


# A Decision Game for Informal Learning

Bruno Souza<sup>1</sup>, Marcos Almeida<sup>1</sup> and Rui Pedro Lopes<sup>2</sup> <sup>a</sup>

<sup>1</sup>*Federal University of Technology – Parana, Campo Mourão, Paraná, Brazil*

<sup>2</sup>*Research Center for Digitalization and Industrial Robotics, Instituto Politécnico de Bragança, Portugal*

**Keywords:** Informal Learning, Serious Games, Game-based Learning.

**Abstract:** Lifelong learning implies that people are willing to change their attitude, way of thinking or acting, usually based on some objective. For that, a decision game was developed for iOS and Android devices, using the Unity Game Engine. The premise of the game puts the player in the role of a business manager facing situations that require a decision. The game presents a card based mechanics, allowing the player to choose between two options, sliding the card to the right or to the left, influencing the outcome of the game. The game allows to use different decks of cards. The experience was assessed with the assistance of three instruments: closed questions questionnaire, written exams before and after playing the game and observation.

## 1 INTRODUCTION

Informal learning can be defined as learning obtained outside organized and structured classes (McCartney et al., 2011). As a consequence of this definition, instead of traditional, in-classroom, pedagogical methodologies, informal learning assumes anywhere, anytime and self-learning approach, usually in informal settings or even in the workplace. Learning resulting from daily and family-related activities, work or leisure (such as games) can also be considered informal learning (European Commission, 2001)

Regardless of the learning methodology, the effectiveness of the process strongly depends on the motivation and involvement of the actors (usually, the learner) (Mesquita et al., 2014; Lopes et al., 2018). The scientific literature has been confirming that motivation is higher when playing games (Protopsaltis et al., 2011). This kind of educational games (also known as serious games) includes objectives and intentions beyond entertainment (Deterding et al., 2011). Thus, serious games explicitly designed for learning, if well planned and developed, can foster the informal learning experience and succeed in the construction of knowledge (Protopsaltis et al., 2011).

The methodology of using games for learning (Game-Based Learning - GBL) allows players to experience different roles, take risks, make mistakes and repeat without fear, encouraging the learner to contact


and experience the content (Lopes, 2014; Pivec, 2007; Tenório et al., 2018a,b).

In this paper, we describe the development and use of a serious game with a focus on learning called *Escolha* (Choice, translated from Portuguese). The game adopts a decision making mechanics and it targets small, portable devices, such as smartphones.

## 2 SERIOUS GAMES FOR MOBILE DEVICES

In general, students like to play and will usually play constantly (Kalloo et al., 2010). Teachers have paid attention to the use of games as a form of learning and how these can contribute to improve and facilitate the learning processes (Yue and Ying, 2017). An important aspect of the game design is the definition of the game mechanics. This is a strategic element, implemented with the purpose of providing a playful experience (game mechanics) or learning activity (learning mechanics) (Patino et al., 2016).

Nowadays, the use of mobile devices, such as smartphones and tablets, is ubiquitous. In addition to the broad connectivity possibilities, they can process, present and transmit information and resources, such as texts, sounds, images and videos (Fonseca, 2013). The mobility and portability aspects also allow users to take their mobile devices anywhere and use them at any time (Hamid and Fung, 2007).

<sup>a</sup>  <https://orcid.org/0000-0002-9170-5078>

The possibilities that these platforms introduce have been making them an important terminal for playing games. In this context, game research and development on mobile devices has been done in several areas. For example, in mathematics, Chang and Yang (2016) present a game for learning basic geometry concepts, such as perimeter, area, surface, volume and capacity. Based on the results through the application of exams before and after the use of the game, they demonstrated significant progress in the average score of students.

In other area, namely citizenship, Chee et al. (2010) used Statecraft X with 15-year-old students. Yue and Ying (2017) described the development of the History Learning Mobile Game (HLMG), which aims to teach history in basic education.

Other contexts can also benefit from serious games on mobile devices, such as teaching first aid to individuals with Autistic Spectrum Disorders (ASD), where Urturi et al. (2011) have developed a game for smartphones and tablets, with evidences that the game contributed to enriching and increasing the impact of education and therapy.

## 2.1 Related Games

Decision making allows the player to opt for different actions according to a choice he has to make. There are some games that build their gameplay and narrative in this mechanics.

*Papers, Please* is an initially independent game (Felan, 2014), developed by the American Lucas Pope. Launched in 2013, it takes place in a dystopian moment inspired by the cold war, in which a fictional country, Arstotzka, reopens its borders in 1982, after six years at war with neighboring Kolechia. The game's protagonist is selected to work as an immigration inspector at Grestin's border checkpoint, Arstotzka. As an immigration inspector, the protagonist must control the flow of people entering Arstotzka from Kolechia (Fassone, 2015).

For the inspector's job at the immigration checkpoint, the protagonist uses the documents provided by the travelers and decides who can enter, who should leave and later on in the game, who should be arrested. The player's role in *Papers, Please* is to control the protagonist, who at no time is shown or has his identity revealed.

The player must always check for discrepancies in travelers' documents and whether they meet the requirements for entry to Arstotzka. In addition to checking travelers' documents, later in the game, the resources to search and analyze fingerprints are made available. Throughout the game, smugglers, spies and

terrorists are hiding among the immigrants, so, in addition to the approving and refusing, the player has the option of arresting an immigrant. In addition to the management of immigrants, the protagonist has a family to support: wife, son, mother-in-law and uncle. Each day of the game, the player must meet as many people as possible to receive a higher salary, but if he makes a wrong decision, he suffers a penalty. *Papers, Please* is a management and decision-making game with simple mechanics, in which it brings the player the responsibility of managing the entry of immigrants and supporting their family, allowing the construction of a character throughout history even without having their identity revealed (Paul Formosa, 2016).

*Reigns* is a game developed by Nerial and published by Devolver Digital<sup>1</sup>. Released in 2016, it has support for Android, iOS, Linux, MacOS and Microsoft Windows platforms. The game takes place in a fictional medieval world, where the player assumes the role of a monarch and rules a kingdom making decisions. The goal is to govern for as long as possible without unbalancing the pillars of society: the clergy, the people, the army and finance. In case he cannot keep the balance, the king is killed and a new king starts to rule, so the player to each new king tries to conquer new goals (Hern, 2016).

The main form of gameplay used in *Reigns* is decision making by sliding cards right and left. The cards are displayed randomly to the player, presenting a situation where he must make a decision. Each card is composed of one character, text and two options to choose from. With each choice made by the player, changes occur in resources as consequences, increasing or decreasing the pillars of his kingdom.

*Lapse: A Forgotten Future* is an independent game, developed by Stefano Cornago<sup>2</sup>. Following the same graphic style and gameplay as *Reigns*, in *Lapse* the player assumes the role of a president, who wakes up without knowing what happened in the past and how he became president, so he must make decisions before several characters to control his country in a world post-apocalyptic and with nuclear wars in the year 2075. The game uses the interaction of swiping right and left when making decisions and with characters in the form of cards. With each decision making, a change occurs in the pillars of environment, population, army and finance. The player must always ensure that none of the pillars zero or fill completely, as it will cause the president to die. Unlike *Reigns*, when the protagonist dies, he is not replaced by a new

<sup>1</sup><https://www.devolverdigital.com/games/view/reigns>

<sup>2</sup><https://play.google.com/store/apps/details?id=com.cornago.stefano.lapse>

president, but ends up waking up again. Another difference is that with each decision made, a day passes and not a new year. Even with a shorter story, the game has three different endings in addition to death.

In *Nirvana: Game of Life*<sup>3</sup>, the player assumes the role of a soul that is born as a person, and, when dying, he is born as a new person, maintaining this cycle until the end of the game. During life, you must make everyday decisions, but managing so that there is no imbalance in the pillars of health, happiness, popularity and money. Among the games presented, *Nirvana* has the simplest graphic style. Also using the swipe to the right and left as a form of interaction, the cards show only text, without the silhouette of a character as in *Reigns* and *Lapse*.

Every new person starts at the age of one, and with each decision, a year passes. In the game you can see the cemetery, which shows the people whom the player controlled, and how long they lived. In addition to death, the game has three different endings. *Nirvana: Game of Life* is a simple game, focused on history, with a lot of humor and everyday life decisions. Its gameplay is intuitive and easy to learn, the player uses the slide of the cards to the right or to the left, always trying to manage so as not to unbalance the four pillars of the game.

*Soccer Kings* is a game developed by Tapps Games<sup>4</sup>. The game takes place in a football scenario, in which the player controls a coach hired by a team and must make management decisions to lead the club to success. With each decision a month passes in the game. Its main objective is to keep the three pillars balanced: management, fans and players. In the event of an imbalance, the coach is fired and the game is restarted with a new coach. Similar to the games already presented, in *Soccer Kings* the characters are presented in the form of cards, and you must answer them with a swipe to the right or left, which makes the learning curve very accessible.

## 2.2 Sliding Cards for Decision Making

According to the references in the literature and the success and diversity of games, it is possible to say that the mechanics of sliding cards for decision taking is popular, with several examples of interesting and motivating games. The process of decision making also has the potential to increase the reflection time and, consequently, the effort players use in the process, which can have positive results in the learning process (Glass et al., 2013).

<sup>3</sup><http://goldtusk.com>

<sup>4</sup><http://tappsgames.com/>

In this work, we decided to develop a decision game, based on sliding cards mechanics, to support informal learning, targeting mobile devices so that it can be played anytime, anywhere.

## 3 GAME PROPOSAL

The *Escolha* game puts the player in the role of a business manager, in which he must make decisions and define an underlying strategy so that the finances and reputation of his company do not suffer. The situations brought by the cards and the associated choices depend on the content area, so if the purpose is to learn about cybersecurity, for example, the situations presented for decision making will follow the same topic.

### 3.1 User Interface

The game starts on the first day (day 0) and with each decision the calendar advances to a new day. If the game finishes, because the company has run out of money or has been unable to keep a good reputation, the game is restarted, returning to day 0. The user interface and user experience are based on a deck of cards in which each card presents a situation to the player for a decision to be made. The deck encloses the content to be learned by the player and it is possible to create several decks, that the player can choose from (Figure 1a). The deck, besides the content, also defines the narrative, such as the area of operation of the company, and other elements, including characters, conquests and collectibles (Figures 1a and 1b).

The main screen of the game provides two buttons, one for changing decks and another to access the list of conquests. It is also possible to observe the percentage referring to the reputation, the current day, the amount of money and, in the center, the current card with a description above (Figure 1c).

The conquests and collectible cards are extra goals to be conquered by the player during the game, kept even if he loses. Collectible cards do not present a choice situation but, instead, items that should be retrieved and collected by the players.

The achievements are objectives to be obtained during the game. They can represent time (the number of consecutive days playing *Escolha*), effort (the number of matches) or others (for example, if the player reaches 30 days without losing or obtaining 3 specific collectible cards). Some conquests result directly from the choices, for example, an achievement in which he must invest in the reuse of paint. The final aspect of the game is depicted in Figure 2.

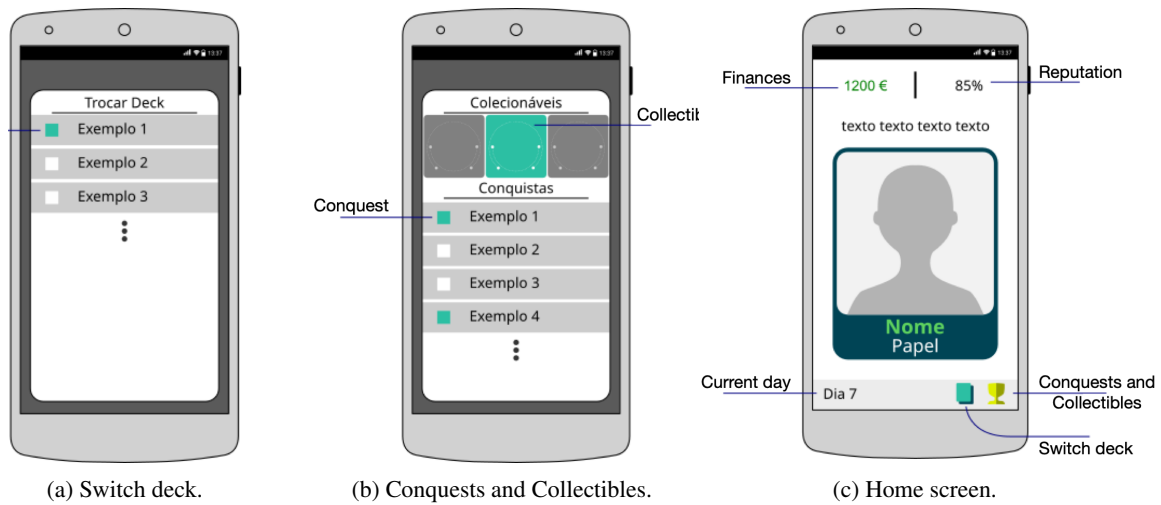


Figure 1: Some *Escolha* screens.

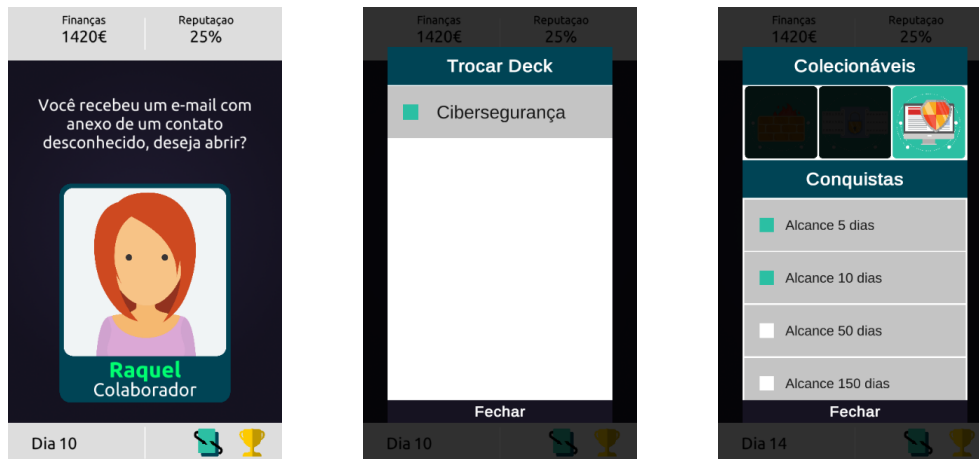


Figure 2: Final design.

### 3.2 Deck Design

The game supports several decks, with a random number of cards. The decks are designed considering the content area and the challenges the player will face. So, deck design should be simple and the game should be able to download decks at runtime.

Each card contains a numeric identifier, a description, the character name, the options available and their respective consequences. This information will be used in the user interface, with the characters' silhouette, names and roles. They can be collaborators, customers, suppliers or community members. Each character can be referenced in several cards, so it can appear multiple times, but in different decision-making situations.

Achievements and collectible cards are objectives to be achieved by the player during the game. Even

if the finances or reputation are zeroed, reaching the end of the game, the goals already achieved are saved in the player's scoreboard.

All decks are defined in structured files, in JavaScript Object Notation (JSON) format, containing all information, such as character, cards, options, consequences, achievements and collectibles. This allows the game to be easily changed, and new content can be added simply by modifying the structured files, or by creating a new file for a new deck.

### 3.3 Game Instrumentation

In addition to the game, additional software was added to implement instrumentation that collects game data and exports them to the cloud. The purpose is to receive anonymous information about the players' choices, for analysis and feedback.

The endpoint was developed in Python and Flask, waiting for data in JSON format from the game. Among the information submitted to the cloud, there is a unique identifier per device, the sequence of cards and the player's decisions, along with the date and time of the decision, the achievements and the collectibles obtained. Such information is separate for each deck. The submission occurs after each player's choice.

The game was implemented in Unity, targeting the Android and iOS platforms. The engine has the necessary libraries already in place, requiring specific compilation afterwards. In this context, the game was compiled to Android using Android Studio (in Windows) and for iOS using Xcode in macOS. The resulting packages were installed in test devices, that were used by the students in class.

## 4 TEST AND EVALUATION

*Escolha* is intended to be played at random times and places, without time constraints or limits. This means that the player should be able to retrieve his phone, play for a couple of minutes, and, later, resume other activities. If he wants to play more time, it is also possible.

The game dynamics occurs as follows. A thematic deck of cards is chosen by the player, marking the context of the choices and narrative. Each card will be presented randomly to the player and, after making a decision, the consequences of the choice must be applied, and the card will be marked as displayed. Cards that have already been shown are only repeated if there are no more new cards to be presented. The game can be interrupted and resumed at later time.

For testing purposes, a test and evaluation scenario was built, according to a specified methodology.

### 4.1 Methodology

First, a deck of cards under the area of cybersecurity was built, based on the course Introduction to Cybersecurity, version 2.1 from the Cisco Networking Academy<sup>5</sup>. This course has 5 chapters with notions about attacks, protection and privacy of personal data and the protection of an organization. The deck consisted of 30 decision cards, with 5 characters, 3 collectible cards and 11 achievements, in a total of 44 cards. All the content focuses on cybersecurity decision making, presenting to the player, as a manager,

<sup>5</sup><https://www.netacad.com/courses/cybersecurity/introduction-cybersecurity>

situations about personal and company data, team and employee management, and internal networks and systems.

A total of 61 students from different study programs, including a class from the Degree in Computer Engineering, Degree in Electrical and Computer Engineering, Superior Professional Technician in Cybersecurity and Superior Professional Technician in Software Development, participated in the test. Of these, 41 played the game.

The students were volunteers and they played the game in classroom. There was an initial questionnaire with questions to assess the game playing habits and opinion and perceptions on the topic of cybersecurity. Then, the classes were divided into two groups, and only one group played. After the first questionnaire, students were given time to obtain the game and install it on their mobile devices. Three days were used for the evaluations and, on average, each class used 40 minutes to answer the initial questionnaire and play the game.

### 4.2 Results

During the evaluation period, players' decisions data were retrieved and submitted anonymously to the cloud, in which it is possible to analyze some aspects about the gameplay and dynamics of the game.

From the JSON file with the users' decisions, some information was extracted and summarized, such as playing time, time for decision making, number of decisions, decision changes for the same card and the management of finances and reputations (Table 1). The average playing time was 14 minutes, enough to explore the whole game, the mechanics and achievements.

Table 1: Player statistics during evaluations.

	Average	SD	Max	Min
<b>Game time (min:s)</b>	14:10	08:32	32:18	00:25
<b>Time for each decision in the 1st minute (min:s)</b>	00:14	00:10	00:56	00:02
<b>Time for each decision in 15 m (min:s)</b>	00:11	00:14	06:53	00:01
<b>Decisions per player in 8 min</b>	32.4	17.2	80.0	4.0
<b>Decisions per player in 15 min</b>	56.7	35.6	138.0	4.0

On average, in the first 8 minutes, 32 decision cards were presented to the player. The remaining achievement and collectible cards were presented and collected also in this time. After 15 minutes, the play-

ers, on average, have already made 56 choices, almost the double of the possibilities contained in the cybersecurity deck. Soon, after this time, the game becomes repetitive, as there are no new situations to be presented to the players. This revealed that 30 decision cards provides a very short experience.

The adaptation to the game mechanics was also analyzed, through the average time taken for each choice. In the test, no demonstrations or tutorials were made to the students, so they had to explore the game autonomously. In the first minute, it is observed that the average for each decision is 14 seconds. It was observed that when some students had discovered the mechanics of sliding the cards, they passed on tips to their colleagues. The fact that decisions take on average more than 10 seconds can demonstrate that students read, interpret situations and options, and then make choices based on the finances and reputation, something important for the purpose of learning.

Initially on the cybersecurity deck, every player starts with 1500 euros of finance. In order to consider the consequences of balanced decisions, one can observe the variation of the players' finances throughout the game. In case the player gradually increases his finances, it indicates that the consequences are mild and the game is easy (Figure 3).

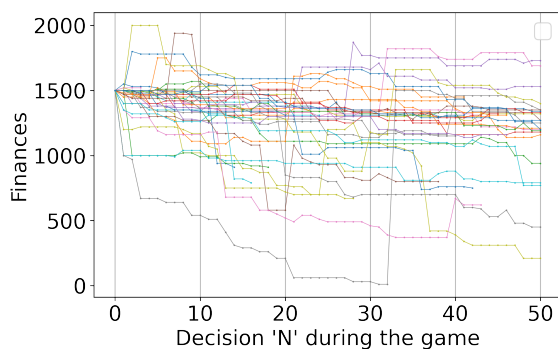


Figure 3: Evolution of the players' finances.

It is observed that the players do not tend to deviate much from the initial finances. It is concluded that the game can be balanced, but not challenging. This is something that should be improved in the design of the decks.

With data for each player, it was verified whether there is a relationship between variables using a correlation coefficient that can indicate patterns in the players' behavior. The coefficient helps us to understand relationships between two variables in the data set. In this work, Pearson's correlation coefficient was used. The Pearson coefficient indicates whether two variables are linearly proportional or inversely proportional. The coefficient is always given in the range

of -1 to 1, with 1 indicating that variables are proportional and -1 inversely proportional. Next to number 1, it indicates that, when a variable tends to grow, the one that is being verified the relationship also tends to grow. The opposite for coefficients close to -1, in which when a variable tends to increase, the one being verified the relationship tends to decrease. If the coefficient is close to 0, the variables have no correlation.

Pearson's correlation coefficient was calculated using the Pandas library with Python. The correlation coefficient between the variables in the data set was calculated, and in this analysis it was possible to obtain two possible relationships. The first is the relationship between the amount of changes in a card presented again and the minimum finances the player had during the game. The diameter of each point indicating the number of total player choices (Figure 4).

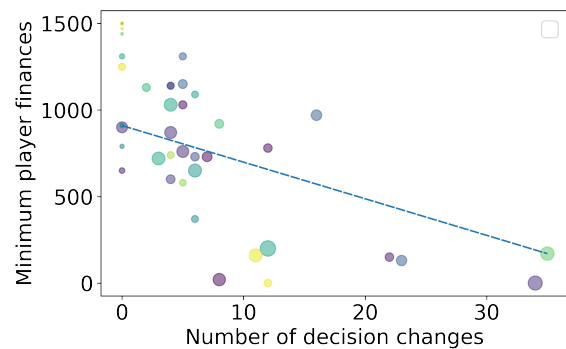


Figure 4: Correlation between choices change and minimum game finance.

A decision change is assumed when a card is presented to the player, he then makes a choice and, when this card is presented again to the player, he makes a different decision. In the first relation, the coefficient obtained was -0.69, that is, players who tend to make different decisions are those who, over the course of the game, occasionally had fewer finances. This relationship can indicate that players who made bad decisions, reducing their finances, when they had new opportunities, changed their choices.

One final analysis was made to assess the percentage of good and bad choices for each player (Figure 5). Analyzing the relationship between the number of bad decisions and the percentage of change from previous decisions, we note a correlation of 0.81. The diameter of each point indicating the total number of choices each player did.

Players who make bad choices tend to change their decisions more for the cards presented again. Therefore, from the two relations obtained, it can be concluded that the players who change their choices

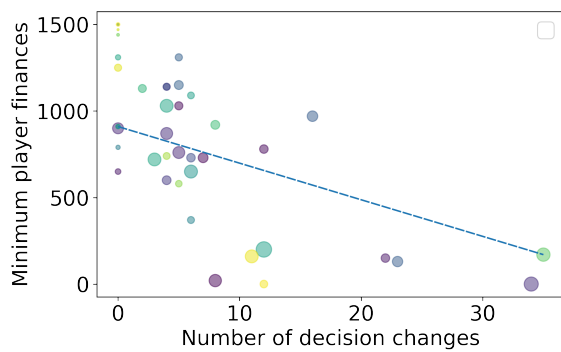


Figure 5: Correlation between good and bad choices.

are also the ones who make bad decisions and occasionally have smaller finances.

## 5 CONCLUSIONS

This work describes the design and development of a game for informal learning. The game was inspired by a sliding cards mechanics, compatible with the reduced screen size of mobile devices. This allows the player to make binary decisions when faced with situations in the role of a business manager. The situations presented to the player are contextualized according to the subject of learning.

The game was tested and evaluated by 41 students, in order to obtain results about the game. They reveal that the playfulness and difficulty strongly depend on the deck design. These should include difficult choices and, eventually, a chance probability for changing the outcome of the narrative. Moreover, the deck should have more cards, to extend the duration of the game.

Nevertheless, this game allows the dealing with different content and areas. In future work, it makes sense to create an online library for sharing decks, which improves the game's relevance. Another aspect to consider is add a possibility for multiple choices, maintaining the game mechanic as simple as possible.

## ACKNOWLEDGEMENTS

This work has been supported by FCT – Fundação para a Ciência e Tecnologia within the Project Scope: UIDB/05757/2020.

## REFERENCES

- Chang, R.-C. and Yang, C.-Y. (2016). Developing a mobile app for game-based learning in middle school mathematics course. In *International Conference on Applied System Innovation (ICASI)*, pages 1–2.
- Chee, Y., Tan, E., and Liu, Q. (2010). Statecraft X: Enacting Citizenship Education Using a Mobile Learning Game Played on Apple iPhones. In *6th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education*, pages 222–224.
- Deterding, S., Dixon, D., Khaled, R., and Nacke, L. E. (2011). From Game Design Elements to Gamefulness: Defining Gamification. In *MindTrek'11*, Tampere, Finland. ACM.
- European Commission (2001). Making a European area of lifelong learning a reality. In *Communication from the Commission. COM(2001) 678 final. In European Commission*. Brussels, Belgium.
- Fassone, R. (2015). Isto é um jogo de vídeo: jogos de vídeo, autoridade e metacomunicação. *Comunicação e Sociedade*, 27:19–35.
- Felan, P. (2014). Indie Game Studies Year Eleven. In *DiGRA'13 - Proceedings of the 2013 DiGRA International Conference: DeFragging Game Studies*.
- Fonseca, A. (2013). Aprendizagem, mobilidade e convergência: mobile learning com celulares e smartphones. *Revista Eletrônica Do Programa de Pós-Graduação Em Mídia e Cotidiano*, 2(2):265.
- Glass, B. D., Maddox, W. T., and Love, B. C. (2013). Real-Time Strategy Game Training: Emergence of a Cognitive Flexibility Trait. *PLoS ONE*, 8(8):e70350.
- Hamid, S. and Fung, L. (2007). Learn Programming by Using Mobile Edutainment Game Approach. In *2007 First IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning*, volume DIG-ITEL'07, pages 170–172.
- Hern, A. (2016). Reigns review: the medieval strategy game based on Tinder. *The Guardian*.
- Kaloo, V., Kinshuk, and Mohan, P. (2010). Personalized game based mobile learning to assist high school students with mathematics. In *Proceedings - 10th IEEE International Conference on Advanced Learning Technologies, ICALT*, pages 485–487.
- Lopes, R. (2014). An Award System for Gamification in Higher Education. In *ICERI2014 Proceedings*, pages 5563–5573.
- Lopes, R. P., Mesquita, C., de la Cruz del Río-Rama, M., and Álvarez García, J. (2018). Developing Sustainability Awareness in Higher Education. In Peris-Ortiz, M., Gómez, J. A., and Marquez, P., editors, *Strategies and Best Practices in Social Innovation: An Institutional Perspective*, pages 131–152. Springer International Publishing, Cham.
- McCartney, R., Eckerdal, A., Moström, J., Sanders, K., Thomas, L., and Zander, C. (2011). Computing students learning computing informally. In *Proceedings of the 10th Koli Calling International Conference on Computing Education Research*, pages 43–48.



- Mesquita, C., Lopes, R. P., García, J. I., and Rama, M. d. I. C. d. R. (2014). Pedagogical Innovation in Higher Education: Teachers' Perceptions. In Peris-Ortiz, M., Garrigós-Simón, F. J., and Gil Pechuán, I., editors, *Innovation and Teaching Technologies: New Directions in Research, Practice and Policy*, pages 51–60. Springer International Publishing, Cham.
- Patino, A., Romero, M., and Proulx, J. (2016). Analysis of game and learning mechanics according to the learning theories. In *8th International Conference on Games and Virtual Worlds for Serious Applications, VS-Games*, pages 1–4.
- Paul Formosa, Malcolm Ryan, D. S. (2016). Papers, Please and the systemic approach to engaging ethical expertise in videogames. *Ethics and Information Technology*, 18(3):211–225.
- Pivec, M. (2007). Play and learn: potentials of game-based learning. *British Journal of Educational Technology*, 38(3):387–393.
- Protopsaltis, A., Pannese, L., Pappa, D., and Hetzner, S. (2011). Serious Games and Formal and Informal Learning. *ELearning Papers*, 25(July 2011):1–10.
- Tenório, M., Reinaldo, F., Esperandim, R., Lopes, R., Gois, L., and Dos Santos Junior, G. (2018a). Céos: A collaborative web-based application for improving teaching-learning strategies. In *Advances in Intelligent Systems and Computing*, volume 725, pages 107–114.
- Tenório, M. M., Reinaldo, F. A. F., Góis, L. A., Lopes, R. P., and dos Santos Junior, G. (2018b). Elements of Gamification in Virtual Learning Environments. In Auer, M. E., Guralnick, D., and Simonics, I., editors, *Teaching and Learning in a Digital World*, Advances in Intelligent Systems and Computing, pages 86–96. Springer International Publishing.
- Urturi, Z., Zorrilla, A., and Zapirain, B. (2011). Serious Game based on first aid education for individuals with Autism Spectrum Disorder (ASD) using android mobile devices. In *16th International Conference on Computer Games (CGAMES)*, pages 223–227.
- Yue, W. and Ying, C. (2017). The Evaluation Study of Gamification Approach in Malaysian History Learning via Mobile Game Application. In *2017 IEEE 17th International Conference on Advanced Learning Technologies (ICALT)*, pages 150–152.