Are university professors of the South American countries preparing students for digital transformation?

Fernando Moreira[1,2,3,4], Natércia Durão[1,2,3], Carla Santos Pereira[1,2,3,6], Maria João Ferreira[1,3,5]

[1] Universidade Portucalense, DEGI, Rua Dr. António Bernardino de Almeida, 541, 4200-070 Porto, Portugal
[2] IJP, Universidade Portucalense, Portugal
[3] REMIT, Universidade Portucalense, Portugal
[4]IEETA, Universidade de Aveiro, Portugal
[5]Centro Algoritmi, Universidade do Minho, Portugal
[6]CEMAT, Instituto Superior Técnico, Universidade Técnica de Lisboa, Portugal
{fmoreira, carlasantos, natercia, mjoao}@upt.pt

Abstract. The higher education provided by universities plays a fundamental role in transforming society in all its dimensions, namely teaching and educational management. The combination of higher education and the increase of mobile technologies (one of the pillars of digital transformation) leads to an increase in training opportunities and the development of new teaching methods. Due to this, several concepts from the e-learning, m-learning to u-learning appeared. Therefore, it is critical to understand whether users (students and professors) are receptive and aware to adapt to this new paradigm before deciding to implement teaching-learning methods based on mobile technology. In this context, the aim of this paper is to investigate the perception if the South American universities professors are using Mobile Learning with gamification and augmented reality apps and how they can be used to promote student's engagement inside and outside of the classroom, in special to prepare the students for digital transformation.

Keywords: Mobile learning, Professors, mobile devices, Higher Education Institutions, South American countries, Gamification, Augmented Reality.

1 Introduction

The society is changing faster than ever including the organizations in general and the Higher Education Institutions (HEI) in particular. Mobility, cloud computing, big data, and social media, the pillars of Digital Transformation (DT) [1] are driving organizations to the next level of digital customer engagement and IT-enabled business processes, products, and services. In the majority of the organizations, digital

technologies are opening unprecedented transformation and changing the work, learning and lives of the people in ways that have never been anticipated.

As referred one of the pillars of DT is mobility, underneath this mobile devices (MD) and ubiquitous computing technologies have created unprecedented opportunities for learning. In this context, in recent years, the education system in the developed countries has seen major upturns [2] to prepare the students for DT. According to Sarrab et al. [3], mobile devices are highly portable and therefore offer flexibility in learning anytime, anywhere. Educational systems in developed countries have developed strong policies and strategies to address the educational needs of the 21st century. These needs make it difficult to implement new teaching methods in HEIs, namely active methodologies, to meet the type of students that are coming to the higher education level, as well as to consider in the development of the educational pillars ("*learning to know, learn to do, learn to live and learn to be*") of the XXI century defined in [4].

In recent years, there has been a rapid increase in the number of mobile phone subscribers and mobile data traffic, while the computing power of smartphones is comparable to desktops. According to an Ericsson [5] report, the number of smartphone subscriptions worldwide in 2015 was 3.2 billion, a 23% increase compared to 2014, and the monthly data traffic per smartphone has increased from 1 GB / month to 1.4 GB / month.

The combination of the results presented previously and the definition of the generation that currently reaches HEIs is verified, according to Dahlstrom et al. [6] by a growing tendency for students to have a laptop or smartphone to facilitate their learning. Similarly, Farley et al. [7] indicated that 86% of the 18-24 age group and 91% of the 25-29 age group had at least one smartphone. In this context, this generation is experienced in technology and is familiar with the use of smartphones. Soon, they are already using, or at least ready to use, their mobile devices in the teaching-learning process (TLP).

As mobile devices and ubiquitous computing technologies create unique learning opportunities, mobile learning (m-learning) is increasingly seen as an advantage for TLP in HEIs, due to its characteristics relative to the characteristics of millennial learners [8], [9]. Essentially, m-learning is based on the use of mobile devices anywhere at any time [10] and the prevalent use of portable technologies facilitates learning when and where they intend to access learning materials [11]. The capabilities of mobile devices have led to the emergence of technologies that have opened up new possibilities in the teaching and learning processes, namely Augmented Reality (AR) [12] and Gamification [13].

As evidence of this ability there are already countries that have managed to make the best use of mobile devices in learning. Some European countries have presented m-learning projects with great impact, for example MoLeNET [14] in the United Kingdom, with a budget of 12 million pounds sterling and 40 thousand students. Many countries [15], including the European Union [16] recognize the importance of the knowledge-based economy, innovations and technological adaptation. The US and Canada also present projects with impact, namely, 14 US states and Canadian provinces have adopted m-learning initiatives. However, the Middle East [17] and Asia [18] still work on a small scale, or almost do not works with mobile devices in

learning, but in most cases use these devices only to support traditional learning. Regarding the South American countries, UNESCO does not present any study.

As a result, the successful integration of m-learning technologies in education require the perception of these technologies by professors, so it is possible to question "*How do professors percept the importance of m-learning in DT?*". In this context, the aim of the presented research is to assess the perception of professors in higher education of the technology area, in less advanced countries, particulary in South American countries regarding the use of m-learning with gamification and augmented reality, and if so how they can be used to promote student's engagement inside and outside of the classroom.

2 State of the art

The literature in the area of m-learning is vast. However, studies that highlight the position of teachers in South American countries, related with m-learning approaches, with gamification and augmented reality are non-existent. Only the study presented in [19] this topics is investigated and analyzed, but in Portugal. In that study authors concluded that the majority of Portuguese professors have knowledge on how to perform the most trivial tasks with mobile devices and shown high results on the utilization of both AR and gamification applications.

For the construction of the state of the art, the B-on portal (www.b-on.pt) was used, which is an Online Library of Knowledge that provides unlimited and permanent access to thousands of international scientific journals and e-books. The number of papers on the applicability of m-learning from the professors' point of view is reduced globally, and it was verified that papers relating to HEIs in South American countries were non existant. The research was carried out for the period 2014-2017 with the following queries search: (1) *"(mobile learning OR m_learning OR mLearning OR Mobile Learning) AND (South American countries) AND (Augmented reality) AND (Gamification)*"; (ii) *"(mobile learning OR m_learning OR mLearning OR Mobile Learning) AND (South American countries)*"; (iii) *"(South American countries) AND (Augmented reality) AND (Gamification)*" it was the inexistence of any paper related with these issues. To verify that there are already studies performed when the search is *"(mobile learning OR m_learning OR mLearning OR Mobile Learning) AND (Augmented reality) AND (Gamification)*", there were 509 entries, even though most of them are not directly related to the entire search query. In this context, from this study it was possible to conclude that there is no study on mobile technologies in education, particularly in HEIs in South American countries, thus making it relevant and justified.

3 Research methodology

The purpose of this section is to describe the procedures used to collect data that are the basis for this research. The main feature of the scientific method is an organized research, strict control of the use of observations and theoretical knowledge.

For the present study, we used the methodology of quantitative research, since it is more appropriate to determine the opinions and attitudes of the respondent based on structured questionnaires. In this approach, data is collected through structured questionnaires, and clear goals in order to ensure uniform comprehension of the respondents and a consequent standardization of results.

The undertaken study was descriptive in nature. Data collected for quantitative research through the use of questionnaires requires special care, because it is not enough to collect responses about the issues of interest, it is also important to know how to do statistical analysis to achieve proper results validation. Aspects such as the sample size, the way the questionnaire is prepared, the questions formulation, data analysis, error margins, the selection of individual process of who should compose the sample, among other issues, are important and they should be taken into account for any research [20]. This method is recommended when you want to know a population, to analyse social phenomena and, in cases where it is necessary to inquire a huge amount of people about a certain subject. The questionnaire before being delivered was subjected to the evaluation of four experts in the field.

The aim of this study is to investigate the perception of professors in higher education, the area of technology in less advanced countries in particular South American countries, in relation to using m-learning with gamification and AR and how they can be used to promote student's engagement inside and outside of the classroom.

The quantitative study was based on an online questionnaire with 5 sections which include: Demographic information (Section 1), Prior knowledge (Section 2), Participation /Engagement (Section 3), Use of Mobile Devices (Section 4) and Mobile use in the classroom (Section 5). The first section (Demographic information) consists of 6 questions, which include, the age, gender and teach program(s). To achieve our goal, in the other sections we will only analyze the results regarding the issues related to AR and Gamification in the MD (8 questions - Q1 to Q8). Almost all questions were close-ended type. Sections 3 and 5 use five-point Likert scale ranging: "*Strongly disagrees*" (1), "*Disagree*" (2), "Neutral" (3), "*Agree*" (4) and "*Strongly Agree*" (5).

The questionnaire has been online for 60 days and 61 valid responses were received. Data collected were pooled and treated ~~by~~ using the IBM SPSS Statistics 24.0 software. Statistical analyses used for the data analysis were frequency analysis, descriptive statistics, non-parametric tests (Chi-square with continuity correction and Mann-Whitney) and Hierarchical Cluster Analysis (with Single linkage).

4 Analysis and discussion of results

The study sample consists of 61 professors from higher education in the area of technology in HEIs originals from some countries on South America. Most respondent´s gender were male (60,7%) whereby, the majority (65,6%) of professors were aged between 31 to 50 years old (of which 36,1% are in the younger age group from 31 to 40).

Regarding the level of education they teach, we found that: 36,1% of them teach in PhD, 39,3% in Master and a significantly higher percentage (60,7%) in Degree. This may be due to the young age of professors.

Being usual at the higher education, professors teach simultaneously various levels of education, we found that in South America most of them (approximately 62%) teach only one level. Additionaly, here, crossing the age of professors with the various levels of education, we concluded that, above the age of 30, the percentage of professors teaching PhD and Master is equivalent. Not being verified that the older the professor is, the higher the level that teaches.

When it comes to the matter of "*Prior Knowledge*", we aim to assess whether the percentage of higher education professors knows how to download augmented reality and gamification applications for MDs (Table 1). Despite being new technologies, we denote that the majority of professors (above 50%) have knowledge on how to perform the downloaded augmented reality applications and download Mobile App Gamification on a MD, although, the percentage of those who are not familiarized is low, it is yet still considered high.

Table 1. Percentages of Yes and No responses for questions Q1 and Q2

Questions		No/Yes	(%)
Q1	Download augmented reality applications on a MD	No	43,3
		Yes	55,7
Q2	Download Mobile App Gamification on a MD	No	45,9
		Yes	54,1

Next, we check if the gender of professors is independent of their knowledge on how to download AR and gamification applications for MDs (Tables 2-3). Since all conditions of applicability of Chi-Square test are satisfied, and the cross tables constructed to perform the test are 2x2 tables, we had to opt for Chi-Square test with continuity correction (p-value = 0.01 and p-value = 0.067, respectively) [21, 22].

Table 2. Frequencies for question Q1 by gender

Question		Male	Female	Total
Q1	No	11	16	27
		40,7%	59,3%	100%
		29,7%	**66,7%**	44,3%
	Yes	26	8	34
		76,5%	23,5%	100%
		70,3%	33,3%	55,7%
Total		37	24	61
		60,7%	39,3%	100,0%
		100,0%	100,0%	100,0%

Table 3. Frequencies for question Q2 by gender

Question		Male	Female	Total
Q2	No	13	15	28
		46,4%	53,6%	100,0%
		35,1%	**62,5%**	45,9%

	Yes	24	9	33
		72,7%	27,3%	100,0%
		64,9%	37,5%	54,1%
Total		37	24	61
		60,7%	39,3%	100,0%
		100,0%	100,0%	100,0%

Assuming a level of significance higher than 6.7%, we can conclude that there is an association between gender and the download of AR applications for MDs and between gender and download mobile gamification apps on a MDs, which can be confirmed by carefully analyzing Tables 2-3. In Table 2, we can see that for female "*No*" predominates (66,7%), and for males the "*Yes*" predominates (70,3%), and, in Table 3 we found that for female "*No*" predominates (62,5%), and for males the "*Yes*" predominates (64,9%). Therefore, gender has influence in prior knowledge about AR and mobile gamification apps on MDs.

As can be seen in Table 4, in terms of Participation/Engagement, both mean values are above 4, the "*Agree position*", which suggested that professors agree / strongly agree that augmented reality and gamification could be incorporated into ML classes.

Table 4. Descriptive Statistics for questions Q3 and Q4.

Questions		Mean	Std. Deviation
Q3	Augmented reality could be incorporated into ML classes	4,02	1,025
Q4	Gamification could be incorporated into ML classes	4,11	0,968

As questions Q3 and Q4 are measured on an ordinal scale, in order to assess whether there are differences in professors' opinions, to incorporate into the classrooms, augmented reality and gamification according to gender, we performed the Mann-Whitney statistical test (p-value = 0.950> 0.05 and p-value = 0.918> 0.05 respectively). These results lead us to conclude that there is no statistically significant differences in regard of the gender.

In conclusion, regarding gender, we had verified differences in knowledge about how to download augmented reality applications and app gamification on a MD, however when the question is to incorporate these applications into ML classes, these differences, by gender, no longer exist.

In regard to Use of Mobile Devices to perform educational tasks, inside or outside the class, we conclude that most professors agree (57,4%) that students play an educational game on their MD (Q5), although with regard to use MD with augmented reality as a learning tool (Q6), most do not agree (52,5%) (see Table 5).

Table 5. Percentages of Yes and No responses for questions Q5 and Q6

Questions		No/Yes	(%)
Q5	Students play an educational game on MD	No	42,6
		Yes	**57,4**
Q6	Students use MD with augmented reality as a learning tool	No	**52,5**
		Yes	47,5

Crossing these two questions with gender, after checking Chi-square test conditions of applicability, we used this test with continuity correction to evaluate this

possible association. The values obtained for these tests (p-value = 1,000> 0.05 and p-value = 0.633> 0.05), means that, statistically we cannot state the association between the gender and Q5 and Q6 variables.

Table 6. Percentages of Yes and No responses for questions Q5 and Q6 by degrees of teach

		PhD		MSc		Degree	
		No	Yes	No	Yes	No	Yes
Q5	No	43,6%	40,9%	37,8%	50,0%	33,3%	46
	Yes	56,4%	**59,1%**	62,2%	50,0%	66,7%	**53**
Q6	No	59,0%	40,9%	51,4%	**54,2%**	38,9%	**58**
	Yes	41,0%	**59,1%**	48,6%	45,8%	61,1%	41

We will analyze the professors' opinions regarding Q5 and Q6 according to the degree they teach (PhD, Master or Degree) in order to verify if the tendency (verified in Table 5) is maintained throughout the several degrees. As regards question Q5 ("*Students play an educational game on their MD"*), we found that, professors that teach in PhD or Degree, predominantly agree with the use of this educational tool. For students who use their MDs with augmented reality applications as a learning tool (question Q6), professors' opinions, regardless of the degree they teach, are different, which means: professors that teach in PhD predominantly agree and professors that teach in Master or Degree predominantly disagree.

As we can be see in Table 7, in terms of mobile use in the classroom, both mean values are above 4, the "*Agree position*", which suggested that professors strongly believe that students can appropriately use MD with augmented reality apps (Q7) and with gamification apps (Q8), for learning.

Table 7. Descriptive Statistics for questions Q7 and Q8.

Questions		Mean	Std. Deviation
Q7	MD with augmented reality apps for learning	4,16	1,003
Q8	MD with gamification apps for learning	4,23	1,101

In order to evaluate whether gender influences the professors' opinions regarding Q7 and Q8 questions given the measurement scales of the variables are ordinal, we performed the Mann-Whitney statistical test (p-value = 0.639> 0.05 and p-value = 0.298 > 0.05, respectively). Although these results lead us to conclude that there are no statistically significant differences, the separate calculation by gender of the means reveals that for both questions the female professors have a upper tendency to believe that students can be taught how to appropriately use MD with augmented reality apps and with gamification apps, for learning (male: mean = 4.14 / 4.11; female: mean = 4.21 / 4.42 for questions Q7 and Q8, respectively).

Finally, in order to group the variables into homogeneous groups, we use Hierarchical Cluster Analysis (exploratory multivariate data analysis) [22] where each variable belonging to a given cluster is similar to all others belonging to that cluster and is different from the variables belonging to other clusters. The method used to define the distances between the clusters was the Single linkage (or nearest neighbor). This method is one of the most used, being particularly robust to the existence of structural relations between the initial data.

The obtained dendogram (Figure 1) highlights the existence of 2 clusters of variables. Cluster 1 is formed by variables Q1, Q2, Q5 and Q6 that group at the same distance. Cluster 2 consists of variables Q7 and Q8, which have the shortest distance, to which Q3 and Q4 are still joined.

So, variables Q1 ("*Professors know how to download augmented reality applications on a MD*"), Q2 ("*Professors know how to download mobile app gamification on a MD*"), Q5 ("*I would ask students to play as educational game on their MD*") and Q6 ("*I would ask students to use their MD with augmented reality as a learning tool*") are very close (strongly correlated) as well as the variables Q7 ("*Professors believe that students can be taught how to appropriately use MD with augmented reality apps for learning"*) and Q8 ("*Professors believe that students can be taught how to appropriately use MD with gamification apps for learning*") of the Cluster 2. The variables Q3 ("*Augmented reality could be incorporated into mobile learning classes*") and Q4 ("*Gamification could be incorporated into mobile learning classes*") are associated with Q7 and Q8 a slightly greater distance. We can thus conclude that the professors' opinion of these two tools is very much the same. Moreover, professors who have a priori knowledge of how to download these applications to the MDs are the most favorable for students to use gamification and augmented reality in their MD as a study tool. In addition, professors who believe that students can be taught how to use augmented reality appropriately are also of the same opinion when the tool is gamification, and therefore are also in favor of incorporating these tools into mobile learning class.

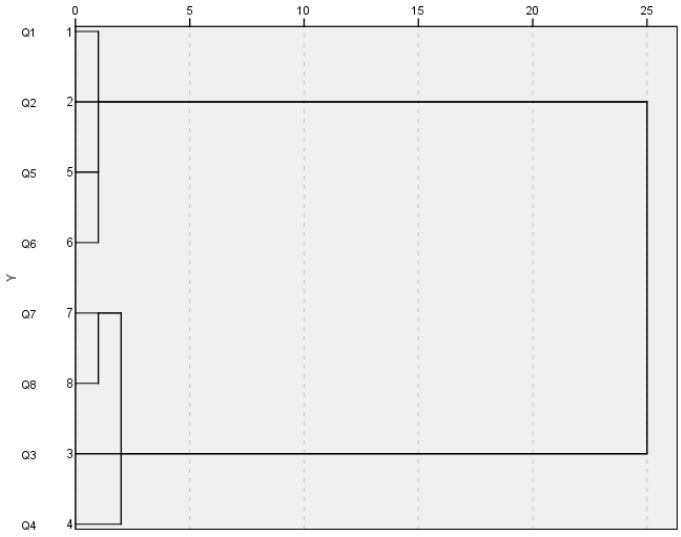

Figure 1. Dendogram for questions Q1 and Q8.

As the percentages of positive answers to questions Q1, Q2, Q5 and Q6 are close to 50% (they are not as high as we expected) we try to understand why. For this we analyzed in more detail the answers given by professors to the open question "*What are the most important elements (technical and pedagogical) needed for m-leaning to be used in the classroom*?".

The answers obtained point to the following needs: "*Wi-Fi connection in the classroom (good and speed) and a platform (iOS, android, web) to interact with students; Applications with pleasant interfaces, easy to use and preferably free; Guidance to the student (educational materials), technical support for the used tools and communication tools;Professors with technical knowledge and clear strategy of activities according to the topics and levels;A complete protocol, with rules, about the correct use of mobile devices on a classroom*".

However, it must be taken into account that it is important to make the device a mean of learning and not a distraction!

5 Conclusions and future work

The new technologies, such as mobile devices and internet are becoming mainstream at a massive new scale. HEIs must transform their TLP and approaches to change how they engage with their students, innovate around new techniques and models and re-think how they operate, because DT demands it. The use of the new approaches like AR and/or Gamification is a reality at this moment. In this context, higher education needs to respond to the needs of contemporary society, i.e. must create learning options that involve and encourage current students and those who are coming to take part in a highly digital community.

In this study , we focused on analysing the use of m-learning with gamification and AR in TLP in high education of the South American countries. From the obtained results, it is possible to emphasize that the professors do not have a strong previous knowledge regarding on how to download applications of AR and gamification (55,7% and 54,1%, respectively). One of the most interesting obtained results is that women tend to have less know-how for technologies, however, relatively to incorporating these tools in the classroom, the behaviour by gender is identical. On the other hand, the participation and the engagement to include these two technologies in the classroom is seen by the professors as very positive, therefore, essential conditions for their adoption in the TLP are gathered.

Finally, when professors are questioned about their belief in the added value of using these technologies (AR and gamification apps), the results obtained are very positive. However, by analyzing the results obtained, it can be seen that in these countries there aren´t neither the technical conditions, nor the teachers' perception in the identification of the importance for TD. On the one hand, the preparation of students according to the educational needs of the 21st century and, on the other hand to having, professionals prepared to promote and give continuity to TD.

As future work, it would be interesting to continue our research from the student's point of view and the reality in other countries. It would also be of increased interest to carry on this study (both from the point of view of professors and students), in order to compare opinions in several countries and, possibly on other continents.

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