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*M.D. Díaz-Noguera,*
*P. Toledo-Morales,*
*C. Hervás-Gómez*
Spain

# Augmented Reality Applications Attitude Scale (ARAAS): Diagnosing the Attitudes of Future Teachers

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**Abstract**

The aim of the presented study is to identify the attitudes of future teachers (in pre-service teacher education) toward Augmented Reality (AR) applications. The innovation experience was carried out in the academic year 2016/17. For the collection of data, the Augmented Reality Applications Attitude Scale (ARAAS), by Küçük, Yilmaz, Baydaş & Göktaş (2014), was adapted to the Spanish context. It is a Likert scale grouped into three dimensions that determine the attitudes of future teachers toward the use of AR applications in education, which are Relevance, Satisfaction and Reliability. In order to analyse data, the statistical software SPSS 23.0 was used. The Bartlett test of sphericity and the Kaiser-Meyer-Olkin (KMO) test for sampling adequacy were also conducted. Results of the study led to the following conclusions: the students developed a favourable attitude in their role as future teachers toward the use of AR applications as learning tools, which have also provided deep learning.

**Keywords:** *augmented reality, teaching attitudes, educational innovation, good educational practices, higher education*

## Introduction

The present study aims to show the impact of Augmented Reality (AR) in the development of educational activities with future teachers, experimenting with AR applications and implementing these in real teaching situations. In order to achieve this goal, educational modules with AR were designed. AR allows for enriching the information given by the objects or materials used. The difference between Augmented Reality and Virtual Reality (VR) is known in the scientific community. VR immerses us in a digital world. In our case, since we chose AR, we work in real environments where we can significantly enhance information. The history of AR is well documented in the technological literature, even though AR is a relevant topic worldwide in the field of education (Johnson, Levine, Smith & Stone, 2010). In our case, it poses a great advancement in the educational processes.

Nowadays, the international scientific community analyses the consequences of Augmented Reality (AR) in terms of its adoption and incorporation into educational practices. Revising the educational practices and recent research, or the current phenomena, such as the emergence of "Pokemon Go", inspire us about the educational possibilities that this phenomenon can have, even the famous videogames "Angry Birds" and "Candy Crush" (the successful mobile phone games). In the future of educational ecosystems, AR and Virtual Reality (VR) are not only games and gadgets, but they are becoming communication tools themselves.

For some of the reviewed authors, they are trendsetter ways of communication and show us what they call "new communication tools" or "new media" (Waugh & Su-Searle, 2012). If online learning has brought us the democratisation of knowledge, then AR offers the democratisation of virtual teaching in a real world and VR provides the democratisation of experience (Clark, 2016). The educational scientific community is eager to do research into the possibilities that AR may integrate in educational centres, and the roles that the training and education of future teachers will play in the development of this process.

The AR scenarios help students contextualise information and, at the same time, reinforce it with additional information in different formats and symbolic systems, which allows for individualisation of training and adaptation to students' different types of intelligence and preferences (Jeřábek, Rambousek & Wildová, 2014). These scenarios or contexts may be real, fictional or designed *ex post facto* with the aim of achieving a certain intentional goal to acquire knowledge. Submerging in digital environments or activities causes attitude change in students toward that particular learning and increases their motivation. From the research reviewed, it was confirmed that they also increase critical thinking in students, as well as their academic performance (Billinghurst, Clark & Lee, 2015).

Recent studies (Cabero & Barroso, 2016) consider AR as an emerging technology in the field of education, to which the university level can be added (Liu & Tsai, 2013), without ignoring the innovative approaches associated with this application (Wu, Lee, Chang & Liang, 2013). We refer to training ecosystems (Han, Jo, Hyun & So, 2015). Increased learning, according to Azuma (1997), can be defined as a technique or display that meets three main characteristics: a combination of the real and virtual worlds, real-time interaction, and identical 3D registration of virtual and real objects. AR can be considered as one of the formats within the idea of Virtual Reality (VR) that ranges from a completely real environment to a completely virtual environment (Kesim & Ozarslan, 2012).



## Research Problem

The aim of this study was to identify the attitudes of future teachers (in pre-service teacher education) toward AR applications. More specifically, the study was focused on the following objectives:

1. To describe the attitudes of teachers in pre-service teacher education toward AR applications in the aspects related to: Relevance, Satisfaction, and Reliability.
2. To determine the inner consistency and reliability of the Augmented Reality Applications Attitude Scale (ARAAS).

### Research Focus

One of the most significant foci of the studies of AR is the importance of motivation, since it is the force that initiates and drives behaviour. Therefore, it can be asserted that motivation provides the source of energy that accounts for students deciding to make an effort and get involved in the activity regardless of how difficult it is to be carried out, and the cognitive development it generates in them (Munnerley, Bacon, Wilson, Steele, Hedberg & Fitzgerald, 2012).

These two factors are key for the self-regulation of learning (Pintrich, 1999), and it is clearly the academic aspiration of achieving goals which was analysed throughout the twentieth century. Some authors (Cuendet, Bonnard, Do-Lenh & Dilenbourg, 2013) developed three learning environments where prototypes and tests were designed and created, in which cooperative learning was achieved. AR poses great challenges to future teachers (Wu, Lee, Chang & Liang, 2013), identifying all the possibilities in the educational scope (Yuen, Yaoyuneyong & Johnson, 2011), detecting the difficulties and giving examples of their good practices (Waugh & Su-Searle, 2014).

In this research line, what we consider essential is the level of satisfaction of students when they learn with AR devices. The most natural way of learning something new is doing it, as stated by the theory of experiential learning (Dünser, Walker, Horner, & Bentall, 2012). In this regard, we add all the studies that assess the mixed-learning environments in which AR plays a relevant role (Yusoff, Ibrahim, Zaman, & Ahmad, 2011), taking into account students' personal differences.

## Research Methodology

### General Background of Research

In order to carry out the present research, a non-experimental methodology was followed; more specifically, a descriptive study based on surveys was conducted.

The sample of the study consisted of all the students registered in the Faculties of Educational Sciences of five Spanish universities during the 2016/2017 academic year. The Faculties of Educational Sciences are organised by degrees (Early Childhood Education, Elementary Education, Pedagogy, and Physical Activity and Sport Sciences) and by groups (a maximum of nine, although not all the degrees offer the same number of groups).

In this study, non-random or intentional sampling was conducted, and the criterion was to provide the students with the easy access that researchers have. Regarding the stratum, we intended to include a wide representation of students from every group, every shift (morning and afternoon), and both genders, i.e., men and women from all the Educational Faculties from the different Spanish universities involved, the latter being a slightly more complex aspect since in this kind of degrees the majority of students are women.

### Sample

In our case, the present study consisted of 1,533 students registered in the 2016/2017 academic year, in the Degree in Elementary Education, from five Spanish universities, of whom 450 (29%) were male and 1,103 (71%) were female. Throughout the course of the study, they took Information and Communication Technologies as a core subject, which had its practical lectures focused on the use of AR in pre-service teacher education.

### Instrument and Procedures

For data collection, the Augmented Reality Applications Attitude Scale (ARAAS), created by Küçük, Yilmaz, Baydaş & Göktaş (2014), was used. The data were collected from 167 students (84 male, 83 female) in the 5$^{th}$ grade from 7 different secondary schools. The final scale had 15 items grouped into 3 factors.



In the present study, the instrument developed by Küçük, Yilmaz, Baydaş & Göktaş (2014) was adapted to the Spanish context. Item 18 "I want AR applications to take place in course books in the future" was removed, and the following items were added: develop positive emotional tones, difficulties, and good practices, collaborative and learning environment, motivation, mixed learning, cognitive skills, change of attitude, learning satisfaction, etc.

This instrument consists of 23 items, measured in a Likert scale of five points 5 (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree), and organised in three dimensions that determine the attitudes of future teachers toward the use of AR applications in pre-service teacher education, which are Relevance, Satisfaction, and Reliability.

To analyse the data, the statistical software SPSS 23.0 was used. Exploratory factor analysis was conducted to obtain the factor structure. The Bartlett test of sphericity and the Kaiser-Meyer-Olkin (KMO) test for sampling adequacy were also conducted. Factor extraction was performed through principal component analysis; the eigenvalues and the percentage of applied variance were determined. An oblique rotation was conducted, since the possible factors should be strongly correlated. KMO of 0.908 was obtained, which indicates adequacy to the model and significant Bartlett test of sphericity (p=.000). Three factors were obtained, which account for 58.4% of the variance (Table 1).

Reliability was determined with Cronbach´s Alpha by factor and global to the instrument. This indicator gave good results in all cases: Satisfaction ($\alpha$ =.854), Relevance ($\alpha$ =.795), and Reliability ($\alpha$ =.794).

## Results

### Validity and Reliability

Prior to factor analysis, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) was checked and the Bartlett Test of sphericity was analysed. The calculated KMO was 0.908, above the recommended valued of 0.6 (Field, 2009), which indicates that the factor analysis is appropriate for the data set. The results of the Bartlett Test of sphericity were ($\chi 2$ =1621.667, df =253, P = .000), suggesting the factor ability of the correlation matrix (Field, 2009).

Cronbach's alpha for the 23-item scale ($\alpha$ = .923) demonstrates high internal consistency. Analysing the internal consistency of the subscales, we found the following highly reliable: Satisfaction (F2) ($\alpha$ = .854), Relevance (F1) ($\alpha$ = .795), and Reliability (F3) ($\alpha$ = .794) (Tables 1 and 2).

**Table 1.** Cronbach´s alpha for the factors and items of the Augmented Reality Applications Attitude Scale (ARAAS)

| Items | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| **Relevance (α = .795)** | **Loadings** | | |
| I get bored while I use AR applications | -.809 | | |
| It is difficult to use AR applications | .882 | | |
| The AR applications of 3D objects provide a feeling of reality | .773 | | |
| Studying the topics is more difficult due to AR applications | .757 | | |
| I would like to use AR applications in other topics and modules | .800 | | |
| The use of AR applications in the classroom is a waste of time | .731 | | |
| AR applications make my learning difficult because they confuse my mind | .736 | | |
| There is no need to use AR applications in the classroom | .732 | | |
| AR improves my opinion about the content of the subject (practical view) | .651 | | |
| **Satisfaction (α = .854)** | | **Loadings** | |
| I gain better focus on the topic when AR applications are used | | .664 | |
| Demonstration of 3D objects, videos and animations with AR applications increases my curiosity | | .781 | |
| I attend a lecture with enthusiasm when AR applications are used | | .704 | |
| I enjoy the lectures in which AR applications are used | | .879 | |
| AR applications do not catch my attention | | .760 | |
| I enjoy studying subject topics with AR applications | | .776 | |
| Using AR motivates me to work more on this module | | .826 | |
| I feel more involved in this module (AR) than if I worked in a more theoretical manner (useful view) | | .589 | |
| In general, I think that the use of AR indicates that the teacher is interested in teaching | | .756 | |
| **Reliability (α = .794)** | | | **Loadings** |
| I think that the generalisation of this type of AR initiatives would significantly improve the quality of university teaching | | | .795 |
| Working with AR allows me to share my ideas, answers and views with my teacher and classmates | | | .733 |
| This activity with AR makes me develop other cognitive skills (analysis, synthesis, critical thinking) | | | .689 |
| AR has changed my attitude as a student, not only in this module, but generally in all subjects | | | .645 |
| The use of AR makes me develop other instrumental skills (handling of tools, information search) in my way of studying | | | .890 |



**Table 2.** Cronbach´s Alpha and KMO for the subscales of the Augmented Reality Applications Attitude Scale (ARAAS)

| Subscales | Number of items | Cronbach-α | KMO |
|---|---|---|---|
| Relevance | 9 | .795 | .833 |
| Satisfaction | 9 | .854 | .879 |
| Reliability | 5 | .794 | .801 |
| Total | 23 | .923 | .908 |

## Student attitudes

The mean values of the attitudes of future teachers in pre-service teacher education toward AR applications according to the items and factors of the ARAAS are shown in Table 3. The highest score was obtained in *AR usage reliability* ($\dot{x}$ = 3.63), followed by *satisfaction* ($\dot{x}$ = 3.48) and *relevance* ($\dot{x}$ = 2.66), which is below the average score of attitudes.

With regard to the results obtained in the items of the scale, it is seen in Table 3 and Figure 1 that no item reaches the maximum value of 5, which indicates that the students have a middle attitude toward the use of AR for teaching. The items of *reliability* obtained mean values over 3, with the highest items being those of "I think that the generalisation of this type of AR initiatives would significantly improve the quality of university teaching" ($\dot{x}$ = 3.78), and "This activity with AR makes me develop other cognitive skills" ($\dot{x}$ = 3.74). The results indicate that the future teachers show reliability with respect to the fact that the use of AR allows for improving the quality of university teaching, as well as developing cognitive and instrumental skills throughout their training, and sharing ideas and new educational perspectives.

*Satisfaction* shows high levels, above the average value of 3, except in the item "AR applications do not catch my attention" ($\dot{x}$ = 1.99), which obtained the lowest scores in the satisfaction of future teachers. The items with the highest scores are "Demonstration of 3D objects, videos and animations with AR applications increases my curiosity" ($\dot{x}$ = 4.07), "In general, I think that the use of AR indicates that the teacher is interested in teaching" ($\dot{x}$ = 3.80), "Using AR motivates me to work more on this module" ($\dot{x}$ = 3.76), and "I enjoy the lectures in which AR applications are used" ($\dot{x}$ = 3.73). These results indicate that the future teachers, after experiencing the use of AR as a teaching tool, show user satisfaction levels above the average.

**Table 3.** Dimensions and items of the Augmented Reality Applications Attitude Scale (ARAAS)

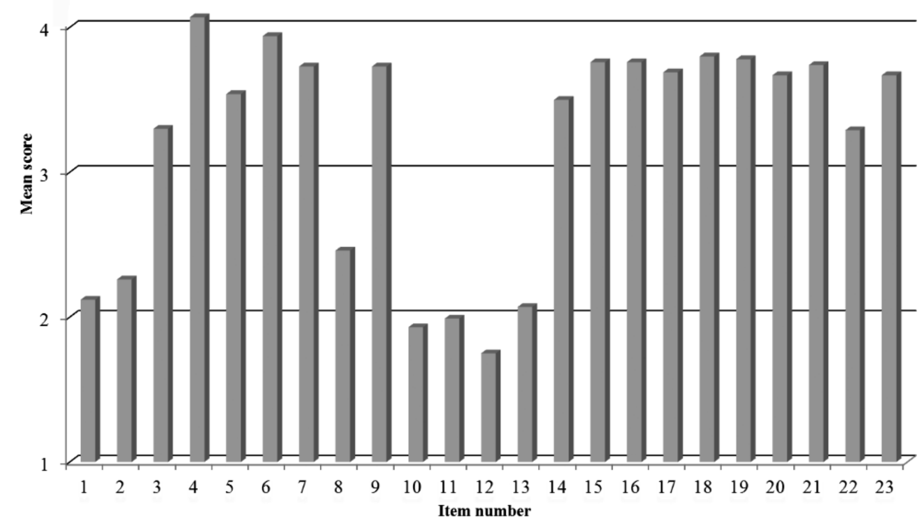
| Items | Mean Ẋ | Deviation δ | Dimensions |
|---|---|---|---|
| Item 1 | 2.12 | 1.112 | **Relevance** Ẋ = 2.66 δ = .365 |
| Item 2 | 2.26 | .937 | |
| Item 6 | 3.94 | .926 | |
| Item 8 | 2.46 | 1.192 | |
| Item 9 | 3.73 | 1.065 | |
| Item 10 | 1.93 | 1.046 | |
| Item 12 | 1.75 | .855 | |
| Item 13 | 2.07 | 1.043 | |
| Item 16 | 3.76 | .901 | |
| Item 3 | 3.30 | .987 | **Satisfaction** Ẋ = 3.48 δ = .525 |
| Item 4 | 4.07 | .915 | |
| Item 5 | 3.54 | .918 | |
| Item 7 | 3.73 | .988 | |
| Item 11 | 1.99 | 1.130 | |
| Item 14 | 3.50 | .911 | |
| Item 15 | 3.76 | .932 | |
| Item 17 | 3.69 | 1.115 | |
| Item 18 | 3.80 | .918 | |
| Item 19 | 3.78 | .959 | **Reliability** Ẋ = 3.63 δ = .666 |
| Item 20 | 3.67 | .909 | |
| Item 21 | 3.74 | .809 | |
| Item 22 | 3.29 | .910 | |
| Item 23 | 3.67 | .912 | |

With respect to *relevance*, the items with the lowest scores are: "The use of AR applications in the classroom is a waste of time" (ẋ = 1.93), "AR applications make my learning difficult because they confuse my mind" (ẋ = 1.75), "There is no need to use AR applications in the classroom" (ẋ = 2.07), and "I get bored while I use AR applications" (ẋ = 2.12). On the other hand, the items with the highest scores are: "The AR applications of 3D objects provide a feeling of reality" (ẋ = 3.94) and "AR improves my opinion about the content of the subject (practical view)" (ẋ = 3.76).

The results of the *relevance* dimension indicate that the future teachers in pre-service teacher education show very positive attitudes toward the use of AR in the teaching/learning process; they do not get bored, and they think that it is easy to use, prevents a waste of time, provides a feeling of reality, and increases their motivation to study topics in AR, which makes it easier for them to acquire new knowledge.



**Figure 1.** Mean value of the scores of each of the items of the Augmented Reality Applications Attitude Scale (ARAAS)




## Discussion

Considering the perceptions of the students, and meeting the objectives proposed in the presented study, it can be concluded that AR applications are efficient since they improve students' personal projects. AR helped the students to immerse in complex topics and increased their motivation, encouraging them to design and create multimedia materials proposed in the learning modules. There was a change of attitude towards AR, in particular, and about the use of Information and Communication Technologies, in general. The results of this study were not compared in relation to sex, course or shift. Also, no data was provided about another hypothesis, which considers student evaluation, learning orientation, the effort to achieve the goals proposed, etc.

The main contribution of this study is that AR improved the learning processes and enhanced the acquisition of professional skills. Moreover, AR provided the description of very positive attitudes in the students who had experienced it, as shown by the statistical data.

## Conclusions

The results of the presented study allow for drawing the following conclusions: the students developed a favourable attitude in their role as future teachers toward the use of AR applications as a learning tool, which provided them with great immersion or increased their resources to understand and learn disciplines with a high degree of abstraction. They felt happy with the new knowledge acquired, and their motivation increased with the use of the applications. However, it is important to highlight that, due to the exploratory nature of this study, a careful interpretation of the results is advisable, especially when generalising them in other contexts. Nevertheless, the initial character of this work opens new perspectives of special interest in research in this field (expand the study to the whole teaching staff, design and create new instruments that allow for a more detailed analysis of the different attitudes and professional teaching skills, include new contexts, create more mixed interactive environments, etc. (Dünser, Walker, Horner & Bentall, 2012).

Augmented reality has allowed us to identify and analyze the effects of its use on the curricula of future teachers. Regarding the impact that these practices have on educational centers, we must refer to the results obtained in the following study, which are consistent with the objectives we set in the present research, such as: to analyze the effects of its use on educational environments, whether it modifies and facilitates the acquirement of knowledge, attention and motivation, as well as students' academic performance, and the perceptions they had after the use of this novel technology (Toledo-Morales & Sánchez-García, 2017). AR has gained prominence as a key digital resource for the transformation of education systems around the world. Especially in the last four years, our contribution has been in the work line proposed in the Horizon Report 2017, and of course in Horizon 2020 and 2030 as well.

We have stated that the ways to learn have changed, and one of the most significant implications is that future teachers must integrate new strategies and resources in their educational projects and performance. Since we are a Faculty of Education, we had the opportunity to experiment with future professionals about an educational reality of the future. The students had the chance to approach this cultural change, where the curriculum was enriched and the available resources, at that time, were given the best educational use.

Finally, we would like to highlight the idea that AR applications can be used as communication tools themselves, which opens other research lines on aspects that could be developed in current training ecosystems.



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