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ORIGINAL RESEARCH ARTICLE

Application of augmented reality, gamification and m-learning

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ABSTRACT

Augmented reality, gamification and m-learning occupy today an important place in education, given the advantages that the use of mobile technologies has brought, independently or in combination with other technological scenarios and different devices that affect the teaching and learning of disciplines or that serve as a bridge to improve various processes mediated by ICT in teaching and/or learning. In this sense, the article presented here shows an analytical study that was developed under an exploratory, descriptive and interpretative methodology of the categories augmented reality, gamification and m-learning, based on a characterization in the databases, a literature review was conducted in the main databases such as Science direct, Scopus and web Science, obtaining 100 reference articles. Thus, it was found that these three categories determined as teaching strategies significantly influence motivation, interest in knowledge, retention and understanding of information for the development of teaching and learning processes. The method used allowed to develop the description of the panorama about the use of augmented reality, m-learning and gamification in elementary, middle and higher education.

Keywords: teaching; gamification; m-learning; augmented reality

1. Introduction

The incursion of emerging technologies in learning methods for elementary, middle and higher education has become a common theme in recent years, because augmented reality translates the integration of virtual images in the real world, i.e., reality is augmented with virtual elements[1]. The implementation of such images is done through the use of Information and Communication Technologies (ICT), through electronic devices such as (tablet, computer, phone, etc.) which allow access to information available in augmented reality applications[2].

Likewise, augmented reality is the combination of digital and physical content through technological devices generating a new reality by interposing digital information on the physical one. In relation to teaching, this technology is reflected as a didactic tool in learning, providing greater effectiveness in the educational area[3]. A shortcoming in the process of adapting technology in education is the lack of financial resources for the acquisition of devices, the

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devices previously obtained do not meet the necessary characteristics or parents and teachers resist the use of this type of products for learning[4].

Gamification is defined as the use of game design elements and game mechanics in non-game contexts to engage people and solve problems[5]. The growing interest in the use of gamification in educational aspects to improve student engagement and learning outcomes formalizes it as an attractive and innovative methodology. However, the existing documentation has few appearances in journals, implementing gamification without a gradual incorporation can be detrimental in the learning process, experiencing confusion and possible distractions in students by new rules and ways of learning[6].

According to m-learning can be defined as the implementation of learning in multiple contexts using personal electronic devices, through social interactions and content[7], in relation to education it can be developed both outside and inside a classroom, being an attractive way of learning for students and teachers. However, there is still a need for more extensive research on the incursion of technology in the classroom, especially on how it affects the role of the teacher in the classroom[8].

This paper aims to develop a literature review of the use of augmented reality, m-learning and gamification in teaching, using scientific articles, literature review, case studies among other review articles, among others.

2. Methodology

The present study was conducted from an exploratory method with a descriptive approach, applying this method a search was conducted in the databases “ScienceDirect”, “Web Science” and “Scopus” of significant experiences related to the use of augmented reality, gamification and m-learning in teaching. To perform the searches, the categories of augmented reality, gamification and m-learning were approached, obtaining a universe of 100 articles related to the different categories. After the search, we proceeded to perform the analysis based on the following research questions and the contribution made by the articles to answer the questions posed. What are the gaps in the topic? How is the topic developing over the years? What is the current discussion focusing on? What are the relevant topics in these investigations? Based on these four questions, the classification of the articles in the previously established categories and possible emerging categories was carried out in a systematic way and answers were obtained from the analysis of each article.

3. Augmented reality

Augmented reality as a technology has had little intervention in education compared to others, university education centers present lack of adoption of this tool with respect to other educational levels, ignoring its characteristics as a learning environment, likewise, research on the use in this area are few. Another factor causing the minimal use of this technology is the insufficient number of experts in the field with the necessary skills to develop, design and train a community that requires the incursion of these alternative teaching methods[9]. According to Lee[10] the research and design of an Augmented Reality system requires a great amount of resources to be executed, being the lack of investment of large entities and the lack of awareness of the needs of this tool recurrent limiting factors for its implementation.

Due to the aforementioned factors, the number of students without experience in interacting with equipment adapted to this technology is significant. Therefore, when having a first contact, difficulties are reported during the initial development of the activities, making the adaptation and learning process tedious; these situations are later overcome and once learned, it is expressed how easy it is to use the tool. Regarding whether these applications will be used in the future in their classrooms, users have doubts due to technological limitations such as symbol recognition and not being able to control aspects such as the spatial depth of the scenes, which causes a conflicting visual adaptation[11,12].

On the other hand, augmented reality applications are compatible with few electronic devices, discouraging users with difficulties to possess these elements and harming the progress of this technology[13]. For the correct use of augmented reality in experiential learning it is necessary to have mobile devices such as tablets; not all users have this type of elements due to different aspects among these we can distinguish the following, the lack of economic resources for their acquisition, the devices previously obtained do not meet the necessary characteristics or parents make resistance to the use of this type of products for their children's learning[4].

Regarding the time given for experimentation with AR tools for teaching activities, the time is short and as a consequence users express to have deficit in content retention. In AR applications based only on images, difficulties can be evidenced with the environment in which it is developed, being factors such as lights and angles fundamental to incur in failures and affect learning outcomes[14], in turn the large amount of information contained in the application influences the levels of confidence and interest, becoming for most students an annoying aspect which hinders the instructional process and causes increases in the level of distraction[15], students present greater mental effort and their anxiety levels increase considerably[16], however, in the same document it is recommended to make adaptive learning designs for these systems in order to reduce the aforementioned aspects. It should be noted that this technology is considered as the engine of teaching and learning activities and not as the facilitator[17].

The history and advances of augmented reality date back to the 50's through classic areas such as medicine, engineering, military actions among others and over time have diversified into fields such as the rise of social networking, translation, security and e-learning in order to mediate a better development in these areas[18], the first AR tools focused on learning were based on the construction of magic books for teaching reading, reason for which was appreciated in these environments a greater interaction between students and teachers, augmented reality is not only applied to the teaching of reading, over time innovated in different areas such as mathematics, electronic engineering, architecture and others[2].

Currently, augmented reality is focused on the development of applications for teaching educational content which encourage self-learning, interest in knowledge, retention of information, understanding of topics, among other benefits during the learning experience of each student, which when compared to traditional methods has a larger scale. On the other hand, the ease and simplicity of the tool to be implemented in mobile devices allows users to interact with it anywhere and there is greater satisfaction when learning in this medium[9]. Statistical analyses reported in the paper demonstrate a high quality of learning in students with tablets or mobile devices compared to students with desktop computers[19].

This technology manages to increase learning achievement, raising the level of satisfaction and generating positive attitudes towards the subject matter addressed, in addition to increasing engagement. Something similar occurs in inverted learning in the classroom[14], where the aim is to improve the learning motivation of students by evaluating their critical thinking, motivation for science, performance in projects, group self-efficacy and cognitive load; from two points, the use of augmented reality and conventional methodology. Finally, improvements are reported for students who implemented the tool in aspects such as self-learning, interest in the topics and personalized guidance, benefiting the learning process of writing in the structuring and mastery of the content, especially in particular topics such as outdoor writing[20].

A variety of studies linked to user behavior when acquiring STEM (science, technology, engineering, mathematics) knowledge through augmented reality focused on the possible emotions presented by the user. According to one of the studies, the relevant issues were: attitude, satisfaction, motivation, interest, among others; of students when they make use of augmented reality to acquire knowledge[21].

Another aspect on which augmented reality focuses is on improving the motivation of vocational training students, influencing satisfaction and confidence for the development of experiential learning activities; it also seeks to meet special educational needs by offering means of representation and expression. On the other hand, it uses strategies to capture the user's attention through situations based on problems that activate curiosity and the attention factor[22], useful features to capture the attention of children with autistic disorder, where through exemplifications of facial expressions and emotions it tries to improve social interaction[23].

An important feature of augmented reality as a learning tool is the position of teachers, in a survey of teacher candidates they were asked their opinion about its use; according to most respondents the application is useful to encourage fun while learning and involves facilitating the work of teachers, encouraging teachers to develop their qualifications in a techno-pedagogical way[12].

Augmented reality and QR technology in the laboratory environment with computer, projection and voice systems are postulated as relevant topics for teaching[24], in addition to Mobile Augmented Reality which allows students to easily acquire knowledge due to devices such as cell phones and tablets are used on a daily basis in homes offering advantages over traditional teaching methods[25].

4. Gamification

There is complexity in choosing the elements and approach of gamification to employ due to little information regarding these issues. The existing documentation has few appearances in journals, implementing gamification without a gradual incorporation can be detrimental in the teaching/learning process, students experience confusion and possible distractions from new rules and ways of learning[6]. The literature on this topic is not conclusive about its effectiveness, there are different types of motivations, not all the elements designed for gamification are compatible with these; research still needs to be done on the motivational processes activated by specific elements of the game[26].

The attitude of teachers of educational institutions towards gamification is an area little studied so far, likewise the actual use of this learning methodology in classrooms is minimal as a cause of a gap in terms of training and lack of time of teachers[27]. In other words, there is a significant lack of methodological and technical support in the application of gamification[28].

Currently the discussion on gamification is focused on the analysis of various models used in education to increase the motivation and participation of students, therefore it is recommended to combine the different elements of gamification in order to intensify the effects on players[29]. The evaluation of reward strategies through gamification in learning e-learners is stipulated as a motivational model, the strategies are set as loss or reward, only reward and no reward; The results reveal higher motivation in the first two strategies for learners, at the same time students report feeling more anxiety when only having the option of reward. As a result, the learning performance of the participants improves significantly, interacting with a loss strategy generates in the students more attention to the learning content[30].

In the same way, gamification achieves to enhance students' skills such as competence, autonomy and the relationship between them. The feedback offered during the interaction stimulates learning whether or not there is game experience[31].

In relation to the types of learning activities in gamification, the following can be distinguished: competitive, collaborative and adaptive, for teaching in different areas of knowledge, for example in mathematics, adaptive gamification reveals a higher level of learning, however, it generates stress in students causing a greater number of failed attempts, this is due to the level of demand during the challenges, the greater the demand the greater the number of students with intentions of giving up in a short period of time[32]. The evaluation of motivation in students

when interacting with gamification tools is a fundamental aspect, differences are revealed between their initial state and the level of each of the students at the beginning of the courses, i.e. there is relevance of the individualistic nature of the motivational effects of gamification[26].

Gamification has not only made inroads in classes with traditional methodologies and face-to-face development, but also in massive online courses, qualifying itself as a contributing factor for the success of these, consequently, this factor is perceived by users as enjoyment and challenge, positively influencing their use, their own impacts and the organization. The use of point systems linked to the completion of each level of the course intervenes in the motivation of users and is a key element of gamification[33].

Regarding the analysis of the attitudes of higher education teachers towards the use of gamification in their teaching methods, studies show that university teachers have a positive attitude towards the use of gamification in their classes, higher than the attitude of teachers at other levels of education. Gamification is presented as an innovative and attractive methodology in the teaching/learning process, this methodology is used by a low percentage of teachers[27].

In research areas it reflects a trend in proof-of-concept systems and theoretical works on the different notions and elements, simultaneously the trend is registered in its implementation in e-learning applications[34], in the same way it is related to augmented reality, object recognition and virtual over-positioning in reality, managing to improve the interactivity of the gamification model causing improvements in the teaching/learning process[29].

5. M-learning

The purpose of mobile learning or m-learning is that citizens can use their mobile devices to access educational resources, connect with others and create content both in and out of the classroom, however, despite the benefits provided by this type of tools, there is little research on the model of technological acceptance in relation to mobile learning, and there are gaps on the subject, which provides the possibility of developing new studies to expand knowledge of this and other possible related areas[35]. At the same time, there is a lack of documentation on the interference caused by m-learning in the classroom, based on research conducted by where it is concluded that there is a high probability of distraction and danger when manipulating this type of devices, among these problems can be found cyber bullying, cheating and access to inappropriate content. On the other hand, the lack of restriction policies on the use of the devices generates a poor acquisition of knowledge on classroom topics. Likewise, there is a need for theoretical bases on m-learning in educational contexts. The lack of technological support in educational institutions for teacher-student interaction plays a crucial role in this major shortcoming[3]. Not all people have the skills to interact with technology, training should be designed for teachers, students and the student community in general to strengthen the knowledge of these and get to know their innovation capabilities and potential in pedagogical processes.

Studies related to m-learning have been approached with greater interest or attraction since 2014[35]. The research conducted so far on this topic has focused on: evaluating the acceptance and attitude of students, in addition, case studies have been conducted frequently in areas of educational context, computer science and humanities. Regarding the population chosen to carry out these studies, higher educational environments have been the most used.

The use of mobile technology has been implemented in university courses for educational purposes, positioning itself as a way of learning, which improves the process of building classes allowing teachers to structure their topics in a simple way and also giving students easy access to content where they will find attractive and preferable options[3]. Mobile devices are currently part of the usual elements of students, it is very easy to access it as a method of learning[7].

Simultaneously, m-learning studies focus on the evaluation of the determinants of students' behavior in the use of mobile technology. Perceived usefulness and perceived ease of use are essential factors in predicting subsequent learner attitude, in turn social influence and recommendations are conclusive for behavioral intention on learning applications, on the contrary, social influence was an important but less significant factor[36,37]. The success of m-learning is in the continuity intention of users by perceiving such ease and usefulness; the use of these tools benefits teachers and students in the processes of requesting comments, participation and response to frequently asked questions[38]. Having said this, the implementation of this form of learning must be chosen correctly, leading to the ideal being to have the support of mobile devices as a complement to inquiry and discussion of activities while the teacher performs his interventions and dictates his subject matter[8].

Other studies focus their research on whether university students make use of their mobile devices for educational purposes, the results stipulate that students use their technological devices to study on various occasions due to the lack of instructions from teachers or in order to acquire new definitions, although this is reflected as a routine act and not purely academic[39].

Students prefer the use of audiovisual content to strengthen their learning; in general, m-learning encourages self-learning and motivation, giving instructors or teachers the role of coaches or guides to solve specific doubts in favor of the efficient use of technological resources, from which a new teaching model and informal learning environment can be inferred[40,41].

6. Conclusions

Teaching and learning was developed as a central theme throughout the paper, in relation to augmented reality it is concluded that the low investment and lack of resources generates in the educational environment lack of experts on the subject, with skills needed to develop, design and train the educational community stopping the process of immersion of technology. Regarding gamification, there are gaps in terms of methodological and technical support for a good choice of playful elements in school activities. In relation to m-learning, there are great security challenges, and mobile devices are conducive to generate distraction in students.

From the analysis developed in the 100 articles chosen, it is concluded that augmented reality is more valid through time, this technology dates back to the 50's, unlike m-learning, which is documented more frequently in a period of approximately five years ago. With respect to the areas of learning that have been addressed by augmented reality, there is an extensive number of topics addressed. According to the results obtained, it is concluded that the categories exposed as teaching strategies have a significant influence on motivation, interest in knowledge, retention and comprehension of information for the development of learning in children and adults.

QR systems in relation to Augmented Reality is perceived as a relevant topic for teaching. Based on the study carried out in the articles consulted in the databases "Science Direct", "Web Science" and "Scopus", no information was found related to the relevant topics of the category of m-learning and gamification; therefore, it is recommended to carry out further research in other sectors or databases in order to continue advancing in the literary construction.

The method used allowed to develop the description of the panorama or superficial knowledge about the use of augmented reality, m-learning and gamification in basic, middle and higher education.

Conflict of interest

The authors declare no conflict of interest.

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