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# The Impact of Serious Games on Learning in Primary Education: A Systematic Literature Review

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**Abstract.** In recent years, serious games have gained greater relevance in the educational field due to their usefulness in the intellectual development of students. With this objective in mind, we conducted a systematic literature review on serious games in the learning of primary-school students to reveal the advantages and the disadvantages, as well as the effects of educational game strategies and in the application areas, when using the PRISMA methodology to analyse the academic progress during the last 10 years. We conducted the search, selection and analysis in different databases, such as SCOPUS, ERIC and Dimensions, and analysed 54 studies. The results showed that serious games have a positive impact on cognition; and they generate significant learning achievements. Likewise, the game-based learning strategy concentrates a high level of motivation, generated by the interest, commitment and fun to solve the activities. However, it was also noted that the competition among students to reach the highest competencies can increase the level of anxiety. In addition, inadequate methodology and teacher unfamiliarity can cause negative effects, such as apathy towards serious games. Regarding the intervention areas, a greater application was observed in mathematics, the social sciences, communication and natural sciences. On the other hand, mathematical and communicative skills are the most addressed topics.

**Keywords:** elementary education; primary education; serious games; serious video games

## 1. Introduction

The current society is experiencing constant change, due to technological advances, which have led individuals to acquire new skills and knowledge, in order to develop themselves comprehensively (Navarro, 2017). In the field of education, educational software has now been revolutionised, thanks to the incorporation of specific designs, based on serious games (Fraga-Varela et al.,

2021), which are considered useful tools for learning; because they bring students closer to real-life scenarios (Martin & Aznar, 2015), thereby allowing for a more enriching learning experience. In the face of the current circumstances, generated by the pandemic and technology, students spend more time in the activities related to games (Homer et al., 2012), which represent an opportunity to adapt these environments as an alternative method (Ronimus et al., 2019) that responds to learning objectives. However, these premises lead to a rethinking of the educational scenario, since games require time to learn the use of technological materials, pedagogical and technical support, and digital access, as well as gap capacity, which needs to be examined (Hanna et al., 2021; Rodríguez, 2020). And this makes it difficult to choose the most suitable serious game (Muñoz et al., 2021). For this reason, it is desirable to analyse the advantages and the disadvantages in their use, the game-based learning strategies that favour their application, and the academic achievements in the different areas of application.

Serious games are defined as a mental strategy played with a computer, according to specific rules that use entertainment to promote learning objectives (Zyda, 2005). The main objective of this tool is learning, with the playful aspect of the activity taking a backseat; and it aims to achieve the acquisition of competences and skills (Sandí Delgado & Bazán, 2021), thereby achieving a comprehensive development of the student (Taípe et al., 2017). To achieve this, it must have a clear objective, present challenges at different levels, have the agreement of the participants to interact, making time go unnoticed, and to offer feedback (Amzalag, 2021). These aspects are essential to obtain the advantages in terms of enjoyment, fun, attraction, interest, and motivation (Gounaridou et al., 2021; Hanna et al., 2021; Fraga-Varela et al., 2021).

In the literature review, a classification of digital and non-digital games, based on their affective and motivational assessment, has been found (Connolly et al., 2012). In addition, the impact and positive results of computer games have been analysed in terms of interaction and analytical, logical, and problem-solving novelty (MENDEZ & BOUDE, 2021). The use of computer games and their genre has also been studied. In the educational field, serious games are an innovative tool that promotes learning and/or academic performance, mainly in the field of adventure and experiential studies (Kara, 2021). Furthermore, the use of emerging technologies has allowed the classification of serious games into gamification, serious games, and simulation, with gamification being the emerging topic (Toukourmidis et al., 2021).

According to the analysed literature, digital games improve students' levels of knowledge and attitudes towards learning, as long as they are adapted to primary curricula (MENDEZ & BOUDE, 2021; Sandí Delgado & Bazán, 2021). Serious games permit the development of skills and competences for educational purposes; and they carry out interactive learning. Therefore, video games must respond to the students' teaching-learning process and be linked in their context (Marín Suelves et al., 2021).

However, there are still gaps in the research, such as the lack of studies on the risks and the benefits of serious games (MENDEZ & BOUDE, 2021), the effects during the learning session, when using serious games (Kara, 2021), the emotional state of the students and the evaluation of their engagement during the game, including its social, behavioural, affective, and cognitive dimensions (Daoudi, 2022), as well as the identification of the learning achievements acquired (Marín Suelves et al., 2021).

Therefore, it is important to identify the aspects of impact, harm, motivation, affect, and behaviour in students when interacting with serious games; and whether this influences their knowledge acquisition and the improvement of content related to game-based learning. This perspective involves the level of engagement and positive or negative experience generated in the intervention (Boots & Strobel, 2014; Daoudi, 2022). To address these issues, a systematic review of the impact of serious games on learning in primary education was conducted, by using the databases of SCOPUS, ERIC, and Dimensions over a ten-year period, from 2012 to 2022. The findings derived from this study can be useful in decision-making and opening up the use of game-based learning methodology, in order to promote efficient learning achievements. In this sense, the following research questions were sought to be answered: What are the advantages and disadvantages during the application of serious games in learning activities developed? What effects do the game-based strategy have on primary-education students? In what areas have serious games stood out, and what didactic applications have been developed?

## **2. Review of the Literature**

In the literature review conducted, serious games are defined as digital games that are closely linked to education, rather than entertainment. That is, they are designed with a primary purpose that is not necessarily entertainment (Susi et al., 2007). Their main goal is to educate or train users; and they are considered to be pedagogical achievements (Su et al., 2013). They can also have other purposes, such as marketing or advertising (Noemí & Máximo, 2014).

Currently, there are several serious games that aim to solve challenges, in order to provide quantifiable results to support the educational process in the areas of learning and instruction (Wouters et al., 2013). These games lead to educational changes; they develop soft skills and explicitly support active learning through collaborative activities (Echeverría et al., 2011). In this sense, they allow students to experience complicated situations in the real world for different reasons, such as safety, cost, time, among others (Susi et al., 2007). Therefore, 3D (third dimensional) applications are interesting and attractive, with real simulations that reduce the complexities of the environment (Gros Salvat & Bernat Cuello, 2008; Flores-Bascuñana et al., 2019; Rocha & Dondio, 2021).

### **2.1 The advantages of serious games**

Serious games allow for the development of various motor, cognitive, visual, and spatial skills in individuals from a young age (Mielgo-Conde et al., 2022). Additionally, they increase student motivation, achieving optimal attention and

concentration on the activity (Rosas et al., 2003), reinforcing satisfaction in learning and teaching through action, thereby creating an interactive context for learning (Hieftje et al., 2017).

Although serious games do not present a great difficulty, the intervention of the teacher is necessary, in order to guide the activity (Eguia-Gómez et al., 2015). Their application in the teaching-learning process reveals that they are a useful media (Mielgo-Conde et al., 2022), with an agile and dynamic interface to achieve the development of students' skills in an enjoyable and interesting way (Rawansyah et al., 2021).

Therefore, game-based learning strategies allow for fun learning; and they motivate students to improve their concentration (Hafeez, 2021), memory, socio-emotional skills, computer fluency, simulations, achievement of competences, and above all, the interest that can be provoked in their design, so that the students can carry out their interactions autonomously.

## **2.2 The disadvantages of serious games**

The application of serious games requires the knowledge of appropriate techniques for developers and teachers, in order to apply them correctly (Hussein et al., 2019); since they have a significant influence on learning experiences (Chen et al., 2021), which could be negatively affected if not properly conducted, damaging thereby the initial motivation that the game should generate (Hafeez, 2021). However, existing literature indicates that the disadvantages are associated with excessive screen time, games that are not understandable or boring, games with too much distraction, and games that allow tracking of the learning curve (Hafeez, 2021). Likewise, the lack of an educational focus, the need for a device, and time management are added, as disadvantages that could be evident in the classroom (Shiau Gee et al., 2022).

## **2.3 Competences and skills developed by serious games**

Given that digital games allow the development of affective, motivational, cognitive, and social skills, a comparison has been made between the traditional teaching strategy and game-based learning, with the latter proving highly effective (Hafeez, 2021). According to the literature review, most digital games allow for the acquisition of knowledge and the understanding of content, followed by motivational, perceptual, and affective skills (Rocha & Dondio, 2021). In addition, studies focus on the development of mathematical skills to obtain rewards, by using gamification as an alternative to generate cognitive competition (Rawansyah et al., 2021; Flores-Bascuñana et al., 2019; Akcaoglu et al., 2021; Qolbi et al., 2019). All of this is possible when the game-based learning methodology focuses on the game characteristics and the principles to promote internal motivation and problem-solving (Amzalag, 2021).

However, gaps are evident that point to upcoming efforts in the evaluation of emotional factors (Flores-Bascuñana et al., 2019; Shiau Gee et al., 2022) and the negative experience of using digital games during mathematics learning that could lead to maths anxiety, with a loss of confidence that is more attenuated in women than in men (Rocha & Dondio, 2021).

### 3. The methodology

This study was carried out through a systematic literature review, which provided a holistic view of the research area and provided general information on serious games (Aydin et al., 2022). The research focus was on the impact of serious games in primary education. This is a type of scientific research that collects the results of empirical studies, in order to present the existing work on a specific topic.

Articles were down-loaded from the database, taking into account the title, abstract, and keywords of the text, which were transferred to a matrix. Inclusion and exclusion criteria were used to select the 54 documents that were analysed in the reading phase, according to the search chain. To achieve the research objective, the following research questions were posed:

- RQ1. What are the advantages and the disadvantages of using serious games in learning activities?
- RQ2. What effects does the game-based strategy have on primary education students?
- RQ3. In what areas do serious games excel; and what educational applications have been developed?

The search, selection, and analysis were conducted on three (3) different databases: Scopus, Educational Resources Information Centre (ERIC), and Dimensions. The identification of articles was done by using the following terms. (see Table 1)

**Table 1: Dimensions and questions evaluated in the interview**

Scopus	TITLE-ABS-KEY (("serious games" OR "serious video games") AND ("basic education" OR "primary education" OR "elementary school" ))
ERIC	[("serious games" OR "serious videogames") AND ("basic education" OR "primary education" OR elementary school)]
DIMENSIONS	("serious game" OR "serious video games") AND ("basic education" OR "primary education" OR "elementary school")

Source: Own elaboration

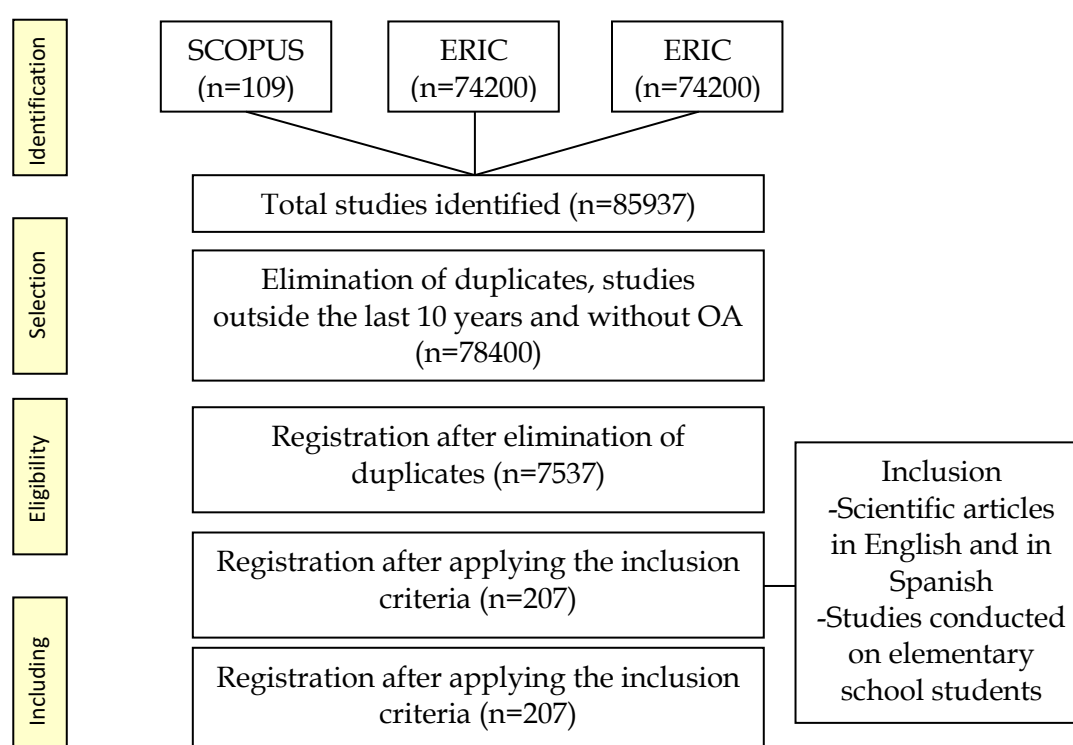
Subsequently, the inclusion and exclusion criteria, as detailed in Table 2, were applied.

**Table 2: Inclusion and exclusion criteria for the review**

Criteria	Inclusion	Exclusion
Document type	Article	Other's publications
Period	2012- 2022	Outside range
Accessibility	Open publication	Restricted or paywalled

Population	Primary school students	SEN students
		Students from other educational levels
Idiom	Publications in English and Spanish.	Publications in other languages.

The employed method was PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), which is designed to demonstrate that the selection of studies was carried out objectively by describing the process for such selection (Yepes-Nuñez et al., 2021). (See Figure 1)



**Figure 1: Article search and selection process**

Source: Own

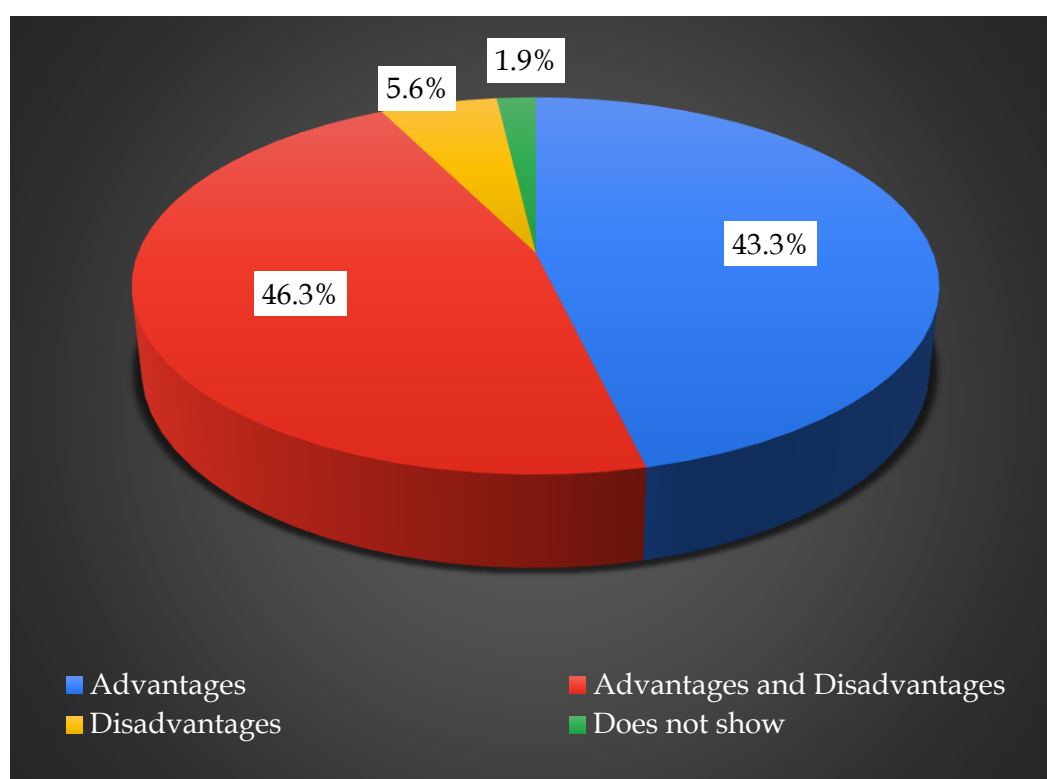
As seen in the PRISMA flowchart, a total of 85937 documents were obtained and downloaded to the EndNote manager for compilation. Subsequently, the Herzing's Publish or Perish program was used to eliminate any duplicate documents. Finally, the inclusion and exclusion criteria were applied, resulting in a total of 54 selected articles for the review, of which 47 were from DIMENSIONS, 2 were from ERIC, and 2 were from SCOPUS. Three articles did not have their source of origin listed.

## 4. The Results

### 4.1 Advantages and disadvantages during the application of serious games

Of the analysed studies, 25 mentioned only the advantages during the application of serious games; while another 25 mentioned both the advantages and the disadvantages during their application; while 3 articles mentioned the disadvantages of applying serious games; and a single study did not show many differences, so it could not identify either the advantages or the disadvantages.

It should be noted that from the analysed articles, a large number of them provided more data of the advantages during the application of serious games. Therefore, it may be inferred that the research is more focused on the positive aspects of the usability of different applications during learning sessions. In that sense, we can affirm that there is a minimum number of articles that refer to the disadvantages of the application of serious games. (See Figure 1)



**Figure 2: Advantages and disadvantages during the application of serious games**  
Source: Own

#### 4.1.1 Advantages during the application of serious games

The literature review revealed that serious games achieve their educational purpose beyond the entertainment offered by common computer games. Among the advantages obtained during the application of serious games are the attraction to learning, attention, as well as the concentration thereon (Rosas et al., 2003).

Students achieve learning in different ways guided by the game, such as mathematics, communication, computer science, health, among various others.

During their application, many of the students participated actively, demonstrating attraction, fun, enthusiasm, interest, and emotion in different themes, which allow for better learning and academic performance. Additionally, the students did not show any aversion to the application of serious games for this purpose.

The way of use also plays an important role; since students could perform adequately and achieve perceptual, visual, and cognitive skills (van der Ven et al., 2017). (See Table 3).

**Table 3: Advantages during the application of serious games**

Advantages	Article N°
Attraction and enjoyment in learning.	(5,6,19,20,22,26,27,28,29,31,33,35,37,38,39,53)
Acquisition of knowledge and learning achievements (cognitive competence).	(7,10,12,13,15,18,26,30,32,37,40,41,43,46,48,49,51,52,53)
Participation and interaction with enjoyment and commitment.	(1,2,3,9,11,20,21,22,25,28,29,33,35,40,42,44,47,54)
Usability.	(4,16,17,20,22).
Improvement of perceptual, attentional, and cognitive skills.	(14,23)

Source: Own elaboration

#### 4.1.2 Disadvantages during the application of serious games

During the analysis of the reviewed studies, several disadvantages were identified in the application of serious games. Firstly, it was evident that in some cases, the educational objective of the game was not achieved; rather the games generated negative responses from the students, such as rejection attitudes, stress, anxiety, boredom, and frustration (Hanna et al., 2021; Rocha & Dondio, 2021).

These forms of behaviour can provoke panic feelings and low satisfaction in the usability of the game. Additionally, it was found that in some cases, teachers lacked appropriate knowledge and methodologies to apply serious games in the classroom (Hafeez, 2021; Shiau Gee et al., 2022), which generated greater exhaustion and discouragement in students to continue interacting on the computer or mobile device. The following issues were mentioned in the analysis of the research.

**Table 4: Disadvantages during the application of serious games**

Disadvantage	Article N°
Vague objections and a feeling of wasted time due to the complexity of the problems posed.	(9,10,12,14)
Lack of knowledge and the use of the teacher's methodology to participate	(16,25,31,46)



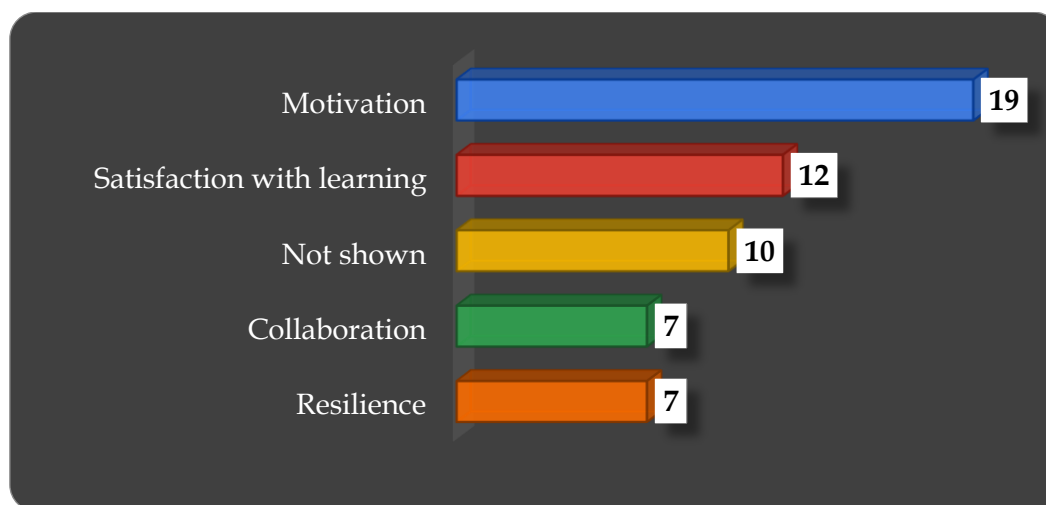
in a game.	
Negative feelings (anxiety, stress, boredom, anger, frustration, pressure), due to the level of complexity generated in the classroom.	(5,22,28,31,33,44,50,)
Disengagement with the curriculum.	(16,19)

## 4.2 The after-effects of game-based strategy implementation

### 4.2.1 Motivational effects of students in the application of serious games

From the analysed articles, it was evident in 44 of them that there were positive effects in applying serious games on students' motivation, thereby promoting attitudes of self-efficacy, self-determination, attribution, and goal-orientation. Additionally, these attitudes are reinforced by collaboration, enthusiasm, interest, and commitment, which are learned in shared spaces, generating thereby social learning. All of these aspects, in turn, feed into the cognitive aspect; since they are interrelated (Bottino et al., 2014).

According to the analysed, articles, serious games are useful tools to encourage students' participation during the learning process, and also to influence the students' ability to develop resilience, as they face challenges inherent in the course of the game (see Figure 3).

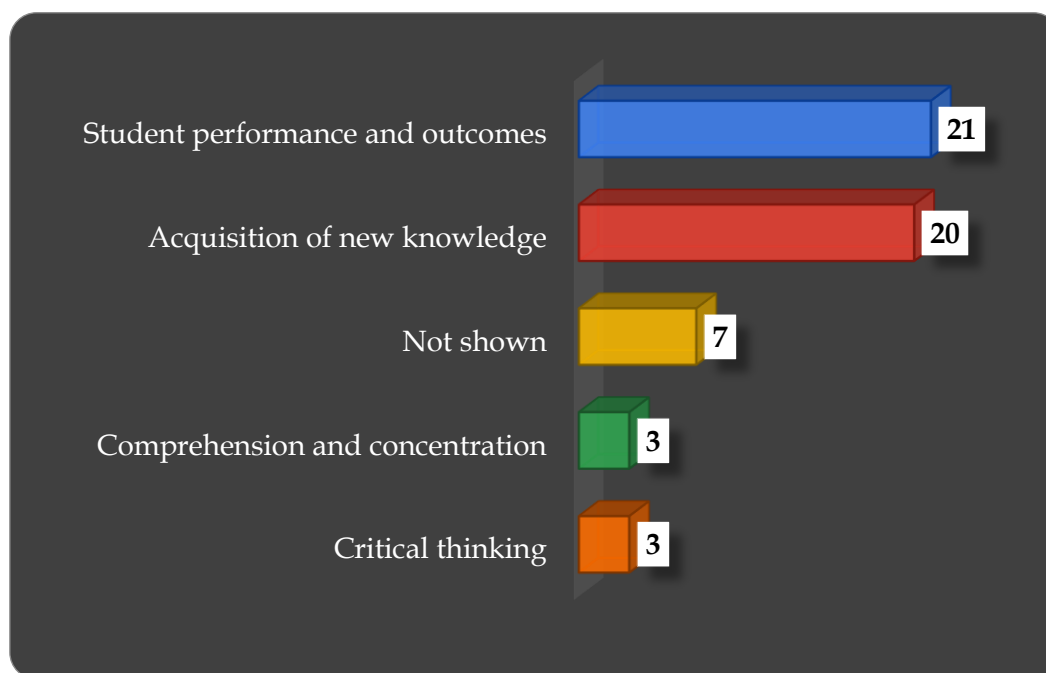


**Figure 3: Motivational effects of students in the application of serious games**  
Source: Own

### 4.2.2 Cognitive effects

The analysis of a total of 47 articles shows that instruction based on serious games has significant benefits in the cognitive aspect, such as the acquisition of new knowledge, better performance and achievement by students, and to a lesser extent, greater understanding and concentration on the content taught, as well as the development of critical thinking. In a study carried out by Chen et al., (2019), it was found that those students who received instruction based on serious games improved significantly in various aspects, such as concentration and learning.

Additionally, students acquired new knowledge in various areas and improved their skills; since they were able to use more interactive methodologies and the games were adapted to their context. This type of game places the players or learner in a special context, which permits them to more easily develop their knowledge and skills (see Figure 4).

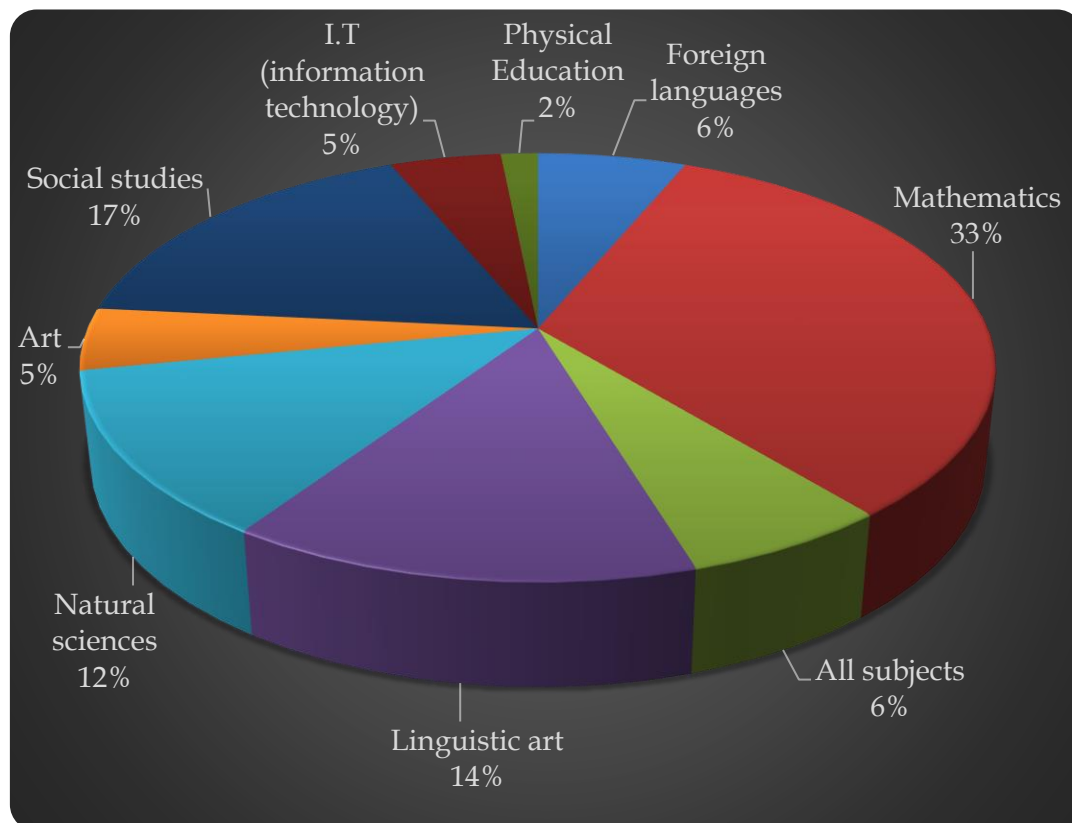


**Figure 4: Cognitive effects**  
Source: Own

### 4.3 Developed application areas of serious gaming

#### 4.3.1 The areas developed

In the analysed studies, it was found that mathematics was the one area most developed in the implementation of serious games, followed by the development of the social sciences, communication, and the natural sciences. This indicates that research is more focused on the mathematical, social, communicative, and natural development in primary level classrooms. This is because they are the core areas, that are the main areas that allow for the development and impact with everyday surroundings (Vilella & Rodríguez, 2020). It was also observed that the application of serious games was not focused on the development of any single area, but rather on the contrary; since they could be adapted for the development of all areas, making them thereby an even more useful and versatile tool in the classroom. In addition, their use is evidenced to a lesser extent in areas such as languages, computer science, art, and physical education, as shown in Figure 5.



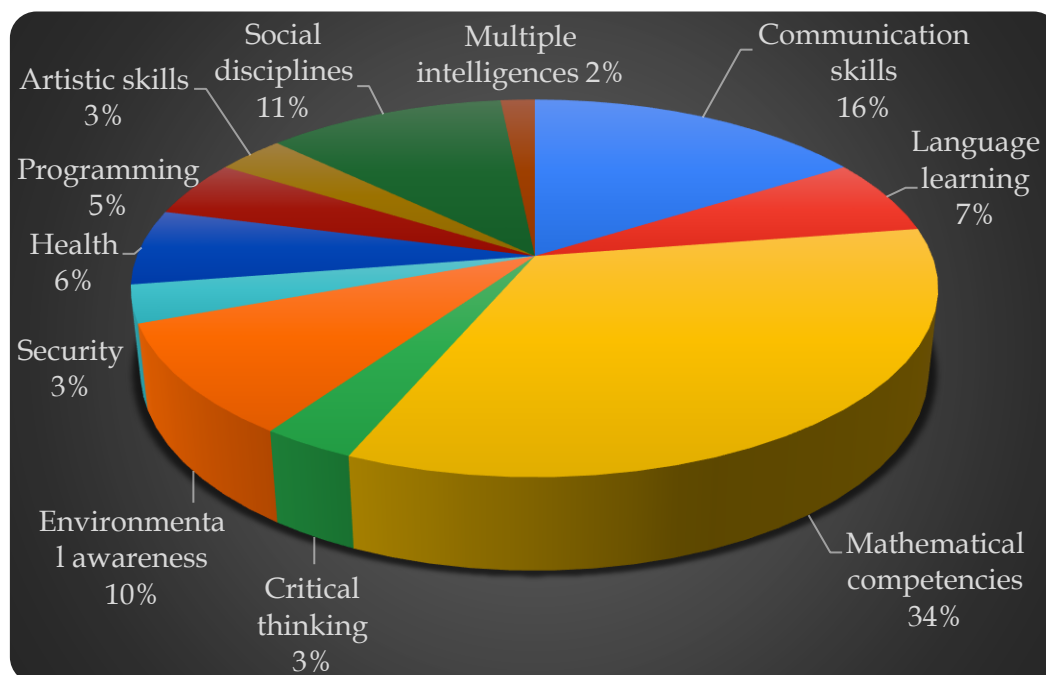
**Figure 5: Areas developed**

Source: Own

#### 4.3.2 Thematic contents developed

Regarding the thematic content developed through serious games, it was observed that after the thematic analysis conducted in the studies, researchers mainly focused on developing mathematical skills, as this is an area in which weaknesses are more commonly found. Secondly, the development of communication skills is prioritised, followed by social and environmental disciplines, learning a new language, health, programming skills, artistic skills, critical thinking, security, and the development of multiple intelligences, to a lesser extent. In this way, perceptual, attentional, and cognitive skills are promoted in the execution of tasks, generating thereby new stimuli for students (Papanastasiou et al., 2017).

It should be noted that the application of serious games in the classroom is not limited only to the core subjects, but also to a wide variety of topics that are addressed, from theoretical learning to the development of critical thinking, argumentation, as well as awareness. (See Figure 6)



**Figure 6: Thematic contents developed**

Source: Own

## 5. Discussion

The use of technology is constantly increasing, as evidenced by the creation and design of new equipment based on artificial intelligence, which is generating a new revolution, especially in the field of education. Additionally, the different combined and hybrid modalities that have emerged, due to the COVID-19 pandemic, have increased the usability of technology and efforts to evaluate its impact on primary education. Therefore, this systematic review focused on the impact of serious games in the educational field; and it was found that they have a positive effect on knowledge generation and the improvement of academic performance.

Likewise, serious games were confirmed as a powerful, attractive, and effective tool with a high motivational impact (Fraga-Varela et al., 2021; Hanna et al., 2021; Susi et al., 2007; Rocha & Dondio, 2021).

The results of this systematic review show that serious games have a positive effect in the teaching-learning process in cognitive competence, being highly effective in knowledge generation and achieving positive results in academic performance. Additionally, the motivational aspect is highlighted; as it increases enjoyment and commitment. Similarly, other studies have found that students achieved a high impact in game-based strategy, highlighting thereby cognitive development (Papanastasiou et al., 2017) and motivational (Fraga-Varela et al., 2021; Gounaridou et al., 2021) skills.

However, it is important to consider that this impact depends on the technical aspects of the game and the methodology and technique used by the teacher

(Backlund & Hendrix, 2013). When applied poorly, serious games can cause negative effects, such as anxiety and stress (Rocha & Dondio, 2021). Therefore, these consequences must be taken into account, when considering how pedagogical work should be developed in the classroom; since serious games are seen as appropriate methods, especially in the context of primary education (Gounaridou et al., 2021), as they respond to the interests of the students, especially if they are based on real experiences organised into stories, in order to solve situated problems (Flores-Bascuñana et al., 2019; Rocha & Dondio, 2021).

Regarding the disadvantages of using serious games in the classroom, it is important to consider the level of competition that can arise from the generated activities. This competition can lead to feelings of frustration and discouragement among some students; since not everyone can work under pressure, which can lead to unwanted stress (Hanna et al., 2021).

However, positive motivational and cognitive effects have been observed in students who participate in serious games in the classroom. In terms of motivational effects, it has been found that students experience positive attitudes, such as satisfaction with the learning, resilience, collaboration, and active participation in learning. Regarding cognitive effects, it has been demonstrated that students achieve higher performance and academic achievement, as well as the acquisition of new knowledge, as highlighted by (Mielgo-Conde et al., 2022) in their systematic review. It has also been observed that gamification and virtual reality can improve cognitive competence in students (Rawansyah et al., 2021; Flores-Bascuñana et al., 2019; Akcaoglu et al., 2021; Qolbi et al., 2019).

Two findings can be identified in this review. Firstly, it is observed that the analysed research focuses mainly on mathematics, the social sciences, communication, and on the natural sciences. This differs from the findings of a previous study conducted by MENDEZ & BOUDE, (2021) that indicated a greater application in the area of the natural sciences. In addition, it is highlighted that mathematical skills are the most frequently addressed topics, especially those that involve real environments that trigger reflection to organise information and to provide solutions to the problems posed. Secondly, studies suggest that the disadvantages may be attributed to the level of competition generated in the classroom, which can lead to difficulties in managing time and generating anxiety, especially in women (Rocha & Dondio, 2021). The lack of knowledge and the educational approach by the teacher can also contribute to a false attribution in achieving objectives (Hafeez, 2021; Shiau Gee et al., 2022).

Although this study does not focus on the attitudinal effects, it is recommended that future research considers these effects, in order to measure the students' emotions. Additionally, no distinctions were made regarding the duration of digital game applications, which would be important to consider in future research, as some studies have short periods of application; while others are longitudinal. Examining long-term experimental results and considering the age of the students and the demands generated from the actors' perspective is also suggested (Flores-Bascuñana et al., 2019; Shiau Gee et al., 2022).

The limitations of this study include the lack of emphasis on attitudinal effects; but it is recommended that this aspect should be considered, in order to measure students' emotions (Flores-Bascuñana et al., 2019; Shiau Gee et al., 2022). Additionally, no distinctions were made in the recovered studies regarding the duration of application, as some studies have short periods; while others are longitudinal, which were not analysed in this study. It would be important to incorporate these aspects in future research. Based on this literature review, more experimental results with longer application times are required. The age at which the digital games are applied and the demands generated from the actors' perspective should also be taken into consideration.

## 6. Conclusion

During the literature analysis, and the varied use of serious games in different curricular areas were found. Therefore, it is clear that they have a high impact that is not limited to any specific area; but they offer a number of possibilities and alternatives to be used for specific purposes. These games cover various themes; and they give students different skills and levels of performance with a positive advantage. When incorporated into game-based learning strategies, they enhance cognitive and motivational aspects; and they have a positive impact on learning achievement. During the literature analysis, different applications of serious games were found in diverse curricular areas, indicating a high impact that is not limited to a single area. Serious games offer a variety of possibilities, and alternatives to be used, for specific purposes, covering a wide range of topics that give students various skills and levels of performance, which represent a positive advantage. By incorporating serious games into learning strategies, cognitive and motivational aspects are thereby enhanced, which positively affect learning achievement. However, it is necessary to consider the limitations of this study, such as the lack of emphasis on attitudinal effects and the lack of distinction in the periods of serious game application, suggesting thereby the need to examine more experimental results that have a longer application time. It is also recommended to take into account the age of the students at which the digital game is applied and the demands it generates from the actors' perspective in any future work.

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