Augmented Reality Digital Technologies (ARDT) for Foreign Language Teaching and Learning

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***Abstract*—The present study focuses on Augmented Reality and its role in language education. It has often been claimed that emerging technologies have great potential to improve language learning and increase learner performance. While their digital capabilities are almost limitless, to our knowledge, no study has been conducted to measure their effectiveness on actual language learners. In this paper we report and discuss our ongoing work on the design, management, and implementation of Augmented Reality experiences for foreign language instruction. We concentrate on the beginner's level Spanish course for which we have used Aurasma, an augmented reality app for mobile devices. The project has a three-fold purpose: 1) to increase second language learners' motivation, 2) to measure statistically the effectiveness of this technology in classroom settings, and 3) to contribute to our knowledge of digital technology and language instruction.**

Keywords*—augmented reality; language instruction; mobile, emerging technologies

I. Introduction

This research study is a part of a broader interdisciplinary project that aims to advance our understanding of emerging mobile technologies, namely virtual, augmented, and mixed realities, and their role in language education. Recent advances in technology have made it possible to add these interactive visual dimensions to nearly any learning environment. It has also been claimed that 3D technology can help students learn more effectively, understand hard concepts, and increase their retention compared to traditional 2D surfaces [3]. Thus, this technology has the potential to improve language learning, since visualization and interactivity foster better memory retention and increase student performance, as well as lower student anxiety [7,11,16]. In recent years, we have also seen a significant increase in the use of mobile devices as tools in education. The 2014 NMC Horizon Report for K12 and Higher Education has identified the use of emerging mobile digital technology as a key trend and has predicted its large impact on teaching and learning. Indeed, many schools have started implementing mobile apps to increase the engagement of their digital native students [20].[1] One such app is Augmented Reality *Aurasma* [1], built for IOS and Android devices. According to its developers, the number of *Aurasma* customers has already surpassed 100,000.[2] While Augmented Reality is often associated with commercial use, this mobile technology is gaining popularity in education. However, this technology is still relatively new to education, especially in the field of foreign languages. Despite the growing number of experimental studies [4,6], many theoretical and methodological questions remain unanswered, such as the effectiveness of this technology in classroom settings, how it may advance learner experience, and how it may affect teacher-student and student-student interactions, classroom dynamics, and contextual relations.

Our study focuses on the role of mobile augmented reality in foreign language instruction. The goal of our research is to assess the effectiveness of augmented reality (AR, henceforth) as a teaching tool in classroom and individual settings. This assessment includes i) exploring AR learning potential in language instruction, ii) gathering statistical evidence to test previous claims, iii) comparing data with results obtained from language classrooms that use traditional technology, iv) developing methodological recommendations for language instructors, and v) further contributing to our knowledge of mobile digital technology and language instruction. Our study is guided by the following questions:

1) Does the emerging technology positively affect student motivation and performance?
2) Does the amount of time that students spend using AR textbooks increase compared to traditional textbooks?
3) How do students respond to AR interaction?
4) How do instructors feel about teaching with AR technology?
5) What types of AR interactions are more suitable for language instruction?
6) How do lesson tasks differ when using traditional versus AR textbooks?

The remainder of this paper is organized as follows: Section 2 reviews the concept of AR and its use in education. Section 3 provides an overview of existing AR apps. In Section 4 we describe our project design and methodology. Conclusion and future development of this research are presented in Section 6.

II. Background

A. Augmented Reality Definition

Augmented Reality can be defined as "a real time direct or indirect view of a physical real world environment that has been enhanced/augmented by adding virtual computer generated information to it" [9]. While there are many types of AR devices (e.g. head-mounted, hand-held, and spatial displays - see [9] for a more detailed overview), in this study we focus on a hand-held display, namely a mobile device. This type of display is portable and widespread, especially among

[1] 98% of young adults own a cell phone - from the 2014 Pew Research Center Survey.

[2] https://www.aurasma.com/news/hp-aurasma-accelerates-momentum-passes-100-000-customer-milestone/ accessed 10/29/15

(a) Aris (b) Mentira

Fig. 1. AR game *Mentira* for Spanish language

younger generation, which makes it convenient for use in educational settings. Equipped with cameras, apps, and the internet, today's mobile devices allow for the superposition of virtual graphics and media over a physical object, such as an image, object, or place. By viewing an object through a mobile device camera, the user is exposed to enhanced virtual layers placed on top of the real object. As soon as the user's camera points at the predefined trigger, such as an image or object, augmented media (e.g. video, 3D, and animation) are sent to the mobile device from an online database. That is, this technology can transform a classroom setting into a virtual learning environment: for example, real cultural artifacts will trigger images or videos of their history, wall maps will display geographical locations, portraits will bring to life real stories, and textbooks will launch interactive reviews and quizzes.

B. Augmented Reality in Education

While Augmented Reality is often associated with marketing and entertainment, AR use has started gaining momentum in education. According to the 2012 NMC Horizon Report, this technology will be adopted by K12 educators within the next four to five years.[3] Several recent studies have also demonstrated its value in learning environments. According to these studies, AR enhances problem solving, critical thinking, and collaboration [21], students have more authentic learning experiences [17]; it also increases motivation and face-to-face and remote collaboration [4,13], and results in better performance and learning attitudes [15]. In addition, it is argued that AR portability and context sensitivity make this mobile technology ideal for all educational environments, from elementary school to university levels [17]. AR applications have already been successfully used in science, biology, and math, as well as in literary and poetry development [4,6,18]. Enhanced by scenario-based simulations, students are able to work in groups to gain math, medical, and scientific skills [13]. The field of foreign language instruction has, however, been slow to embrace this emerging technology. To our knowledge, only one AR project, *Mentira*,[4] has been developed for foreign language learning. *Mentira* is a place-based game developed at the University of Wisconsin-Madison for 200-level Spanish language courses. The game is constructed as a murder mystery with 70 pages of dialogue, 150 photos, and 4 short movies. The game is developed with *Aris*, an open-source platform for creating mobile interactive games.[5] *Aris* app is shown in Figure 1a, and Figure 1b illustrates a game dialogue, as it would be viewed by a user. In this scenario, written mini-dialogues prompt users to select a linguistically appropriate response.

It should be noted that various practical limitations still act as barriers to AR advancement, such as budget and time constraints, teacher interest and involvement, and initial learning curve. Finally, there are a number of technical issues related to the use of mobile devices in classrooms: i) small screen size, ii) network speed, and iii) battery capacity [10].

III. Augmented Reality App

Recent advances in mobile technology have made AR applications and platforms accessible to a large audience of mobile users. At present, there exist many types of AR apps (e.g. AR flashcards, AR games, AR finders). In this study, we will focus on AR systems. These systems are "potentially more exciting for educators", as they allow users to select and design their own triggers and augmented overlays [6]. Among these systems are Layar,[6] Aurasma,[7] and buildAr.[8] While *Layar* is based on printed materials, e.g. photos, books, and maps, *Aurasma* and *buildAr* enable users to create their material using any digital or physical object. Furthermore, *Aurasma* and *Layar* are free apps, whereas *buildAr* allows users to build free projects only for a limited time. Finally, a small independent study has conducted a comparative analysis of various available AR software and apps.[9] According to their findings *Aurasma* seems to offer "the best augmented reality (AR) experience for classrooms" [14].

Based on the above-mentioned qualities, such as user-friendliness and free access, our choice fell on *Aurasma*.

[3] http://redarchive.nmc.org/publications/2012-horizon-report-k12
[4] http://www.mentira.org/overview
[5] http://arisgames.org/
[6] https://www.layar.com/
[7] https://www.aurasma.com/
[8] https://buildar.com/about
[9] http://www.edudemic.com/aurasma-for-your-classroom/ accessed 10/29/15

(a) Mini-dialogue

(b) Vocabulary practice

Fig. 2. Final AR output using mobile device

Furthermore, *Aurasma* provides two kinds of user interfaces: a mobile app and a web application. The mobile app can be freely downloaded on iPhones, iPads, Android phones, and tablets. This interface is mainly used for viewing and playing AR experiences. Mobile devices also allow for a limited AR creation from *Aurasma*'s online library and the user's photo library. In contrast, *Aurasma studio* is a web interface offering more sophisticated functions, such as design, sharing options, content management, a storing system, and statistics.[10]

Similar to other AR systems, *Aurasma* uses images (aka triggers) and object recognition technology to activate AR content. In addition, it is possible to use a geographical location to create triggers from physical objects. The digital AR content (aka overlay) can be represented in various formats (e.g. videos, images, web pages, or 3D scenes) as single, multiple or sequenced overlays [2]. Finally, interactive actions can be added to the AR experiences.

IV. Project Overview

A. Methodology

Our research team is made up of two faculty members from the Department of Spanish and Portuguese, one graduate student in Visual Arts, and several recruited language instructors. Given the lack of research on this topic in the field of foreign languages, our project examines various methodological and theoretical questions regarding AR design, use, interaction, and evaluation in classroom settings. Questions addressed in the proposed project have been developed during our pilot AR project in Summer 2015 and Fall 2015. Students from two different language courses were exposed to various assignments in the classroom using their mobile devices with a free augmented reality app. Students were instructed to point their mobile devices at certain images and interact with augmented 2D video layers (e.g. listen, answer questions, repeat). This app was user-friendly and only a couple of students had technical issues.

Our current research concentrates only on one language course - beginner's level Spanish.[11] This methodological decision helps us avoid biased data, where students have various levels of Spanish at the beginning of the experiment. This level uses the textbook *Anda! Curso Elemental*, which provides many illustrations and photos that can be used as triggers. Our workflow consists of three stages: 1) preparation of triggers (images), 2) video recording, and 3) creation of AR experiences (*auras*, henceforth). First, the textbook is digitally scanned in high quality. Then, the images for the *Aurasma* triggers are isolated and cropped in photo-editing software. The trigger images are uploaded to Aurasma studio, and any necessary adjustments are made to the images in order to produce a working, trainable trigger for the Aurasma app. Second, a team of graduate students (native speakers of Spanish) has compiled sketches with mini dialogues and vocabulary practice. Video recordings were produced at Video Lab, where we were able to add background pictures and powerpoint slides to our videos. These recordings aim to expose learners to various varieties of Spanish and enhance their understanding of different pronunciations, intonation, and vocabulary.

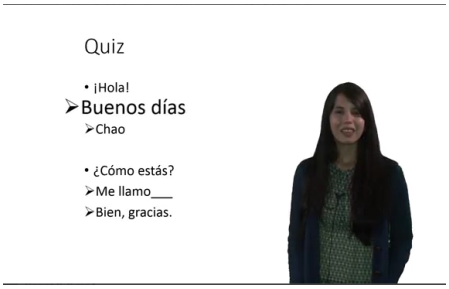
Finally, each trigger image is combined with a specific video overlay. Figure 2 illustrates *auras* as they are seen from the user's mobile device. The mini-dialogue helps retain new vocabulary and grammatical constructions in context, whereas vocabulary practice provides visual and audio reinforcement. Each AR content is followed by a short quiz that helps students evaluate their comprehension. We have implemented two types of quiz presentations: one with powerpoint-style questions and another with direct questions. A sample of quiz is shown in Figure 3a, where the background of video is composed from powerpoint slides with questions and multiple answers. At the same time, these questions are asked interactively by an instructor. The reader is welcomed to view the AR content from a mobile device. First, the reader will need to add and follow our channel *spanishIU*. Second, the mobile device (view screen button) needs to be pointed at Figure 3a (trigger) in order to activate the Spanish quiz.

B. Augmented Reality Evaluation

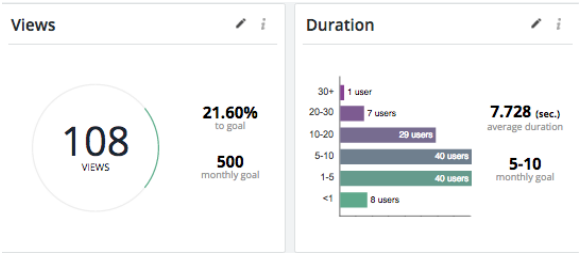
To evaluate AR effectiveness as a tool in the classroom setting, we analyze technical and learning components of the AR app. While non-commercial Aurasma accounts do not provide statistical data, our SOTL grant with the support of the Aurasma team gives us an opportunity not only to evaluate students' engagement but also the design of each aura. The following information is collected anonymously: i) number of unique users, ii) frequency of use, iii) time spent on each aura, iv) location, and v) number of clicks. The sample of collected data is shown in Figure 3b. In addition to built-in statistics in Aurasma, we also conduct a survey using Qualtrics, an online

[10]Statistics and some advanced design features are available only for professional accounts.

[11]There are five basic undergraduate language levels in the Basic Language Program for Spanish at Indiana University [100, 150, 105 (combination of 100/150), 200, 250].



(a) Quiz



(b) Aurasma Insights

Fig. 3. Quiz and Statistical data

survey research platform.[12] With Aurasma studio, it is quite easy to add the survey links at the end of the AR content. In addition, Aurasma data will record the number of clicks for each given url.

For technical feedback, our survey includes questions regarding the friendliness of the app. For example, we ask students to rate the following statements: 1) The application was easy to use and understand and 2) The application was responsive and the content loaded quickly. The evaluation of learning effectiveness consists of a short survey question based on the AR content. By using students' technical feedback, real analytical statistics, and learning assessment, we hope to provide robust evidence to our AR study.

V. Conclusion

We anticipate a two-fold impact of this research. First, this study will add to our understanding of the role of emerging technologies in language instruction. Using the results from this study and previous studies on digital technologies in the classroom, we can improve our teaching and learning experiences in the 21st century. Our world is changing, and "[w]ith each new era, educators must examine the cultural and technological changes that define the times in order to reflect or incorporate them into teaching practice" [5]. Second, this study will allow us to provide methodological recommendations for AR design and for its use as a teaching tool offering powerful virtual learning experiences in language classroom settings.

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