The Development of Augmented Reality Systems in Informatics Higher Education

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Abstract

Because Augmented Reality (AR) is known as a non-traditional interface, it arouses much interest from several researchers, due to the development of the technology and its applications, and to their social and cultural impacts. Research has shown that learning does occur applying AR to an educational context, but not how potential developers, as undergraduate students, are interested in AR and in which application areas. Thus, this article aims to show the interest of students from four undergraduate courses (Bachelors of Digital Design, Multimedia Production, Information Systems and Computer Science) to develop and use AR for many different applications. The proposal is to contribute to the research with a survey from an initial questionnaire about students’ level of knowledge on the subject, their interest in the use of this technology and their intention to develop such systems. After analyzing the results, the goal is to indicate actions that may point ways to the collaborative development of relevant applications in computational terms and to stimulate the work with an Interaction Design that considers the syntactic thought of designer.

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1. Introduction

Augmented Reality (AR) is an emerging form of experience in which the real world is enhanced by computer-generated content. AR supplements reality augmenting one’s immediate surroundings with electronic
data or information [1] and digital assets such as audio and video files, textual information, and even olfactory or tactile information can be incorporated into users’ perceptions of the real world [2].

A relatively high amount of research papers have been investigating the potential impact of augmented reality to benefit education, aiming to improve current models of teaching and learning [3]. The emergence of new technological innovations such as augmented reality technologies was able to demonstrate the weaknesses of traditional teaching methods but also the potential for improving them [4].

According to Klopfer [5], the use of new technologies can engage students in deep, meaningful, realistic and relevant problems, the kinds of complex collaborative problems that education reformers have been clamoring for for many years.

As never before, through AR, learners are able to gain immediate access to a wide range of location-specific information, compiled and provided by a variety of sources. AR refers to a wide spectrum of technologies that project computer generated materials, such as text, images, and video, onto users’ perceptions of the real world and can provide rich contextual customized learning environment and contents for each single individual [6].

Learning activities vary with a broad diversity of learning processes and AR can bridge the gap between the theoretical and practical and focus on how the real and virtual can be combined together to fulfill different learning objectives, requirements, and even environments [7].

Wang [8] also says that as AR advances, there could be significant benefits from the perspective of pedagogical effectiveness of experiential and collaborative learning processes. Pedagogical principles that are addressed by AR include physicality, embodied cognition, situated learning, and mental action.

Research has shown that learning does occur applying AR to an educational context [8], but not how potential developers, as graduate students, are interested in AR and in which application areas.

Based on all above statements, this article aims to show the interest of students from four undergraduate courses (Bachelors of Digital Design, Multimedia Production, Information Systems and Computer Science) to develop and use AR for many different applications. The proposal is to contribute to the research with a survey from an initial questionnaire about students' level of knowledge on the subject, their interest in the use of this technology and their intention to develop such systems. It also shows that the AR increases the motivation and interest in subjects previously not pleasant and it promotes greater collaboration between students.

This paper presents an overview of the differences and similarities of the data collected in both courses. After analyzing the results, the goal is to indicate actions that may point ways to the collaborative development of relevant applications in computational terms and to stimulate the work with an Interaction Design that considers the syntactic thought of designer. According to Azuma [9], experimental results from human factors, perceptual studies and cognitive science can help guide the design of effective AR systems in many areas.

2. Research Methodology

Students of Computer Science, Information Systems, Digital Design and Multimedia Production were selected. These undergraduate courses were chosen because they all explore human and programming aspects following the current technological and technical trends of development.

Although the Information Systems does not focus on systems development as Computer Science, this course has a research and study line in interactive media. The Design area courses (Digital Design and Multimedia Production) have great involvement in innovative digital technology.

An online form was created, with fifteen (15) questions approaching two perspectives: to analyze the student's knowledge and interest in the development and use of Augmented Reality tools and to evaluate their point of views about the benefits of AR in the teaching and learning process.

In order to evaluate the student's interest and familiarity in AR systems, the questions were:
- Do you know Augmented or Mixed Reality?
  - If yes, how long? Less than one year; One to three years or more than three years.
Do you use or have used AR systems?
  o If yes, what kind of application? Media Art, Art History and Heritage Preservation, Architecture and Urbanism, Games & Entertainment, Culture, Social Media, Communication, Formal Education (Faculty), Training and Improvements, Additional Information on Geolocation Systems (in conjunction with GPS) Health Applications and Advertising or Other;
  o If not, why? I had no chance; I have no interest, or do not know the technology.

Are you interested in developing systems for AR?
  o If yes, what kind of application? Media Art, Art History and Heritage Preservation, Architecture and Urbanism, Games & Entertainment, Culture, Social Media, Communication, Formal Education, Training and Enhancements, Additional Information on Geolocation Systems (in conjunction with GPS), Health Applications, Advertising, Industrial and Military Applications or Other.
  o If you are interested in the development, which device do you prefer to work on? Smart Phones with Android, Smart Phones with iOS, Smart Phones with Windows Phone, Tablets with Android, Tablets with iOS, Tablets with Windows Phone, Personal Computers (Desktops and Notebooks) or Other Devices.
  o In the process of AR systems development, what do you think would be your biggest challenges?

Radu [3] conducted literature review of academic publications that investigated the educational impact of augmented reality. Comparing the use of tools in teaching with AR and non-AR experiences, some positive results were identified such as increasing the content understanding and retention in memory, as well as promoting greater motivation and collaboration. Thus, questions were proposed to evaluate these same criteria to the selected students. The intention is to evaluate whether these potential developers agree with the positives results raised by the author. The questions were:
  o Do AR applications facilitate the understanding of some content that normally you would not understand without them?
  o Do AR applications promote greater retention of content?
  o Do AR applications increase motivation and interest in topics that do not please you?
  o Do AR applications improve collaboration?

To all these questions, students had the options "Yes", "No" and "Maybe" to choose and were requested explanations for the answers.

3. Results

Thirty six (36) students completed the questionnaire, 18 in the Design area (9 from Multimedia Production and 9 from Digital Design) and 18 in the Computer area (9 from Computer Science and 9 from Information Systems). Note, then, a balance between the areas surveyed.

The results in Figure 3 show that the majority of students already know Augmented Reality systems. Among all of them, only 7 (seven) did not know it (18% of total). It is important to notice that 5 (five) of them are in Computer area. On the other hand, all students in Multimedia Production course know this emergence technology. Among the students who already know AR, they do it mostly more than one year (58% - 18 students).

A significant number of individuals (19 - nineteen) of both areas did not interact with systems of such nature (Figure 4) and said that the reason is lack of opportunity. However, it is almost unanimous their desire to do so. It is also worth mentioning that besides more Design area students know AR systems, only their minority use or have already used this kind of application.
The major highlight among all used systems is in Game and Entertainment field (79%), followed by communication (32%), Media Art and Social Media (both with 26%). It is interesting to notice that the second most used type of application is Media Art but only by Design students. It is also noteworthy that the students in Design area have experience with a wider range of applications (Figure 5), while the Computing restrict its interaction with games and entertainment (Figure 6).
As the aim of this paper is to identify the interest of students from both areas in developing Augmented Reality systems, it was possible to notice that, as expected, such technology raises interest in the two groups studied. Figure 7 highlights that Design students show greater interest in the development than Computing ones. Seventeen percent (17% - 3 students) are not interested in development in the first area, against 39% (7 students) of the second one.

Concerning the areas of interest in development, games and entertainment are also the most mentioned, but there is a greater variety of areas of interest, as well as a balance between greater amounts of quotes. No Design student chose Industrial and Military applications (Figure 8) and the second area of interest in Computing is Training and Improvements (Figure 9), but it was the least cited by Design students.

Regarding the devices that they wish to work on, it is clear the intention to use mobile ones (smartphones and tablets) to access the applications developed. Among all students interested in development (29 students - 72% of the total), only three mentioned the interest of developing only for desktop. All the others prefer to work on mobile devices, usually more than one and with different operating systems.
In Figures 10 and 11, it is possible to notice that Computing students prefer Android and Design ones prefer iOS operating systems. None of the students mentioned other non-conventional devices and only 2 (two) in Computer area want to work on different devices, like Kinect. Among all students, it is also important to notice that there is little interest to work on Windows Phone operating system.

About the challenges in the development process, it can be perceived programming and its development as key obstacles highlighted. In Design courses, the word “programming” appears most frequently, while in Computing courses it was noticed the lack of knowledge of development languages as the main factor. Thus, it is possible to say that such students are not afraid of programming, but of the complexity of the development tools and the nature of the languages used, as well as issues related to the systems architecture.

Another aspect analyzed in this research was the impression that the students of the two areas have about the relevance of the technology. Regarding Augmented Reality facilitating the understanding of difficult concepts, no students disagree but 6% (2 individuals) chose not to answer. Among the other ones, 67% (24 individuals)
said they consider AR a way of making complex concepts understandable and 27% (10 individuals) believe that technology might help the process of understanding, as shown in Figure 12.

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Fig. 10: Types of devices that Computer area students are interested in for development

![Pie chart showing device preferences for Computer Area students](image)

- Smart Phones with Android: 75%
- Smart Phones with iOS: 14%
- Smart Phones with Windows Phone: 14%
- Tablets with Android: 42%
- Tablets with iOS: 33%
- Tablets with Windows Phone: 17%
- Personal Computers (Desktops and Notebooks): 14%
- Other Devices: 8%

Fig. 11: Types of devices that Design area students are interested in for development

![Pie chart showing device preferences for Design Area students](image)

- Smart Phones with Android: 48%
- Smart Phones with iOS: 43%
- Smart Phones with Windows Phone: 14%
- Tablets with Android: 33%
- Tablets with iOS: 33%
- Tablets with Windows Phone: 14%
- Personal Computers (Desktops and Notebooks): 14%
- Other Devices: 14%

Fig. 12: Students opinions about AR systems facilitating the understanding of difficult

![Bar chart showing AR facilitation opinions](image)

- Multimedia Production: 75% Yes, 25% No
- Digital Design: 75% Yes, 25% No
- Information Systems: 89% Yes, 11% No
- Computer Science: 44% Yes, 56% No

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Fig. 12: Students opinions about AR systems facilitating the understanding of difficult
Regarding AR systems promoting greater retention of content, both areas showed balanced results. Figure 21 shows that only little percentage (22 – 25%) of students disagrees with that but the majority agree (Figure 13).

No one thinks that AR applications do not increase motivation and interest in unpleasant topics. In fact, all Multimedia Production students think otherwise, as shown in Figure 14.

Regarding the question about the relationship between Augmented Reality applications and collaborative work, there is a balance between responses pointing a possible increment or incentive to work of such nature and those who believe in a potential yet to be explored field (Figure 15).

It is worthy to present some comments of the students:

“Depending on how the technology is employed, I believe that it is possible to offer new insights and ways of interacting with content. But I had no experience like this, I just believe in the power of technology.” (Computer Science student)

“I believe that AR do not make a difference in collaborative work, because the experience of going through an AR system is individual.” (Information Systems student)

“I’m very interested in this field, people today cannot stand living in big cities and with AR we can live anywhere in the world, I believe we still have a lot to develop but soon AR will give us the sensation and perception of being beside coworkers even at distance.” (Digital Design Student)
“AR will make you see content in a different way, just by the fact that you are using it.” (Multimedia Production student).

![Figure 15: Students opinion about AR systems improving collaboration](image)

4. Conclusion

This article aims to show the interest of students from four undergraduate courses (Bachelors of Digital Design, Multimedia Production, Information Systems and Computer Science) to develop and use AR for many different applications. The proposal is to evaluate the students' level of knowledge on the subject, their interest in the use of this technology and their intention to develop such systems. This survey also evaluates their opinion about the educational impacts of augmented in terms of increasing the content understanding and retention in memory, as well as promoting greater motivation and collaboration.

Regarding the results, it is possible to conclude that the actions that enable greater understanding of the technology in these redoubts and that provide learning, may result in significant increase in the existing number of AR developers, since the interest of students is high.

Several students of Computer and Design areas have interest in the development of AR systems, but the complexity of programming languages and systems architecture become common challenges.

It can be seen in their statements a concern with the need to refine the technology, bringing closer, in fact, virtual to real, with an effective sense of immersion. It is also possible to notice that the experience is an important and constant factor in the statements of the students, and there is still in a small part in the students, the idea that such experiences are exclusively individual.

The results also show a strong tendency to the use and development of AR applications in games and entertainment field, and as expected, it is possible to confirm the influential impact of mobile devices in this generation of developers.

It is evident the consensus on the importance of this technology in the teaching-learning process, facilitating the understanding of complex issues, providing greater content retention and increasing users' motivation and interest. However, it is not clear the use of AR as a means to promote collaborative work.

Finally, although Digital Design, Multimedia Production and Information Systems courses do not focus on the development of systems, most students show interest in this activity, as well as Computer Science students.
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References


