multimedia Interaktif Berbasis GBL	Increasing motivation and interest in learning	A significant increase was observed between the pre-test and post-test; the media received a "very good" rating from experts and users.
A4	Scratch Game-Based Learning	Increasing enthusiasm and motivation for learning	The t-test showed a significant improvement after the treatment; the implementation success rate reached 90%.
A5	Educational Game	Increasing interest in and positive attitudes towards science	Student response score: 94.19 (very good category); media validity: 0.97 (highly valid)
A6	Quizizz Paper Mode dalam PBL	Enhancing learning engagement and participation	N-Gain was 0.6673 (moderate category) compared to 0.5498 for the control group; the model's contribution was 50.8%.
A7	Educandy	Increasing interest and enjoyment in learning	Media validity was 91.5%; 93% of students and teachers stated that the media was highly engaging and effective.
A8	Science Detective Digital Game dan Energy Expedition Board Game	Boosting motivation, engagement, and curiosity.	High N-Gain category; student motivation and acceptance reached 92%.
A9	Baamboozle	Increasing verbal participation, enthusiasm, and self-confidence.	Observations and interviews indicate a significant increase in verbal participation, group discussion, and student confidence.

A10	Edugame Interaktif	Increasing motivation and learning engagement	Media validity 90%; practicality 96%; student and teacher responses were very positive.
A11	Wordwall dan GBL Konstruktivistik	Increasing interest, motivation, and participation in learning.	83% of students stated that games increased their interest in learning; 79% of teachers stated that student activity increased.
A12	Kahoot	Increasing engagement and enthusiasm for learning	Learning scores increased from 81.3% to 91.3%; observations showed increased engagement during the lesson.

Synthesis of Findings on the Effect of Game-Based Learning on Students' Learning Interest in Elementary School Science

Table 6. Presents the synthesis of results regarding the effect of game-based learning on students' learning interest in elementary school science.

The Theme of Influences on Learning Interest	Indicators of Learning Interest	Inclusion Study
Increased learning motivation	Eagerness to learn, intrinsic motivation, willingness to participate in learning	A1, A2, A3, A4, A8, A10, A11
Increased active engagement in learning	Active participation, interaction, and engagement in tasks and discussions.	A2, A6, A8, A9, A11, A12
Increased enjoyment of and interest in science	Interest in the subject matter, enjoyable learning experiences, positive attitude towards science.	A3, A5, A7, A10
Increased attention and learning focus	Concentration, attention to learning activities, focus on the material.	A1, A4, A7, A12
Increased confidence in learning	Courage to answer, ask questions and express opinions	A9, A11
Increased curiosity and scientific exploration	Curiosity, exploration of science concepts, problem-solving	A1, A4, A6, A8

Based on Table 4 and the synthesis of the 12 studies published during the 2021–2025 period, the findings indicate that the implementation of *Game-Based Learning* (GBL) has consistently exerted a positive influence on students' interest in learning in elementary science education. Various forms of game-based media, including Augmented Reality (AR) games, *Kahoot*, *Quizizz*, *Scratch* games, educational games, *Educandy*, *Baamboozle*, *Wordwall*, as well as the *Science Detective Digital Game* and the *Energy Expedition Board Game*, were found to enhance multiple dimensions of students' interest in learning. The most prominent effect was the improvement of learning motivation, reflected in students' enthusiasm and willingness to participate in learning activities (A1, A2, A3, A4, A8, A10, and A11). This was followed by increased active engagement, as evidenced by higher levels of participation in discussions, interactions, and task completion during instructional activities (A2, A6, A8, A9, A11, and A12). Furthermore, the implementation of GBL contributed to greater enjoyment and interest in science content (A3, A5, A7, and A10), strengthened students' attention and learning focus (A1, A4, A7, and A12), and fostered greater confidence in answering questions and expressing opinions (A9 and A11). The observed improvements in students' attention and engagement can be interpreted through the lens of Flow Theory,

which posits that an optimal balance between the level of challenge and learners' abilities generates enjoyable and deeply engaging learning experiences. Meanwhile, the enhancement of students' interest and enthusiasm for learning is consistent with K. A. Renninger & Hidi (2022), Four-Phase Model of Interest Development which explains that stimulating learning experiences can trigger and sustain situational interest that may gradually evolve into enduring individual interest in science learnig (Grasse et al., 2022). Several studies also reported increases in students' curiosity and scientific exploration skills through problem-solving activities and opportunities to investigate scientific concepts (A1, A4, A6, and A8). The effectiveness of these interventions was supported by substantial empirical evidence, including statistically significant improvements in learning outcomes, normalized gain (N-Gain) scores within the moderate to high categories, media validity scores exceeding 90%, and positive responses from both students and teachers, all of which indicate a high level of acceptance of Game-Based Learning approaches. According to Muda & Zain(2025), the integration of game elements into science instruction functions not merely as a form of entertainment but as an effective pedagogical strategy for enhancing elementary students' interest in learning through multiple dimensions, including motivation, engagement, attention, curiosity, and positive attitudes toward science learning.

4. The Impact of Implementing Game-Based Learning on Students' Interest in Learning Science

Table 7 presents the results of the analysis regarding the impact of implementing game-based learning on students' interest in learning science.

Study Code	Jenis Game Based Learning	Supporting Factors	Inhibiting Factors	Key Findings
A1	Augmented Reality Game	Facilitator support, curriculum relevance, and student and teacher enthusiasm.	Teachers' unfamiliarity with AR, limited equipment, and technical issues.	Interest and motivation increase when AR is supported by training and adequate facilities.
A2	Kahoot dan Quizizz	Motivation, engagement, interaction, engaging game design	Students' working memory capacity, complexity of science material	Kahoot is more effective because it is able to maintain student engagement.
A3	Multimedia Interaktif GBL	Expert validation, active student participation, alignment with the characteristics of elementary school students.	Technological readiness and teacher competence	Interactive media enhances motivation when it aligns with students' characteristics.
A4	Scratch Game Based Learning	Student enthusiasm, teachers willing to learn, and adequate infrastructure.	Low teacher competence, low student digital literacy, and technological limitations.	Effectiveness increases when technological competence is supported.
A5	Educational Game	School support, student enthusiasm, curriculum-aligned design	Limited access to devices and the internet	Relevant game design increases student acceptance.

A6	Quizizz Paper Mode	Integrating PBL and engaging media boosts engagement	Other unidentified external factors	Learning engagement increases through a combination of GBL and problem solving.
A7	Educandy	Expert validation, positive student-teacher response, systematic development	Technical issues and potential limitations on internet access	Structured media design enhances learning appeal.
A8	Digital Game dan Board Game	High interactivity, collaboration, student motivation, teacher support	Limited technology infrastructure, low teacher digital competence, and time constraints.	High motivation arises when the game encourages collaboration and exploration.
A9	Baamboozle	Teacher support, competition and collaboration, heterogeneous groups	Inadequate equipment, unstable internet, and the need for teacher training.	Engagement and participation increase through competitions and group work.
A10	Edugame Interaktif	Engaging visualization, gamification, immediate feedback	Not yet extensively tested in real-world situations.	High potential to boost motivation and learning engagement.
A11	Wordwall dan GBL Konstruktivistik	Teacher commitment, school facilities, relevant game design	Low teacher readiness, limited internet access.	Interest in learning increases when teachers are able to manage game-based learning.
A12	Kahoot	Student enthusiasm, enjoyable learning atmosphere, teacher collaboration	Limited time to respond, unfamiliarity with using the platform.	An enjoyable learning environment strengthens student engagement.

Based on Table 5, the synthesis of the selected studies indicates that the implementation of Game-Based Learning in elementary science education is generally influenced by a range of interrelated facilitating and inhibiting factors.The most prominent facilitating factors include students' high levels of enthusiasm, teachers' support and commitment, the alignment of game design with the curriculum and the developmental characteristics of elementary school students, as well as the availability of adequate technological infrastructure. In addition, gamification elements such as competition, collaboration, immediate feedback, attractive visual features, and exploratory activities have been shown to enhance students' motivation, engagement, and active participation in science learning. Furthermore, integrating Game-Based Learning with other instructional approaches, such as Problem-Based Learning, demonstrates considerable potential for strengthening students' problem-solving skills while simultaneously increasing their interest in learning. Nevertheless, the implementation of Game-Based Learning continues to face several challenges, including limited access to digital devices and internet connectivity, insufficient digital competence and readiness among teachers, low levels of technological literacy among students, and technical constraints associated with the use of digital and immersive learning media such as Augmented Reality. Several studies also highlighted student-

Related internal factors, including working memory capacity and the complexity of science content, which may influence the effectiveness of game-based instructional interventions. Previous research by Ace et al(2024), Reported that Game-Based Learning can significantly improve students' motivation, engagement, and interest in learning when supported by technological readiness, teachers' competencies, game designs aligned with instructional objectives, and a conducive and enjoyable learning environment.Therefore, the successful implementation of Game-Based Learning in elementary science education depends not only on the quality of the game media employed but also on the readiness of the broader educational ecosystem to support its effective and sustainable integration into classroom practice (Muda & Zain, 2025)

CONCLUSION

Based on the findings of the Systematic Literature Review involving 12 studies that met the predefined inclusion criteria, it can be concluded that the implementation of Game-Based Learning exerts a positive and consistent influence on enhancing students' interest in learning in elementary science education. These effects are reflected in increased learning motivation, greater active engagement in classroom activities, enhanced enjoyment and interest in science content, improved attention and learning focus, greater self-confidence, and increased curiosity and scientific exploration among students. Various forms of Game-Based Learning media, including *Kahoot*, *Quizizz*, *Scratch* games, *Educandy*, *Baamboozle*, *Wordwall*, Augmented Reality games, as well as digital and board games, have been shown to create learning experiences that are more interactive, enjoyable, and student-centered. The effectiveness of Game-Based Learning implementation is supported by empirical evidence, including significant improvements in statistical test results, moderate to high normalized gain (N-Gain) scores, high levels of media validity, and positive responses from both students and teachers toward the use of game-based learning media.

Furthermore, the successful implementation of Game-Based Learning is influenced by several facilitating factors, including students' enthusiasm, teachers' competence and commitment, the alignment of game design with curricular objectives and students' characteristics, and the availability of adequate technological infrastructure. Conversely, limitations in digital devices and internet access, insufficient digital competence among teachers, and technical constraints continue to represent major challenges to its implementation. These findings indicate that *Game Based Learning* is not only effective as an instructional strategy for improving cognitive outcomes but also makes a significant contribution to the development of students' affective dimensions, particularly their interest in learning science at the elementary school level. Therefore, the integration of Game-Based Learning should continue to be promoted and supported through strengthening teachers' competencies, improving technological infrastructure, and developing instructional media that are aligned with the needs and characteristics of twenty-first-century learners.

REFERENCE

Adipat, S., Laksana, K., Busayanon, K., Ausawasowan, A., & Adipat, B. (2021). Engaging Students in the Learning Process with Game-Based Learning: The Fundamental Concepts. *International Journal of Technology in Education*, 4(Vol.3), 542–552. https://doi.org/10.46328/ijte.169

Admiraal, W., Huizenga, J., & Akkerman, S. (2011). Computers in Human Behavior The concept of flow in collaborative game-based learning. *Computers in Human Behavior*, *27*(Vol.3), 1185–1194. https://doi.org/10.1016/j.chb.2010.12.013

Aulia Yolanda, S., Susanti, R., Indah Cahyani, R., Hadi, A., Eka Putri, N., & Mutathahirin, M. (2024). Game-Based Learning: A Solution for Improving the Quality of Learning Processes and Outcomes in Elementary Schools. In *International Journal of Islamic Teaching and Learning* (Vol. 2). https://journal.staisni.ac.id/index.php/ijiting

Banff, M. E., Computer, I., Press, S., Felizardo, K. R., Carlos, S., Macdonell, S. G., Martins, R. M., & Carlos, S. (2011). reviews , in Proceedings of the 5th International Symposium on Empirical Software Engineering and Using Visual Text Mining to Support the Study Selection Activity in Systematic Literature Reviews.*jurnal internasional,* (Vol.25)35. https://doi.org/10.1109/ESEM.2011.16

Borit, M., & Stangvaltaite-Mouhat, L. (2020). GoDental! Enhancing flipped classroom experience with game-based learning. *European Journal of Dental Education*, *24*(Vol.4), 763–772. https://doi.org/10.1111/eje.12566

Casanpitarch R.c. (2018). An approach to digital game-based learning: Video-games principles and applications in foreign language learning. *Journal of Language Teaching and Research*, *9*(Vol.6), 1147–1159. https://doi.org/10.17507/jltr.0906.04

Cheung, D. (2018). The key factors affecting students' individual interest in school science lessons. *International Journal of Science Education*, *40*(Vol.1), 1–23. https://doi.org/10.1080/09500693.2017.1362711

Costa, M. C., Santos, P., Patrício, J. M., & Manso, A. (2021). An interactive information system that supports an augmented reality game in the context of game-based learning. *Multimodal Technologies and Interaction*, *5*(Vol.12), 1–25. https://doi.org/10.3390/mti5120082

Dabbous, M., Kawtharani, A., Fahs, I., Hallal, Z., Shouman, D., Akel, M., Rahal, M., & Sakr, F. (2022). The Role of Game-Based Learning in Experiential Education: Tool Validation, Motivation Assessment, and Outcomes Evaluation among a Sample of Pharmacy Students. *Education Sciences*, *12*(Vol.7). https://doi.org/10.3390/educsci12070434

Fitanti, S. Y., Prahani, B. K., & Saphira, H. V. (2025). Optimization of Digital Game Media in Game-Based Learning to Enhance Critical Thinking Skills in Science Learning. *JPPS (Jurnal Penelitian Pendidikan Sains)*, *14*(Vol.2), 227–242.

Fitria, D., Husaeni, A., Bayu, A., & Nandiyanto, D. (2022). Asean Journal of Science and Engineering Bibliometric Using Vosviewer with Publish or Perish (using Google Scholar data): *From Step-by-step Processing for Users to the Practical Examples in the Analysis of Digital Learning Articles in Pre and Post Covid*. *2*(Vol.1), 19–46.

Haryandi, S., Arlinda, R., Muhammad, N., & Harto, M. (2024). Online Learning in Educational Research. *Online Learning in Educational Research*, *5*(Vol.1), 113–128. https://doi.org/https://doi.org/10.58524/oler.v5i1.626

Hidayah, M., Nisa, A. F., Havifah, B., Khosiyono, C., Masjid, A. Al, & Cahyani, H. (2025). Analysis of Android-Based Science Learning Media to Improve Motivation and Learning Outcomes of Elementary School Students *: A Systematic Literature Review*. *11*(Vol.3), 86–96. https://doi.org/10.29303/jppipa.v11i3.10236

Larasati, A. N., Asmarani, R., & Susilo, Z. (2024). Development of Educandy Game-Based

Interactive Learning Media in the Merdeka Curriculum for Elementary School. *Indonesian Journal of Primary Science Education (IJPSE)*, *4*(Vol.2), 187–193.

Larche, C. J., & Dixon, M. J. (2020). The relationship between the skill-challenge balance, game expertise, flow and the urge to keep playing complex mobile games. *Journal of Behavioral Addictions*, *9*(Vol.3), 606–616. https://doi.org/10.1556/2006.2020.00070

Li, J., & Xue, E. (2023). Dynamic Interaction between Student Learning Behaviour and Learning Environment: Meta-Analysis of Student Engagement and Its Influencing Factors. *Behavioral Sciences*, *13*(Vol.1). https://doi.org/10.3390/bs13010059

Nkomo, L. M., Daniel, B. K., & Butson, R. J. (2021). Synthesis of student engagement with digital technologies: a systematic review of the literature. *International Journal of Educational Technology in Higher Education*, *18*(Vol.1), 1–26. https://doi.org/10.1186/s41239-021-00270-1

Okra, R. (2023). The development of educational game-based learning media in natural science subject for elementary school students. *Jurnal Inovasi Teknologi Pendidikan*, *10*(Vol.2), 122–132. https://doi.org/10.21831/jitp.v10i2.54890

Pradani, & Galuh, T. (2022). Penggunaan media pembelajaran wordwall untuk meningkatkan minat dan motivasi belajar siswa pada pembelajaran IPA di Sekolah Dasar. *Jurnal Ilmiah Pendidikan*, *1*(Vol.5), 452–457. https://doi.org/https://jurnal.arkainstitute.co.id/index.php/educenter/index Penggunaan

Puspita, R. D. puspita, & Prayogi, O. (2025). Implementation of Constructivism-Based Game-Based Learning Model in Science Learning for Grade IV. *Jurnal Profesi Pendidikan*, *4*(Vol.1), 107–114. https://doi.org/10.22460/jpp.v4i1.27441

Rahmadina, A., Rohmani, R., & Haryadi, R. N. (2024). Introducing learning models focusing on elementary school science activity in terms of a systemic literature review. *Journal of Science and Education (JSE)*, *4*(Vol.2), 109–124. https://doi.org/10.56003/jse.v4i2.318

Renninger, K. A., & Hidi, S. E. (2022). Interest development , self-related information processing , and practice. *Theory Into Practice*, *61*(Vol.1), 23–34. https://doi.org/10.1080/00405841.2021.1932159

Renninger, K. N., & Hidi, S. E. (2019). Interest Development and Learning. In: The Cambridge Handbook of Motivation and Learning. In *Cambridge Handbooks in Psychology*. Cambridge University Press. https://www.cambridge.org/core/books/abs/cambridge-handbook-of-motivation-and-learning/interest-development-and-learning/DFFCAD9790A83C5CCB07363A69B43F88

Richard M. Ryan, E. L. D. (2017). Self-determination theory (SDT) provides a framework for understanding the factors that promote motivation and healthy psychological and behavioral functioning. In *Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford Publications.

Rosydiana, E. A., Sudjimat, D. A., & Utama, C. (2023). Effect of Digital Learning Media Using Scratch Game Based Learning on Student Problem Solving Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(Vol.11), 10010–10015. https://doi.org/10.29303/jppipa.v9i11.4876

Rusevska, K., Barandovski, L., Petruševski, V. M., Naumoska, A., Tofilovska, S., & Stojanovska, M. (2024). Innovative Learning Activities for Ethnically Diverse Students in Macedonian Science Education. *Center for Educational Policy Studies Journal*, *14*(Vol.1), 55–77. https://doi.org/10.26529/cepsj.1692

Sailer, M., & Homner, L. (2020). The Gamification of Learning: a Meta-analysis. *Educational Psychology Review*, *32*(Vol.1), 77–112. https://doi.org/10.1007/s10648-019-09498-w

Sanchez, R. ., Burgues, L. ., Ana, L.m, A., Ferrer, M. ., Ferrer, & Serna, J. (2023). education sciences Game-Based Learning and Gamification in Physical Education : *Education Sciences*, *13*,(Vol.1) 1–13. https://doi.org/doi.org10.3390

Shabira, Q., Baharudin, B., & Yanti, Y. (2024). Mapping the Literature of Technological Pedagogical and Content Knowledge (TPACK) in Elementary Education: A Bibliometric Review. *Jurnal Penelitian Pendidikan IPA*, *10*(Vol.9), 631–643. https://doi.org/10.29303/jppipa.v10i9.8731

Sukmana, A. I. W. I. Y., Permana, A. A., & Sudatha, I. G. W. (2023). Game Based Learning Interactive Multimedia in Improving Thematic Learning Achievement of Third Grade Students. *Journal for Lesson and Learning Studies*, *6*(Vol.2), 219–227. https://doi.org/10.23887/jlls.v6i2.60622

Susiloningsih, E., Sumantri, M. S., & Marini, A. (2023). Experiential Learning Model in Science Learning: Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, *9*(Vol.9), 550–557. https://doi.org/10.29303/jppipa.v9i9.4452

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., Monés, A. M., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. In *Education and Information Technologies* (Vol. 28, Issue 6). https://doi.org/10.1007/s10639-022-11431-8

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. In *International Journal of Educational Technology in Higher Education* (Vol. 14, Issue 1). International Journal of Educational Technology in Higher Education. https://doi.org/10.1186/s41239-017-0062-1

Wekerle, C., Daumiller, M., & Kollar, I. (2022). Using digital technology to promote higher education learning: The importance of different learning activities and their relations to learning outcomes. *Journal of Research on Technology in Education*, *54*(1), 1–17. https://doi.org/10.1080/15391523.2020.1799455

Wiradarma, K. S., Suarni, N. K., & Renda, N. T. (2021). The Relationship of Learning Interest to Science Online Learning Outcomes for Third-Grade Elementary School Students. *Jurnal Ilmiah Sekolah Dasar*, *5*(Vol3), 425. https://doi.org/10.23887/jisd.v5i3.39544

Yaseen, H., Mohammad, A. S., Ashal, N., Abusaimeh, H., Ali, A., & Sharabati, A. A. A. (2025). The Impact of Adaptive Learning Technologies, Personalized Feedback, and Interactive AI Tools on Student Engagement: The Moderating Role of Digital Literacy. *Sustainability (Switzerland)*, *17*(Vol.3), 1–27. https://doi.org/10.3390/su17031133

Ace, O., A, L., Dayana, N., Halim, A., & Hanid, abdul. f. (2024). A Systematic Literature Review on the Use of Technology Tools Used in Game-Based Learning.*Internasional journal of academic research in progressive education and developmennt ,13*(Vol.4), 2086–2102. https://doi.org/10.6007/IJARPED/v13-i4/23805

Adipat, S., Laksana, K., Busayanon, K., Ausawasowan, A., & Adipat, B. (2021). Engaging Students in the Learning Process with Game-Based Learning: The Fundamental Concepts. *International Journal of Technology in Education*, *4*(Vol.3), 542–552. https://doi.org/10.46328/ijte.169

Admiraal, W., Huizenga, J., & Akkerman, S. (2011). Computers in Human Behavior The concept of flow in collaborative game-based learning. *Computers in Human Behavior*, *27*(Vol.3), 1185–1194.

https://doi.org/10.1016/j.chb.2010.12.013

Apriani, D. A., Mahendra, Y., & Apriza, B. (2025). The Effectiveness of Educational Games in Mathematics Learning in Elementary Schools *: A Systematic Literature Review*. *13*(Vol.1), 115–126.

Aulia Yolanda, S., Susanti, R., Indah Cahyani, R., Hadi, A., Eka Putri, N., & Mutathahirin, M. (2024). Game-Based Learning: A Solution for Improving the Quality of Learning Processes and Outcomes in Elementary Schools. In *International Journal of Islamic Teaching and Learning* (Vol. 2). https://journal.staisni.ac.id/index.php/ijiting

Banff, M. E., Computer, I., Press, S., Felizardo, K. R., Carlos, S., Macdonell, S. G., Martins, R. M., & Carlos, S. (2011). *reviews , in Proceedings of the 5th International Symposium on Empirical Software Engineering and Using Visual Text Mining to Support the Study Selection Activity in Systematic Literature Reviews*. (Vol.26) 12. https://doi.org/10.1109/ESEM.2011.16

Barz, N., Benick, M., & Perels, F. (2023). *The Effect of Digital Game-Based Learning Interventions on Cognitive, Metacognitive, and Affective-Motivational Learning Outcomes in School: A Meta-Analysis*. *94*. https://doi.org/https://doi.org/10.3102/00346543231167795

Borit, M., & Stangvaltaite-Mouhat, L. (2020). GoDental! Enhancing flipped classroom experience with game-based learning. *European Journal of Dental Education*, *24*(4), 763–772. https://doi.org/10.1111/eje.12566

Casanpitarch R.c. (2018). An approach to digital game-based learning: Video-games principles and applications in foreign language learning. *Journal of Language Teaching and Research*, *9*(6), 1147–1159. https://doi.org/10.17507/jltr.0906.04

Cheung, D. (2018). The key factors affecting students' individual interest in school science lessons. *International Journal of Science Education*, *40*(1), 1–23. https://doi.org/10.1080/09500693.2017.1362711

Costa, M. C., Santos, P., Patrício, J. M., & Manso, A. (2021). An interactive information system that supports an augmented reality game in the context of game-based learning. *Multimodal Technologies and Interaction*, *5*(12), 1–25. https://doi.org/10.3390/mti5120082

Dabbous, M., Kawtharani, A., Fahs, I., Hallal, Z., Shouman, D., Akel, M., Rahal, M., & Sakr, F. (2022). The Role of Game-Based Learning in Experiential Education: Tool Validation, Motivation Assessment, and Outcomes Evaluation among a Sample of Pharmacy Students. *Education Sciences*, *12*(7). https://doi.org/10.3390/educsci12070434

Gomez, M. J. (2022). *Game-based Assessment Studies : Trends and A Systematic Literature Review of Game-based Assessment Studies : Trends and Challenges*. https://doi.org/10.1109/TLT.2022.3226661.https

nal Research. *Online Learning in Educational Research*, *5*(1), 113–128. https://doi.org/https://doi.org/10.58524/oler.v5i1.626 INTRODUCTION

Hidayah, M., Nisa, A. F., Havifah, B., Khosiyono, C., Masjid, A. Al, & Cahyani, H. (2025). *Analysis of Android-Based Science Learning Media to Improve Motivation and Learning Outcomes of Elementary School Students : A Systematic Literature Review*. *11*(3), 86–96. https://doi.org/10.29303/jppipa.v11i3.10236

Hussein, M. H., Ow, S. H., Cheong, L. S., Thong, M. K., & Ale Ebrahim, N. (2019). Effects of Digital Game-Based Learning on Elementary Science Learning: A Systematic Review. *IEEE Access*, *7*,

62465–62478. https://doi.org/10.1109/ACCESS.2019.2916324

Jankovic, A., & Lambic, D. (2022). THE EFFECT OF GAME-BASED LEARNING VIA KAHOOT AND QUIZIZZ ON THE ACADEMIC ACHIEVEMENT OF THIRD GRADE PRIMARY SCHOOL STUDENTS. *Journal of Baltic Science Education*, *21*(2), 224–231.

Larche, C. J., & Dixon, M. J. (2020). The relationship between the skill-challenge balance, game expertise, flow and the urge to keep playing complex mobile games. *Journal of Behavioral Addictions*, *9*(3), 606–616. https://doi.org/10.1556/2006.2020.00070

Li, J., & Xue, E. (2023). Dynamic Interaction between Student Learning Behaviour and Learning Environment: Meta-Analysis of Student Engagement and Its Influencing Factors. *Behavioral Sciences*, *13*(1). https://doi.org/10.3390/bs13010059

Nadeem, M., Oroszlanyova, M., & Farag, W. (2023). Effect of Digital Game-Based Learning on Student Engagement and Motivation. *Computers*, *12*(9). https://doi.org/10.3390/computers12090177

Nkomo, L. M., Daniel, B. K., & Butson, R. J. (2021). Synthesis of student engagement with digital technologies: a systematic review of the literature. *International Journal of Educational Technology in Higher Education*, *18*(1), 1–26. https://doi.org/10.1186/s41239-021-00270-1

Okra, R. (2023). The development of educational game-based learning media in natural science subject for elementary school students. *Jurnal Inovasi Teknologi Pendidikan*, *10*(2), 122–132. https://doi.org/10.21831/jitp.v10i2.54890

Pradani, & Galuh, T. (2022). Penggunaan media pembelajaran wordwall untuk meningkatkan minat dan motivasi belajar siswa pada pembelajaran IPA di Sekolah Dasar. *Jurnal Ilmiah Pendidikan*, *1*(5), 452–457. https://doi.org/https://jurnal.arkainstitute.co.id/index.php/educenter/index Penggunaan

Puspita, R. D. puspita, & Prayogi, O. (2025). Implementation of Constructivism-Based Game-Based Learning Model in Science Learning for Grade IV. *Jurnal Profesi Pendidikan*, *4*(1), 107–114. https://doi.org/10.22460/jpp.v4i1.27441

Raharjo, A. D., Putri, A. A., & Budi, H. R. (2024). Jurnal Penelitian Pendidikan Hipkin. *Jurnal Penelitian Pendidikan*, *1*(3), 299–310. https://doi.org/http://ejournal-hipkin.or.id/index.php/hipkin-jer

Rahmadina, A., Rohmani, R., & Haryadi, R. N. (2024). Introducing learning models focusing on elementary school science activity in terms of a systemic literature review. *Journal of Science and Education (JSE)*, *4*(2), 109–124. https://doi.org/10.56003/jse.v4i2.318

Renninger, K. A., & Hidi, S. E. (2022). Interest development , self-related information processing , and practice. *Theory Into Practice*, *61*(1), 23–34. https://doi.org/10.1080/00405841.2021.1932159

Renninger, K. N., & Hidi, S. E. (2019). Interest Development and Learning. In: The Cambridge Handbook of Motivation and Learning. In *Cambridge Handbooks in Psychology*. Cambridge University Press. https://www.cambridge.org/core/books/abs/cambridge-handbook-of-motivation-and-learning/interest-development-and-learning/DFFCAD9790A83C5CCB07363A69B43F88

Rosydiana, E. A., Sudjimat, D. A., & Utama, C. (2023). Effect of Digital Learning Media Using Scratch Game Based Learning on Student Problem Solving Skills. *Jurnal Penelitian Pendidikan*

IPA, *9*(11), 10010–10015. https://doi.org/10.29303/jppipa.v9i11.4876

Rusevska, K., Barandovski, L., Petruševski, V. M., Naumoska, A., Tofilovska, S., & Stojanovska, M. (2024). Innovative Learning Activities for Ethnically Diverse Students in Macedonian Science Education. *Center for Educational Policy Studies Journal*, *14*(1), 55–77. https://doi.org/10.26529/cepsj.1692

Sailer, M., & Homner, L. (2020). The Gamification of Learning: a Meta-analysis. *Educational Psychology Review*, *32*(Vol.1), 77–112. https://doi.org/10.1007/s10648-019-09498-w

Sanchez, R. ., Burgues, L. ., Ana, L.m, A., Ferrer, M. ., Ferrer, & Serna, J. (2023). education sciences Game-Based Learning and Gamification in Physical Education : *Education Sciences*, *13*, (Vol.1) https://doi.org/doi.org10.3390

Shabira, Q., Baharudin, B., & Yanti, Y. (2024). Mapping the Literature of Technological Pedagogical and Content Knowledge (TPACK) in Elementary Education: A Bibliometric Review. *Jurnal Penelitian Pendidikan IPA*, *10*(9), 631–643. https://doi.org/10.29303/jppipa.v10i9.8731

Sukmana, A. I. W. I. Y., Permana, A. A., & Sudatha, I. G. W. (2023). Game Based Learning Interactive Multimedia in Improving Thematic Learning Achievement of Third Grade Students. *Journal for Lesson and Learning Studies*, *6*(Vol.2), 219–227. https://doi.org/10.23887/jlls.v6i2.60622

Susiloningsih, E., Sumantri, M. S., & Marini, A. (2023). Experiential Learning Model in Science Learning: Systematic Literature Review. *Jurnal Penelitian Pendidikan IPA*, *9*(Vol.9), 550–557. https://doi.org/10.29303/jppipa.v9i9.4452

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., Monés, A. M., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. In *Education and Information Technologies* (Vol. 28, Issue 6). https://doi.org/10.1007/s10639-022-11431-8

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. In *International Journal of Educational Technology in Higher Education* (Vol. 14, Issue 1). International Journal of Educational Technology in Higher Education. https://doi.org/10.1186/s41239-017-0062-1

Wekerle, C., Daumiller, M., & Kollar, I. (2022). Using digital technology to promote higher education learning: The importance of different learning activities and their relations to learning outcomes. *Journal of Research on Technology in Education*, *54*(Vol.1), 1–17. https://doi.org/10.1080/15391523.2020.1799455

Wiradarma, K. S., Suarni, N. K., & Renda, N. T. (2021). The Relationship of Learning Interest to Science Online Learning Outcomes for Third-Grade Elementary School Students. *Jurnal Ilmiah Sekolah Dasar*, *5*(Vol.3), 425. https://doi.org/10.23887/jisd.v5i3.39544

Yaseen, H., Mohammad, A. S., Ashal, N., Abusaimeh, H., Ali, A., & Sharabati, A. A. A. (2025). The Impact of Adaptive Learning Technologies, Personalized Feedback, and Interactive AI Tools on Student Engagement: The Moderating Role of Digital Literacy. *Sustainability (Switzerland)*, *17*(Vol.3), 1–27. https://doi.org/10.3390/su17031133