Augmented Reality on High School Academic Performance

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Augmented reality (AR) has recently gained a presence in educational centres. The use of information and communication technologies (ICT) in the classroom has been found to produce a better predisposition towards learning and an ideal emotional state, which leads to improvements in academic performance.

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1. Introduction

The educational field presents a changing scenario where methodological renewal is predisposed and necessitates the use of different technologies [1]. The current educational context proposes a work dynamic that implements new technological tools, accentuates the change in the role of students and teachers, and forces curricula to adapt to the new needs of the 21st century [2]. For this reason, teachers must improve the pedagogical model by introducing active and contextualized methodologies that promote student motivation as well as improved academic performance [3].

Unfortunately, educational centres face unmotivated and disinterested students daily, which leads to disastrous academic results as reflected in low grades and the non-acquisition of skills and abilities [4]. One possible solution is information and communication technologies (ICT) because they promote the acquisition of knowledge in many subjects, which favours their academic expectations [5][6]. These technologies also facilitate connectivity between students and/or teachers. This is a fundamental aspect that must be considered in current education since people are continuously interconnecting with each other in their day-to-day lives, and the suppression or reduction of the use of these tools in the classroom imposes an abrupt change that can have a direct impact on academic performance [7].

On the other hand, the integration of mobile devices in the teaching and learning process elicits new methodological guidelines, where dynamism is deepened, which, together with the high processing speed and portability made possible by certain devices, introduces what is called mobile learning (m-learning) [8]. According to [9], m-learning offers characteristics that are conducive to the dynamic environment of current education, such as direct access to the Internet, high autonomy due to its loading capacity and downloading applications, and teacher-student interaction that enhances the links between them. Moreover, this type of technology is fully integrated, as 97.1% of the users reportedly have a tablet or smartphone [10].

2. Academic Performance and Its Determining Factors

This section addresses the factors that determine the academic performance of students and their importance during the teaching and learning process [11]. In addition, the causes of low performance are reflected on, as school failure is the case for many young people [12]. First, a brief introduction will be made regarding the concept of academic performance and its various determinants, followed by an in-depth look at the different variables.

Academic performance has been defined in various ways. Authors such as [13] define academic performance as the grouping of cognitive, affective, and social skills continuously acquired by students throughout different educational stages. According to [14], academic performance comprises the goals achieved in a social or academic context. Similarly, [15][16] define it as the measure of the academic goals achieved.

The difficulty of measuring or quantifying academic performance has been a challenge for researchers over the years due to the complexity involved. Students' grades may appear to be the most obvious and tangible indicator; however, it is important to highlight that grades do not precisely reflect the students' objectives, competencies, or skills acquired in relation to the subject, the teacher, or the dynamics of the group. Nor do grades usually include all possible aspects of the teaching and learning process, such as student participation, interest shown, behaviour adopted, behaviour with the group, or involvement in the subject [17].

In relation to grades as an indicator of academic performance, the study carried out by [18] included some of these qualifications as well as a personal note on the aspects to be improved in the different activities. The conclusion of that study stated that the low performance of the students was due to a misunderstanding of the contents and the proposed tasks. Nevertheless, grades continue to be the most studied, analysed, and researched predictor in reference to academic performance [19][20][21][22][23].

Student academic performance is determined by multiple factors and variables [24]. In recent years, research has mainly addressed cognitive and motivational variables. The study carried out by [25] analysed study habits and their impact on school performance. Other studies conducted by [26][27] proposed school climate as an indicator of student school performance. New technologies have also played a vital role in education. For example, [28] investigated the impact that technology could have on student academic performance.

In short, many studies have analysed the repercussions and influence of different variables, whether collectively or at the group or individual level, on the academic performance of students. However, the most widely used standard for measuring academic performance is grades. Therefore, this research analyses academic performance by comparing the grades obtained by students in the two groups (experimental and control).

3. Augmented Reality in Education

No fixed or standard definition of augmented reality exists. However, the vast majority of authors consider it to be a combination of reality and virtuality that offers the opportunity to understand real objects far more simply and easily

through audio, images, video, text, URL, 3D models, and animation since AR adds information that is unknown in the real world [29][30]. The implantation or projection of virtual images in real-world objects can be considered to improve reality as it provides a simplification of the real context by creating a better one [31]. Another aspect to highlight, however, is the possible alteration of the real world through virtual content [32][33].

Augmented reality in education allows the acquisition of skills through the visualization and virtual manipulation of information and through the creation of learning objects [34][35]. However, AR technology alone cannot be expected to improve the teaching and learning process but should be integrated into an appropriate methodology that is supported by various theoretical frameworks [32][36]. In this case, the pedagogical theories on which AR technology is based are the situated learning theory and the constructivist learning theory.

According to [37], situated learning theory is the relationship between the student and the context, based on a practical situation. Under this theory, the learning process is based on satisfaction, context, community, and participation. Applying these factors to the use of augmented reality, student satisfaction occurs when students can apply the knowledge acquired through the interaction with the information; the context offers the opportunity to incorporate 3D content that provides innovative activities; students can become part of a community when they are able to transfer the learning acquired through augmented reality to other similar and even more complicated situations; and the active participation of students is one of the main features of this technology [38][39].

The theory of constructivist learning emphasises that the construction of learning by the student must be based on previous experiences. To accomplish this, it is necessary for students to become actively involved in tasks, which are generally real problems [40]. Constructivist learning theory forms the basis of so-called discovery learning, where students achieve skills and abilities by themselves and acquire knowledge through problem solving [41]. Augmented reality enhances learning through discovery since it enables students to interact with the environment and thus gain deeper knowledge of reality as well as engage in new learning experiences. One application is augmented reality books, which provide the opportunity to interact with virtual objects that would otherwise be impossible to manipulate in reality [42][43]. Other methodologies that are based on constructivist learning theory are problem-based learning, gamification-based learning, collaborative learning, and design-focused learning. Whatever the methodology implemented, the characteristics of the students and their educational context must be considered. Such learning must therefore be active and based on the theory of situated or constructivist learning [44].

In reference to learning based on gamification, [45] highlights the scope that augmented reality achieves since it directly affects the motivation and performance of students. Likewise, the authors highlight the use of virtual games in higher education due to the considerable advantages these games provide to university students. Other possibilities are role plays or group discussions, where the acquired knowledge can be put into practice and encourages applicable experiences in the future [46]. Finally, the gymkhanas should be highlighted, where different augmented reality resources are used, such as graphic markers or geolocation [47]. All these types of games can be expected to increase student motivation and participation since they promote the understanding of concepts in an attractive way and foster critical capacity and collaborative learning [48][49].

Regarding problem-based learning, [50] indicates the importance of using augmented reality games that produce the solution to problems since these can help students understand reality, which translates into greater student participation. Similarly, the use of augmented reality in collaborative environments is of vital importance in the acquisition of cognitive skills [51][52]. In addition, design-based learning can use augmented reality to contribute to the acquisition of knowledge with the purpose of making or generating a product, which entails the consolidation of technological skills [53].

Therefore, the integration of augmented reality in the educational field is a fact confirmed by the multiple investigations previously conducted. However, it is essential to know whether the influence of this educational technology is based on the gender of the students [54][55]. A multitude of research studies have attempted to determine the influence of gender on the acquisition of knowledge as well as on performance [56][57]. According to [58][59], male and female students obtain the same results when augmented reality is used during the teaching process, which implies that the academic performance of students does not depend on gender. This finding is of great interest since it allows teachers to incorporate augmented reality in the classroom without having personalise the content based on gender. However, as stated by [60], on certain occasions, a significant difference can be seen between male and female students in terms of content acquisition and, consequently, their grades.

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