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EDUCATIONAL GAMES AND HIGHER-ORDER THINKING SKILLS IN ELEMENTARY SCHOOLS: A SYSTEMATIC REVIEW

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ABSTRACT

The demands of the 21st-century curriculum place Higher-Order Thinking Skills (HOTS)—including the ability to analyze, evaluate, and create—as one of the main learning outcomes, including at the elementary school level. On the other hand, educational games, both digital and non-digital, are increasingly being integrated into learning practices because they are seen as being able to increase student engagement and motivation. This article presents a systematic review of the literature discussing the relationship between the use of educational games and the development of HOTS in elementary school students over the past ten years (2016-2026). A literature search was conducted in scientific databases using a combination of the keywords "educational games," "game-based learning," "higher-order thinking skills," and "elementary school," then filtered following the identification, screening, eligibility, and inclusion process commonly used in the PRISMA approach. Articles that met the criteria were then analyzed thematically to reveal the types of games used, the HOTS dimensions they focused on, and the reported results. The review findings indicate that educational games are consistently reported to positively contribute to elementary school students' critical thinking, problem-solving, creative thinking, and analytical-evaluative skills, although the magnitude of the effect varies depending on the type of game, the duration of the intervention, and the extent of teacher scaffolding. The review also identifies several limitations in the existing literature, including the predominance of quasi-experimental designs, relatively short intervention durations, and the diversity of HOTS measurement instruments that make generalization difficult. Implications for instructional practice and future research directions are discussed.



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Introduction

Changes in the orientation of 21st-century education demand that learning no longer stops at mastering basic facts and concepts, but is instead directed at strengthening higher-order thinking skills (HOTS). Conceptually, HOTS refers to cognitive abilities at the level of analyzing, evaluating, and creating as described in the revised cognitive taxonomy, in contrast to lower-order thinking skills that emphasize

remembering, understanding, and applying. In Indonesia, the emphasis on HOTS is reflected in various curriculum policies, including the development of HOTS-based assessment questions and teacher training oriented towards higher-order thinking skills (Ariyana et al., 2018). However, the implementation of HOTS-oriented learning in elementary schools still faces various challenges, ranging from teacher readiness in designing activities and questions that stimulate higher-order thinking, to students' own readiness to respond to more complex cognitive demands (Utaminingsyas, 2020).

The characteristics of elementary school students, who are generally still at the concrete cognitive development stage, require HOTS development at this level to be concrete, contextual, and enjoyable. Monotonous, lecture-centered learning tends to be less effective in stimulating critical, analytical, and creative thinking in elementary school-aged children. It is in this context that educational games are gaining increasing attention as an alternative approach. Educational games are understood as play activities that are intentionally designed to achieve certain learning objectives, whether in the form of board games, modified traditional games, or digital games (digital game-based learning).

The use of games in learning is not a new idea, but its scope and form continue to evolve with technological advances. Early educational games were generally non-digital, such as puzzles, cards, and board games, designed to practice basic literacy and numeracy. The development of digital technology then gave birth to game-based learning that utilizes computers, tablets, and web-based and mobile applications, enabling more interactive, adaptive, and personalized learning (Alotaibi, 2024). Researchers and educators' interest in the potential of educational games is based on the assumption that game elements such as challenges, immediate feedback, reward systems, and engaging narratives can increase students' cognitive engagement, which in turn opens up space for the development of more complex thinking skills (Qian & Clark, 2016; Hamari et al., 2016).

Several studies have reported that educational games can stimulate various higher-order cognitive processes, such as problem-solving, decision-making, reasoning, and information processing (Alotaibi, 2024). Specifically, in the field of gamification, challenges designed in game form have been reported to encourage students to think critically and strategically when solving problems and achieving game goals (Angelelli et al., 2023). In the context of elementary schools in Indonesia, research on the use of gamification-based game media has also reported an increase in students' critical thinking skills in science and social studies, as reflected in their ability to provide simple explanations, develop basic skills, draw conclusions, and make more advanced decisions (Wibisono et al., 2024). Furthermore, media-based games such as Wordwall have been reported to positively contribute to the understanding of mathematical concepts while encouraging students to think more critically and creatively in solving problems (Marlita et al., 2024).

However, research findings on the effectiveness of educational games on HOTS are inconsistent. Some studies report significant positive effects, while others find no significant effect, or find that game effectiveness is highly dependent on the type of game, the duration of the intervention, and the quality of teacher support (Alotaibi, 2024; Cai et al., 2022). This variation in results suggests the need for a more systematic synthesis of the literature to comprehensively understand the extent and under what conditions educational games are effective in developing HOTS in elementary school students. Most existing systematic reviews focus primarily on early childhood education, secondary education, or higher education (Alotaibi, 2024), while studies specifically targeting elementary school and HOTS dimensions are relatively limited and scattered across various fields of study.

Based on this background, this article aims to conduct a systematic review of the literature on the relationship between educational games and higher-order thinking skills in elementary school students. In more detail, this review is directed to answer the following research questions: (1) what types of educational games are used in research on HOTS in elementary schools; (2) which dimensions of HOTS (critical thinking, problem solving, creative thinking, and analytical-evaluative skills) have been most frequently studied and what are the results; and (3) what factors moderate the effectiveness of educational games on the development of HOTS in elementary school students. Through this synthesis, it is hoped that a more complete picture of the available empirical evidence will be obtained, as well as practical recommendations for teachers and directions for further research for educational researchers.

Method

This study employed a systematic literature review approach, following the commonly used workflow of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach, which consists of study identification, screening, eligibility assessment, and inclusion (Robson et al., 2019).

This approach was chosen because it allows for a transparent and replicable synthesis of empirical evidence while minimizing subjective bias in study selection.

Search Strategy

Literature searches were conducted on scientific databases relevant to the field of education, including Google Scholar, ERIC, ScienceDirect, Scopus, DOAJ, and national journal portals indexed by SINTA/Garuda to reach Indonesian-language literature. Search keywords were arranged in the form of boolean combinations, including: ("educational games" OR "game-based learning" OR "educational games" OR "gamification") AND ("higher-order thinking skills" OR "HOTS" OR "higher-order thinking" OR "critical thinking" OR "creative thinking" OR "problem solving") AND ("elementary school" OR "primary school" OR "elementary school"). The search was limited to articles published within the last ten years, namely between 2016 and 2026, taking into account that the development of research on game-based learning and HOTS has grown most rapidly during that time period.

Inclusion and Exclusion Criteria

Studies included in this review must meet the following criteria: (1) involve elementary school students as participants or as the main focus of discussion; (2) use educational games, gamification, or game-based learning as interventions or objects of study; (3) measure or discuss one or more HOTS dimensions, such as critical thinking, problem solving, creative thinking, or analytical-evaluative skills; (4) be in the form of scientific journal articles, either the results of empirical research (experimental, quasi-experimental, research and development) or review/meta-analysis articles; and (5) be published in English or Indonesian between 2016 and 2026. Studies were excluded from the review if: they focused on early childhood education, secondary school, or higher education without a direct link to elementary school; did not explicitly report data or findings related to higher-order thinking skills; were in the form of opinion pieces, editorials, or conceptual papers without empirical data support; or articles whose full text could not be accessed.

Data Selection and Extraction Procedures

The selection process was conducted in four stages following the PRISMA framework. In the identification stage, all articles identified from the initial search were collected and duplicates were removed. In the screening stage, the title and abstract of each article were examined to assess its suitability to the topic and inclusion criteria. Articles that pass this stage are then assessed for eligibility by reading the full text to ensure methodological and substantial suitability with the review focus. Articles that met all criteria were ultimately included in the final synthesis. Data extraction for each included article included author name and year of publication, country/research context, participant level and characteristics, type and format of educational game used, HOTS dimensions of focus, research design, and reported key findings.

Data Analysis

The extracted data was then analyzed thematically (thematic synthesis). The findings from each study were grouped based on the HOTS dimensions that were the main focus, namely critical thinking, problem solving, creative thinking, and analytical-evaluative abilities, and then synthesized to identify patterns, consistencies, and contradictions between the findings. In addition, an analysis was also conducted on factors that have been consistently reported to influence the effectiveness of educational games, such as game type, intervention duration, and the role of teacher support, as is commonly done in moderator analysis in previous systematic reviews and meta-analyses (Alotaibi, 2024).

Results

General Characteristics of the Study

The literature reviewed in this review shows that research on educational games and HOTS in elementary school students is spread across various subjects, ranging from mathematics, natural and social sciences, language, to religious education and character education. The forms of games used vary, ranging from board games such as educational monopoly (Anggraeni et al., 2022), digital media-based games such as Wordwall (Marlita et al., 2024), interactive quiz applications, to adventure-themed games designed to train students to analyze situations and find solutions (Savira et al., in *ejournal.indo-intellectual.id*, 2024). Most

studies used a quasi-experimental design with a control group and an experimental group, while others used a research and development approach to design and test the effectiveness of certain game media.

In terms of age, the majority of studies target upper elementary school students (grades 4-6), who are considered cognitively more prepared to engage in higher-order thinking activities than students in the lower grades. However, a number of studies also suggest that game elements can be adapted for lower grade students by adjusting the complexity of the cognitive tasks required.

Educational Games and Critical Thinking Skills

One of the most widely researched HOTS dimensions in relation to educational games is critical thinking skills. A study conducted on fifth-grade students at an elementary school showed that the implementation of a gamification-based learning model in science and social studies contributed to improving students' critical thinking skills, as reflected in their ability to provide simple explanations, build basic skills, draw conclusions, and make decisions and take further actions (Wibisono et al., 2024). These findings align with studies that suggest that gamification activities that require students to make strategic decisions in overcoming game challenges can strengthen students' critical thinking skills in dealing with complex situations (Angelelli et al., 2023). Several game design principles that support critical thinking, such as providing tiered challenges and space for reflective discussion between players, have been reported to encourage higher-level discourse and a deeper and more flexible understanding of the material being studied.

In a more specific context in Indonesia, adventure-based educational games designed with tiered missions are reported to train students to analyze situations, evaluate steps that have been taken, and create new strategies in solving problems, so that students indirectly apply higher-order thinking skills at the level of analyzing, evaluating, and creating. A similar pattern is also found in the use of IPAS (Natural and Social Sciences)-based game media in elementary schools, where game media developed with a research and development approach are proven valid, practical, and effective in improving students' critical, evaluative, and creative thinking skills, with n-gain achievements in the high category.

Educational Games and Problem Solving Skills

The second HOTS dimension that has been the focus of much research is problem-solving ability. Studies in game-based learning environments have shown a strong relationship between collaborative problem-solving behavior and task completion outcomes in games, with students who exhibit more focused collaborative interaction patterns tending to achieve better solutions (Sun et al., 2022). Furthermore, providing scaffolding or structured support during gameplay has been reported to significantly impact student learning outcomes in digital game-based learning contexts, with a greater effect on students receiving scaffolding than those without (Cai et al., 2022).

At the elementary school level, educational games that integrate elements of traditional and modern games into thematic learning have been reported to improve student motivation and learning outcomes, which in many cases also leads to improved student problem-solving abilities presented in the context of thematic learning (Sari et al., 2021). In line with this, Wordwall-based games applied to mathematics learning in elementary schools are reported to help students understand abstract concepts more concretely, so that students are better able to relate the concepts learned with steps for solving mathematical problems (Marlita et al., 2024).

Educational Games and Creative Thinking Skills

Several studies have also highlighted the contribution of educational games to students' creative thinking skills. A review of the use of digital game applications in early childhood and elementary school indicates that games designed with open exploration spaces, narrative elements, and problem-solving challenges can foster children's creativity. Although the quality of the game design is a key determinant, as not all digital games automatically support creative thinking processes (Behnamnia et al., 2020). In the realm of computational thinking skills, which are closely related to creativity in developing strategies and solutions, smart toy-based games that integrate logical challenges have been reported to improve computational thinking skills in preschool and early elementary school children (Lin et al., 2020).

In the context of educational board games, the development of monopoly game media for social studies subjects has been reported to not only increase students' learning motivation but also open up space for students to think creatively in formulating game strategies while linking them to the social concepts being studied (Anggraeni et al., 2022). This pattern confirms that the elements of competition and strategy in

educational games have the potential to trigger the emergence of original and flexible ideas in completing learning tasks.

Educational Games and Analytical-Evaluative Skills

The HOTS dimension related to the ability to analyze and evaluate was also highlighted in a number of studies reviewed. Board-based educational games designed based on HOTS questions are reported to be able to improve students' analytical abilities in certain subjects, because the game format requires students not only to remember information, but also to connect the concepts they have learned with the game situations they face. A similar thing was reported in the use of themed map-based game media, which apart from being valid and practical for use by teachers, was also proven to be effective in improving elementary school students' high-level thinking skills with effectiveness achievements in the moderate to high category.

Overall, the findings across all HOTS dimensions examined show a relatively consistent pattern, namely that educational games contribute positively to the development of elementary school students' higher-order thinking skills. However, the magnitude of this contribution is not uniform and is greatly influenced by a number of moderating factors.

Factors That Moderate the Effectiveness of Educational Games

One of the most consistently reported factors influencing the effectiveness of educational games is the type of game used. Moderator analysis in large-scale systematic reviews and meta-analyses indicates that puzzle-type games have a greater effect on cognitive development than other game types, while longer game session durations are also associated with greater effects on student learning motivation (Alotaibi, 2024). A second widely highlighted factor is the role of teacher support or scaffolding during gameplay. The absence of adequate support risks students becoming trapped in the purely entertainment aspect of the game without truly engaging in the expected higher-order thinking processes (Cai et al., 2022).

The third factor relates to the suitability between game design and learning objectives. Several studies have confirmed that not all educational games are adequately designed to support specific learning objectives, so teachers need to critically evaluate the quality, educational value, and suitability of games before integrating them into learning (Alotaibi, 2024). The fourth factor is the availability of facilities and infrastructure, especially for digital-based games, which in a number of elementary schools is still a problem. These factors together show that the success of implementing educational games in developing HOTS is not simply a matter of whether or not there are game elements, but rather how the games are designed, implemented, and accompanied pedagogically.

Discussion

The results of this systematic review confirm that educational games have quite strong potential as a means of developing higher-order thinking skills in elementary school students, in line with the findings of a meta-analysis that reported moderate to large effects of game-based learning on children's cognitive development, with effect sizes ranging from medium to large across various learning outcomes (Alotaibi, 2024). The consistency of findings across HOTS dimensions—critical thinking, problem-solving, creative thinking, and analytical-evaluative skills—indicates that game elements are indeed capable of creating learning conditions that are cognitively more challenging than conventional learning methods.

Several mechanisms may explain why educational games are effective in promoting HOTS. First, the structure of games that present tiered challenges forces students to continually analyze situations, evaluate options, and develop new strategies when previous ones fail—a cognitive process that directly corresponds to the analyze and evaluate levels of higher-order thinking taxonomy. Second, the immediate feedback characteristic of many games allows students to immediately understand the consequences of their decisions, thus accelerating the process of reflection and refinement of thinking strategies. Third, the elements of narrative, competition, and achievement in games contribute to increasing students' emotional engagement and intrinsic motivation, which in turn makes them more willing to tackle challenging cognitive tasks rather than avoid them (Hamari et al., 2016; Qian & Clark, 2016).

However, this review also confirms that the effectiveness of educational games on HOTS is not something that happens automatically. As found in various reviewed studies, the quality of game design, its alignment with learning objectives, and the teacher's active role in assisting and facilitating student reflection during and after play are key determinants of success. Without adequate guidance, games risk becoming merely entertainment activities without truly engaging the expected higher-order cognitive processes (Cai et

al., 2022). This finding aligns with the challenges many elementary school teachers in Indonesia complain about in implementing HOTS-oriented learning: limited knowledge and skills in designing activities and questions that genuinely stimulate higher-order thinking (Utaminigtyas, 2020). This indicates that the success of integrating educational games for HOTS development cannot be separated from efforts to strengthen teacher capacity, both through training and ongoing mentoring.

From a local context, findings from research in Indonesian elementary schools indicate that simple media-based educational games—whether board games, free digital media such as Wordwall, or teacher-created media such as illustrated thematic maps—are quite effective in increasing students' engagement and higher-order thinking skills, even without the need for sophisticated or expensive technology (Marlita et al., 2024). This is a relevant finding considering that limited technological facilities remain a challenge in many elementary schools, particularly in areas with limited access to digital infrastructure.

This review also identified several limitations in the existing literature. First, the majority of studies used quasi-experimental designs with relatively short intervention durations, making it difficult to draw conclusions about the long-term impact of educational games on HOTS. Second, the HOTS measurement instruments used across studies varied widely, ranging from written tests based on critical thinking indicators and performance assessment rubrics to behavioral observations during play, making comparisons between studies less equitable. Third, most studies focused on specific subjects such as mathematics and science, while research on other subjects such as language and character education remained relatively limited. Fourth, few studies explicitly examined differences in the effectiveness of educational games based on individual student characteristics, such as learning styles or prior abilities, even though these aspects could potentially influence the extent to which students derive cognitive benefits from play.

Based on these findings and limitations, several practical implications can be formulated. For teachers and learning media developers, the selection and design of educational games should not be solely oriented towards entertainment, but should be deliberately designed to stimulate thinking processes at the levels of analysis, evaluation, and creation, for example through tiered challenges, reflective questions, and discussion spaces after the game ends. Furthermore, teacher support during the game process needs to be positioned as an integral part of the learning strategy, not merely an add-on. For education policymakers, the results of this review emphasize the importance of strengthening teacher capacity in designing HOTS-oriented game-based learning, including through training and providing examples of good practices that can be replicated in various elementary school contexts with varying resource constraints.

For researchers, this review recommends the need for studies with more robust experimental designs and longer intervention durations to test the medium- and long-term impacts of educational games on HOTS. The development and use of more standardized HOTS measurement instruments is also needed to allow for more valid comparisons between studies. Future research should also expand the scope of subjects and consider individual student variables as moderating factors, in order to gain a more comprehensive understanding of the conditions that maximize the benefits of educational games for the development of elementary school students' higher-order thinking skills.

Conclusion

This systematic review shows that educational games, whether in the form of board games, simple digital media, or gamified learning, are consistently reported to contribute positively to the development of higher-order thinking skills in elementary school students, including critical thinking, problem-solving, creative thinking, and analytical-evaluative skills. This contribution is not automatic, but is strongly influenced by the quality of the game design, its suitability to learning objectives, the duration of the intervention, and the teacher's active role in assisting and facilitating student reflection during the play process. These findings confirm that educational games have the potential to be a relevant learning strategy to meet the demands of a HOTS-oriented curriculum in elementary schools, with the caveat that their implementation needs to be pedagogically planned and supported by teacher capacity building. Given the limited research with robust designs and standardized instruments, further research with broader subject coverage, longer duration, and attention to individual student characteristics is needed to enrich the empirical evidence in this area.

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