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Learning strategies through digital games in a university context

Estrategias de aprendizaje a través de los juegos digitales en un contexto universitario

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ABSTRACT
The relationship between digital games and the mobilization of cognitive and metacognitive learning strategies deserves attention and needs research that contributes to the understanding of how these strategies can favor the teaching and learning processes. This study describes how university students over 18 years of age mobilize cognitive and metacognitive learning strategies through digital games. The research methodology used was ex post facto with a quantitative approach. 941 students from 22 States and from the Federal District, enrolled in higher education courses at Brazilian colleges and universities, participated in this research. Data collection occurred through the application of an online questionnaire that integrates the Metacognitive Awareness Inventory (MAI) and the Inventory of Cognitive and Metacognitive Strategies with Digital Games (ICMSDG). The results indicated that university students make regular use of metacognitive knowledge, skills, and strategies. Moreover, cognitive and metacognitive learning strategies seem to be more mobilized by digital game players than by non-players, particularly among those who played over a longer period of time (9 years or more) and with higher intensity (playing every day). With the results found and analyzed, we observe that this study is relevant for both university professors and game designers who aim to promote metacognition skills.

RESUMEN
La relación entre los juegos digitales y la movilización de estrategias de aprendizaje cognitivas y metacognitivas merece atención y requiere investigaciones que contribuyan a la comprensión de cómo estas estrategias pueden favorecer a los procesos de enseñanza y aprendizaje. Este estudio describe cómo los estudiantes universitarios mayores de 18 años movilizan estrategias de aprendizaje cognitivas y metacognitivas a través de los juegos digitales. La metodología de investigación utilizada fue ex-post-facto con un enfoque cuantitativo. Participaron en esta investigación 941 estudiantes de 22 estados y del Distrito Federal, matriculados en cursos de educación superior en las universidades brasileñas. La recolección de datos fue proporcionada a través de la aplicación de un cuestionario en línea que integra el Inventario de Conciencia Metacognitiva (IMA) y el Inventario de Estrategias Cognitivas y Metacognitivas con Juegos Digitales (ICMSDG). Los resultados indicaron que los estudiantes universitarios encuestados hacen un uso regular de conocimientos, habilidades y estrategias metacognitivas. Además, las estrategias cognitivas y metacognitivas de aprendizaje parecen ser más movilizadas por los jugadores de juegos digitales que por los no jugadores, particularmente entre aquellos que jugaron durante más tiempo (9 años o más) y con mayor intensidad (jugando todos los días). Con los resultados encontrados y analizados, observamos que este estudio es relevante tanto para los profesores universitarios como para los diseñadores de juegos que pretenden promover las habilidades metacognitivas.

KEYWORDS | PALABRAS CLAVE
Digital games, higher education, cognition, metacognition, assessment, questionnaire.
Juegos digitales, educación superior, cognición, metacognición, evaluación, cuestionario.

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1. Introduction

Studies on digital games and their interconnection with education suggest that these artifacts have the potential to promote learning (Prensky, 2007; Castellòn & Jaramillo, 2013; Maharg & de-Freitas, 2011; Pombo & Marques, 2020; Santos et al., 2019). However, there are still gaps in the literature that deserve a closer look and more rigorous research (Van-Eck, 2015). In the digital games research field, there is a limitation in the literature when it comes to research on metacognition, particularly in higher education contexts. This situation implies that it is necessary to invest in this research field. For instance, there is a need to further analyse how people learn with games, when learning happens, or what conditions are necessary for learning with games. In the research studies conducted by Braad (2018), Braad et al. (2019), Hacker (2017), Taub et al. (2020) and Zumbach et al. (2020), metacognitive processes and strategies are presented in their relationship with digital games, either serious games or commercial digital games. These studies indicate that these artifacts can be integrated in the formal education context, with positive or promising results for learning.

From studies on learning strategies that can be implemented or developed with digital games, we sought to clarify the following research problem: how are cognitive and metacognitive learning strategies mobilized through digital games in the context of university students? The aim is to contribute to the literature in the area by analysing how cognitive and metacognitive strategies are mobilized with the use of digital games in the context of university students. The literature specialized on learning processes has sought to know how this phenomenon happens, how it can be enhanced, and what its limits are. In the set of these studies, the concept of metacognition emerges as polysemic. For example, according to Flavell (1979), metacognitive knowledge "is one's stored knowledge or beliefs about oneself and others as cognitive agents, about tasks, about actions or strategies, and about how all these interact to affect the outcomes of any sort of intellectual enterprise" (Flavell, 1979: 906). Several other authors (Hartman, 2001; Matlin, 2004; Fox & Riconscente, 2008; Hertzog & Dunlosky, 2011; Frenkel, 2014) reinforce that metacognition is defined as a person's knowledge, awareness, and control over his or her cognitive processes. Schraw and Dennison (1994), two of the seminar authors on the matter, mention that metacognition refers to one's ability to reflect, understand and control learning, consisting of two main components, knowledge of cognition and regulation of cognition. Firstly, knowledge of cognition includes three subprocesses that facilitate the reflective aspect of metacognition: declarative knowledge (knowledge about oneself and about strategies), procedural knowledge (knowledge about how to carry out the strategies), and conditional knowledge (knowledge about when and why to use the strategies). Secondly, the regulation of cognition refers to the metacognitive activities that help to control thought, and it serves for learning control through a series of sub-processes: planning, information management, comprehension monitoring, debugging, and evaluation.

Boruchovitch (1999) presents a similar understanding to Schraw and Dennison (1994), stating that metacognitive knowledge (or metacognitive awareness) has to do with cognition itself, and concerns: 1) knowledge about oneself (strengths, weaknesses, personal preferences); 2) knowledge about the task (difficulty levels, demands); and 3) knowledge about the use of strategies (which ones, when, why and what for) (Boruchovitch, 1999). According to Boruchovitch, metacognitive monitoring is the evaluation or judgment of the current state of a cognitive activity and/or progress during the performance of a cognitive task (e.g., self-assessment and self-examination). Metacognitive control is understood as the regulation of cognitive activity that is under development; it refers to the actions that can be taken based on the information that resulted from the cognitive monitoring process (Waltz-Schelini et al., 2016).

Analyzing the above presented views on metacognition, we observed that the authors' perspectives complement each other; however, in this study, we adopted the view of Schraw and Dennison (1994). Hence, the data analysis includes the dimensions of knowledge about cognition and regulation of cognition. In a connectivism view, it is understood that several artifacts and technologies can be used to mobilize strategies to support the acquisition, organization, and use of information, aiming at the construction of learning (Pimentel, 2018). Among the technologies, digital games stand out. For Hacker (2017), there are few studies and, hence, there is little empirical evidence that can contribute to the design of serious games that incorporate metacognition, which justifies the study reported in this manuscript.

To understand how digital games can be inserted in the context of metacognitive learning, Castronovo et al. (2018) carried out a quasi-experimental study with 65 engineering students, using a simulation game. In this research with pre-test and post-test, statistical analysis through an ANOVA test was conducted, as data met the assumptions of normality, sphericity, and homogeneity of covariance. Two elements were significant in the results and may help game developers to consider such prompts in their future game design. On the one hand, feedback was an enabler of metacognitive monitoring. On the other hand, play time was also relevant, as it allows the development of discovering which game strategies can correspond to success in a gameplay.

The results obtained with adolescents in this field are also interesting, and prompt us to consider whether or not similar results may be achieved when the participants are higher education students. For example, in the study of Drummond and Sauer (2015), data indicate that metacognitive rates are lower among adolescents who play video games. However, the authors caution that this result does not imply lower academic performance for frequent players. Contrasting research findings were produced by Kim et al. (2009). Their study indicates that a commercial game in conjunction with metacognitive strategies can be an effective way to increase performance in learning or play, stemming from the time they are engaged. For the authors, conversation and observation activities are more effective than writing activities in improving students' achievements. Other studies also favour game's adoption in education. For instance, Ke (2008) sought to analyze whether digital games are effective in promoting math learning. In this study, with 358 students from 18 public schools in Pennsylvania, the researcher carried out a comparative investigation between digital and analog games. The research followed a mixed method model, and the results indicate that computer games, when compared to paper and pencil games, were significantly more effective in promoting learning motivation. However, data showed no significant difference when trying to identify whether digital games facilitated performance in the mathematical cognitive and metacognitive awareness test.

Considering again higher education contexts, Trindade et al. (2019) conducted a study with 91 students, where learning experiences with a digital game were led with an experimental group (N=59). The study results show that games can lead to positive learning outcomes in Physics, in this case regarding electricity, electric charges, and electric field, suggesting that game designers should incorporate metacognitive activities, aiming at promoting activities that generate reflection, which contributes to the consolidation of learning. Moreover, Pouralvar et al. (2019) argue in favour of also considering learning styles in the game design for an effective mobilization of metacognitive strategies. From the above presented analysis, in an understanding of the research on the relationship between cognitive and metacognitive strategies and digital games, this study presents the descriptive statistical analysis of data collected from university students, as will be explained in the following section.

2. Methodology

The conducted study is characterized as a survey (Roni et al., 2020), being an ex post facto research methodology with a quantitative approach (Sampieri et al., 2013; Mattar & Ramos, 2021). Participating in the study, by answering an online questionnaire, were 941 students enrolled in higher education courses from Brazilian colleges and universities. The research field included public and private higher education institutions, receiving responses from 22 states and the Federal District.

2.1. Participants

In this study, due to the difficulty of access to the approximately 8,603 thousand students in higher education courses in Brazil, a non-probability sampling technique was applied to obtain a convenience sample (Neuman, 2014). It is composed of volunteers, contacted by email, who met the desired characteristics: attending a higher education course in a Brazillian institution at the time of the data collection (complying with the research locus), with fluency in Portuguese (the language used in the questionnaires) and signing the Free and Informed Consent Form through virtual means (for conformity with ethical procedures). Hence, participating in this study were adults able to give informed consent. The participants were 941 Brazilian students, enrolled in higher education courses. Most respondents

(67.8%) reported that they lived in the northeast of the country. Students were enrolled between the 1st and 12th period of the course, and 3.2% respondents indicated that they took subjects from different periods. Regarding the age profile, most respondents (42.4%) were aged between 18 and 20 years (Table 1). The sample was composed by convenience and the analysis was made considering two different profiles: game players and non-players.

Table 1. Age by respondents' group (non-players and players)

Age	Non-player		Player		Total	
	frequency	%	frequency	%	frequency	%
18 to 20 years	126	33.60%	273	48.23%	399	42.40%
23 to 27 years	107	28.53%	174	30.74%	281	29.86%
28 to 32 years	38	10.13%	59	10.42%	97	10.31%
33 to 37 years	37	9.87%	21	3.72%	58	6.16%
38 years or more	67	17.87%	39	6.89%	106	11.27%
Total	**375**	**100%**	**566**	**100%**	**941**	**100%**

The study received a Research Ethics Council approval, reference CAAE 4,566,901, and follows all the guidelines indicated by the ethical regulations, including in relation to the Brazilian General Law for the Protection of Personal Data (LGPD, Law No. 13.853/2019).

2.2. Data collection procedures and tools

Data collection was conducted through the application of a self-administered online questionnaire, developed in the form of self-report, in which the respondents themselves must fill in the answers. The questionnaire (Pimentel & Marques, 2021; Pimentel et al., s.n.) consists of three sections: (a) Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994); (b) Inventory of Cognitive and Metacognitive Strategies with Digital Games (ICMSDG) (Pimentel & Marques, 2021); and (c) respondent profile. Section (b) was answered only by those who declared themselves players (N=566).

In the first section, a), the MAI is used. The MAI is an instrument with 52 items built and validated by Schraw and Dennison (1994) to measure the metacognitive awareness of adults. Items are classified into eight subcomponents grouped under two broader categories, knowledge of cognition and regulation of cognition. In this study, the translated version was used and validated in Brazilian Portuguese by Lima Filho and Bruni (2015).

The second section comprises the ICMSDG, which is a 20-item instrument to self-assess the use of cognitive and metacognitive strategies in game play scenarios, presented in Pimentel and Marques (2021). Items are classified into two categories: cognitive and metacognitive learning strategies. An example of a cognitive item is "7. I watch tutorials about games, made by other players" and an example of a metacognitive item is "9. In the game, I think of several ways to resolve a situation and I try to choose the best one."

The ICMSDG development and validation process were described before (Pimentel et al., s.n.). In summary, after a content validation phase, internal validation was performed through a pre-test of the questionnaire and Cronbach's alpha calculation (Cronbach, 1951) with a group of Brazilian university students and players, who composed a convenience sample of 32 respondents. The analysis was performed using the Statistical Package for Social Sciences 24 (SPSS) software and considered the responses of 29 respondents, who indicated that they were digital game players. The responses of 3 subjects were discarded as they were not players. The Cronbach alpha result was 0.84, which is considered an indicator of a highly reliable instrument, according to Cohen et al. (2018). Hence, the ICMSDG has been validated and its reliability tested/confirmed (Roni et al., 2020).

In the MAI and ICMSDG items, a 5-point Likert scale was used, with the following indicators: (1) Strongly disagree; (2) Disagree; (3) Undecided; (4) Agree; and (5) Strongly agree. The third section of the instrument comprises questions that aim to identify the respondents' profile as gamers. Initially, respondents are questioned about what types of digital games they play: Role-Playing Game (RPG), adventure, emulation, simulation, strategy, action, and puzzle. Respondents could also indicate other types. For playing frequency, the following scale was used as a reference: (1) I do not play; (2) Occasionally or (3) Often. In sequence, it was asked which types of digital games the respondent usually plays the most. In addition, it is asked how long he/she plays, on average, with the following options: 1 to 2 hours; 2 to

3 hours; 3 to 4 hours; 4 to 5 hours; more than 5 hours a day. Regarding how many years playing, the options were: 1 to 4 years; 5 to 8 years; and 9 years or more.

The third section of the instrument includes questions to identify the respondents' profile as higher education students. Thus, students are asked to identify the university or college they are enrolled in, as well as the area of knowledge of their course and which period / semester they are attending. For age, the following options are presented: 18 to 22 years; 23 to 27 years; 28 to 32 years; 33 to 37 years and 38 years or more.

2.3. Analysis procedures

The questionnnaire obtained 981 responses, which after data cleaning were reduced to 941 reliable responses. For data cleaning, subjects who were not in graduation, who were not attending Brazilian universities or colleges, who did not agree to participate in the research, who did not complete part 1 of the questionnaire (MAI), and whose questionnaire was completely blank were excluded. Duplicate responses were also excluded. Of the responding students, 376 claimed they do not play digital games (39.79%) and 566 claimed they are players (60.21%).

Regarding the interpretation of results in Likert scales, caution is needed. For example, Pornel and Saldaña (2013) analyzed 53 dissertations and found that the use of a flawed interpretation scheme of the scale items' mean responses was common. For the purpose of interpretation of the mean response, the authors advise the use of the natural boundaries of the integers used as number anchors of the scale as boundaries for categories. According to the authors, the scheme that makes use of the integers' natural boundaries has a good efficiency in estimating the respondent's latent ability that the scale aims to measure. Consequently, considering that this study used a 5-point Likert scale, the interpretation scheme used was: Mean Interval 1.00–1.49=Strongly disagree; Mean Interval 1.50–2.49=Disagree; Mean Interval 2.50–3.49=Undecided; Mean Interval 3.50–4.49=Agree; Mean Interval 4.50–5.00=Strongly agree

Moreover, statistical tests (Shapiro Wilk and Mann Whitney) were performed with the support of the Jamovi software. The normality of the data was verified using the Shapiro Wilk test. The data are presented and analyzed below. For the descriptive data analysis, the information was organized and tabulated. Subsequently, data were analyzed using the following software: Microsoft Office Excel 2019, R 4.0.5 and Jamovi version 1.8.2 for descriptive analysis and statistical tests.

3. Results and discussion

3.1. Metacognitive awareness inventory

Data normality was checked through the Shapiro Wilk test for an alpha level of 0,05. Data descriptives for the MAI section of the questionnaire ($N=941$) respondents, reveals the values: $W=0.738$ for $p<0.001$, thus, the null hypothesis that the sample comes from a population with a normal distribution is rejected. Hence, non-parametric statistical tests were performed, assigning the confidence interval of 95%.

Mann-Whitney tests were performed for Knowledge of cognition ($U=96614$, $p=0.005$) and for Regulation of cognition ($U=97293$, $p=0.004$). According to Bruce et al. (2018), if the data does not fit the normal distribution, we need to use a non-parametric method, for example, the Mann-Whitney U test as the significance is less than 0.05. By the null hypothesis of the Mann Whitney Test, we assume that the means are not statistically significant. To assess the homogeneity of variance Levene's test was used, and its results are $p=0.470$ for Knowledge of cognition and $p=0.156$ for Regulation of cognition (with $p>0.05$), confirming that the variances of the groups are homogeneous.

The results of the MAI present significant indicators for this study. The Knowledge of cognition and Regulation of cognition categories are identified among the respondents, as the selection of the answers "Agree" (or 4) and "Strongly agree" (or 5) was frequent throughout the sample. Descriptive statistics showed that the median values were the same for the two groups of categories (Knowledge of cognition and Regulation of cognition), and also when the values of these two categories were added together. It is noteworthy that these categories are complementary, forming part of what is called metacognitive awareness. The analysis of these values indicates a great proximity of the responses in these two groups of metacognitive elements, reinforcing the thinking and conviction in the respondents' use of metacognitive skills and experiences.

The data presented in Table 2 indicate a higher incidence of mobilization of both cognitive and metacognitive strategies by respondents that claim to play games, when compared to those who do not. In other words, this study indicates that Knowledge of cognition and Regulation of cognition are mobilized more effectively by students who use digital games, as there is a relevant selection of "Agree" and "Strongly agree" responses. However, despite the correlation coefficient being very weak ($p<.001$), there is a more frequent mobilization of Knowledge of cognition and Regulation of cognition by those who declare themselves as players.

Table 2. Mobilization of cognitive and metacognitive strategies

	Knowledge of cognition				Regulation of cognition			
	Non-players		Players		Non-players		Players	
	frequency	%	frequency	%	frequency	%	frequency	%
Strongly disagree	0	0	0	0	0	0	0	0
Disagree	6	0.6	4	0.4	0	0.0	0	0.0
Neutral	64	6.8	105	11.2	18	1.9	24	2.6
Agree	217	23.1	372	39.5	181	19.2	328	34.9
Strongly agree	89	9.5	88	9.4	177	18.8	217	23.1

Although the objective of this research is not to make a comparison between players and non-players, the distinction between these two groups of participants is interesting to observe, particularly in that which concerns how metacognitive strategies can be potentiated from the insertion of digital games. This may be used in the context of formal education. As previously seen, the studies of Ke (2008), Kim et al. (2009), Drummon, and Sauer (2015) Castronovo et al. (2018) already indicate that there is a relationship between metacognition and digital games, and the data of the present investigation follow the trend pointed out by these authors. The results obtained in the first part of the instrument indicate that the individuals participating in the study have metacognitive awareness, which may favor their studies, as pointed out in the literature. Based on this result, university professors may carry out a focused planning, taking advantage of the more mobilized strategies, as well as investing on the development of strategies that were not so highlighted, such as those related to procedural knowledge and planning.

3.2. Cognitive and metacognitive strategies with digital games inventory

The second part of the instrument, the ICMSDG, was answered only by students who declared themselves players (N=569). The result was computed and analyzed to relate how cognitive and metacognitive strategies are enhanced from the use of digital games. At this stage, the sums of the responses within the categories were adopted to enable a parametric view of the collected values.

The data can enlighten digital game developers, as well as professors who seek to integrate these artifacts into everyday education. Through analysis it is possible to think of new decisions. For example, activities that promote the development of cognitive strategies need to be provided as the result was neutral in 48% of the responses. For the metacognitive strategies, the score for "Agree" and "Strongly Agree" was 95%, adding the two answer options together. For the cognitive strategies, the result was 39%. In other groups of students, it is possible that this index may be different, depending on the strategies they use in the learning processes. These seemingly not-so-favorable results come close to Drummond and Sauer's (2015) results. These authors indicate that there is a disposition towards higher scores for those who play less frequently. Hypothetically, we can infer that the fact that teachers are not using games in their classes also originates from a negative view by society, and prevents students from being aware of their learning from games. Designers can consider how to incorporate more elements that enable the mobilization of cognitive strategies in addition to the consolidation of metacognitive strategies. On the other hand, professors can carry out a planning focused on the implementation of digital games that give students opportunities to mobilize cognitive and metacognitive strategies.

Among the participants, there is a prevalence of digital games of RPG, Strategy, and Action (Table 3), with a higher incidence among those who indicated being between 18 and 22 years old (48.5%). This result is relevant for professors, who can focus on planning didactic strategies involving these types of games. Designers can also consider this result so that in the development of new games they can privilege these types of games, as well as rethinking which elements can be incorporated into other types of games, in order to make greater use of them. One possible correlation between the type of games and metacognitive mobilization lies in the fact that role-playing, action, and strategy games require more attention from the players in order to find the alternatives in the face of the challenges presented in the games. This element is relevant from the perspective of planning the use of games in the classroom. The preference for games that motivate concentration are the most indicated.

Table 3. Frequency for each age range by type of game

Age range	Type of game								%
	Action	Adventure	Emulation	Strategy	Other types	Puzzle	RPG	Simulation	
18 to 22 years	20.2%	8.2%	1.1%	17.2%	10.5%	12%	21.7%	9%	100%
23 to 27 years	14%	12.3%	1.2%	22.2%	11.1%	7%	22.8%	9.4%	100%
28 to 32 years	5.2%	8.6%	0.0%	25.9%	3.4%	8.6%	43.1%	5.2%	100%
33 to 37 years	10%	5.0%	0.0%	30.0%	5%	35%	0.0%	15.0%	100%
38 years or more	17.1%	20.0%	0.0%	31.4%	8.6%	11.4%	5.7%	5.7%	100%
Total	16.2%	10.2%	0.9%	21.1%	9.6%	10.9%	22.5%	8.7%	100%

Based on the results of the ICMSDG, it is possible to analyze the implications of playing time in relation to the mobilization of cognitive and metacognitive strategies. Such considerations were made from three categories: (a) Average time playing; (b) Playing frequency; and (c) How many years playing. The study of the relationship of the mobilization of metacognition over time starts from Moncart's (2012) understanding that there is a cumulative effect on metacognitive awareness of all the games a person has played. For the author, metacognitive awareness is not likely to measurably increase by playing a game for a relatively short period of time.

Regarding the average amount of time playing (Table 4), the data also indicate that those who declared playing more time per week mobilize more cognitive and metacognitive strategies, agreeing with the assumptions of Moncarz (2012). That is, there is a positive growth in the mobilization of these strategies from the average time playing per week: students who play more than 5 hours per week mobilize more cognitive (average=22.4) and metacognitive strategies (average=57.9), compared to those who play less time (e.g., averages are 15.2 and 51.8, respectively, for those that play less than 1hour/week).

Table 4. Averages for Cognitive and Metacognitive strategies by time playing

	Cognitive Strategies assessment		Metacognitive Strategies assessment		Total	
Average playing time	Average	SD	Average	SD	Average	SD
Less than 1 hour/week	15.2	6.36	51.8	8.22	67.1	11.2
1 to 2 hours/week	17.1	6.17	53.8	6.70	70.9	10.5
2 to 3 hours/week	18.2	6.18	52.7	7.29	70.9	11.3
3 to 4 hours/week	18.3	6.18	54.1	7.81	72.4	11.9
4 to 5 hours/week	20.4	4.69	55.1	5.36	75.5	8.37
5 hours/week or more	22.4	7.03	57.9	6.45	80.4	11.4

Note. SD=Standard Deviation.

Regarding the frequency of play, as shown in Table 5, there is a higher average for those university students who claim that they play every day (Cognitive Strategies=18.7; Metacognitive Strategies=54.5 and Total=73.2), followed by those who indicate that they play a few days a week. These results reveal that those who play every day tend to mobilize more cognitive and metacognitive strategies.

These results indicating increased mobilization of metacognitive strategies by those who spend more time playing is consistent with the studies by Castronovo et al. (2018). It is observed in this result that sporadic use as an intentional educational strategy may not offer the expected results. Planning is required for a more systematic use of games.

Table 5. Frequency of play

	Cognitive Strategies assessment				Metacognitive Strategies assessment				Total			
	1	2	3	4	1	2	3	4	1	2	3	4
Average	17.6	14.6	17	18.7	53.1	51.6	52.2	54.5	70.7	66.2	69.2	73.2
Q1	13	11	13.8	13	49	47	48	49	64	60	61	64
Median	17	14	16	18	53	53	52	55	71	67	68.5	73
Q3	21.3	17.8	21	23.5	59	58.8	57.5	61	77	73.8	76.3	81.5
SD	6.03	5.69	5.40	7.30	6.87	8.89	7.35	7.47	10.5	11.7	9.75	12.5

Note. 1=A few days per week; 2=Sporadically; 3=Weekends; 4=Every day; Q1=1st quartile; Q3=3rd quartile.

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Table 6. Number of years students play

	Cognitive Strategies assessment			Metacognitive Strategies assessment			Total		
	1	2	3	1	2	3	1	2	3
Average	16.4	16.7	18	52.2	52.1	54.3	68.6	68.8	72.3
Q1	11	12	14	47	49	49	60	61	65
Median	15	15	18	52	53	55	68	69	72
Q3	20	21	22	59.5	58	60	75	75	79
SD	7.12	6.13	6.10	7.88	7.22	6.73	12.1	11	10.6

Note. 1=1 to 4 years; 2=5 to 8 years; 3=9 years or more; Q1=1st quartile; Q3=3rd quartile.

For students who indicated that they have been playing for 9 years or more, there is a higher result in the assessments in Cognitive Strategies (median=18), Metacognitive Strategies (median=55) and Total (median=72), when comparing with the remaining groups of students. These results correspond to the results of those who play every day, as previously reported. Considering the number of years' students report playing, with the analysis from the Kruskal-Wallis test, the results gave a χ^2 of 11.5 for Cognitive Strategies, χ^2 of 10.5 for Metacognitive Strategies, and χ^2 of 16.4 for the Total. The effect size of the difference in scores is small (Cohen, 1992), with ε^2 below 0.20. With this study's sample, in relation to the number of years playing, we cannot infer that there is a change in the mobilization of cognitive and metacognitive strategies. A new hypothesis was raised from the result that, apparently, players who play many hours have the tendency of stagnation or decrease of cognitive and metacognitive strategies. As no new challenges are posed, or as players enter a comfort zone, they do not need to operationalize new efforts, which does not imply mobilization of new strategies.

4. Study limits

The results of this study indicate that digital games provide opportunities to mobilize cognitive and metacognitive learning strategies. However, the results also suggest that only two variables influence this mobilization: type of game (Table 3) and time played (Table 4 and 5). The number of years playing, and frequency of play were not found to have an influence. Other studies, including observation or an experimental approach, may present data to support the identification of other variables that should be taken into account.

In the literature, as in this study, there was no evidence of data collected specifically in higher education teacher training courses. It is understood that teacher training, in addition to epistemological issues, should also seek training for the development of learning strategies since these are necessary for the development of learning. Thus, future studies could focus on data collection with students from these higher education courses that qualify for teaching work. Given the finding of a probable stagnation of metacognitive strategies (Table 6), in this aspect, there is a limit to the study, which can be extended with the adoption of other research projects, including, in the long term, the search for data that can answer the new hypothesis presented. It will be necessary to analyze other data collection instruments that reveal elements that support the statement.

5. Conclusions

In agreement with the literature, this study's results suggest that digital games mobilize Knowledge of cognition and Regulation of cognition, two main categories of metacognition according to Schraw and Dennison (1994). In the crossing of data on the age group with the types of games used (Table 3), a strong indication for the preferences that should be used in the classroom or even in gamification strategies, when the results point to those of RPG type, followed by Strategy and Action. Another finding is a greater mobilization of metacognitive skills when observing the time users allocate to gaming, described in Table 4, 5 and 6. Hence, an increased use of cognitive and metacognitive awareness in relation to time was observed in this sample; that is, respondents who play more, claim to have a higher level of metacognitive skills. This claim is corroborated by the indicators in the table of frequency with which they play (Table 5). Observing people who play sporadically, it is seen that they are the ones with the lowest results, highlighting that the frequency at which students play is directly related to greater activity, both cognitive and metacognitive.

Considering the number of years, the respondents play (Table 6), it is clear that the metacognitive resourcefulness is much greater than the cognitive one; that is, there is greater control, thinking and strategies that have been refined over time in gaming practices. In this way, the metacognitive knowledge acquired to guide the player in deciding which strategies work best for a given situation strongly demonstrates their awareness of controlling thought and creating strategies to conduct a quick and effective solution.

Authors' Contribution

Idea, FSCP, VBSJ, MMM; Literature review (state of the art), FSCP, VBSJ, MMM; Methodology, FSCP, MMM; Data analysis, FSCP, VBSJ; Results, FSCP, MMM; Discussion and conclusions, FSCP, VBSJ, MMM.; Writing (original draft), FSCP; Final revisions, FSCP, MMM; Project design and funding agency, FSCP, VBSJ, MMM.

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