






ORIGINAL

Update on the use of gamified educational resources in the development of cognitive skills

Actualización sobre el uso de recursos educativos gamificados en el desarrollo de habilidades cognitivas

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ABSTRACT

Introduction: the use of game elements and game design techniques in content unrelated to the same is known as gamification. It is likely that gamified environments generate a fruitful scenario to evoke complex processes within higher nervous activity and thus develop cognitive skills. This facilitates its application for educational purposes. The objective was to characterize the use of gamified educational resources in the development of cognitive skills.

Method: a total of 27 articles in Spanish and English were reviewed, from Pubmed, Scielo and Scopus; using as keywords: gamification, game, cognition, being more than 50 % of the last five years.

Result: gamification improves the services in which it is applied through playful experiences, it can positively influence aspects of the student experience such as level of interest, intellectual intensity and intrinsic motivation, by providing opportunities for autonomy, relationship and competition. There is a strong need for further exploration and experimentation to provide a gamified design that meets user preferences, tailored to individual characteristics.

Conclusions: Gamified educational environments facilitate learning like a game. Through gamification it seems to increase motivation, commitment, active interaction, level of interest, critical thinking, intellectual intensity and intrinsic motivation. The effectiveness of gamification largely depends on the use of different game features and how they are implemented.

Keywords: Gamification; Game; Cognition.

RESUMEN

Introducción: se conoce como gamificación al uso de elementos de juego y de técnicas del diseño de juegos en contenidos ajenos al mismo, es probable que los entornos gamificados generen un escenario fructífero para evocar procesos complejos dentro de la actividad nerviosa superior y así desarrollar habilidades cognitivas, ello facilita su aplicación con fines educativos. El objetivo fue caracterizar el uso de recursos educativos gamificados en el desarrollo de habilidades cognitivas.

Método: se revisaron un total de 27 artículos en español e inglés, provenientes de PubMed, Scielo y Scopus; utilizando como palabras clave: gamificación, juego, cognición, siendo más del 50 % de los últimos cinco años.

Resultado: la gamificación mejora los servicios en los que es aplicada a través de experiencias lúdicas, esta puede influir positivamente en aspectos de la experiencia del estudiante como el nivel de interés, la intensidad intelectual y la motivación intrínseca, al brindar oportunidades de autonomía, relación y

competencia. Existe una gran necesidad de mayor exploración y experimentación para proporcionar un diseño gamificado que satisfaga las preferencias de los usuarios, adaptada a las características individuales. **Conclusiones:** Los entornos educativos gamificados facilitan el aprendizaje como un juego. A través de la gamificación parece incrementar la motivación, el compromiso, la interacción activa, el nivel de interés, el pensamiento crítico, la intensidad intelectual y la motivación intrínseca. La eficacia de la gamificación depende en gran medida del uso de diferentes funciones del juego y de cómo se implementan.

Palabras clave: Gamificación; Juego; Cognición.

INTRODUCTION

Considering play as an exclusively entertainment or amusement activity is a fairly generalized social conception; it has been used in other areas such as teaching and learning.⁽¹⁾

Game-based learning (GBL) is defined as a methodology in which games are used for the purpose of learning through play. The game becomes the vehicle for learning or for working on a given concept.⁽¹⁾

Gamification (GM), on the other hand, emerged in 2002 as an expression to describe the interest in incorporating game elements in the user interfaces of applications. Later, other authors have adapted the concept to statements such as the use of game elements and game design techniques in non-game content,⁽¹⁾ so that a product, service, or application becomes more fun, attractive, and motivating.⁽¹⁾

Gamification is a process that is related to the player's thinking and game techniques, allowing the user to solve problems, which is why by encouraging the individual to solve them, he/she will be able to seek strategies that encourage this process and achieve the objectives set.⁽³⁾

The areas of use range from innovation, marketing, talent management, and learning to the development of healthy and responsible habits.⁽²⁾ In recent years, the use of gamified environments to develop cognitive skills and strengthen education at different levels has become popular in the international community.

Cognition is the capacity of people to acquire and develop knowledge.⁽⁴⁾ At the same time, cognitive skills are operations of the intellect by which the subject is able to assimilate the information, content, or skill to develop it at another time in life.⁽⁵⁾

Cognitive functions are first established in the social sphere and then in the individual sphere, and it is through the mental operations that occur during the interaction of the person with the world that learning crystallizes. Cognitive strategies significantly develop logical thinking.⁽⁶⁾

It is considered that gamified environments generate a fruitful scenario to evoke complex processes within higher nervous activity and thus develop skills such as reasoning, short-, medium-, and long-term memory, mental agility, orientation, language, comprehension, learning, evaluation, organization, and emotional self-regulation.

Through gamification, motivation and engagement increase, and active interaction is favored, thus positively affecting the learning process.⁽⁷⁾ Although considerable research efforts have been made in this field, conclusive evidence on the effectiveness of gamification in the educational context has yet to be provided.⁽⁸⁾

In view of the above, the present study was carried out with the aim of characterizing the use of gamified educational resources in the development of cognitive skills.

METHODS

A review of the literature was carried out, analyzing articles in Spanish and English from the Scopus, PubMed, and Scielo databases using the following keywords: gamification, game, and cognition. The necessary information was extracted from the 21 selected articles, which, after synthesis and ordering, were used for the preparation of this research.

DEVELOPMENT

The human brain is compared to a computer that can perform rapid serial processing of stimuli to achieve cognitive goals. Functions such as attention, memory, and decision-making are generally associated with cognition. The cognitive functions listed in the taxonomy of brain mapping include attention, language (spelling, phonology, semantics, speech, syntax), memory (explicit, implicit, and working), music, reasoning, social, somatic, spatial, and temporal. Their integration contributes to emotions and complex activities.⁽⁹⁾

Cognitive skills are also considered strategies aimed at encoding, comprehension, retention, and production; they are also divided into retention, elaboration, and organization strategies.⁽⁵⁾

Advances in cognitive neuroscience have led to the understanding that emotion and cognition determine human behavior, and the latter is driven by complex and confounding interactions along multiple affective and cognitive dimensions. Gamified experiences must generate emotions so that these interact with cognitive skills

to influence behavior and enable desired outcomes.⁽⁵⁾ Changes in cognitive, affective, or skill capabilities often measure learning outcomes.⁽¹⁰⁾

Although gamified learning and game-based learning have overlapping research literature, common tools, and game design elements and the same focus on adding value beyond entertainment, they are different. While game-based learning approaches involve designing complete (serious) games, gamified learning approaches focus on augmenting or altering an existing learning process to create a revised version of this process that users experience as a game.⁽⁸⁾

There is a theory of gamified learning that proposes that instructional content directly influences learning outcomes as well as learner behavior; because GM is generally not used to replace instruction but rather to enhance it, effective instructional content is a prerequisite for successful GM. The goal of GM is to directly affect behaviors and attitudes relevant to learning.⁽⁸⁾

Lander's Gamified Learning Theory, based on the Input-Processing-Output model, suggests that the instructional material drives the training process and that the material is expected to trigger a learning cycle. The process of visiting and reviewing the material is expected to enhance the learning process and outcomes.⁽¹⁰⁾

GM enhances the services in which it is applied through playful experiences. A playful experience involves the subject perceiving that he or she is playing, whether the activity is normally associated with games or not.⁽¹¹⁾

Despite academic interest in understanding and utilizing the engaging features of games, academia has needed to be faster to react to the rise of gamification projects in companies and on the Internet. Initial support for the effectiveness of gamification came primarily from business, where the idea that tasks can be made more efficient and engaging by wrapping them in game design elements quickly gained popularity.⁽¹²⁾

This technology can influence both working memory and episodic memory. Gamified working memory training increases motivation to train near peak levels compared to traditional training. Episodic memories often have strong associations with a particular time or place, so the potential for creating them through immersive games is high. To the extent that game design elements can enhance motivation and provide an immersive and memorable environment through emotional experiences, designers can leverage cognitive-emotional processes to help achieve memory and learning goals.⁽⁹⁾

According to Csikszentmihalyi and Bronfenbrenner⁽¹³⁾ more cognitively complex and challenging classroom work engages students more deeply. Research corroborates this theoretical position and demonstrates that students become significantly more engaged and focused when they are challenged in classrooms. The challenge-ability dynamic has also been found to increase motivation while expanding players' capabilities. When invited to engage in complex problem-solving rather than confronting issues only superficially, students see more connections, become more intrinsically interested, and therefore also pay better attention.

In the body of empirical literature, flow (challenges and skills), engagement, and immersion have a positive impact on learning. Research suggests that increases in challenges and skills are related to higher degrees of engagement and immersion and that challenges, skills, engagement, and immersion may also be directly related to greater learning, in addition to mediated effects.⁽¹³⁾

UNESCO (2020) mentions that adaptive technology matches materials to the educational needs of learners, which is why technology has been considered an important element in stimulating educational learning.^(3,14)

Authors^(3,15) affirm that this modality has been criticized due to the idea that games and learning do not go hand in hand. Although the main criticism of this method is its very nature, the authors agree that gamification should be used proportionately by qualified personnel, as this is a factor that determines its effectiveness.

In an ideal educational game environment, students learn to solve complex problems. Problems within a game generally begin easily and then become progressively more difficult as players' skills develop. They are motivated to learn because learning is situated and occurs through a process of hypothesizing, probing, and reflecting on the simulated world within the game. In addition, the objectives are clear, and information is available to players when they need it to achieve each objective. Making sense of that information becomes an intrinsic goal of the game.⁽¹³⁾

In combination, various attributes such as "challenge/surprise" (difficulty and uncertainty) and "rules/goals" (to enable performance control) have a positive influence on knowledge application, cognitive strategies, declarative knowledge, and knowledge organization. These practices may be related to deep learning, and gamification may have more far-reaching consequences than those commonly measured.⁽¹⁶⁾

Games typically generate physical or mental stimulation, and often both; they help acquire practical skills, serve as exercise, have an educational role, and contribute to psychological development and balance. Playing is a way of exercising concentration and, at the same time, awakening curiosity, which is what drives learning; it is a complete activity that encompasses the areas of knowledge: physical, psychic "provokes thinking, expressing oneself" affective "provokes feelings" and social "involves relating to others".⁽¹⁾

The GM of educational methods has the advantage of incorporating what is important in the world of video games to increase student participation without using any particular game. Students learn by playing a specific

game rather than by learning as a game.⁽¹⁷⁾

Most authors agree that gamification is a fundamental factor in increasing user motivation.⁽¹⁸⁾ For his part, Carpio Lozada⁽¹⁹⁾ mentions that the game is an essential tool in teaching practice, the implementation of which constitutes an innovative mechanism adapted to the university context.

The implementation and use of gamified environments for educational purposes is determined by the technological development of the institution that wishes to promote it; being a first-world technology, it requires specific informational elements for its proper functioning. This can be an obstacle to the popularization of this practice in developing countries.

There is evidence that games and GM can positively influence other aspects of the learner experience, such as interest level, intellectual intensity, and intrinsic motivation, by providing opportunities for autonomy, relatedness, and competence.⁽¹⁶⁾ Gamification allows awareness of the mechanisms of motivation, increases strength with each triumph, and new learning is acquired through simple activities, with the aim of increasing the level of complexity.⁽³⁾

Studies on the positive impact of games on university students often analyze existing video games and consider how different genres can support the development of certain skills, such as critical thinking or teamwork.⁽²⁰⁾

Current approaches to studying gamification adopt psychological perspectives based on traits, behavioral learning, cognition, self-determination, interest, or emotion. This same author states that GM environments influence engagement. GM outcomes vary depending on the gamified tasks and include increasing attention and engagement, improving service encounters and decision-making.⁽¹¹⁾

Peculiarities

The term gamification is not just about the use of games, nor is it just about obtaining incentives or rewards as a source of motivation; the gamification process goes beyond that; it is about the development of skills and abilities that allow the organization of sequences through different elements that are part of a game. There is no game as such; rather, the student is encouraged to perform the activities and distribute the tasks, making him/her believe that he/she is in a game.⁽³⁾

Cornellá et al.⁽¹⁾ cite in their article the characteristics of the game that make gamification a valuable resource: it is free, not compulsory; it is, therefore, a voluntary activity. It is separate from the routine of life; it occupies its own time and space. It is uncertain; this means that the results of the game cannot be predetermined, and the player's initiative is involved. It is unproductive; it does not generate wealth, and, economically speaking, it ends as it begins. It is governed by rules that change the laws and normal behaviors that players have to follow. It involves imaginary realities that can be set against "real life."

According to Mageswaran,⁽²¹⁾ a simple use of GM without proper thought will result in a meaningless GM. At the same time, the activity includes points and external rewards for achieving specific goals. This will create an unwarranted dilemma among users as if they are attracted to the gamified system that only uses extrinsic rewards to attract users. Someday, this will create a scenario where, when the reward is non-existent or not rewarding enough, their internal motivation will be affected, and eventually, they will find it uninteresting.

Welbers⁽¹²⁾ clarifies that GM for learning can only be successful when students play for an extended period so that they process enough (new) information for learning to take place.

The impact of the relationship on interpersonal activities may be crucial; the type of social interaction that is likely to occur as a result of gamification could be affected in relation to learning outcomes. Collaboration and competition are particularly important in this context. Competition may cause social pressure to increase the level of learner engagement and may have a constructive effect on participation and learning.⁽⁸⁾

A recent literature review of academic research related to GM found that most research on the topic verified that GM can work, although the effects differ across contexts. By context, the authors refer to the type of activity being gamified, such as exercise, sustainable consumption, tracking, or education.⁽¹²⁾

The characteristics that an ideal gamified environment should possess are varied within the international scientific community, and the authors consider it necessary to develop guidelines for the correct development and use of gamified environments in education with international participation.

GM generally leads to positive results, but some findings are mixed or even negative. Failed GM efforts are the result of poor game design, for it is through gameplay that game experiences are manifested, and these elements must interact to evoke emotional engagement in the player.⁽¹¹⁾

Zainudina⁽²²⁾, in their systematic review on the impact of gamification on learning and instruction, found that the main reason why gamified learning was ineffective in the available studies was related to the use of game-based elements, instructional design, and technical issues. Welbers⁽¹²⁾ agrees that the effectiveness of gamification depends largely on the use of different game features and how they are implemented.

Jeffrey⁽¹¹⁾ states that it is important to ensure that most gamified experiences are pleasant; however, it is valid to recognize that both positive and negative experiences can help to achieve the desired goals.

The authors found that, among the studies consulted, those that provided negative data regarding this practice were associated with misuse of the environment and poor preparation of the personnel who directed its use, and it could even be inferred that these are results associated with the methodological characteristics of the chosen research.

Khaldi⁽²³⁾ indicates that there is a great need for further exploration and experimentation to provide a gamified design that satisfies the preferences of the users as well as the task at hand. In other words, personalization in GM should be extended to content, as it does with user profiles, for example, by applying machine learning techniques to adapt the choice of game elements to the gamified content.

Dahalan et al.⁽²⁴⁾ in their systematic review of GM and game-based learning in vocational education and training, concluded that both can improve academic performance, engagement, and motivation in vocational education students, although they suggest the need to determine the most appropriate strategies in the application of these modalities.

Smiderle⁽²⁵⁾ found that GM affects users in different ways according to their personality traits, indicating that the effect of GM depends on the specific characteristics of the users. Hamari,⁽¹³⁾ asserts that one of the possible factors that can help improve the effects of GM on the learner experience is the personalization of the design.

In many learning environments, pedagogy assumes that all learners have homogeneous characteristics. However, research argues that only some gamification projects work because they are designed for a group of system users without considering the personal needs of each. Hence, the advantage of personalized learner training is that all learners differ in preferences, styles, and abilities with respect to learning processes with or without technological mediation.⁽²³⁾

Some authors agree that GM should not be one-size-fits-all but should be tailored to the user. It should make the user feel in control and that achieving the objectives will not only be rewarded with points but also create a sense of accomplishment and completion. This avoids the existence of rewards that a user may become too accustomed to and start to expect. Focusing solely on the mechanics of the game will create a false scenario in the achievement of a goal. The positive of the game-based experience lies in the fun.⁽²¹⁾

Increasing evidence suggests that GM is accepted as an effective learning strategy used to create highly engaging experiences. Based on empirical evidence from recent studies, the success of digital games in education has sought to validate the effects of GM in support of its potential to enhance motivation, engagement, and social influence while allowing students to immerse themselves in experiential learning.⁽²²⁾

Application

GM applications can be very diverse, and research has often needed to recognize that many different elements of game design can result in different opportunities for learners, modes of social interactions, and learning arrangements.⁽⁸⁾

Turan⁽²⁶⁾, in his study on GM and elementary education, examined the effect of GM strategies on students' cognitive load levels and achievement, along with their views on GM. They found a significant difference between the two groups, indicating higher achievement in the experimental group. When comparing cognitive load levels, the experimental group also scored higher than the control group. The interviews indicated that the students had positive views on GM strategies. The authorship is necessary to clarify that the research sample was selected non-randomly. Furthermore, the instrument was not administered to both groups by the same staff, and participation was by availability.

Khoshnoodifar et al.⁽⁷⁾ in their study on the effectiveness of GM in improving learning and attitudes about statistics education for health school students, point out that the use of GM environments with active learning methods enables students to discover, construct, and understand important statistical concepts as well as to develop statistical thinking.

The author feels it necessary to cite the term active learning, which is defined as a set of approaches that involve learners in working or solving problems related to what they are doing.⁽⁷⁾

The same work had results that compared to the control group, the intervention group had a more positive attitude toward learning difficulty, value, and cognitive competence; however, learning between the two groups was not different.⁽⁷⁾

Prieto Andreu et al.⁽²⁷⁾ in their systematic review on the use of GM in education, selected and analyzed a total of 37 studies purposively chosen following specific evaluation standards and found that GM has a direct and positive impact on students' experiences in terms of motivation and performance. It highlights that GM is being approached academically from two perspectives: as a methodology aimed at motivating students in their competency-based learning and as a way of boosting academic performance in the different areas of knowledge.

Sailer⁽⁸⁾ in his meta-analysis on the gamification of learning, obtained results that the models showed small significant effects of gamification on cognitive, motivational, and behavioral aspects. These results suggest that gamification, as currently operationalized in empirical studies, is an effective method for instruction. However,

the factors contributing to successful gamification are still somewhat unresolved, especially for cognitive learning outcomes.

Khoshnoodifar⁽⁷⁾ indicates that the literature consulted in his study demonstrates that the application of GM in the educational field improves cognitive, motivational, and behavioral outcomes to a small to medium extent.

Huston, 20 points out that there are several strategies that educators at different levels can adopt when gamifying their curriculum. For example, activities within the classroom can be gamified, such as adding point systems to responses and discussions for fully immersive adventure experiences that last an entire course. Regardless of an educational institution's resources, there are many educational video games freely available on the web, with experiences from preschool through sixth grade.

Among the main limitations of this study are: its bibliographic nature, the fact that the characteristics of the research found needed to be analyzed in detail in order to clarify the scientific evidence available on the subject, the fact that only articles in two languages were reviewed. For future research, it would be necessary to pool and systematize the main results of GM applied to education in order to clarify its true usefulness.

CONCLUSIONS

Gamified educational environments facilitate learning as a game. Through gamification, it increases motivation, engagement, active interaction, interest level, critical thinking, intellectual intensity, and intrinsic motivation. The effectiveness of gamification depends largely on the use of different game functions and how they are implemented.

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