Digital Educational Games: Tensioning the Production Process

Juegos digitales educativos: tensionar el proceso de producción

Jogos Digitais Educacionais: Tensionamentos no Processo de Produção

1

ARTICLE

William de Souza Santos

Federal Institute of Paraíba

Postdoctor - Postgraduate Program in Teaching, Philosophy and History of Sciences - UFBa. Doctor and Master in Computational Modeling of Cognitive Systems - Senai / Cimatec. Specialist in Education, Communication and Technologies in Digital Interfaces. Specialist in Mathematics Teaching Methodology. He has a degree in Mathematics. Creator of the Virtual Mathematics Reinforcement website. www.reforcovirtualdematematica.com.br. Pedagogical Consultant in the Mathematics Area in the creation of digital games. His area of interest is Mathematics Education and Technologies.

william_tenor@yahoo.com.br
orcid.org/0000-0002-8598-9756

Lynn Rosalina Gama Alves

Federal University of Bahia

Fellow of Productivity Technological Development and Innovative Extension of CNPq - Level 2, she has a degree in Pedagogy from the Faculty of Education of Bahia (1985), Master degree (1998) and Doctorate (2004) in Education from the Federal University of Bahia. Her postdoctoral fellow was in the area of electronic games and learning at the Università degli Studi di Torino in Italy. She is currently a professor and researcher at the Institute of Humanities, Arts and Science - IHAC - UFBA. She has experience in the area of Education and Digital Games. She has conducted research on the digital universe and its interfaces, especially on the following topics: electronic games, interactivity, mobility and education. She has also investigated the television serial narratives. Coordinator of research and development in digital games projects such as: Triad (FINEP / FAPESB / UNEB), Buzios: Echoes of Freedom (FAPESB), Forest Guardians (CNPq, FAPESB, Proforte), Brazil 2014: Towards Hexa (SEC- Ba), Insitu (SEC-Ba), Industriali (SEC-Ba), Games studies (FAPESB), DOM (SEC-Ba), Janus (SEC-Ba) and Gamebook (CAPES / FAPESB). For eleven years, she has been organizing and coordinating the Seminar on Electronic Games, Education and Communication - building new trails. Research group productions are available at the URL: www.comunidadesvirtuais.pro.br

lynnalves@gmail.com
orcid.org/0000-0003-3688-3506

Abstract

In 2018, the Gamer Census conducted in Brazil recorded that the production of digital educational games surpassed entertainment games, showing a growing interest in the production of this type of learning oriented games. This research has an exploratory character and seeks to discuss which elements should be contemplated in digital educational games, as well as their levels of importance. The results of this research revealed the dichotomy between developers, teachers and players of what should be a digital educational game and what features should be prioritized.

Resumen

En 2018, el Censo de jugadores realizado en Brasil informó que la producción de juegos digitales educativos superó a la de los juegos de entretenimiento, lo que indica un creciente interés en la producción de este tipo de juegos orientados al aprendizaje. La investigación presentada aquí tiene un carácter exploratorio y busca discutir qué elementos deben contemplarse en los juegos digitales educativos, así como sus niveles de importancia. Los resultados de esta investigación revelaron la dicotomía entre desarrolladores, maestros y jugadores acerca de lo que debería ser un juego digital educativo y qué características deberían priorizarse

Resumo

No ano de 2018, o Censo Gamer realizado no Brasil registrou que a produção de jogos digitais educacionais superou a dos jogos de entretenimento, sinalizando um crescimento do interesse na produção desse tipo de jogo voltado para a aprendizagem. A pesquisa aqui apresentada possui um caráter exploratório, e busca discutir quais elementos devem ser contemplados nos jogos digitais educacionais, como também seus níveis de importância. Os resultados dessa pesquisa revelaram a dicotomia entre desenvolvedores, professores e jogadores do que deve vir a ser um jogo digital educacional e quais características devem ser priorizadas por eles.

1. INTRODUCTION

Globally, digital games have been used for various purposes besides entertainment. An example of this are educational games, whose purpose is to mediate learning, allow the construction of school knowledge and stimulate motor, affective or cognitive skills.

Studies by researchers such as Boyle, Connolly and Hainey (2011) sug-gest that teaching based on digital games can provide effective learning experiences. Authors such as Petry, Contreras Espinosa and Eguia Gómez share the same point of view. Their articles are organized in the book written by Alves and Coutinho (2016) and indicate that research conducted in Europe through focus groups, observations, case studies and content analysis, show that games can effectively contribute to learning.

This is one of the reasons why the digital games industry, especially the Brazilian one, has invested in the production of educational games. The 2nd Brazilian Gamer Census of 2018, ABRAGAMES (2018), showed that the production of these interactive educational environments exceeded the production of commercial games (entertainment). According to the overall census, 874 games were educational and 785 games were for entertainment purposes only, out of the total of 1,718 games produced in Brazil. However, it is important to note that this production is not significantly reflected in the pedagogical practices with games in public and private schools. There have only been occasional experiences such as the Virtual Communities Group, Joy Street productions, among others.

The lack of infrastructure in schools or the quality of games can generate a difficult environment, which may be related to the lack of teacher interaction with educational games. This article aims to discuss how to develop digital educational games that motivate teachers and students, along with the evaluation of what characteristics these games should have.

2. HOW EDUCATIONAL GAMES ARE AND HOW THEY SHOULD BE?

According to Domingues (2018),

> ...os serious games pretendem que, por meio de sua aplicação, os seus usuários "sintam" um impulso de fazer uma tarefa que de outro modo não estariam tão atraídos em realizar. Ou seja, o que se pretende é que os seus usuários se sintam motivados a executar uma atividade sem grandes dificul-

dades, algo que os jogos normalmente fazem muito bem. (p. 12)

Despite this perspective, digital educational games do not have to stimulate their players to immerse themselves in narratives, stay motivated and entertain themselves. According to Resnick (2004), entertainment in digital games is a reward after fulfilling missions around school content that need to be learned. That is, the player needs to learn the content before having fun.

As Costa (2009) cites, educational games in general are not fun, while entertainment games have good learning outcomes and are fun. Considering what Costa says, it can be deduced that there is something that does not work with educational games. Perhaps they focus more on content or exercises, when they could learn from games created for entertainment that allow players to experiment joy, entertainment and fun (it emphasizes some exceptions where games such as Assassin's Creed are also being used in school spaces).

For Costa (2009), the development of educational games should be based on the assumption that an educational game must be an entertainment game created from the structure of the knowledge object and not an adapted entertainment game.

This fact was considered by Santos (2014) in the game development process of DOM[1]. According to the author, this game was born from the perspective of articulating the content of quadratic functions with the entertainment and fun features of a game created solely for entertainment purposes. Within an interesting and immersive narrative, the player has direct and

---

1 Available at: http://comunidadesvirtuais.pro.br/cv/games/#4

indirect access to the content without breaking the dynamics of the adventure.

Despite these experiences, such attractive educational games are not evident in most cases. Most educational games are memory games and other casual games that are often confused with virtualized exercises. In addition, the educational "stamp" presented on the name of the games causes a distance from the students, since their immersion in the school universe is characterized as an obligation and not as a recreational space. In this way, an educational game is related to uninteresting situations for users.

Trying to reverse this stigma, there have been attempts to develop educational games that are closer to the characteristics of entertainment games and that can also directly or indirectly fulfill pedagogical purposes.

To deepen the study, the founding elements present in educational games were characterized by the research detailed in the next section.

denced the application of digital games in educational contexts, some elements considered important for digital educational games were identified (it is observed that the emphasis is instrumental, that is, games are present in the school context for a particular purpose: to help learn a concept). The analyzed productions showed the following aspects: immediate and constructive feedback, clear and well-defined educational objectives, challenges in levels, levels of interactivity, concept integration, narrative, transmedia, learning curve and collaborative practices.

After classifying these aspects, an investigation was carried out with a sample of 86 students, professionals and academics from the areas of games and digital technologies. The study was conducted through social networks (Facebook and WhatsApp) and mailing lists (with an online questionnaire available on Google). It was evaluated which of the aspects presented above must be present in a digital game developed for educational purposes.
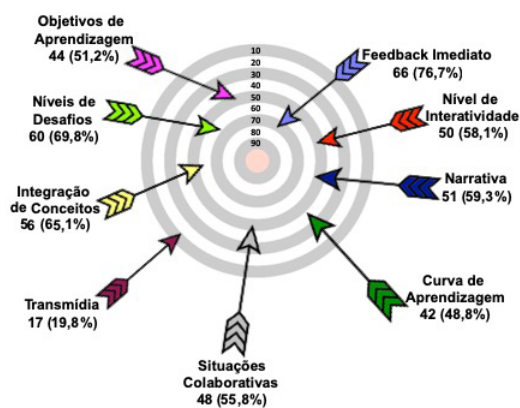
3. MATERIALS AND METHODS

To identify how educational digital games are characterized, a review was performed with the literature database (Thomson Reuters, Educational Resources Information Center (ERIC)), the CAPES Thesis Database and the records of the main gaming events from Brazil: The Brazilian Symposium on Games and Digital Entertainment (SBGAMES) and the Seminar on Electronic Games, Education and Communication (SJEEC).

This research conducted in 2018, looked for productions in the Portuguese or English languages with the descriptors of digital games and evaluation produced between 2012 and 2017. When analyzing the productions that evi-

Figure 1. Selected elements

From this survey, it was shown that eight of the nine elements presented similar values. The deleted element (less chosen) was "transmedia". It is considered that research participants cannot yet relate the transmedia extensions that occur

for different narratives as an important possibility in the learning scenario. Our hypothesis is that games produced for education are often mini games or casual games that do not start from a narrative that allows the construction and expansion of a transmedia universe, such as games produced by Ubisoft.

The Analytical Hierarchy Process Method – AHP[2], is a decision making technique that establishes the relative importance between several criteria, comparing and placing them in a general classification of alternatives. This was the method that was used to establish the level of importance of each of the elements indicated above.

In this stage, 66 responses were obtained and the subjects involved in the research were classified according to their training and their level of experience in digital games, as can be seen in Table 01.

Expe-rience Training	High	Me-dium	Low	Total
Graduates / Students	2	7	2	11
Specialists	7	2	3	12
Masters	10	12	2	24
Doctors	11	4	4	19
Total	30	25	11	66

Table 1. Training and Experience

According to the training of the participants, this division allowed to establish relations between the educational level and the generational stages in which they were, paying attention to their level of experience or knowledge in the area of digital games.

4. RESULTS

After applying the AHP Method, the elements could be compared within the level of importance recorded from their positions, as can be seen in Figure 2.

Analyzing these data based on the training of the participants, it can be evidenced that the graduates/students think that digital educational games must prioritize the levels of interactivity, increase the levels of challenge and the integration of concepts. In order to identify the motivators of this selection, it must be remembered that the graduates/students were part of Generación Z which, according to McGonigal (2011), is composed of young people with an average of 21 years of age who have spent over ten thousand hours with digital games and have invested only three thousand hours reading books in their life.

The integration of concepts, objectives of learning and feedback were the aspects of the composition of digital educational games that drew the attention of people with more specialization. For those with a master's degree, the most important elements are interactivity, integration of concepts and learning objectives. For those who have completed a doctorate, priority is given to learning objectives, feedback and concept integration.

As a result of observing these four profiles, the learning objectives stand out as one of the three elements that experts and people with fourth level education consider most important for digital educational games. Here appears the first disagreement on the conception of digital educational games. Expectations for students/graduates are different from those who intend to use these resources with educational purposes, that is, their teachers. Taking into account
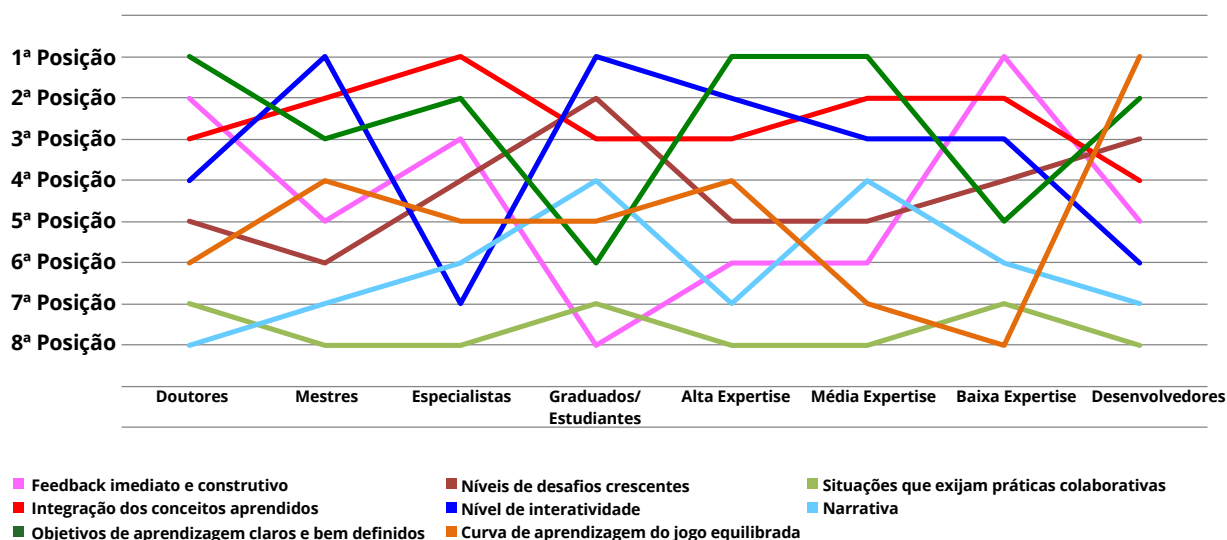
Figure 2. Comparative Chart

that most of them are consumers of digital games for entertainment.

Here are the main problems in the development of digital games for school learning scenarios: neglecting entertainment and forgetting that games have to be fun. This is what the study seeks to find, the idea that it is possible to have fun and learn, as is evidenced in Minecraft.

In the conception of teachers, the resources used in the school must seek the learning of contents. This criterion becomes a priority. As quoted by Pretto (2013), teachers have an instrumental perspective of technologies, but they consider them as simple animators of classes without building a view that can identify them as elements that enhance pedagogical prac-ti-ces. Therefore, when thinking about digital games as animated electronic books, basic characteristics of these artifacts are neglected: entertain or allow to distance from real life, for example (Huizinga, 2000).

This dichotomy of views has sparked a discussion about entertainment and educational games, which are not so fun. For this reason, students and players are not interested in interacting with this type of game.

An issue that is shown in the comparative graph (figure 02) is the low score in "situations that require collaborative practice". In spite of the fact that collaboration could be one of the important factors for success in multiplayer games, this potential for educational games is not perceived. This is a major contradiction, considering that educational practices must prioritize collaboration and cooperation over competition and individual learning.

A possible reason for this is that the skills related to social interaction and collaboration in problem solving are not always evident in schools. Usually, the students think that group work has to be done individually to be later integrated; they do their part instead of looking for collaborative work. Therefore, these skills are also not considered for digital games. This information is based on the experience of the authors of this article, who have been working

Digital Educational Games: Tensioning the Production Process

on basic and higher education during more than twenty years.

Another point that can be observed is the place occupied by the narrative for interviewees who are farther from the students. For graduates/students, the narrative is an element of intermediate importance, while it is the penultimate item for people with fourth level education. According to Alves, Martins and Neves (2009):

> [...] One of the factors that attracts more players to the narratives offered by the games is the possibility of choosing a path that often goes beyond the common linear logic of conventional narrative formats. Another important factor is that the narrative of games is not simply understood and interpreted by the players, but experienced and defined through the transformation of players into characters. (p.10)

For this reason, the narrative is an important element for the player to be transported to the fictional world of the game and have a greater immersive experience. This fact is also evidenced by game developers who have invested heavily in digital game narratives, as noted in the Assassin's Creed and God of War games. On the other hand, educational games have not yet presented good narratives, becoming boring games that do not attract. They often become virtualized exercises without a context or story that connects them to the logic of the game. Usually, "mini games" have no relation to the main theme of the game. However, the opening of courses and book publications that discuss the participation of the narrative in education is emphasized at the market level. The culture is marked by narratives that seduce, involve and motivate humans.

A similar behavior was found with the "increasing challenge of levels" item whose importan-

ce decreased with the increase in the level of education. It is common for players that the challenges grow at each stage of the game, since the player needs to establish new strategies using previously acquired knowledge for each new challenge in order to win.

> One of the most important points in the games is the conflict because each player seeks appropriate challenges, thereby solving the problem of game balance. This is why mechanisms must be created to adequately challenge the player, avoiding boring him with trivial tasks or frustrating him with impossible tasks. (Andrade *et al*., 2005, p.13)

For this reason, authors such as Gee (2005) point out that the school needs to learn from game designers how to propose a balance in activities and challenges for students, offering rewards and learning compatible with their experiences in the game. Therefore, paying attention to the learning curve present in the "gameplay" is essential.

Analyzing the obtained data and taking into account the level of experience of the subjects, it is observed that the responses of those who consider themselves with little experience in the field of digital games, the three most important elements were: feedback, integration of concepts and "interactivity". For those who consider themselves of medium expertise, the three priorities were "clear and well defined learning objectives", "integration of concepts learned " and "level of interactivity".

A similar event occurred with those who consider themselves very skilled in digital games, who maintained these same elements as priorities. However, "clear and well defined learning objectives" remained first, "level of interactivity" ranked second and "integration of concepts learned" ranked third.

Analyzing the comparative chart (Figure 02), it was possible to identify that the integration of concepts learned is an element that remains in the first positions, regardless of the level of experience. This highlights the importance of the application of concepts and their feedback in a digital educational game.

This fact is corroborated in the discourse of Botelho (2004) when he states that:

> digital games can be used for operational skills training, awareness and motivation reinforcement, knowledge and perception development, communication and cooperation training, integration and practical application of the concepts learned, and even the evaluation. (p.12)

The level of interactivity is also among the most important elements. According to Prensky (2012), interactivity is present in digital games through practice and feedback. That is, the player learns through tests and errors. The player must be free to act guided by objectives, discover-ies, tasks and questions in order to have a better immersion in the activity.

There is also an increase in the importance of the item "clear and well defined learning objectives" for those with a higher level of expertise, which shows the concern that educational games need to define this item well as a way to better mediate learning.

Corroborating this thought, Lemos (2016) indicates that:

> To be used for educational purposes, games must have well defined learning objectives, teach the content of the subjects or promote the development of important strategies or skills to increase the cognitive and intellectual capacity of students. (p. 11)

According to the author, it is possible to note that she relates the learning objectives to content teaching. Which indicates that if the game aims to teach certain content, there is a need to define learning objectives. On the other hand, if the game seeks to promote the development of other skills, defining them would not be necessary.

A controversial element in the comparisons was the feedback, which decreased in importance as the level of experience increased. This fact is contrary to the perspective of authors such as Rhodes *et al*. (2017), Freitas Araújo and Almondes (2015), Tonéis (2015), Sung, Chang and Liu (2016), who defend the importance of this element as one of the main items to be considered in educational digital games.

Looking at the perspective of the developers, it can be seen that digital games for educational purposes should include a "balanced learning curve", followed by "clear and well defined lerning objects" and "increasing challenge of levels." Considering these data, it is important to keep in mind that, as developers, these professionals seek to produce a game whose design attracts their consumers and provides a better immersion and flow experience. Attention to the learning curve is key for this to happen, as it motivates players to interact continuously and maintains their persistence and tolerance towards "mistakes" and losses.

According to Trois and Silva (2012), a game must have a well balanced learning curve. If it is very flat, active perception, fun and learning are less intense. If the curve is too high, it will make the player find the game difficult and lose interest in it.

5. CONCLUSIONS

Digital Game Based Learning (DGBL) is gaining importance on the world stage as the production of these technologies increases.

The data presented confirm the premise that games for educational purposes are not fun like entertainment games (commercial games). The latter, ironically, end up being more effective than educational games when used for pedagogical purposes.

Through the analysis of the data presented in this research, it was observed that the generational differences impact on the understanding of how a digital educational game should be. Students, people with third and fourth level education and developers understand digital educational games from completely different points of view and this has a strong impact on the final product that is developed and used in schools.

What most interests players is to immerse themselves in the fictional environment created by digital games and for this reason they prefer interactivity and challenges. People with more training, masters or doctorates, often focus on preparation through continuous evaluations and seek to address the integration of concepts and learning objectives.

Taking these results into account, it becomes increasingly necessary to discuss the participation of entertainment games in education, the differences between them and the games produced for educational purposes. The best way is to listen to students and learn about their experiences and interests around the digital universe and, especially, digital games. In this way, games can be produced in tune with the desires and interests of the users, but considering the school concepts that must be presented and stimulated. At the same time, the specificity of digital games as a product and as a language with its limits and possibilities must be respected.

We believe that the findings and confirmations of previous studies evidenced in this article can support the development of new digital educational games and support what teachers and game designers should consider in the production of these media in order to make them more effective in school learning.

BIBLIOGRAPHY

ABRAGAMES - Associação Brasileira das Empresas Desenvolvedoras de Jogos Digitais. (2018). Dados sobre o Mercado de Games do Brasil. Retrieved from: http://www.abragames.org/o-que-estamos-fazendo

Alves, L., and Coutinho, I. (2016). Games e educação: Nas trilhas da avaliação baseada em evidências. In: Alves, L., Coutinho, I. (Org.). *Jogos digitais e aprendizagem: Fundamentos para uma prática baseada em evidências* (pp. 9–15). Campinas-SP: Papirus.

Alves, L., Martins, J., and Neves, I. (2009). A crescente presença da narrativa nos jogos eletrônicos. In: *VIII Brazilian Symposium on Games and Digital Entertainment*. PUC. Rio de Janeiro. Rio de Janeiro: [s.n.]. Retrieved from: http://www.sbgames.org/papers/sbgames09/culture/full/cult2_09.pdf

Andrade, G., Ramalho, G., Santana H., and Corruble, V. (2005). Challenge-sensitive action selection: an application to game balancing. In: *IEEE. Intelligent agent technology*, ieee/wic/acm international conference (pp. 194–200). France: Compiegne. Retrieved from: http://repositorio.roca.utfpr.edu.br/jspui/bitstream/1/8329/1/PG_COCIC_2017_2_09.pdf

Boyle, E., Connolly, T. M., and Hainey, T. (2011). The role of psychology in understanding the impact of computer games. *Entertainment Computing,* 2(2), 69–74. Retrieved from: https://www.sciencedirect.com/science/article/pii/S1875952110000200

Botelho, L. (2004). Jogos educacionais aplicados ao e-learning. São Paulo. Retrieved from http://www.elearningbrasil.com.br/news/artigos/artigo_48.asp

Costa, L. D. (2009). O que os jogos de entretenimento têm que os jogos educativos não têm. *In VIII Brazilian Symposium on Games and Digital Entertainment: 8-10 de outubro de 2009* (pp. 8-10). Rio de Janeiro.

Domingues, D. (2018). O sentido da Gamificação. In: *Gamificação em debate* / Organização de Lucia Santaella, Sérgio Nesteriuk, Fabricio Fava. – São Paulo: Blucher.

Freitas-Araújo, D. de, *and* Almondes, K. M. de. (2015). Evaluation of intervention with electronic games upon cognitive processes of elementary school students in a Brazilian state-run school: the role of sleep. B*iological rhythm research*, 46(3), 389 – 401. doi:10.1080/09291016.2015.1015234

Gee, P. (2005). Learning by design: Good video games as learning machines. *E-Learning and Digital Media*, 2(1), 5–16. doi:10.2304/elea.2005.2.1.5

Huizinga, J. (2000). *Homo ludens*. Trad. João Paulo Monteiro.

Jenkins, H. (2006). *Convergence culture: Where old and new media collide.* New York: NYU press. Retrieved from: https://www.hse.ru/data/2016/03/15/1127638366/Henry%20Jenkins%20Convergence%20culture%20where%20old%20and%20new%20media%20collide%20%202006.pdf

Lemos, R. da F. (2016). *O uso dos jogos digitais como atividades didáticas no 2° ano do ensino fundamental*. 26 f. Monografia Especialização — Universidade Federal de Santa Catarina. Retrieved from: https://repositorio.ufsc.br/bitstream/handle/123456789/168860/TCC_Lemos.pdf?squence=1&isAllowed=y

McGonigal, J. (2011). *Reality is broken: Why games make us better and how they can change the world*. New York: Penguin.

Prensky, M. (2012). *Aprendizagem baseada em jogos digitais*. SENAC, São Paulo, p. 575.

Pretto, N. de L. (2013). *Uma escola com/sem futuro: Educação e multimídia.* EDUFBA, Salvador.

Resnick, M. (2004). Edutainment? No thanks. I prefer playful learning. *Associazione Civita Report on Edutainment*, MIT Media Laboratory, 14, 1-4.

Rhodes, R. E. *et al*. (2017) Teaching decision making with serious games: An independent evaluation. *Games and Culture*, 12(3), 233–251. doi:10.1177/1555412016686642

Santos, W. S. (2014). *DOM: um modelo de game para a aprendizagem das funções quadráticas no ensino médio*. Dissertação. Programa de Pós-Graduação em Modelagem Computacional e Tecnologia Industrial - Centro Universitário Senai Cimatec, Salvador/BA.

Santos, W. S. (2018). *PAJED: um modelo de avaliação para jogos digitais educacionais.* Retrieved from: https://12c3b48d-162b-3b3a-fc8a-2606b9d4a-f6e.filesusr.com/ugd/5d4133_778e405012704102b37c134417d-2ca81.pdf

Sung, Y-T., Chang, K-E., and Liu, T-C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta- analysis and research synthesis. *Computers & Education*, 94, 252–275. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0360131515300804

Tonéis, C. N. (2015). *A Experiência Matemática no Universo dos Jogos Digitais: O processo do jogar e o raciocínio lógico e matemático.* 160 f. Tese (Doutorado em Educação Matemática) — Universidade Anhanguera de São Paulo–UNIAN/SP, São Paulo. Retrieved from: https://www.capes.gov.br/images/stories/download/pct/2016/Teses-Premiadas/Ensino-Cristiano-Natal-Toneis.PDF

Trois, S., and Silva, R.P. da (2012). Desafiando para ensinar: estudo comparativo entre níveis de dificuldade em games educacional e comercial. In: *Brazilian Symposium on Computer Games and Digital Entertainment*, XIX. (pp. 93–99). Brasília: Sbgames. Retrieved from http://sbgames.org/sbgames2012/proceedings/papers/artedesign/AD_Full12.pdf

OBRA
revista de comunicación
DIGITAL