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## EDITED BY

Pedro Román-Graván,  
University of Seville, Spain

## REVIEWED BY

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University of the West of Scotland,  
United Kingdom  
Jesús Valverde-Berrocoso,  
University of Extremadura, Spain

## \*CORRESPONDENCE

Mirian Checa-Romero  
✉ m.checa@uah.es

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# Video games and metacognition in the classroom for the development of 21st century skills: a systematic review

Mirian Checa-Romero\* and José Miguel Gimenez-Lozano

Department of Educational Sciences, Area of Developmental and Educational Psychology, University of Alcalá, Alcalá de Henares, Spain

**Introduction:** Game-based learning is a methodology that has gained importance in the world of education due to the benefits of implementing ICT in the classroom. Due to the intellectual and competence demands that some commercial video games promote, they can be very valuable tools to stimulate and promote metacognitive abilities in students. Therefore, this paper aimed to analyze the use of commercial video games in educational contexts and their impact on the development of metacognitive skills.

**Methods:** For the analysis of the study, a systematic review of the literature was carried out following the PRISMA statement. Specialized databases such as Scopus, WoS, PsylInfo, PubMed, SciELO, and Eric were consulted, which helped capture the essence of the problem between 2004 and 2024.

**Results:** The review was then carried out on 10 selected articles. The results obtained show the following evidence: (a) commercial video games, together with the use of metacognitive strategies, enrich academic and social aspects as well as the metacognitive level, and (b) commercial video games are as effective in promoting metacognition as other more traditional methodologies or tools.

**Discussion:** Finally, there is a need to rethink the implications of the use of video games in the classroom if we want students to acquire skills that will be essential to successfully respond to the demands and challenges of their academic and professional future.

## KEYWORDS

commercial video games, 21st century skills, metacognition, systematic review, education

## Introduction

### Play and its cultural and educational impact

Play is essential to understanding what it means to be human. It has always been a fundamental part of life, present in every culture and situation. Through play, people have learned important life skills, and it has shaped the identity of each society while continuously contributing to the development of culture (Andrade, 2020; Delgado, 2011; Montero, 2017). In education, the role of games in the classroom is changing, largely due to advancements in information and communication technologies (ICT) and the need to improve learning processes. To address these changes, methods such as game-based learning (GBL) have emerged, integrating video games into educational settings to meet specific learning goals (Pegalajar Palomino, 2021; Torres et al., 2019). GBL uses video games as powerful tools to

create engaging and innovative learning environments, especially as they are often the first digital technology that children access directly (Gee, 2007; Levis, 2013; Tokarieva et al., 2019) and are highly popular among this age group (Kahila et al., 2020).

Among the different types of video games, commercial games are the most commonly used by children and young people. They have several advantages over educational games, including being developed independently of specific educational goals, being easy to access, not requiring programming skills, allowing learning to happen outside the classroom, and being widely appealing due to their entertainment value (Connolly et al., 2012; Gee, 2011; Kahila et al., 2023). Beyond their ability to create engaging and innovative learning environments, commercial video games also have great potential to develop metacognitive skills. Metacognition—defined as the ability to reflect on, regulate, and plan one's own thinking processes (Flavell, 1979)—is essential for independent and effective learning. These games present complex and dynamic scenarios where players must constantly evaluate their choices, plan strategies, and adapt to new challenges. This continuous process helps build key metacognitive skills, such as self-monitoring and flexible thinking (Schrader et al., 2020). Moreover, commercial video games are often the first type of digital technology that children interact with directly and personally (Gee, 2007; Levis, 2013; Tokarieva et al., 2019). Their widespread popularity among young users makes them an excellent tool for promoting autonomous, self-regulated learning—both essential 21st-century skills (Kahila et al., 2020). By encouraging players to reflect on their thinking during gameplay and adjust their strategies, these games play a key role in developing metacognitive abilities.

In this context, digital and playful environments have great potential to cultivate key 21st-century skills, as highlighted by recent scientific literature (Kickmeier-Rust and Albert, 2012; Sourmelis et al., 2017; Erstad and Voogt, 2018; Erstad et al., 2021; Zimmerman, 2008). Beyond fostering creativity, motivation, and social skills (Ames and Burrell, 2017; Hall et al., 2020; Sánchez-Rodríguez et al., 2010; Diaz-López et al., 2023), these digital environments play a pivotal role in enhancing metacognition. Studies show that engaging with video games helps players build cognitive flexibility, self-monitoring, and strategic thinking, all of which are core components of metacognitive growth (Ouellette, 2019; Squire, 2011; Taub et al., 2018; Yoon and Baek, 2018; Teng, 2024; Mitsea et al., 2024). Mastering digital literacy demands the development of sophisticated cognitive skills (Henderson, 2005; Weber and Greiff, 2023). Video games are particularly powerful tools in this regard because they provide dynamic scenarios where players must regulate their thought processes to succeed. This makes the field of metacognitive research, especially relevant, as it allows us to examine how players develop metacognitive strategies, such as planning, evaluating, and adjusting their actions to achieve in-game objectives (Bullard, 2013; Carter, 2015; Donaldson, 2017; Chatzivasileiou and Drigas, 2022; Pillay et al., 1999; Mayor et al., 1993).

## The role of video games in developing metacognitive skills

Metacognition refers to the knowledge and control individuals have over their cognitive and behavioral processes (Flavell, 1979; Ford

et al., 1998; Hughes et al., 2013; Fleming, 2024). It can be divided into two key dimensions: metacognitive knowledge and metacognitive control. Metacognitive knowledge includes three components: (1) declarative knowledge—what one knows about their cognitive abilities and strategies, (2) procedural knowledge—how to apply these strategies, and (3) conditional knowledge—when and why specific strategies should be used (Baker and Brown, 1984; Efklides, 2008; Pérez and González, 2020). Metacognitive control, on the other hand, involves three processes: (1) planning, which occurs before starting a task and involves setting goals and selecting strategies, (2) monitoring, which entails tracking progress and adjusting strategies while performing the task, and (3) evaluation, where the effectiveness of strategies is assessed after the task is completed.

Metacognitive development also encompasses behavioral aspects, including emotional and social factors. Flavell (1979) recognized the role of affect in metacognitive processes, proposing that individuals can develop their cognitive skills autonomously by exercising control over their mental states and processes. This highlights the critical role of self-awareness and self-regulation in metacognition. Metacognition has been defined as an individual's ability to actively monitor, regulate, and organize cognitive processes to achieve specific goals (García Madruga et al., 2002). Within this framework, two essential concepts emerge: (1) knowledge of one's cognitive system, which is divided into awareness of one's abilities (person), understanding task objectives and complexity (task), and identifying the necessary strategies to succeed (strategies) (Gandini, 2018); and (2) metacognitive control, which focuses on the actions needed to complete a task effectively. Moreover, Brown (1978) introduced the concept of conditional knowledge, emphasizing its importance in recognizing the optimal conditions for applying strategies. For example, understanding when and why to use specific study techniques when preparing for an examination enhances strategic learning. This integration of knowledge and regulation underscores the central role of metacognition in fostering independent, effective learning.

Recent research underscores the importance of how cognitive processes interact with specific tasks, which often evoke emotions such as familiarity, confidence, and satisfaction (Pérez and González, 2020; Fernández Velasco and Loev, 2024). In this context, metacognitive models currently integrate emotional self-regulation alongside knowledge and cognitive control. Emotional self-regulation involves managing affective factors during planning, monitoring, and evaluation processes (Efklides, 2009; Pintrich et al., 2000; Zimmerman, 2000; Zhu et al., 2024). In particular, ineffective regulation of emotions can contribute to cognitive-attentional syndrome (CAS), a condition where maladaptive patterns, such as persistent negative thoughts and avoidance of positive ones, dominate mental processes, potentially leading to psychological disorders such as anxiety and depression (Wells, 2009). Research suggests that metacognitive beliefs about uncontrollability and perceived danger are central indicators of these conditions (Cano-López et al., 2022).

In this sense, play is a powerful tool for developing metacognitive skills. It involves rules, objectives, feedback, problem-solving, competition, and challenges—all of which require players to engage in cognitive processes such as planning, monitoring, and adjusting strategies. These activities activate critical cognitive functions, including working memory, attention, processing speed, and abstract reasoning (Wilson et al., 2023). Video games, as a form of play, further amplify these metacognitive processes by providing immersive, interactive environments that encourage learners to apply their knowledge in enjoyable and

Abbreviations: RPG, Role-playing game.

meaningful ways (Valencia-Molina et al., 2017). The bidirectional relationship between play and metacognition means that each gaming experience strengthens learner's ability to regulate and reflect on their cognitive processes. In the social dimension, metacognition has traditionally focused on individual self-awareness (Hadwin and Järvellä, 2011; Pérez and González, 2020). However, studies show that collaboration within peer groups enhances the metacognitive processes of planning, monitoring, and evaluating knowledge (McCaslin and Hickey, 2001; Schunk, 2001; Zimmerman, 2000; Sun et al., 2022). Group interactions provide opportunities for learners to develop a shared understanding, refine strategies, and co-regulate their learning, thereby strengthening both individual and collective metacognitive skills.

## Research on commercial video games and metacognitive processes in education

The implementation of tools such as video games can effectively target and enhance the previously mentioned metacognitive factors. From a sociocultural perspective on development (Gauvain, 2020; Hu and Luo, 2024), metacognitive processes related to knowledge (e.g., what do I know and how do I know it) and control (the regulation of what I know) can be enhanced, as the use of video games necessitates ongoing digital literacy (Henderson, 2005). Moreover, factors such as interest, satisfaction, engagement (Bond et al., 2020), and perceived difficulty play a crucial role in shaping learning experiences. Interest drives curiosity and sustained attention, satisfaction reinforces motivation and a sense of achievement, and engagement ensures active participation and immersion in the activity. However, perceived difficulty can influence the learner's emotional state—moderate difficulty may encourage persistence, whereas excessive difficulty might induce anxiety, thereby hindering metacognitive processes (Misak, 2018; Moncarz, 2011; Monem, 2015; Naeimi and Rafezi, 2023).

Among other benefits, such as fostering emotional awareness and promoting reflective thinking, this approach would enhance students' ability to recognize their emotional states, enabling them to more effectively address behavioral aspects in the classroom and guiding them toward improved emotional self-regulation (Broadbent and Poon, 2015). Additionally, video games possess an interactive capability that promotes coordination among students when collaborating to achieve a common goal (Vlachopoulos and Makri, 2017). Research on video games for educational purposes or "serious games" and metacognition has covered various aspects, with the most notable focusing on motivation and feedback (Kapp et al., 2019; Zumbach et al., 2020; Singh and Muis, 2024), robotics, design, and collaborative learning (Yoon and Baek, 2018; Li et al., 2024), scientific reasoning and self-regulated learning (Taub et al., 2018; Dörrenbächer-Ulrich et al., 2024), or English language acquisition (Mahayanti et al., 2020; Tan et al., 2022; Zhang, 2024).

However, the application of commercial video games in the classroom to enhance metacognitive processes remains insufficiently explored in the scientific literature. Limited research has examined the presence of dynamic stimuli within these multimodal, interactive, and multisensory tools, which can promote both self-scaffolding and metacognitive awareness (Monem, 2015), as well as support self-regulation, planning, and continuous monitoring of one's actions (Lickteig, 2020). Therefore, it seems necessary to deepen our

understanding of the current state of research, and a systematic review of the existing literature would be a good approach.

The general objective of this study was to analyze the role of video games in fostering metacognitive skills within classroom settings and their contribution to the development of essential 21st-century skills, such as critical thinking, problem-solving, and self-regulated learning, through a comprehensive review of existing literature and evidence-based practices. This general objective is specified in two specific objectives: (1) to analyze the use of commercial video games in education and how they stimulate metacognition and (2) to explore whether commercial video games are capable of fostering metacognitive abilities in the same way as other more traditional tools or methodologies. To answer these objectives, the following research question has been posed: (1) What impact do commercial video games have on metacognitive skills?

## Methodology

To achieve the research objectives and provide answers to the questions formulated, a systematic review of the literature was carried out (Medina et al., 2020; Páramo, 2020; Sánchez-Meca, 2010). This review is proposed with the purpose of analyzing and specifying those studies that analyze the inclusion of commercial video games in the classroom and their impact on metacognitive skills and competencies necessary for the citizens of the 21st century (Prendes Espinosa et al., 2017).

## Protocol and record-keeping

A series of guidelines and guidelines proposed by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology (Liberati et al., 2009; Page et al., 2020) for scientific systematic reviews were established, as well as some of the definitions and elements recommended by the Cochrane Collaboration (Urrútia and Bonfill, 2010), in order to carry out methodical planning (Hutton et al., 2015).

## Procedure

The literature search completed during the months of June and July 2024, consulted the following electronic databases: *Scopus*®, *Web of Science*®, *PsycInfo*®, *PubMed*®, *Scielo*®, and *Eric*®. In addition, the different thesauruses provided by the different databases were considered, which helped broaden the search and better synthesize the results. The search for published scientific articles began in 2004 and ended in May 2024, with the purpose of extracting as many documents as possible on the research problem addressed.

## Search strategy

To optimize the search and target the selection more specifically, a series of inclusion and exclusion criteria were used (Table 1). Some of these filters were provided by the databases themselves (article, year of publication, book, conference proceedings, press, or language), and others were proposed to narrow down the overview of the study as

TABLE 1 Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
a. Review articles b. Completed doctoral theses	a. Conference proceedings, books, and press. b. Other areas
c. Publications from 2004 to 2024	c. Theoretical studies or narrative reviews.
d. Language: English or Spanish	d. Languages other than English or Spanish.
e. The sample is composed of students: kindergarten, elementary school, middle school, high school, and university.	e. The sample is composed of non-student participants: adults, professional video game players, senior citizens, etc.
f. Video games must be either casual or commercial.	f. The video games are formal and educational, developed for the study itself, or belong to the classification of “serious games.”
g. Studies that focus on the subject of the research or object of analysis: education, metacognition, and video games.	g. Studies that do not focus on the analysis of the variables presented in the research.
h. Studies with qualitative, quantitative, or mixed methodology.	

much as possible (methodology, sample, subject matter, and duplicate articles).

## Study selection

As a result of applying these search strategies, a total of 545 articles were obtained from the different databases mentioned above. As can be seen in Figure 1, all these articles went through different vetting phases, eliminating any article that was affected by the exclusion criteria and admitting those that matched the inclusion criteria and the research topic (Table 1). Articles addressing aspects of metacognition, the use of digital educational games, or variations of analytics based on a learning or cognitive framework were collected. To define the target population, labels indicating the intended medium (e.g., educational video games) were applied. The outcome section was defined by keywords aimed at capturing the overarching cognitive and learning focus of this review (e.g., cognition and learning). Finally, the comparison component, which involves directly contrasting the effectiveness of commercial video games with traditional educational tools or methodologies, could not be included in this review because no specific empirical procedures, such as experimental or control group setups, had been pre-established; instead, this component served as a focal point of interest for the review. In order to simplify the search in each of the databases consulted, the following keywords and Boolean operators were used to obtain as many articles as possible, as well as to narrow the search in order and structure: (“videogame” or “game” or “digital games”) and (“metacognition” or “metacognitive” or “metagame”).

The final result of the whole process produced a total of 19 items for detailed review and analysis.

## Data analysis

A database was generated to record and systematize the following information of the selected articles: title of the study, author/s, year and place of publication, study sample, objectives, methodology, design and data collection instruments, and results of the study, thus following the PICoS strategy (Pertegal-Vega et al., 2019) through Rayyan Intelligent Systematic Review© software. We then used

Review Manager 5.4© software to examine, code, and categorize in detail the most relevant information units of the final sample selected.

## Evaluation of methodological quality

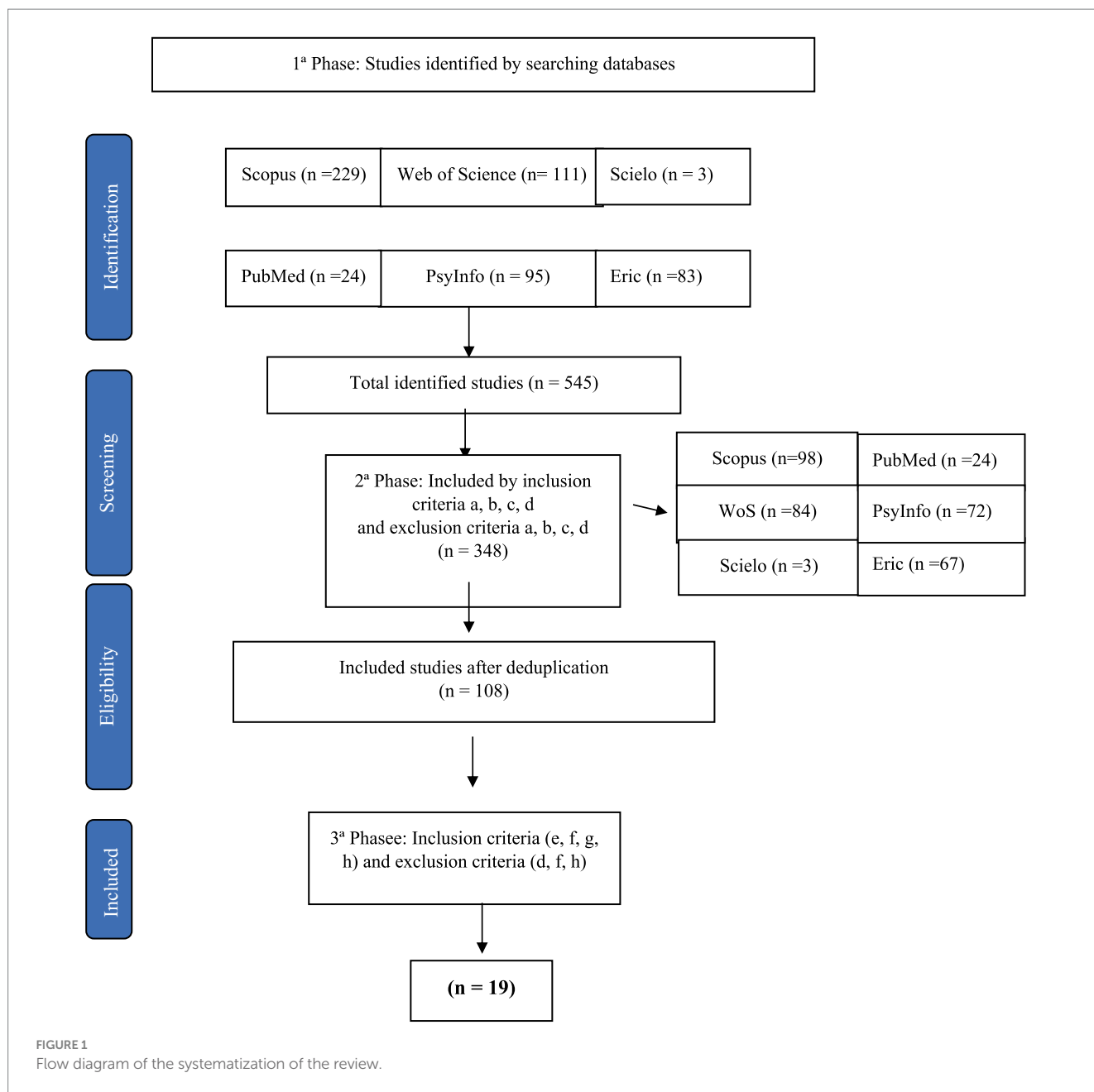
Independently selected articles ( $n = 348$ ) were evaluated in the eligibility phase through Rayyan Intelligent Systematic Review© software. In situations of disagreement, the judgment of a third person from the research team was requested. For the methodological review of the studies, the articles were evaluated based on satisfactory compliance with the criteria indicated.

## Results

### Publications

In addressing the research problem and adhering to the proposed eligibility criteria, the final sample size ( $n = 19$ ) demonstrates that the use of commercial video games as a tool to develop metacognitive skills in the classroom remains a relatively unexplored area in the scientific literature. However, this limited number of studies should not be interpreted as a lack of relevance or interest in the subject. On the contrary, the emerging data suggest a growing awareness of the potential that these digital tools hold in educational contexts. As illustrated in Figure 2, the number of articles published on the topic has grown exponentially in recent years ( $n = 348$ ). This trend underscores an increasing recognition of the critical role video games may play in fostering metacognitive processes. Although the existing literature is still in its infancy, the surge in academic publications signals a shift toward exploring how video games can serve not only as entertainment but as powerful vehicles for developing essential 21st-century skills, such as critical thinking, problem-solving, and self-regulated learning.

The significance of this study lies precisely in the current gap within literature. The intersection of metacognition and video games is an innovative area with untapped potential, where empirical evidence is gradually emerging but remains insufficient to fully understand the depth and scope of this relationship. This underrepresentation in the scientific discourse highlights the necessity for further research and



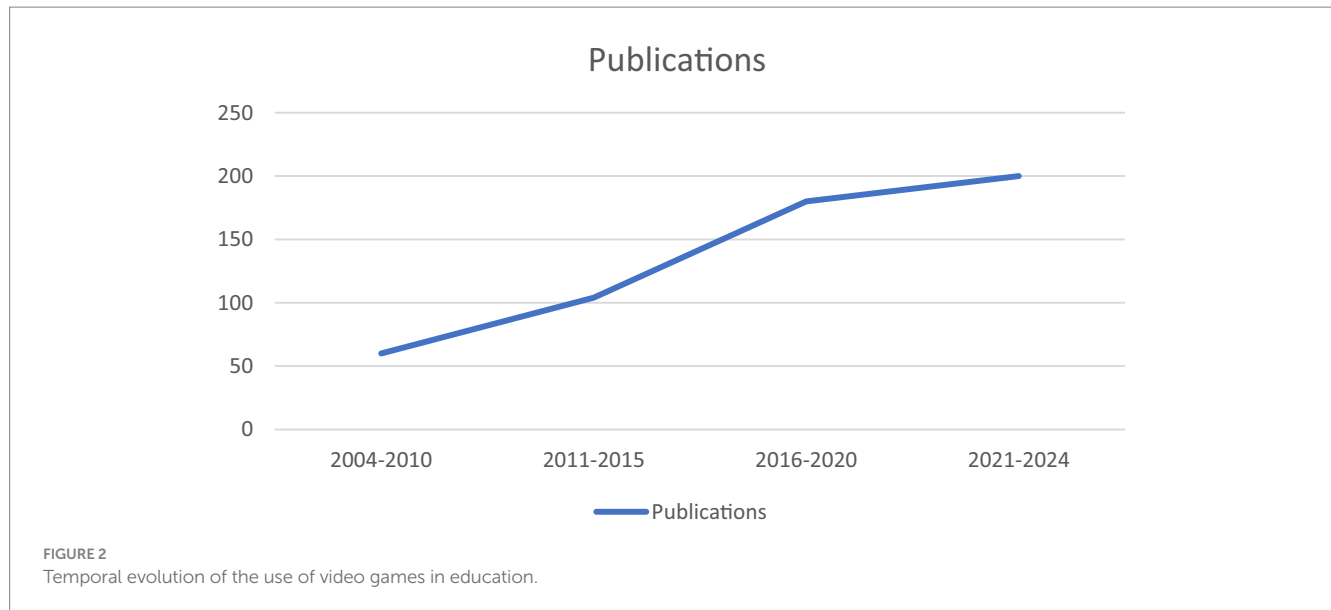
makes this study particularly relevant. By contributing to this nascent field, the present research sheds light on how commercial video games can be harnessed to promote metacognitive skills, thereby enriching both educational theory and practice. Moreover, the growing body of work emphasizes that the use of commercial video games goes beyond mere engagement. It intersects with cognitive and emotional dimensions, providing students with opportunities to practice planning, monitoring, and evaluating their learning processes in real time. Therefore, the importance of continuing to explore this relationship cannot be overstated, as it holds the potential to transform traditional educational methodologies and foster more holistic learning experiences.

Specifically, with regard to the systematic and individual analysis of each of the articles that form the basis of this study, the most important aspects are analyzed in detail below, in accordance with the inclusion criteria of the study: objectives, research design, instruments used, main results and conclusions, limitations, and practical applications in

the educational setting. The process of obtaining the sample was carried out by generating a database to record and systematize the most relevant information contained in the selected articles (Table 2).

### Sample characteristics

The studies reviewed encompass a wide range of sample sizes, ages, and designs, reflecting the diversity of research on metacognition and cognitive skills in video game contexts. Sample sizes varied significantly, from single-case studies such as Monem (2015), who observed a 16-year-old player’s self-scaffolding in an MMORPG, to large-scale studies such as Hardy et al. (2015), with 4,715 participants exploring the impact of cognitive training versus crossword puzzles on neuropsychological performance. Most studies targeted adolescents and young adults, with average ages often ranging from 10 to 20 years,



including a notable sample of 285 university students in [Shaw \(2022\)](#) who used *Minecraft* to examine cognitive predictors of creativity. Only a few studies focused on children, such as [Harris et al. \(2008\)](#), who analyzed goal-oriented problem-solving in a sample of 48 nine-year-olds, and [Ricker and Richert \(2021\)](#), who assessed metacognitive awareness in 103 children averaging 8 years of age. Additionally, [Valentine and Jensen \(2021\)](#) used a phenomenological approach with 30 *Pokémon Go* players over a period of 4 to 12 months, examining how augmented reality plays influences social and cultural interactions.

Across these studies, research designs varied from qualitative approaches, such as [Luang-Ng et al. \(2022\)](#), observing vocabulary learning in four MMORPG players, to experimental and quasi-experimental designs, exemplified by [Tangkui and Keong \(2023\)](#) with a sample of five students learning fractions using *Minecraft*. Mixed-methods designs were also prevalent, enabling researchers to capture both quantitative and qualitative aspects of gameplay. Certain studies, like [Wilson et al. \(2022\)](#) with *The Sims 4*, used pre-test/post-test evaluations to assess changes in vocabulary and metacognitive awareness among 65 students. In contrast, some studies focused on specific cognitive assessments, such as [Imanian et al. \(2024\)](#), which evaluated attention, working memory, and cognitive flexibility in 40 participants through *FIFA*, noting differences between single-player and cooperative play modes. This diverse array of samples and methodologies highlights the breadth of current research exploring how video games impact metacognitive and cognitive skills across varied populations and gaming environments.

## Research design and methodology overview

Regarding the aim of the studies, one of these is to use metacognitive strategies and commercial video games as a support to improve relevant educational aspects, such as academic performance, social problem-solving, narrative skills, or motivation ([Valentine and Jensen, 2021](#); [Shaw, 2022](#); [García Martínez, 2014](#); [Kim et al., 2009](#)). Other studies establish correlations between the metacognitive

construct, the difficulty of video game practice, and participants' mental ability ([Tangkui and Keong, 2023](#); [Hardy et al., 2015](#); [Hughes et al., 2013](#)) or analyze the process students use to achieve an educational goal with respect to their level of metacognitive awareness and regulation ([Piédalúe, 2022](#); [Lickteig, 2020](#); [Michael et al., 2012](#); [Harris et al., 2008](#)). In terms of research design, the sample of studies used both qualitative and quantitative methodology, as well as mixed methodology designs, with no clear predominance, as can be seen in [Figure 3](#).

Quantitative designs also played a central role, with many studies implementing pre-test/post-test structures to assess the impact of video games on cognitive and metacognitive abilities. [Wilson et al. \(2022\)](#) used such a design to measure the effects of *The Sims 4* on vocabulary acquisition and metacognitive awareness in an undergraduate sample. In another quantitative approach, [Piédalúe \(2022\)](#) employed a questionnaire and observational measures to analyze executive functioning in children with ADHD using *Minecraft*. Mixed-methods designs, such as the quasi-experimental structure by [Tangkui and Keong \(2023\)](#), allowed for a comprehensive comparison of traditional teaching methods with video game-based learning in a small sample of Year 5 students. Additionally, [Hardy et al. \(2015\)](#) utilized a randomized control design to compare cognitive training in the *Lumosity* program with a crossword puzzle control group, examining neuropsychological outcomes across a large sample of over 4,000 participants. This methodological diversity highlights the adaptable nature of video game research in capturing complex cognitive and metacognitive phenomena across varied contexts and participant groups.

The remaining studies aim to understand the metacognitive dimension. For instance, [Wilson et al. \(2023\)](#) found that using *The Sims 4: Get to Work* in a Business English course enhanced students' metacognitive skills—such as planning, monitoring, and evaluating—while also improving their use of Business English in practical, goal-oriented tasks; [Lickteig \(2020\)](#) defined the phenomenon known as *metagaming*, highlights how players leverage external information and strategies beyond the game itself to optimize their experience. A compelling example is the

TABLE 2 Selection of articles to be analyzed in the systematic review.

Article	Goal	Sample ( <i>n</i> =) Age ( <i>x</i> =)	Methodology	Video games	Metacognitive measures and instruments	Results
Harris et al. (2008)	Investigates the influence of mastery and performance goals on the nature of children's collaborative participation while playing a problem-solving computer game with a peer.	<i>n</i> = 48 <i>x</i> = 9	Qualitative research. Two groups: 1) Strong personal goal preferences ( <i>n</i> = 14). 2) No consistent bias for either mastery or performance goals ( <i>n</i> = 34).	Logical Journey of the Zoombinis	1) Level of argument 2) Metacognitive awareness 3) Metacognitive regulation 4) Metacognitive control 5) Brief response	Children who were assigned mastery goals engaged in significantly more elaborated problem-solving discussion while children who were assigned performance goals engaged in more executive help-seeking and displayed lower levels of metacognitive control.
Kim et al. (2009)	Explore the effects of the metacognitive strategies (self-recording, modeling, and thinking aloud) on academic and gaming achievements and the effects of those achievements on social problem-solving.	<i>n</i> = 132 <i>x</i> = 15.50	Pre-test/post-test evaluation, between 10 weeks playing 45 min per day	Gersang	1) Economy concepts: <i>Gersang</i> 2) Metacognitive strategies 3) Social problem-solving abilities: <i>social problem-solving inventory—revised (SPSI-R)</i> by D'Zurilla et al. (2002). 4) Academic achievement: <i>by the Incheon Metropolitan Office of Education</i> . 5) Game Ability: <i>measured by the game's level scores</i>	Thinking aloud strategy is the most influential variable in social problem-solving ability. The least influential variable is 'self-recording', where students record their play activities during breaks.
Michael et al. (2012)	Investigates how the difficulty of learner-controlled practice influences the training of a complex task, focusing on cognitive and motivational mechanisms.	<i>n</i> = 112 <i>x</i> = 21.50	Three framing conditions: 1) Positive error framing 2) Negative error framing 3) No error framing	Unreal Tournament 2004	1) Self-efficacy: <i>12-item self-report (Bell and Kozlowski, 2002)</i> . 2) Metacognition: <i>Eleven items adapted from Ford et al. (1998)</i> . 3) Self-evaluation: self-report 4) General Mental Ability (GMA): <i>Raven Advanced Progressive Matrices (APM) (Raven et al., 1998)</i> . 5) Videogame experience: <i>Two items were used to measure participants prior videogame experience</i> . 6) Task knowledge: <i>16-item multiple-choice test</i> .	GMA was directly related to learner-controlled practice difficulty even after controlling for its effects on pre-training skills. A positive relationship between pre-training self-efficacy and learner-controlled practice difficulty. Positive but not negative error framing during training was directly related to learner-controlled practice difficulty. This study has demonstrated that error-framing interventions can be used in the context of complex tasks.

(Continued)

TABLE 2 (Continued)

Article	Goal	Sample ( <i>n</i> =) Age ( <i>x</i> =)	Methodology	Video games	Metacognitive measures and instruments	Results
Monem (2015)	Analyses how an adolescent uses metacognition and self-scaffolding while playing an MMORPG. It focuses on the strategies he employ to overcome challenges and improve his performance in the game.	<i>n</i> = 1 <i>x</i> = 16	Observational case study approach Observed 120 min, divided into four 30-min sessions	Massively Multiplayer Online Role-Playing Game (MMORPG)	1) Self-scaffolding of directions 2) Stating existing self-knowledge 3) Questioning self-knowledge <ul style="list-style-type: none"> <li>• External audit</li> <li>• Reflective journaling</li> <li>• Triangulation of data sources</li> <li>• Member checking</li> </ul>	Self-scaffolding strategies include repeating missions to master specific skills, collaborating with other players to gain knowledge, and using online resources such as forums and guides. The player employs self-scaffolding techniques to facilitate his or her own learning and progression in the game. This includes breaking down complex tasks into more manageable parts, seeking additional information, and practicing specific skills.
Li et al. (2015)	Develop and validate an online tool designed to assess individuals' metacognitive planning abilities.	Two studies 1) <i>n</i> = 71 <i>x</i> = 20 2) <i>n</i> = 440 <i>x</i> = ?	First study: Proposed as a phase of the instrument development study. Second Study: Scale Validation	Sokoban	First study: 1) metacognitive planning a) absolute planning time b) ratio between planning time and total time. Second study: 1) Time Ratio: <i>Tower of London (ToL)</i> , <i>intelligence test</i> , and <i>academic achievement</i> .	The results showed that valid inference could be made from the time ratio score. After controlling for demographic variables, intelligence, and motivation, the time ratio score still accounted for a significant proportion of the variance in Sokoban's performance. The time ratio score was also found to increase with age.
Hardy et al. (2011)	The study evaluated an online cognitive training program comprised of 49 exercises targeting a variety of cognitive capacities. The cognitive training program was compared to an active control condition in which participants completed crossword puzzles.	<i>n</i> = 4.715 <i>x</i> = 39.0	Two groups: 1) Crossword puzzles control 15 min per session. Instructed to complete as many crossword puzzles as possible. ( <i>n</i> = 2.048). 2) Cognitive training treatment. Trained in Lumosity Program where they should resolve 49 cognitive tasks ( <i>n</i> = 2.667).		Neuropsychological assessment battery 1) Forward 2) Reverse memory 3) Grammatical reasoning was based on Baddeley's grammatical reasoning test 4) Progressive matrices 5) Go/No-Go was designed to assess response inhibition and processing speed 6) Arithmetic reasoning was designed to assess numerical problem-solving ability 7) Two-target search was created for the purposes of the study	Participants randomly assigned to the treatment group improved significantly more on the primary outcome measure, an aggregate measure of neuropsychological performance, than did the active control group. Treatment participants showed greater improvements than controls on speed of processing, short-term memory, working memory, problem-solving, and fluid reasoning assessments.

(Continued)



TABLE 2 (Continued)

Article	Goal	Sample ( <i>n</i> =) Age ( <i>x</i> =)	Methodology	Video games	Metacognitive measures and instruments	Results
Lickteig (2020)	Explore how learning occurs during iterative experiences within a game-based environment, using constructivist learning theories as a basis.	<i>n</i> = 8 <i>x</i> = 15	Qualitative research; 6-week program.	Magic: The Gathering	1. Mechanical metagame. 2. Social metagame. 3. Reflective Journaling.	Participants showed a high incorporation and practice of skills through different forms of engagement with the game. Learning related to direct interaction with game systems, mechanics and processes, where players analyze and synthesize complex systems to inform their future play.
Ricker and Richert (2021)	Two studies 1. Examine the different types of digital games to which children are exposed to assess the opportunities for metacognitive experience that they provide. 2. investigate whether exposure to these different games is differentially associated with children's metacognitive awareness	<i>n</i> = 103 <i>x</i> = 8	Qualitative research. The study examined 15 interactive games to assess their levels of adaptability.	Wii Sports FIFA Sims Virtual-Families Angry-birds Super-Mario Lego-City Just-Dance Farmville Tetris Candy-Crush Bubble-Shooter Mario-Kart 64 Cars-Racers	1) Interactive Gaming Exposure. 2) Metacognitive Awareness: Metacognitive Awareness Inventory ( <i>Jr. MAI</i> ; Spierling et al., 2002).	The study suggests that assessing adaptability, player control, and feedback in interactive games can provide a deeper understanding of the metacognitive opportunities available to children during play.
Valentine and Jensen (2021)	Explores the embodied nature of play, specifically in the context of the location-aware augmented reality mobile game Pokémon Go.	<i>n</i> = 30 <i>x</i> =?	Phenomenological study. 4–12 months of program	Pokémon Go	1) Reflexive practice	Technology entanglements, detailing the simultaneous emergence of virtual and real spaces, variant modes of embodied mobility, the way players shaped physical spaces, and the emergence of human–technology relations. Community that emerged among Pokémon Go players, helping characterize embodiment as it permeates social and cultural aspects of play.

(Continued)

TABLE 2 (Continued)

Article	Goal	Sample ( <i>n</i> =) Age ( <i>x</i> =)	Methodology	Video games	Metacognitive measures and instruments	Results
Luang-Ng et al. (2022)	The study investigates the impact of Massively Multiplayer Online Role-Playing Game (MMORPG) on players' application of vocabulary learning strategies	<i>n</i> = 4 <i>x</i> = 23	Qualitative research. Video and audio recordings of the 12-h game-play sessions	Guild Wars 2	1) Vocabulary Learning: Semi-Structured Online Interviews.	Four factors that affect the vocabulary language learning experience of the players. 1) The role of game storylines in enhancing MMORPG gaming immersion. 2) Freedom to learn while being away from classroom-related rules. 3) Social interaction that enriches players' learning experience. 4) Role of collaboration among the MMORPG community in enriching learning experience.
Piédalue (2022)	Assess executive functioning difficulties in children diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) using task performance in the popular video game Minecraft.	<i>n</i> = 26 <i>x</i> = 10	Quantitative analysis	Minecraft	1) Questionnaire for the Parent/Legal Guardian: containing demographic questions about the child and few questions about ADHD. 2) Minecraft measures: Few factors were assessed, observing the time to solve and the steps needs to reach the end.	The ADS scores predicted two of the four measures. The distance walked measure and the chest time measure were predicted by ADS scores, whereas the construction measure and the distraction measure were not predicted by ADS scores.
Shaw (2022)	This study explored the predictive effects of cognitive abilities and Big Five personality traits on creativity and its two aspects in addition to the intercorrelations between creativity, novelty, and usefulness in a Minecraft building task	<i>n</i> = 285 <i>x</i> = 20	Quantitative analysis	Minecraft	1) SAT Total Scores: the standardized test of college students' academic/intellectual aptitude, one's SAT total score could serve as a suboptimal substitute for direct measurement of general intelligence (Frey, 2019). 2) International Personality Item Pool (IPIP; Goldberg et al., 2006) inventory was used for measuring the Big Five personality traits. 3) Alternate Uses Task (AUT; Guilford, 1967) Consensual Assessment Technique (CAT; Amabile, 1988, 1996), to asses Divergent Thinking Task. 4) Minecraft Task.	Minecraft creativity was predicted by divergent thinking SAT scores and openness to experience supporting the standing beliefs regarding individual antecedents of creativity. Personal characteristics had different predictive effects on the two components of creativity, in that novelty was predicted by divergent thinking SAT scores and openness to experience whereas usefulness was predicted by openness to experience. Intercorrelations among creativity and its two subdimensions, novelty and usefulness, were found to be highly correlated with each other and were also both highly related to creativity

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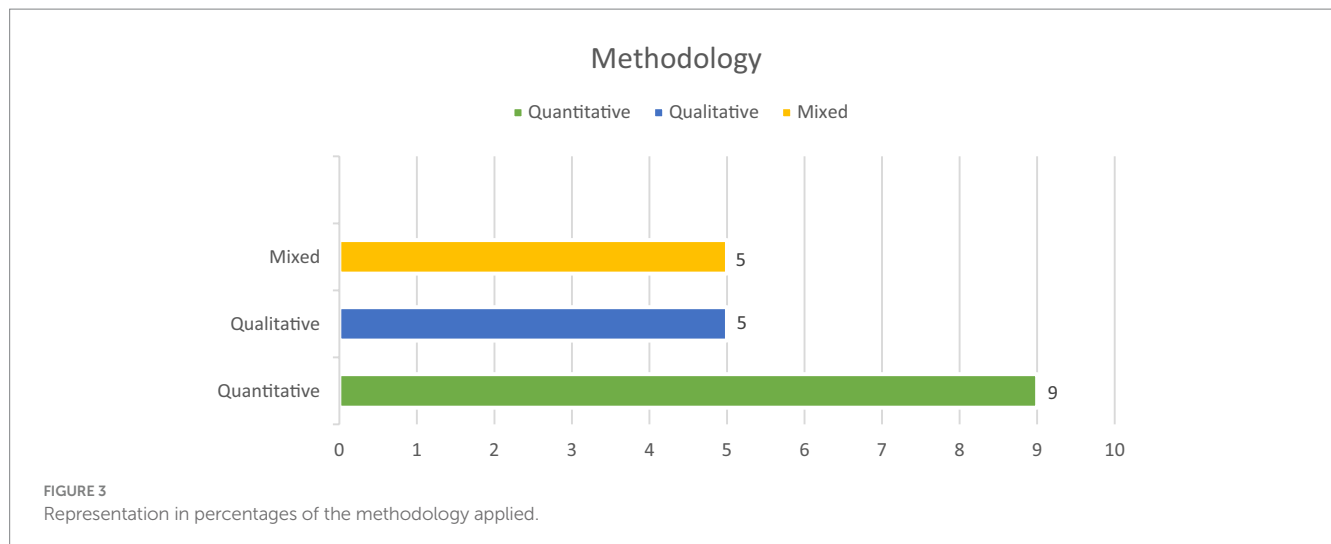
TABLE 2 (Continued)

Article	Goal	Sample ( <i>n</i> =) Age ( <i>x</i> =)	Methodology	Video games	Metacognitive measures and instruments	Results
Wilson et al. (2022)	To determine whether The Sims 4 has an effect on ESP undergraduates' acquisition of English vocabulary. To determine whether The Sims 4 has an effect on ESP undergraduates' metacognitive awareness.	<i>n</i> = 65 <i>x</i> = 14	Game-based learning program Pre-test and post-test evaluation Two groups, the experimental group had to survive and establish a business plan, and then a control group.	Sims 4	1) Metacognitive Awareness: Metacognitive Awareness Inventory (MAI) Schraw and Dennison (1994). 2) Language proficiency.	The experimental group has shown significant improvement in English vocabulary and greater metacognitive awareness from the instruments administered.
Tangkui and Keong (2023).	Analyze the effect of using Minecraft on Year 5 pupils' higher order thinking skills (HOTS) in fractional problem-solving.	<i>n</i> = 5 <i>x</i> = 65	Quasi-experimental design Two groups, the experimental group had to survive and establish a business plan, and then a control group	Minecraft	1) Higher order thinking skills (HOTS) 2) Problem-solving abilities. Malaysian Year 5 Mathematics Curriculum and Assessment Standard Document and textbook.	Significant difference in the ability to solve fractional problems which requires the use of HOTS between pupils who were exposed to the teaching and learning of fractions using Minecraft and pupils who were exposed to the teaching and learning of fractions using conventional methods
Wilson et al. (2023)	Explores the learners' experiences with using the digital simulation video game to support their learning of Business English and develop their metacognition.	<i>n</i> = 25 <i>x</i> = ?	Qualitative case study Three phases 1) Phase 1, players need to establish a retail store including selecting the location of the retail store, hiring employees, selecting the sales percentage, and price markup for the items in the retail store. 2) Phase 2, players make decisions on the best marketing strategies and manage their employees. 3) Phase 3. Players were given tasks on handling business operation and expansion such as managing employee's attitude, performance of sales, and expansion of their business.	SIMS 4: Go to work	Knowledge of Cognition 1) Declarative Knowledge 2) Procedural Knowledge 3) Conditional Knowledge Regulation of cognition 1) Information management strategies and planning 2) Comprehension monitoring, debugging strategies, and evaluation	Findings revealed that learners displayed declarative knowledge, procedural knowledge, and conditional knowledge of metacognitive processes during the game play and indicated the ability to regulate their cognitive processes to achieve the business goals of the retail simulation game while using Business English

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TABLE 2 (Continued)

Article	Goal	Sample ( <i>n</i> =) Age ( <i>x</i> =)	Methodology	Video games	Metacognitive measures and instruments	Results
Von Gillern and Stuff (2023)	The study examines how 31 middle-school children conducted multimodal analyses of video games	<i>n</i> = 31 <i>x</i> = ?	Qualitative case study Over 4 consecutive days, students played video games for 30 min and then wrote reflections about the multimodal symbols within the game and how these symbols influenced their interpretation and decision-making processes during gameplay.	Minecraft Zoo Tycoon: Ultimate Animal Collection Lego Worlds	<ol style="list-style-type: none"> <li>1) Interpreting</li> <li>2) Decision-making</li> <li>3) Dynamic visuals</li> <li>4) Still images</li> <li>5) Audio</li> <li>6) Oral language</li> <li>7) Written language</li> <li>8) Abstract symbols</li> <li>9) Tactile experiences</li> </ol>	The study highlights the relationship between students' understanding of multimodal symbols and their decision-making during gameplay, contributing valuable insights to literacy research. The research found that students focused more on dynamic visuals and written language than on audio or tactile experiences, reflecting the salience of these modes in games.
Sobocinski et al. (2024)	The study examines the embodied ways in which learners monitor their cognition while learning about exponential functions in an immersive virtual reality (VR) based game, Pandemic by Prisms of Reality	<i>n</i> = 15 <i>x</i> = 29	The data were collected in a research laboratory infrastructure. The think-aloud protocol and participants' movement were captured via a video camera, which provided a bird's eye view	Pandemic by Prisms of Reality	<ol style="list-style-type: none"> <li>1) Think aloud data—qualitative coding: participant monitored their cognition, including task understanding, previous knowledge, task product, content understanding, or procedural knowledge</li> <li>2) Motion detection. To quantify the amount of movement of the participants, we conducted an optical flow analysis using FlowAnalyzer package</li> </ol>	Findings demonstrated a temporal interplay among cognitive load, metacognitive monitoring, and motion during VR-based learning. Specifically, cognitive load, indicated by the low- and high-frequency heart rate variability index, predicted instances of metacognitive monitoring, and monitoring predicted learners' motion while interacting with the VR environment.
Imanian et al. (2024)	Explore the effects of esports in the cognitive skills of attention, working memory, and cognitive skills among gamers	<i>n</i> = 40 <i>x</i> = 20	Quantitative analysis Two groups: 1) Single players ( <i>n</i> = 20) 2) Coplayers ( <i>n</i> = 20); 8 weeks.	FIFA	<ol style="list-style-type: none"> <li>1) Stroop Task (Stroop, 1935).</li> <li>2) N-Back Task (Overall, 1958).</li> <li>3) Wisconsin Card Test (Grant and Berg, 1948).</li> </ol>	The findings suggested that FIFA can improve attention and working memory in both single-player and co-player groups. However, cognitive flexibility was only improved for the co-player group.



introduction of patient-accessible online medical records, which function as a metacognitive extension of the game, transforming player interaction while enhancing self-regulation and strategic planning—skills essential not only in gameplay but also in real-world applications; in Monet’s study (2015), the focus was on how an adolescent male gamer in an MMORPG developed metacognitive skills, self-awareness, and a virtual identity, highlighting the use of self-scaffolding strategies within immersive digital environments. On the other hand, other studies validate an instrument in relation to metacognition and a video game (Imanian et al., 2024; Li et al., 2015). In the study by Imanian et al. (2024), the effects of esports on cognitive skills were analyzed with 40 undergraduate students. Participants played FIFA for 8 weeks, in either single-player or co-player mode. Results showed improvements in attention and working memory for both groups, while cognitive flexibility improved only in the co-player group. These findings suggest that esports can enhance cognitive skills with potential applications in learning and instruction. Finally, highly interactive digital games enhance metacognitive awareness in children aged 6–10 years, while less interactive games show no such effect. Game preferences do not vary by age or sex, highlighting differences in cognitive opportunities across game types (Ricker and Richert, 2021).

Within the quantitative studies, pre-test/post-test designs predominate (Shaw, 2022; Piédalue, 2022; Hardy et al., 2015; Harris et al., 2008; Hughes et al., 2013; Kim et al., 2009), using control and experimental (Wilson et al., 2022; Harris et al., 2008) or quasi-experimental groups (Tangkui and Keong, 2023).

In terms of qualitative studies, we find an observational case study (Monem, 2015), an action research study (Imanian et al., 2024; Wilson et al., 2023), and a study based on focus group interviews (Lickteig, 2020). The forms of qualitative data collection are audio (Luang-Ng et al., 2022), journals, or reflections (Von Gillern and Stufft, 2023). With respect to the target population of the different studies, it is noteworthy that the male university population occupies a large part of the total sample. The predominance of male university students in the sample aligns with the objective of the study because men are generally more engaged in commercial video games, particularly in highly interactive genres (Gisbert-Pérez et al., 2024).

## Analysis of video game types and genres used

The range of video games used across the studies reviewed reflects a diverse approach to examining the effects of different game types on metacognitive and cognitive skills. Popular sandbox and simulation games such as *Minecraft* and *The Sims 4* were frequently employed due to their open-ended structures, which encourage problem-solving, strategic planning, and cognitive flexibility. *Minecraft* was notably used in studies by Piédalue (2022), focusing on executive functioning in children with ADHD, and by Shaw (2022), examining the relationships between cognitive abilities, personality traits, and creativity. Similarly, *The Sims 4* was implemented by Wilson et al. (2022) and Wilson et al. (2023) to assess its effects on vocabulary acquisition, metacognitive awareness, and Business English learning, given its potential for simulating real-world scenarios that require both language skills and metacognitive regulation.

Other studies explored the impact of specific genres such as massively multiplayer online role-playing games (MMORPGs) and strategy games, as these genres are known for their emphasis on complex, multi-layered decision-making and social interactions. For example, *Guild Wars 2* was used by Luang-Ng et al. (2022) to study vocabulary acquisition, highlighting how MMORPGs foster social and collaborative learning environments. *Unreal Tournament 2004*, used by Michael et al. (2012), allowed for the examination of error framing in a fast-paced gaming context, providing insight into motivational mechanisms and self-efficacy. Additionally, games with distinct educational and problem-solving elements, such as *Logical Journey of the Zoombinis* by Harris et al. (2008) and *Pandemic by Prisms of Reality* by Sobocinski et al. (2024), were chosen for their capacity to facilitate cognitive monitoring and metacognitive awareness. Even classic games such as *FIFA* (Imanian et al., 2024) and *Pokémon Go* (Valentine and Jensen, 2021) were analyzed for their unique contributions to cognitive skills such as attention, working memory, and spatial awareness. This variety of game types and genres highlights the tailored approach researchers take in selecting games that align with specific cognitive and metacognitive constructs under investigation, thus offering insights into how different gaming environments can enhance or influence metacognitive processes and learning outcomes.

## Assessments instruments and tools

Some of the assessment tools used in each of the investigations were Sperling's Metacognitive Awareness Inventory (Jr. MAI; [Sperling et al., 2002](#)) ([Wilson et al., 2022](#); [Ricker and Richert, 2021](#)), General Mental Ability (GMA): Raven Advanced Progressive Matrices (APM) ([Raven et al., 1998](#); [Michael et al., 2012](#)), Alternative Uses Task (AUT; [Guilford, 1967](#)), Consensual Assessment Technique (CAT; [Amabile, 1988, 1996](#)), to assess Divergent Thinking Task ([Shaw, 2022](#)) as well as the modification of others ([Hardy et al., 2015](#); [Li et al., 2015](#)) to adapt the procedure, methodology, sample, etc., to the object of research. In qualitative studies, there is an almost unique use of techniques such as interviews, field or reflective diaries ([Lickteig, 2020](#); [Monem, 2015](#)), modeling, think-alouds, and recordings ([Harris et al., 2008](#); [Kim et al., 2009](#); [Misak, 2018](#)).

## Main findings by study focus

### Metacognitive awareness and self-regulation enhancement

Many studies demonstrated that video games effectively enhance metacognitive awareness, helping players become more conscious of their thought processes and learning strategies. [Wilson et al. \(2022\)](#) found that *The Sims 4* facilitated significant gains in metacognitive awareness among undergraduate students, particularly in vocabulary acquisition, by requiring players to continuously monitor and adjust their in-game actions to achieve goals. Similarly, [Piédalue \(2022\)](#) reported that children with ADHD displayed improved metacognitive regulation when using *Minecraft*, as the game encouraged them to plan, track progress, and make strategic adjustments. These findings underscore the role of video games in fostering self-awareness and self-regulation—skills critical for effective learning in educational contexts.

### Integration of metacognitive strategies within gameplay

Studies indicated that games designed with complex problem-solving or open-ended tasks promote active engagement with metacognitive strategies, such as planning, evaluating, and revising approaches. For instance, [Kim et al. \(2009\)](#) found that players using strategies such as thinking aloud and self-modeling in *Gersang* showed significant improvements in social problem-solving skills. This demonstrates how integrating explicit metacognitive strategies within gameplay can create an environment where players naturally engage in cognitive monitoring, which reinforces learning processes.

### Decision-making and problem-solving as vehicles for metacognitive growth

Games that require players to make decisions in real time or solve multifaceted problems provide ideal conditions for practicing metacognitive regulation. [Harris et al. \(2008\)](#), who used the *Logical Journey of the Zoombinis* with children, observed that participants with mastery goals engaged more in reflective problem-solving discussions, enhancing metacognitive control. Additionally, studies on RPGs and MMORPGs, such as [Monem \(2015\)](#) and [Luang-Ng et al. \(2022\)](#), showed that these genres facilitate self-scaffolding as players manage complex in-game scenarios, make decisions under pressure,

and seek resources collaboratively. Such dynamic problem-solving environments allow learners to apply and refine metacognitive skills, making them more adept at managing cognitive challenges in both gaming and educational settings.

### Role of game difficulty and error feedback in metacognitive engagement

Research on game difficulty and error management suggests that carefully calibrated challenges and error feedback within games can foster metacognitive reflection and adaptation. [Michael et al. \(2012\)](#) highlighted that positive error framing in *Unreal Tournament 2004* helped participants develop resilience and self-efficacy, key components of metacognitive regulation. The need to confront and learn from errors creates a cycle of self-monitoring and strategy adjustment, which mirrors effective learning practices. This controlled introduction of error-based learning within games can thus cultivate a mindset beneficial for academic learning, where resilience and adaptive thinking are essential.

### Metacognitive benefits of collaborative gameplay

The social aspect of certain games enhances metacognitive engagement through peer interaction, feedback, and collective problem-solving. [Luang-Ng et al. \(2022\)](#) showed that *Guild Wars 2* encouraged players to adopt metacognitive strategies through collaboration, with players gaining insights into their own learning processes while observing others' strategies. This aligns with findings from [Harris et al. \(2008\)](#), where collaborative problem-solving in children led to higher levels of metacognitive engagement, particularly for those oriented toward mastery goals. These social dynamics promote reflective thinking, mutual regulation, and shared goal-setting, all of which are foundational metacognitive skills relevant to group-based academic tasks.

### Transfer of metacognitive skills to academic contexts

Several studies suggest that video games serve as a bridge for transferring metacognitive skills into academic settings. For example, [Tangkui and Keong \(2023\)](#) demonstrated that students using *Minecraft* for fraction problem-solving developed higher order thinking skills that are directly applicable to classroom tasks. This transferability was also evident in studies using *The Sims 4*, where students not only improved vocabulary but also gained a heightened sense of self-regulation, aiding their learning in formal settings ([Wilson et al., 2023](#)). These findings emphasize that video games can be powerful tools for cultivating metacognitive skills with real-world educational applications, promoting strategic thinking, persistence, and adaptability.

### Limitation of the studies

Regarding the limitations of the different studies, the most significant ones were found with respect to the measurement of the metacognitive construct ([Hardy et al., 2015](#)), due to the use of a type of questionnaire that attended more to metacognitive knowledge than to metacognitive regulation, the latter option being more relevant to the objective of the study. In this sense, there could be some mismatch in the results if the same psychometric items were applied to participants of different ages ([Li et al., 2015](#)). On the other hand, it is not possible to clarify,

based on the results of the different studies, whether subjects with high metacognitive levels tend to choose a particular type of video game or, on the contrary, it is the video game itself that develops these metacognitive skills in the subject (Ricker and Richert, 2021). However, there seems to be a correlation between the type of video game chosen and the metacognitive level developed (Moncarz, 2011). Similarly, the authors acknowledge some sociodemographic limitations within their studies such as sex (Hardy et al., 2015; Hughes et al., 2013; Lickteig, 2020), sample representation (Harris et al., 2008; Monem, 2015; Ricker and Richert, 2021), or age (Harris et al., 2008; Hughes et al., 2013; Moncarz, 2011).

Finally, when considering future practical applications on the use of video games in formal educational contexts, the articles highlight the importance and difficulty of including these cultural tools in classrooms (Hughes et al., 2013; Monem, 2015). The causes of this reluctance could be explained by the teachers' need for specific training in these tools, which are essential for them to be able to value the positive educational aspects of video games (Martín del Pozo et al., 2017; De Sousa and Rasmussen, 2019). In this way, methodological initiatives could be promoted where video games are the protagonists, with the aim of achieving both curricular objectives and the development of transversal cognitive and metacognitive competencies within their teaching practice (Kim et al., 2009; Lickteig, 2020). This prior training would also be useful to select which video game is the most appropriate to include in classrooms (Hughes et al., 2013; Lickteig, 2020), thus establishing a forecast on what cognitive or metacognitive abilities each one develops and thus making the best choice within the large existing offer (Moncarz, 2011; Ricker and Richert, 2021).

## Discussion and conclusions

One of the primary outcomes of this systematic review is the identification of limited studies explicitly examining the relationship between commercial video games and metacognitive skill development, despite a growing body of research on video games in other educational contexts. This scarcity may stem from the challenges associated with integrating commercial games in educational settings (Marín-Díaz, 2019; Quesada and Tejedor, 2016) and the lack of consensus on defining and measuring metacognitive constructs (Gaviria, 2019; Huertas et al., 2014; Li et al., 2015; Mariano and González, 2020). However, the studies reviewed provide insights into how specific game genres and in-game features can stimulate metacognitive processes, offering clear but preliminary answers to the research questions.

For the first objective—understanding how commercial video games in education might foster metacognition—findings indicate that games facilitate a range of metacognitive activities, such as planning, self-monitoring, and evaluation (Wilson et al., 2022; Kim et al., 2009; Lickteig, 2020). Several studies focused on integrating metacognitive strategies such as reflective journaling, modeling, and verbalization (Kim et al., 2009; Li et al., 2015; Misak, 2018), while others found that orienting educational goals toward mastery supports deeper metacognitive engagement (Harris et al., 2008). Additionally, some researchers highlighted the impact of game genres and specific mechanics (e.g., RPGs,

MMORPGs, and sandbox games) in promoting metacognitive skills through decision-making and collaborative problem-solving (Monem, 2015; Ricker and Richert, 2021). These findings suggest that well-chosen commercial games can support metacognitive development, though targeted research on genre-specific effects is needed to strengthen this conclusion.

In relation to the second objective—assessing whether commercial video games can cultivate both metacognitive and other cognitive skills—the evidence suggests that video games indeed support broader educational outcomes. Games were shown to enhance critical thinking, problem-solving, self-regulation, and engagement in learning tasks (Coutinho and Neuman, 2008; Kleitman and Gibson, 2011; Klimenko and Alvares, 2009; Schraw et al., 2006; Sungur, 2007). Specific examples, such as the increased self-monitoring and regulation observed in players of *The Sims 4* and *Minecraft* (Wilson et al., 2022; Piédalue, 2022), align with Flavell's (1979) definition of metacognition as active monitoring and control of cognition, suggesting that commercial games do not hinder but rather promote valuable learning and motivational benefits in educational contexts.

However, this review reveals notable limitations, as highlighted in some studies (Hughes et al., 2013; Kim et al., 2009; Ricker and Richert, 2021), including the lack of standardized psychometric tools for assessing metacognitive processes in gaming contexts. Although six major databases were searched, the few studies meeting the inclusion criteria reflect limited research on the impact of commercial video games on metacognition, suggesting a need for further exploration, potentially including doctoral dissertations and unpublished studies. Another limitation concerns the reliability of existing measures for metacognition, underscoring the importance of validating tools that capture metacognitive elements specific to interactive gaming environments.

In conclusion, the metacognitive dimension, with its potential to enhance educational outcomes, aligns well with the engaging and dynamic environments created by commercial video games. Integrating these tools could significantly support metacognitive development alongside traditional academic skills, advocating a pedagogical shift toward more reflective and controlled learning experiences (Osse Bustingorry and Jaramillo Mora, 2008; Roque-Herrera et al., 2018). To fully leverage this potential, further research is necessary to identify effective game genres, validate psychometric tools, and establish instructional frameworks that incorporate video games into curricula, ultimately fostering a participatory and self-regulated learning process that meets contemporary educational needs.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Author contributions

MC-R: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project

administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JG-L: Investigation, Resources, Supervision, Writing – original draft, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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