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The Role of Multiplayer Online Educational Games in Enhancing Critical Thinking

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ABSTRACT

Objective: This research aims to determine the role of multiplayer online educational games in enhancing students' critical thinking skills. **Method:** This study utilizes a systematic review method guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach. A comprehensive search was conducted using Scopus, PubMed, and Web of Science (WoS) databases, identifying studies that focused on multiplayer online educational games and their impact on critical thinking skills. Out of 910 studies identified, 20 met the inclusion criteria after a rigorous screening. **Results**: The results indicate a positive association between multiplayer educational games and enhancing critical thinking skills across various educational settings. Key aspects extracted include game design, educational context, participant demographics, and methodologies for assessing critical thinking outcomes. However, variability in game designs and measurement tools highlights a need for standardized assessment approaches in future research. **Novelty**: This review underscores the evolving potential of multiplayer online educational games as innovative tools for developing critical thinking skills. With the increasing integration of digital technologies in education, this study sheds light on how game-based learning can address 21st-century educational needs by fostering essential cognitive skills.

INTRODUCTION

Critical thinking is increasingly recognized as a core competency for students in the 21st century due to its essential role in navigating the complexities of modern life. The rapid technological, economic, and societal changes demand that individuals possess the ability to adapt and innovate, making critical thinking a vital skill for success and prosperity in this era (Todorova, 2024). It equips students with the ability to solve problems, make informed decisions, and generate innovative solutions, which are crucial for personal and professional development (Mardatillah & Prayudha.S, 2024). Educational strategies such as Problem-Based Learning (PBL) have effectively enhanced critical thinking skills, as evidenced by significant improvements in students' abilities to understand and apply complex concepts (Wardani & Fiorintina, 2023).

Furthermore, critical thinking is closely linked to logical reasoning, which provides a foundation for understanding and evaluating information critically, thus enabling individuals to combat misinformation and make sound judgments. Integrating critical thinking into educational curricula prepares students to tackle complex challenges and fosters a lifelong learning mindset, encouraging adaptability and continuous skill development (Ramamonjisoa, 2024). Therefore, developing critical thinking skills is about enhancing academic performance and preparing students to become responsible,

engaged citizens capable of contributing meaningfully to a globalized society (Ramamonjisoa, 2024). This holistic approach to education emphasizes the importance of nurturing curiosity and creativity, allowing students to explore diverse perspectives and solutions (Axmetovna, 2024).

Traditional methods of teaching critical thinking often rely on established pedagogical techniques that emphasize structured problem-solving and clear communication, as highlighted by Carina Nădăban, who underscores the role of educators in directing the development of students' critical thinking from an early age through various instructional methods (Nădăban, 2023). However, there is a growing recognition of the need for innovative approaches to enhance critical thinking skills, as traditional methods alone may not suffice in today's rapidly changing educational landscape. Yuliia Korneiko et al. (2023) argue that while traditional methods are foundational, integrating innovative techniques can renew and strengthen the educational process, suggesting that a balance between tradition and innovation is crucial for effective education (Korneiko et al., 2023). Further, it emphasizes the importance of innovative education in higher education, noting that modern universities are increasingly adopting innovative methods to integrate into the global educational space, including technology and research activities (Mnozhynska, 2022). Identifies specific innovative strategies such as Socratic questioning, collaborative learning, and problem-based learning as effective in promoting critical thinking, highlighting the need for educators to implement these strategies to foster critical thinking skills (Mittal & Anggarwal, 2023). Additionally, the transformative impact of new technologies and interactive methods in business education illustrates how innovative approaches can radically change traditional educational paradigms (Abdulkadir, 2023).

These insights suggest that while traditional methods provide a necessary foundation, incorporating innovative approaches is essential to effectively develop critical thinking skills in students across various educational contexts. Integrating educational games into modern classrooms has been increasingly recognized as a valuable tool for enhancing student engagement, motivation, and learning outcomes (Harahap et al., 2024). This trend is driven by the growing acceptance of digital culture and the potential of games to foster intrinsic motivation and connect with curricular content (Ellsworth, 2023). Using game-based learning platforms, which incorporate gaming elements into educational activities, has shown promising results in boosting student engagement and productivity by creating a balance between subject matter and gameplay (Ismaizam et al., 2022).

The differences between single-player and multiplayer educational games are multifaceted, encompassing design, learning outcomes, and user engagement. Single-player educational games are characterized by data-intensive structures, formal rules, and a focus on direct transfer and individual learning, which can lead to a more straightforward and controlled learning environment (Nuryadin et al., 2022). In contrast, multiplayer educational games are process-intensive and incorporate social rules, promoting engagement, collaboration, and debate, which can lead to more active and meaningful learning experiences (Yudin et al., 2023). Multiplayer games, particularly in virtual reality settings, have been shown to enhance enjoyment and reduce annoyance compared to single-player experiences, suggesting that collaborative aspects can significantly improve the game experience (Hansen et al., 2020). Furthermore, multiplayer games can foster continuous improvement and engagement

by allowing users to compete with friends, which can be particularly beneficial for lower-grade students who show better improvement in such environments (Atanasova, 2024; Asadi et al., 2021). However, integrating multiplayer games into educational settings presents challenges, such as the need for varied gameplay mechanics and content integration, which are crucial for creative learning and maintaining user engagement (Atanasova, 2024; Alwhaibi et al., 2024; Garneli et al., 2021; Heryanto & Rosmansyah, 2024; Damaševičius & Sidekerskienė, 2024; Lucy et al., 2021).

Despite the growing interest in multiplayer educational games (MMOEG), there is limited consolidated evidence on their impact on critical thinking skills. Existing studies often vary in methodology, game design, and assessment measures, making it challenging to draw consistent conclusions (Laine & Lindberg, 2020; Tao et al., 2021; Makri et al., 2021; Russell et al., 2021; Tian et al., 2022). To address these gaps, this systematic review uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a structured and transparent analysis of relevant literature (Arya et al., 2021; Rethlefsen et al., 2021; Prill et al., 2021; Oláh et al., 2020; Kolaski et al., 2023). By following PRISMA, this review offers a rigorous approach to synthesizing current findings and identifying areas for future research (Askarizad et al., 2024; Chigbu et al., 2023; Kraus et al., 2024; Anton et al., 2023; Thanasi-Boçe et al., 2023). The primary objective of this study is to assess the effectiveness of MMOEG in enhancing critical thinking skills among students. This review synthesizes studies published in academic databases, including Scopus, PubMed, and Web of Science (WoS), up to 2023. Articles were selected based on specific inclusion criteria focused on game design, educational context, and critical thinking outcomes (Mao et al., 2022; Puig et al., 2020; Bakhtiari et al., 2024; Gomez et al., 2023; Zaremohzzabieh et al., 2024). This review contributes valuable insights for educators, researchers, and game designers seeking to integrate critical thinking into educational gaming frameworks (Dimitri et al., 2021). By examining MMOEG, this study highlights their potential as dynamic tools for cognitive skill development and sets a foundation for future research on effective game-based learning strategies (Hartt et al., 2020).

With the growing use of multiplayer educational games to support 21st-century skills, this review uniquely consolidates recent findings on the effectiveness of these games in fostering critical thinking. This study aims to guide future development in the educational game sector by identifying familiar game mechanics and proposing standardized assessment criteria (Kalogiannakis et al., 2021; Gris & Clarissa, 2021; Jääskä et al., 2021). This review contributes novel insights into the effectiveness of multiplayer educational games as tools for critical thinking, providing the first systematic synthesis of current findings under the PRISMA framework. By identifying trends, challenges, and opportunities within existing research, this study establishes a foundation for improved design and assessment of educational games (Valverde et al., 2020; Ofosu, 2020; Greenhow et al., 2022; Araújo et al., 2021; Mourtzis et al., 2022).

Recent research has demonstrated the potential of game-based learning to enhance critical thinking and engagement. Studies such as Efendi (2023), Fatih (2024), and Solikah (2023) show how multiplayer games promote problem-solving, cognitive skills, and collaboration, all of which are integral to critical thinking. Additionally, Lee (2023) and Chainilpan (2024) have highlighted the growing use of multiplayer online educational games (MOEGs) in developing higher-order thinking skills and fostering analytical capabilities. Although these studies highlight the potential of MOEGs in enhancing critical thinking, more systematic reviews are needed to consolidate these

findings across recent studies. This review fills this gap by synthesizing emerging trends and identifying critical factors contributing to developing critical thinking skills through MOEGs.

RESEARCH METHOD

This review was performed according to the PRISMA guidelines, thus providing a comprehensive framework that objectively assesses quality indicators and the risk of biases in included studies. Eligibility Criteria: A total of 910 studies from Scopus, n = 451; Web of Science, n = 232; and PubMed, n = 227 were identified via the initial search process. Initially, a comprehensive search was performed to identify relevant articles published between 2018 and 2024. Only the most recent studies within a five-year range were selected to ensure the relevance and recency of the data analyzed. Information Sources and Search: To ensure comprehensive literature retrieval, this research systematically searched PubMed, Scopus, and Web of Science for studies published from January 2015 to 2024. Our search, focusing on MOEGs and critical thinking, was limited to articles and book reviews in English and Malay involving human subjects. In PubMed, researchers used a combination of MeSH (Medical et al.) terms and keywords. In Scopus and WoS, researchers employed similar strategies. Additionally, researchers manually reviewed the reference lists of selected publications and examined key journals in educational technology and game-based learning for further relevant studies. Study Collection & Selection Process: All papers were initially screened by reading the abstract of potentially interesting research. Further examination was done by reading the full papers to remove those which did not fit the criteria. After the title and abstract of each study were examined, 860 studies were excluded due to unsuitability for the present review. A further 18 studies were excluded due to duplication (n=15) and only having an abstract (n=3). Consequently, a total of 32 studies were selected for the eligibility phase. Out of these, four studies were excluded mainly for (i) language issues (n=4), (ii) unpublished dissertations (n=2), and (iii) problem-solving and social interaction (n=6). Following this procedure, 20 empirical studies fully met the previously stipulated eligibility criteria for inclusion in the systematic review process in **Figure 1.**

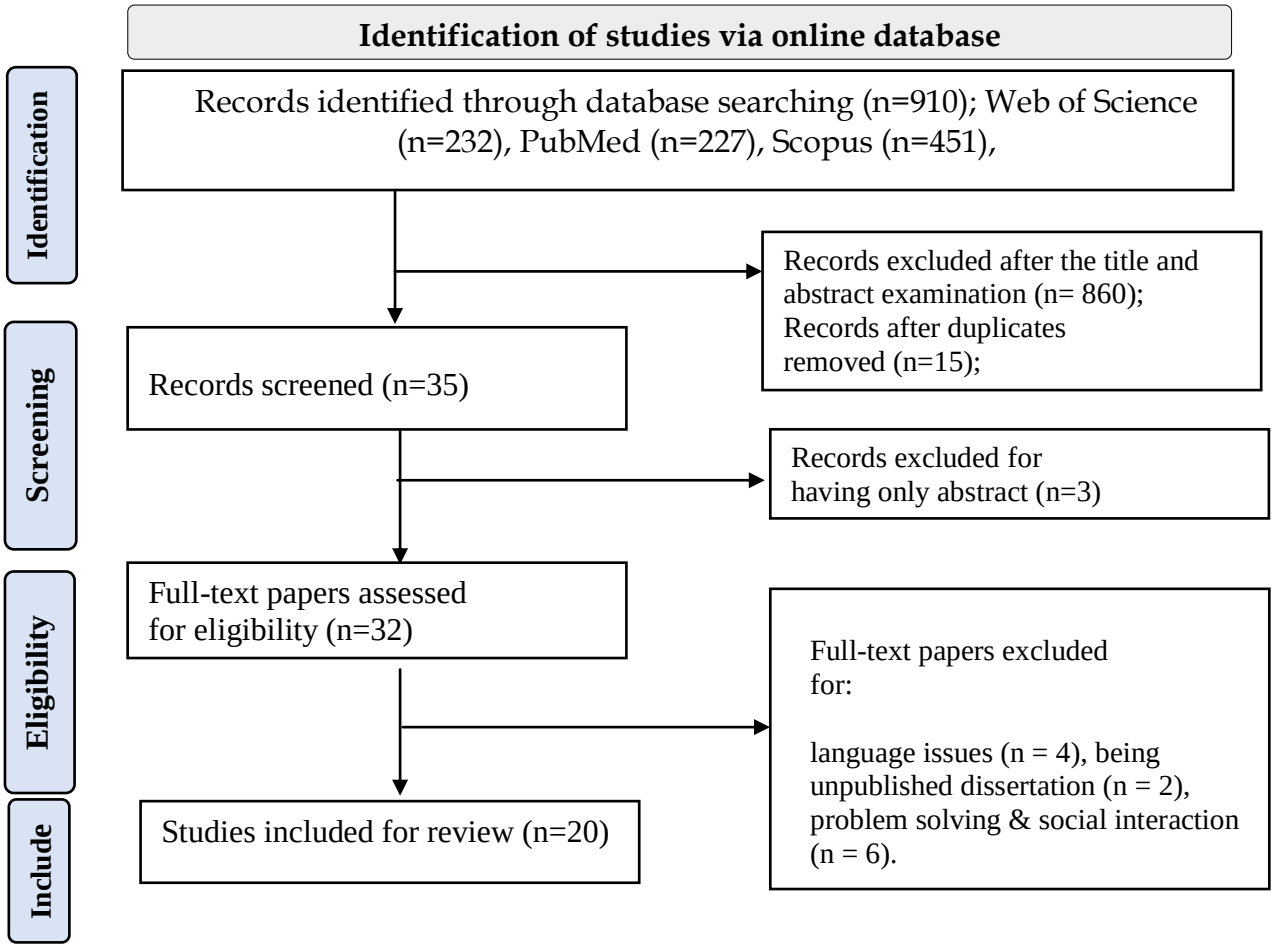

Figure 1. PRISMA flow diagram of the study selection process.

RESULTS AND DISCUSSION

Results

This study addresses the following research question, RQ: How do multiplayer online educational games (MMOEG) enhance critical thinking skills in students? To investigate this research question, a comprehensive analysis of 18 carefully selected studies was conducted, all focusing on implementing online educational games to improve critical thinking skills. Table 1 presents the articles referenced in this review. The findings indicate that MMOEG can significantly enhance critical thinking by engaging students in interactive, problem-based scenarios and supporting the educational impact emphasized in the research question. The discussion of these findings follows Table 1, providing further insights into the educational benefits and challenges associated with MMOEG.

Discussion

Multiplayer educational games significantly enhance students' critical thinking skills by providing interactive and engaging learning environments. These games leverage digital technology to create complex scenarios requiring players to analyze, evaluate, and make decisions based on evidence and logic, fostering critical thinking. For instance, mobile-based game applications in high school sociology classes have significantly improved students' critical thinking skills, categorizing the approach as efficient in building 21st-century competencies (Efendi & Qodr, 2023). Similarly, augmented reality-based Science Learning Games (SLG) have substantially improved

science literacy and critical thinking skills among Grade 6 students, with posttest scores significantly higher than pretest scores (Fatih et al., 2024). Game-assisted problem-based learning (PBL) also effectively enhances critical thinking and learning motivation, as evidenced by increased test scores and observations in classroom settings (Solikah et al., 2023). The integration of interactive multimedia in Android-based platforms further enhances critical thinking by providing a medium for students to actively engage with learning materials (Hamdani et al., 2022). Theoretical frameworks, such as the Game Framework Analysis (GAF) model, suggest that educational games manage cognitive load effectively, facilitating deeper conceptual understanding and application of knowledge (Davis, 2020).

Additionally, collaborative problem-solving within game-based learning environments has been identified as an effective method for promoting critical thinking, with significant effect sizes reported in meta-analyses (Xu et al., 2023). Overall, integrating multiplayer educational games in learning contexts enhances critical thinking skills and supports the development of cognitive abilities and motivation, making them a valuable tool in modern education. Multiplayer educational games significantly enhance critical thinking by providing interactive and immersive learning environments that engage students in problem-solving and decision-making processes.

Integrating gamified elements into mobile learning platforms has been shown to foster critical thinking by creating dynamic environments that encourage learners to engage in decision-making scenarios and collaborative experiences, which are essential for developing critical thinking skills. Similarly, digital game-based learning (DGBL) environments, particularly those incorporating puzzle boxes in virtual reality settings, have been found to enhance reasoning and analytical skills, thereby expanding the cognitive demands placed on learners and improving their critical thinking capabilities (Lee et al., 2023). Game-based learning frameworks, especially those embedded within socio-constructivist environments, have been positively received by students, enhancing engagement, understanding, and teamwork, which are crucial for cultivating critical thinking and collaboration skills in hybrid learning settings (Mai et al., 2024). Furthermore, educational digital games based on phenomenon-based learning have demonstrated significant improvements in students' critical thinking skills, as evidenced by higher posttest scores compared to pretest scores (Chainilpan et al., 2024). Informatics educational games, designed with higher-order thinking skill questions, have significantly improved students' critical thinking abilities, as indicated by increased scores in experimental settings (Samin & Efendi, 2022).

Additionally, interactive game-based assessments using simulation tasks have proven effective in measuring critical thinking, offering a dynamic approach to evaluating complex higher-order competencies (Wang et al., 2021). While some games, like the card game "Follow Me," aim to develop critical thinking in countering fake news, the results suggest further refinement to achieve statistically significant improvements (Pomichal & Trnka, 2023). Overall, through their interactive and engaging nature, multiplayer educational games provide a valuable platform for enhancing critical thinking skills across various educational contexts.

Table 1. Research results in the article.

Author (Year)	Research Result
Agus Efendi (2023)	The effectiveness of mobile game-based learning was further supported by N-Gain score analysis, which demonstrated that the developed mobile game learning products were efficient in enhancing students' critical thinking skills, thereby contributing positively to their overall academic performance in sociology.
Mohamad Fatih (2024)	The effectiveness of this study was demonstrated through significant improvements in students' critical thinking and science literacy skills, with Pretest scores increasing from 72.21% to 93.57% for critical thinking, and from 74.28% to 92.14% for science literacy in the Posttest results.
Umi Nur Solikah (2023)	Data analysis from pretests and posttests indicated significant improvements in both critical thinking skills and student motivation, confirming the effectiveness of the PBL model integrated with games in enhancing these educational outcomes.
Salma Almira Hamdani (2022)	The research demonstrated that all 30 students improved their critical thinking skills after using the Android-based interactive multimedia, as indicated by the positive ranks in the data analysis. No hostile ranks suggested a decrease in scores from the pretest to the posttest.
Jason Stratton Davis (2020)	The Game Framework Analysis (GAF) model, developed from the Interactive Qualitative Analysis (IQA) process, indicates that games create complex learning environments that effectively manage cognitive load, facilitate optimal use of working memory, and result in effective learning outcomes.
Dwi Sulisworo (2024)	The findings indicate that gamified mobile learning is an effective tool for enhancing critical thinking skills. Leveraging the motivational aspects of games encourages learners to engage in critical thinking, problem-solving, and a deeper understanding of the material.
Enwei Xu (2023)	The meta-analysis revealed that collaborative problem-solving is an effective teaching approach for fostering students' critical thinking. Its significant overall effect size of 0.82 indicates a strong positive impact on learners' ability to engage in critical thinking practices.
Vanessa Ortega-Quevedo (2023)	The study demonstrated significant improvements in both critical thinking skills and concepts of the nature of science and technology among the 130 sixth-grade students, as evidenced by a mean increase of 0.34 on a 2-point scale regarding their understanding of the dependence on the use of new technologies from pretest to posttest assessments.
Boon Giin Lee (2023)	The integration of puzzle boxes within a virtual reality-based educational game significantly enhances students' critical thinking and engagement. Participants reported high motivation to play the game despite the challenges posed by the puzzles. They found the experience to be engaging, creative, and innovative.
Neo Mai (2024)	Students very positively received the game-based learning environment, significantly improving learner engagement, experiences, and technology support. Students reported enhanced enjoyment, understanding, teamwork, and real-world relevance during their learning process.
Taree Chainilpan (2024)	The average critical thinking skill scores of students who engaged with the educational digital game were significantly higher than those

Author (Year)	Research Result
	who did not use the game, indicating a positive impact on critical thinking skills at a significance level of .05.
Evangeli Boti (2023)	The research demonstrated that using digital simulation games significantly improved students' critical thinking skills compared to traditional teaching methods.
Samin (2022)	The study found that the use of informatics educational games significantly improved students' critical thinking skills. The experimental class showed an N-Gain of 0.63 in the medium category, compared to the control class, which had an N-Gain of 0.43, also in the medium category.
Dang Wang (2021)	The study found that students exhibited hesitance in querying others and demonstrated weaknesses in applying critical thinking to problem-solving. This aligns with previous research that suggests students infrequently utilize critical thinking to address complex, real-world problems.
M. Esther Del-Moral (2018)	The analysis of war video games reveals that while some games effectively address critical issues related to war, such as ethical dilemmas involving child soldiers and the economics of war, the majority tend to trivialize the subject matter, presenting it through hyper-realistic simulations that may not foster critical thinking.
Vajk Pomichal (2023)	The study investigated the effects of a game-based instruction approach, explicitly using bingo games and a mobile application, on enhancing motivation among participants.
Wei-Lun Chang (2024)	The data collected from the experiment provided insights into students' attitudes toward fake news, which can inform the development of future games and educational experiments aimed at enhancing critical thinking and resilience against misinformation.
Mahmood H. Hussein (2019)	The educational computer game Ecoship Endeavour significantly improved the critical thinking skills of fifth-grade students who participated in the experimental group, indicating the effectiveness of the digital game-based learning (DGBL) approach in fostering critical thinking in elementary science education.

Impact of Multiplayer Online Educational Games on Critical Thinking Skills

Multiplayer online educational games have been shown to impact the development of critical thinking skills among students significantly. These games provide dynamic and interactive environments that encourage learners to engage in problem-solving, decision-making, and collaborative learning, all essential components of critical thinking. The integration of gamified elements and digital simulations in educational settings has been found to enhance students' ability to analyze, evaluate, and create solutions to complex problems. Below are essential aspects of how multiplayer online educational games influence critical thinking skills:

- Digital Game-Based Learning: Digital games, such as simulation games, have significantly contributed to developing critical thinking skills compared to traditional teaching methods. These games provide a platform for students to engage in interdisciplinary learning, which enhances their ability to think critically about various subjects.
- Gamified Mobile Learning: Gamified mobile learning environments offer engaging challenges and decision-making scenarios that promote critical thinking. These

environments leverage the motivational power of games to inspire learners to think critically and solve problems, providing meaningful learning experiences that encourage active engagement and reflection.

- Game-Assisted Problem-Based Learning (PBL): Game-assisted PBL has improved students' critical thinking skills and learning motivation. This approach involves using games to facilitate problem-solving and critical thinking processes, equipping students with the skills to tackle complex problems.
- Collaborative Learning: Game-based collaborative learning enhances critical thinking by allowing learners to share diverse perspectives and approaches to problem-solving. Collaborative learning conditions have been found to lead to significant differences in critical thinking levels, suggesting that learning in pairs or groups can result in positive intellectual outcomes.

Student Ability on Critical Thinking Skills.

Students' critical thinking abilities are crucial for academic success and practical problem-solving in real-world situations. Critical thinking skills enable students to analyze, evaluate, and synthesize information, equipping them to approach challenges logically and open-mindedly (Kumar, 2024). However, fostering these skills requires structured learning environments encouraging inquiry, reflection, and active engagement with complex ideas. Many students exhibit basic critical thinking skills, such as recalling facts and making straightforward inferences (Safitri, 2024). However, developing higher-order thinking skills, such as analyzing relationships between concepts, evaluating evidence, and making reasoned judgments, often require more interactive, problem-based learning approaches. Multiplayer educational games (MMOEG) provide such environments, allowing students to engage actively with tasks that require critical analysis and decision-making. Through gameplay, students practice reasoning, adaptability, and perspective-taking, which are fundamental to developing advanced critical thinking abilities (As'ari, 2023). In addition, collaborative tasks within MMOEG allow students to gain confidence in their reasoning abilities by learning to justify their decisions and consider alternative viewpoints. This interactive and social element of MMOEG nurtures both cognitive and social dimensions of critical thinking, helping students build resilience, independence, and adaptability in their problem-solving approaches (Iwan, 2023). Ultimately, providing students with opportunities to exercise these skills within structured, interactive settings enhances their ability to think critically and prepares them for complex academic and life challenges.

CONCLUSION

Fundamental Finding: This study highlights the significant role of multiplayer online educational games (MMOEG) in enhancing students' critical thinking skills. Through interactive, problem-based scenarios, MMOEG creates engaging learning environments that foster students' analytical and evaluative abilities. The systematic review supports the thesis that these games promote cognitive development and equip students with essential skills for academic success and real-world problem-solving. **Implication:** The findings underscore the potential of MMOEG to address 21st-century educational needs by providing tools for developing critical thinking skills in diverse subjects and settings. As educational institutions increasingly incorporate digital technologies, MMOEG offers a powerful medium to cultivate independent thinking and teamwork, preparing students for complex challenges beyond the classroom. **Limitation:** While this review

confirms a positive association between MMOEG and critical thinking, the variability in game design, educational contexts, and assessment methods presents a limitation. Future research should work towards standardizing these aspects to improve the comparability and validity of results. **Future Research:** Further research is encouraged to explore the long-term effects of MMOEG on critical thinking across varied age groups and subjects. Additionally, investigating optimal game designs and assessment tools will help refine educational game-based strategies, ensuring an even more significant educational impact on critical thinking development.

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