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The Use of Augmented Reality to Enhance Learners' Comprehension and Retention

A Case Study of Third Year English Students at Biskra's University

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Declaration

I, Rayene Ben Aissa, do hereby solemnly declare that the work presented in this thesis is my own, and has not been submitted before to any other institution or university for a degree.

This work was carried out and completed at Mohamed Kheider University of Biskra, Algeria.

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Dedication

In the Name of God, Most Gracious, Most Merciful.

I dedicate this modest work, with all my love and respect, to

My beloved parents and grandmother who gave me every opportunity to achieve and reach this moment. May Allah almighty protects them.

To all my friends, teachers, and colleagues.

To whoever happens to read this dissertation.

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Abstract

Over the last decade, the rapid evolution of technology applications has yielded new ways to approach education and develop the teaching and learning process. Augmented reality (AR) is a new instructional tool that allows learners to be immersed in natural realistic experiences. It aids learners to enhance critical capacity and deeper understanding of concepts while offering a new educational approach to the program. Therefore, it is important to properly test and evaluate it so practitioners feel more confident in its use. Accordingly, this study aims at investigating the workability and usefulness of AR applications (apps) in enhancing reading comprehension and retention. It also seeks to highlight a better understanding of the designed prototype and unraveling teachers' attitudes towards the latter's implementation. The study hypothesizes that AR has a positive impact on enhancing learners' academic achievement in terms of comprehension and retention. For this purpose, the study documents a mixed-method investigation, the fundamentals of which are an experimental design that consists of 60 students divided into two groups _ experimental group and control group_ alongside with the structured observation during the treatment. Simultaneously, a questionnaire was submitted to 12 teachers in order to gather sufficient descriptive data regarding their attitudes and opinions towards AR integration. The results show that English as a foreign language (EFL) learners lack reading skills; thus, AR is a recommended effective tool that provides a multimedia learning environment presenting relevant materials in various formats. Although students were initially overwhelmed with AR, findings also show the appreciative positive attitudes of teachers towards this technology, which consequently rendered the alternative hypothesis confirmed.

Keywords: Augmented Reality (AR), Applications (Apps), English as a Foreign Language (EFL).

List of Abbreviations and Acronyms

App: Application

AR: Augmented Reality

EFL: English as a Foreign Language

ICT: Information and Communication Technology

VR: Virtual Reality

VLE: Virtual Learning Environment

CAI: Computer Assisted Instruction

SMART: System of Augmented Reality for Teaching

HMD: Head-Mounted Displays

QR: Quick Response

GPS: Global Positioning System

STM: Short Term Memory

LTM: Long Term Memory

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General Introduction

Introduction

Until the emergence of new technological innovations, the most commonly used teaching method has been the direct communication between instructors and learners within the classroom. Even though they work effectively, professionals have demonstrated a considerable interest in more productive methods by incorporating technology such as VLE (virtual learning environment) to pedagogy and learning. The relatively new concept of education going digital was a target for several institutions as it was proven in recent studies to provide the tools for improving learning and motivation.

Information and Communications Technology (ICT) has been welcomed in education by teachers and students across the world. The two-dimensional media used texts, sounds, images, and videos in the classroom built upon traditional teaching methods, making the subject more challenging and interesting for both parties. Even though the two-dimensional world is very convenient and affordable, the shift to three-dimensional techniques must be taken into consideration.

Furthermore, many institutions are eager to exploit new visualization methods and one of the most promising ones is augmented reality (AR). In definition, AR is a technology that combines the real world with virtual (computer-generated) objects for a new kind of visualization that promises to build an interactive learning experience. In AR, the physical world must be synchronized with the virtual in position and setting to provide a significant view.

In order to improve learners' comprehension and retention in advanced learning problems, researchers recommended the use of high-fidelity and low-latency correspondence of sound and

video data, complemented by multichannel, and spatialized audio. Therefore, this paper demonstrates how the use of AR in classroom environments increases the level of learner's understanding and engagement (both cognitive and affective domains).

1. Statement of the Problem

The world is rapidly evolving; therefore, changes must be made to improve the quality of learning and bring education to a new level. While research into the effect of educational technology on learners exists, adapting new processes in education is required because the traditional way of learning does not satisfy the students any longer. In fact, forming an interest in the classroom remains a major concern for most professionals. Due to the limitation of learning tools, learners find it difficult to visualize and end up losing focus in the learning activity.

The present research investigates whether new technologies such as Augmented Reality can be used by English language students at Biskra's University to improve their levels of reading retention, comprehension, and motivation. For this reason, AR books are designed to simplify the efforts that are put to comprehend materials; therefore, it saves time and energy spent on searching filtered relevant information of the course. Certainly, using AR in education will add not only images and videos but also 3D rendered models to the learning context, allowing students to move around and engage in the multimodal environment.

Since augmented reality is a new technological innovation that has not been massively used, it became the center of discussions. Although there are only a few studies that have conducted the practical part of this research, AR can be the future of education as it has the ability to create a real-life experience in terms of instructional teaching tools. This paper shows how AR is a revolutionary innovation that creates meaningful learning experiences that benefit the educational system and

study process. In the same way, it examines empirically the use of this technology on mobile devices for English language students at Mohamed Kheider University of Biskra.

2. Research Questions

The following research questions were addressed to provide insight for successful integration of AR applications in Algeria's higher education:

1. What is Augmented Reality?
2. Can AR improve students' academic performance within the classroom?

Sub-question: Will students retain more knowledge within an AR group?

3. What are teachers and students' current perceptions about the transference of AR practices to educational settings?

3. Research Hypotheses

In this research, we hypothesized:

1. If students receive AR learning materials, they might report higher rates of retention and demonstrate a moderate increase in academic performance than those of a traditional one.
2. Both teachers and students have a positive attitude towards the addition of AR tools to the teaching and learning materials in classrooms.

4. Research Design

A mixed-method explanatory research was designed to improve the accuracy and reliability of the study's results.

> Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis and the mixture of qualitative and quantitative approaches in many phases of the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches, in combination, provides a better understanding of research problems than either approach alone. (Creswell and Clark, 2007, p. 5)

Since the mixed method approach uses both qualitative and quantitative methods, there were two stages. In the first stage, participants from third year English branch were randomly selected based on probability simple sampling for an experiment; therefore, it consisted of an experimental group which was familiarized with AR and a control group that was not. To be more precise, the population of third year English branch includes 372 students, and the sample taken has 60 students. On the other hand, the second stage, a sample was chosen purposively; i.e., a questionnaire distributed to 12 Literature teachers. The three primary tools of data collection (post-test, observation, questionnaire) were utilized during the research to provide a thorough understanding of the study.

To sum up, the explanatory design is used to bridge the research practice and objectives which involves quantitative methods to test a hypothesis in the theoretical framework, then qualitative ones to dig deeper and provide explanations to the results.

5. Aims and Objectives of the Study

AR technology provides the students with information and experiences while maintaining the level of immersion through a blending of a virtual learning object that is not available in current technological replacements. "Compared to traditional and superficial displays, AR has some advantages in developing spatial abilities and strengthening cognitive abilities" (Shelton and Hedley, 2004). Regarding that, the primary aim of this study is to explore the potential effects of AR integration including the increase of comprehension and engagement level within classroom. To achieve this goal, we examined previous works related to this research and conducted an experiment to contribute to AR implementation. This study seeks to achieve few goals:

1. Understand the feasibility of AR implementation and the insights it offers for teachers and administration members as an instructional tool.
2. Measure and compare the academic performance of an AR based learning environment and traditional one.
3. Demonstrate the benefits and opportunities to effective learning that this innovation gives students.

This study, thus, seeks to discover the many facets of digital educational technology; specifically, AR implementation on students' interaction, comprehension, and retention within a classroom context.

6. Significance of Study

AR technology is the new future of the educational field. This technology is entering the practical application stage, and currently, several AR books have been developed as mobile applications. In particular, these tools are already developing; therefore, there is a need to integrate them in the curriculum. According to Yuen, Yaoyuneyong, and Johnson (2011): “AR has vast potential implications and numerous benefits for the augmentation of teaching and learning

environments". In this designed study, we build upon previous researches and the conducted experiment by providing a number of recommendations for AR use in the educational setting and create a solid knowledge foundation for the adaptation of AR in Algeria's institutions. Even though there is a number of successful experiences in terms of AR innovation in different countries; a practical research in Algeria should be conducted as a future reference since more research is needed in relation to embodied experiences. Certainly, the potential of AR in education remains unexplored due to limited amount of studies investigating it.

By demonstrating that AR based learning is a promising method for education in the near future, instructors need to learn to adopt this technology soon to receive the most out of it. In fact, they will have an effective alternative to conventional teaching either as a supplement or even a replacement. Thereby, this research supports the process of transferring learning for students from a traditional conventional method to a technology-rich 21st century one, and may also impact how universities and schools prepare new and experienced teachers for future generations.

Chapter 1. Augmented Reality in Education

1.1. History

Even though the term "Augmented Reality" was coined by Thomas Caudell and David Mizell in 1990s to describe how the head-mounted displays (HMD) allowed electricians to see digital prompts over real-time imagery in order to direct employees while assembling complicated wiring harnesses tasks (Caudell and Mizell, 1992); its roots actually go way back before that. Having its beginning in the 1960's with the creation of 'Sensorama Simulator' by Morton Heilig, which was the first real multi-sensorial simulator; it included visuals, sounds, vibrations, and smells (see Figure 2).

Figure 1: Sensorama (Kipper and Rampolla, 2013, p.9)

Moreover, the combination of computer graphic displays and views of real world appeared as early as 1968 when Ivan Sutherland created a system called it 'The Sword of Damocles' (see Figure 3) representing the first augmented and virtual reality in history (Kipper & Rampolla, 2013).

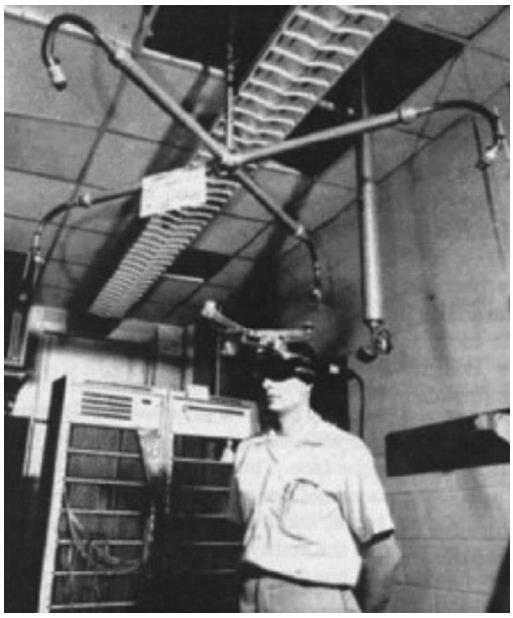

Figure 2: The Sword of Damocles (Kipper & Rampolla, 2013)

Later in 1975, Myron Krueger was the first to create a system that allows users to interact with virtual objects and named it 'Videoplace' (see Figure 4). In 1996, Jun Rekimoto developed an AR prototype that enhanced the idea of the 2D matrix maker.

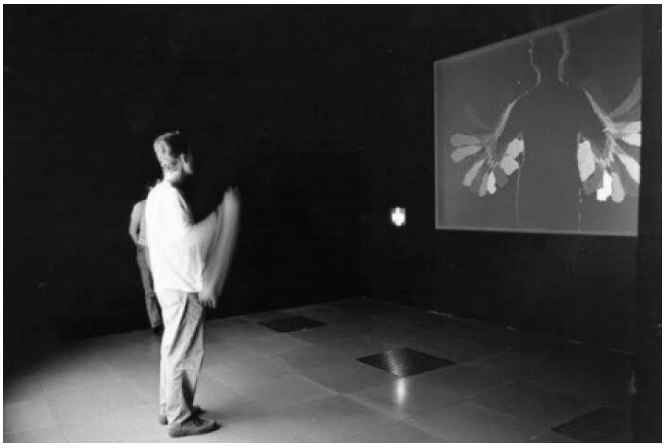

Figure 3: Videoplace (Kipper & Rampolla, 2013)

To further explain this technology, Paul Milgram proposed a reality-virtuality continuum in 1994 to differentiate between AR and VR, as the former developed in time and had similar

characteristics with the latter (Milgram & Kishino, 1994). According to Wu, Lee, Chang, Liang's definition (2013), AR is “a form of virtual reality where the participant’s head-mounted display is transparent, allowing a clear view of the real world”.

In 1997, Ronald T. Azuma published his paper “A Survey of Augmented Reality” which was the first comprehensive paper examining the existing various uses for AR. He characterized an AR system to have certain attributes namely: combining real and virtual objects in an actual interactive environment, in real time; and registers both objects with each other (Azuma et al, 2001).

The first commercial AR application appeared in 2008. It was created for advertising purposes by German organizations in Munich. They designed a printed magazine advertisement of a vehicle model which was a trigger for computers’ cameras. This application was one of the main marketing campaigns that permitted interaction with an advanced model in real time. After, different brands started embracing the idea of positing content on a screen while allowing consumers to interact with it through physical tracking markers; for example, National Geographic in 2011, which displayed rare animal species in malls; Coca-Cola in 2013 simulated environmental problems such as ice melting; and Disney in 2011 showed cartoon characters interacting with people on the streets (Javornik, 2016).

At present, Google have developed Google Glass and Google HoloLens, and their usability have begun to test AR applications in several domains (Cipresso et al.,2018). As AR continues to advance, Google also invested $542 million at an AR firm called Magic Leap Inc., as it had high expectations of the AR technology (Olivarez-Giles, 2016).

The developmental timeline of AR from the 1950s to current time is stated in detail in Figure 5.

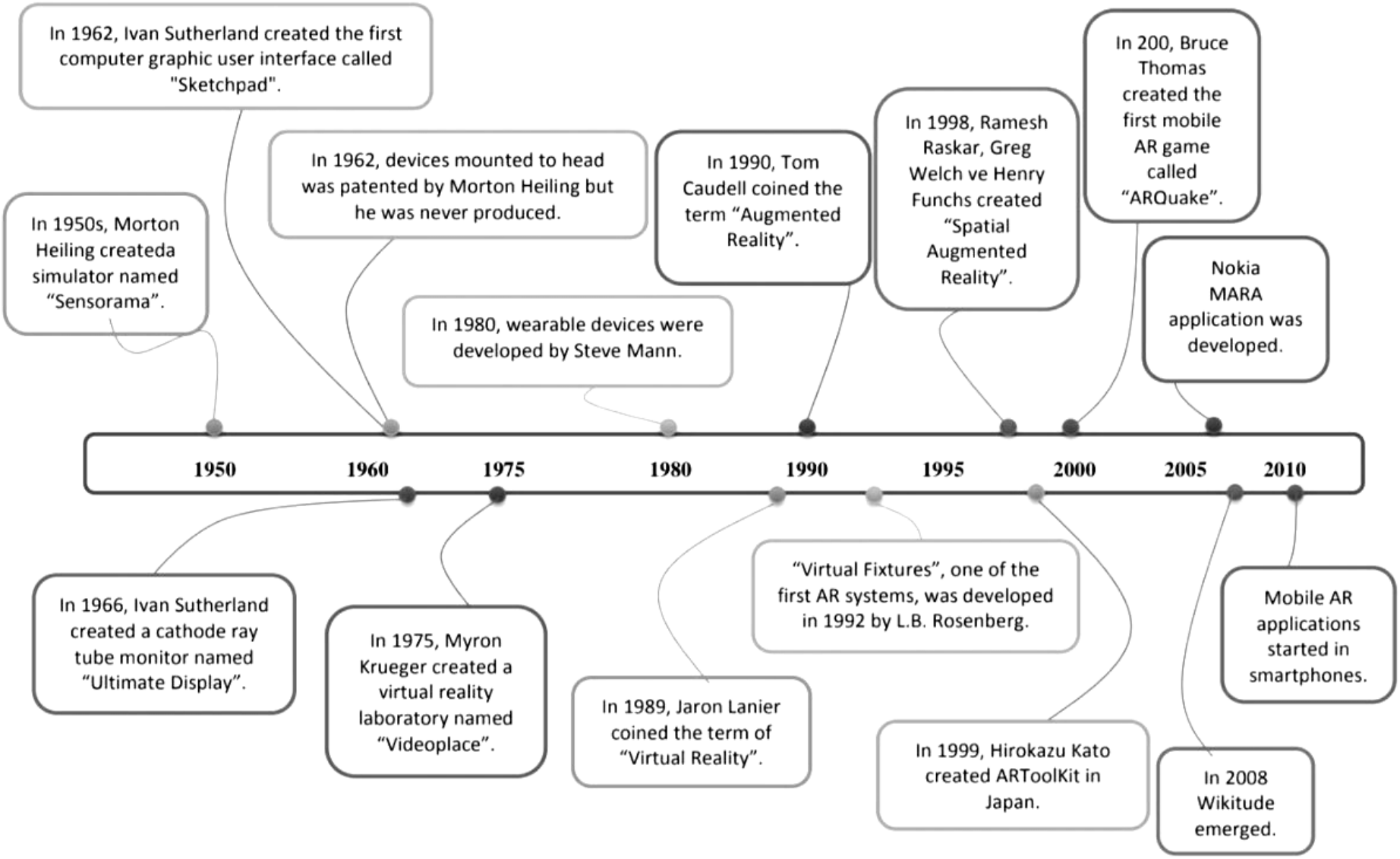

Figure 4: Historical Development of AR (Yilmaz & Göktaş, 2018)

1.2. A Description of Augmented Reality

1.2.1. Definitions

Höllerer and Feiner (2004) define AR systems as those that mix real and computer-generated information in a real interactive environment which align virtual objects with physical ones. In this case, AR is viewed from a restricted approach that emphasizes on the technological aspect of the term. Similarly, Zhou, Duh, and Billinghurst (2008, p.193) define AR as the technology "which allows computer generated virtual imagery to exactly overlay physical objects in real time". According to El Sayed, Zayed, & Sharawy (2011) AR enables the addition of missing information in physical world by adding virtual objects to real scenes.

To be precise, the main idea of AR is to turn a text into more interactive material by blending physical and digital worlds; it bridges the gap in seamlessness between the two worlds (Lee, 2012). Alternatively, some researchers emphasized on defining AR based on the aspect of features and characteristics; Vogt and Shingles (2013, p.47) assert that "augmented reality consists of merging live images with virtual layers of information". The authors explained that these layers of information consist of 3D models that include content, pictures, audio, and videos; "The principle of AR, in which virtual content is added on top of a real environment, is not to be confused with Virtual Reality, where the environment is mostly or totally virtual" (ibid). That is to say, it is a layer of augmentation which enhances the perception of the reality.

These definitions are based on a one restricted AR feature which is the possibility of superimposing digital information to real objects. On the other hand, a broader perspective has been adopted in Wojciechowski and Cellary's study (2013) within which these authors define AR as an extension of VR with some advantages over it. To further explain, supporters of the broad

perspective indicate that the term can be applied to any technology that blends physical and virtual information in a meaningful way; “AR might be based on and accompany with technology, but it should be conceptualized beyond technology only” (Wu et al., 2013).

According to Merriem Webster dictionary (2020), AR is “an enhanced version of reality created by the use of technology to overlay digital information on an image of something being viewed through a device (such as a smartphone camera)”. This is considered as the most recent generalized definition.

1.2.2. AR Components

The AR systems can be viewed through essential technological components such as the displays, tracking methods and user interfaces, all of which have implications on various settings. ‘Augment information’ refers to the use of augmented reality for providing supplemental material by means of markers placed on printed material that individuals use to access digital resources (Huang, Wu, & Chen, 2012).

1.2.2.1. Display. Broadly, displays are the devices that provide signals for our senses to perceive; they can be categorized as to what senses they stimulate such as visual, audio, olfactory, and gustation.

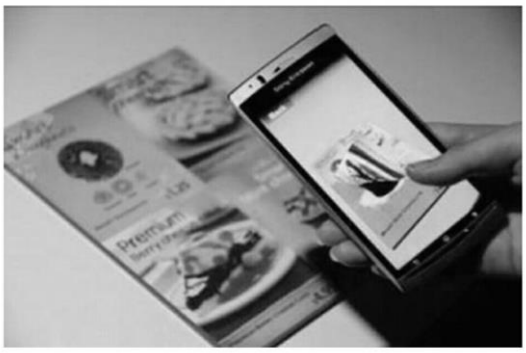

Figure 7: Handheld Display (Sangoi, 2011)

Figure 6: Head Mounted Display (Trivisio, 2011, p.1)

Figure 9: Spatial Projection Display (Bimber & Raskar, 2004)

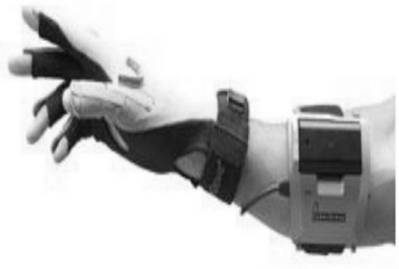

Figure 8: Pinch Gloves (CyberGloves, 2011)

The sensor system provider is responsible for detecting physical world objects and translating them in a seamless manner into a message. The latter contains an accurate real world digital image with the particular event/ object indication and position. That being the case, the logical overlay between computer-generated information and the real world is believed to enrich interaction and engagement which posits augmented reality displays to be highly anticipated as the next-generation display devices.

1.2.2.2. Tracking Methods. AR applications are categorized by different researchers based on the types of technologies used. Johnson, Levine, Smith and Stone (2010) use marker-based applications and markerless application categories, whereas Cheng and Tsai (2012) categorizes AR as image-based and location-based applications. Today, to utilize AR applications on a smartphone, it must be considered that they are designed to perform in one of the two ways:

1.2.2.2.1. Marker-based AR. This method uses a physical object (printed marker) as a trigger to the display of digital information; for instance, using quick response (QR) codes through devices' webcam. It possesses a booklet that includes the marker, a device that transforms information into digital data and a monitor that shows digital data in 3D; I.e., users can view the world through smartphone cameras to see digital content combined with the actual environment. Yilmaz and Göktaş (2018) infer that AR marker-based applications are used for transforming

marker images into digital 3D objects by the aid of specific AR monitoring software that are gathered via a computer or mobile camera.

1.2.2.2.2. Markerless AR. It is sometimes called location-based AR because it uses a Global Positioning System (GPS), compass, internet, and/or other tools to recognize the user's location and to display the digital content corresponding to that certain location. The device must be equipped with several necessary tools: GPS technology; an accelerometer, and a digital compass (magnetometer). Location-based applications are triggered by the user's arrival at a particular location. In this case, these applications do not require a marker to display the content which makes it more interactive than the marker-based augmentation.

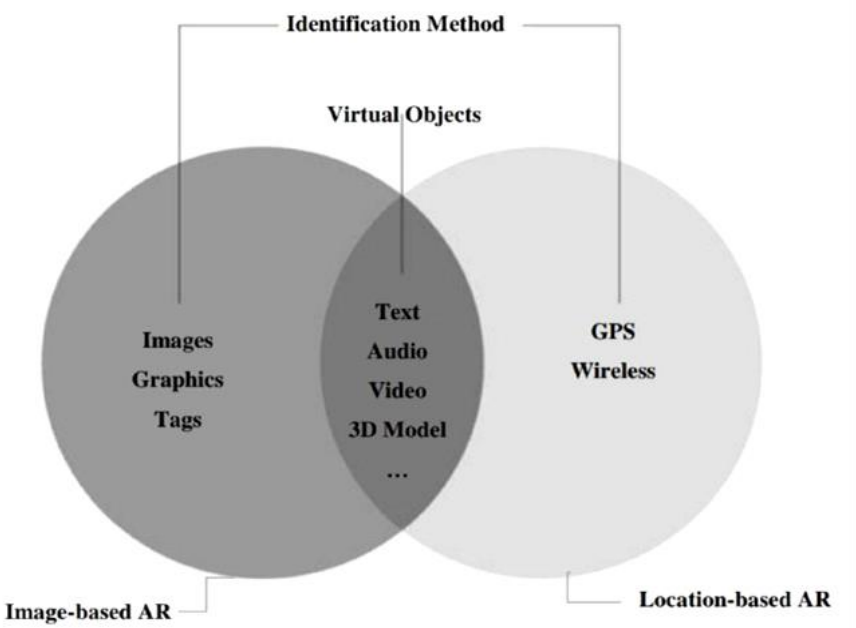

Figure 10: Comparison of Image-based and Location-based AR applications (Cheng & Tsai, 2012)

The figure illustrated above shows the comparison between image-based and location based augmented reality applications. As the two mentioned applications have similar features namely the use of virtual objects such as video, text, audio, and 3D models; the main difference that distinguishes these two is the fact that image-based applications use pictures and graphics as identifiers whereas location-based applications use GPS or wireless as an identifier.

1.2.2.3. User Interface. Sensors gather user's input using user interface devices as buttons, touchscreens, keyboards, and other (whether real or virtual); "the user can interact with the system through a user interface (UI) by using tablets, smartphones or any device with the camera" (Kim, Perey, & Preda (2014) as cited in Sliusar, 2017). After registering to digital data with the user's perception of real world, an interface with both real and virtual objects needs to be provided in order to enable engagement in those environments.

To elaborate, an AR application designer makes use of the sensors to provide the participant with a way to directly control and interact with the application. Schmalstieg and Reitmayr (2007) denote:

> The system should provide context-sensitive cues while the user is busy performing a task or navigating through the environment. Consequently, most input to the system should be automatically derived from situational context, without requiring explicit user attention. The main method for achieving this is by tracking the user's position in the environment, and the user's current viewing direction.

1.3. Augmented Reality in Education

The digital era we are undergoing is a time point where internet and smart phones applications occupy a greater period with high amounts of individuals' daily life. Regarding that, students use these devices frequently throughout the day and in classrooms; therefore, instructors need to take advantage of the availability of students' mobile devices in classrooms and encourage them to connect these devices to the curriculum more critically. Vogt and Shingles (2013, p.47) posited "the rapid growth in the popularity of smart phones and tablets over recent years has provided a large base of potential users of Augmented Reality technology, and virtual layers of information can now be attached to a wide variety of physical objects".

In recent years, numerous studies have focused on AR technology and increased since 2007 till 2017. This technology has been recognized from educational associations as one of the most promising technologies (Ibáñez & Delgado-Kloos, 2018) that will be adopted by educators the next years (Scrivner et al., 2016).

Since the use of various types of technology in the educational setting could simplify complex information, motivate learners, and engage them in the learning process, Balkun (2011, p. 16) emphasized the idea that "students not only must have access to digital media but also learn how to use technology thoughtfully, creatively, and cooperatively". Consequently, students should be familiarized with this technology to profit from it as it involves several gains that indicate its potential in the teaching and learning process. For example, using AR is an efficient aid especially for the subjects that require visualization from students.

In his recent work "Augmented Reality: Concepts and Applications", Craig (2013) clarifies that AR is a medium where digital information overlays the physical world, both in spatial and

temporal registration with the real world, and that is interactive in real time. The researcher expands Azuma's three principles of AR and lists four key aspects that could be beneficial for teachers to design an AR environment within the classroom (Table 1).

Key aspects (ingredients) of augmented reality :
1. The physical world is augmented by digital information superimposed on a view of the physical world. 2. The information is displayed in registration with the physical world. 3. The information displayed is dependent on the location of the real world and the physical perspective of the person in the physical world. 4. The AR experience is interactive, that is, a person can sense the information and make changes to that information if desired. The level of interactivity can range from simply changing the physical perspective (e.g., seeing it from a different point of view) to manipulating and even creating new information.

Table 1: Key Aspects of Augmented Reality (Craig, 2013)

Considering these aspects, learners must use the physical environment to access the digital content in order to be able to manipulate the latter by moving around in a given environment. In some cases, they can even edit or change the digital content. On that account, learning through an interactive experience will enable the learner to correlate an experience with new acquired information, thus strengthening the ability to recall and retain the information. According to Cerqueira and Kirner (2012), AR displays objects and concepts in different ways and at different

viewing angles which helps the students to understand the subjects better. Kangdon (2012, p.19) states:

> It is highly likely that AR can make educational environments more productive, pleasurable, and interactive than ever before. AR not only has the power to engage a learner in a variety of interactive ways that have never been possible before but also can provide each individual with one's unique discovery path with rich content from computer-generated three dimensional environments and models.

In fact, comparative studies between the augmented reality and traditional classroom practices have shown that AR technology improves learners' learning (Kerawalla et al, 2006). In spite, researchers have explored the use of AR applications within a variety of educational fields and disciplines ranging from advertisements, entertainment, manufacturing or medical applications. For example:

a. Liarokapis et al., (2004) have examined the use of AR as a tool for engineering concepts.
b. Kaufmann and his team have focused on AR applications in mathematics and geometry (Kaufmann & Dünser, 2007).
c. Liu et al., (2010) have examined medical applications of AR in general anesthesia.

In these situations, learners must engage with the physical objects to gain the experience each situation offers (learners' shift from observing to physically and mentally interacting with subject concepts develops their understanding highly). Thereby, this interactive engagement increases motivation and extends the learning retention (Billinghurst & Denser, 2012).

1.3.1. Five Directions of AR in Educational Environments

The five directions are introduced by Yuen et al. (2011); the researchers classify AR applications into five groups as follows:

1.3.1.1. Discovery-based Learning. It consists of AR applications that convey information about a place in the physical world. For example, LearnAR application consists of a pack of ten curriculum resources and activities in various subjects such as chemistry, biology, English and other foreign languages, in addition to physical education, for both teachers and students to explore by using a webcam. This direction focuses mainly on flexible independent learning of subjects.

1.3.1.2. Objects Modeling. AR can also be used in objects modeling applications where objects are generated and manipulated in different settings enabling learners to envision the respected model. According to Yuen et al. (2011) "Students receive immediate visual feedback about their ideas and designs in a way that allows them to spot inconsistencies that need to be addressed". Such applications can be used in architectural education as it allows learners to explore and present constructions' proposals.

1.3.1.3. AR Books. It offers students 3D presentations which encourage readers to build a connection with a book. For example, MagicBook, an AR interface system that allows AR content to be created for any book with animated and interactive models drawn from texts and illustrations in the book with the purpose of bringing the book to life (Billingurst, 2002). Yuen et al. (2011) demonstrate: "AR books will open the art of fiction and storytelling to an entirely new interface, demanding greater attention from the 'authors' to a variety of issues, such as the books cohesion, quality on many fronts, and immersiveness".

1.3.1.4. Skills Training. It is an educational function which describes the support of training individuals in specific tasks such as mechanical or airplane maintenance skills (i.e., contextual learning experiences). For instance, an ultrasound medical program developed by the University of North Carolina for physicians projects the pregnant woman's womb onto the doctor's glasses (Yuen et al., 2011). The AR goggles can display every step during a repair, identify the necessary tools, and include textual instructions (ibid).

1.3.1.5. AR Gaming. Often educators utilize new highly visual and interactive forms of learning such as games to assist students in grasping class concepts. Now, AR games provide frameworks for engagement in education and an efficient learning form due to its 'platform-less' nature. Consequently, many teachers include games based learning settings to transfer the learner involvement and energy from games to educational activities. Through these instructional games, learners develop higher cognitive skills (Sandford & Williamson, 2005; as cited in Chen, Ho & Lin, 2014). It is believed to be an effective tool for gaining students' interest and attention as they are learning a variety of skills.

1.4. Benefits of AR

It is anticipated that the z-generation (digital generation) is an active creative one comparing to other generations. Consequently, when their interest is aroused in a certain instruction, it fosters and deepens their learning process. AR is believed to be adaptable to a variety of pedagogies and instructional content; thereby, it possesses several advantages to teachers, learners, and the educational field in general. Today, augmented reality applications development has transformed the educational sector completely and it continued to expand into most areas of the teaching learning process.

Since the use of AR applications is mainly through smartphones and tablets, it is easier for both teachers and learners to utilize in classrooms because they are familiar with such devices. Therefore, there are no limitations in terms of the use; the complexity of augmented reality is removed from the end user product, and is gradually less likely to slow or halt the expansion of AR (Vogt & Shingles, 2013, p. 56). Another point is, distance learning is a mode of education where teachers and students are not present physically as opposed to the traditional institutionalized learning. In this case, AR displays the recorded material along with all additional information in various forms such as videos, graphics, sounds, and texts through the devices making the information more active and vivid.

In spite of that, a number of strengths and educational gains are associated with adopting digital media specifically Augmented Reality in the classroom. The benefits listed below indicate that there is significant potential to implementing this technology in teaching and learning:

a. Singhal et al. (2012) demonstrate that it supports interaction between real and virtual environments in a seamless manner while enabling the use of a tangible interface metaphor for object manipulation.
b. Supports the process of constructing information (Lin et al., 2013).
c. Facilitates transfer of the acquired knowledge and skills in the digital environment to physical world (Abdüsselam & Karal, 2012).
d. Creates contextual awareness, facilitates understanding, and ensures permanent learning (Ivanova & Ivanov,2011).
e. Provides concrete abstract concepts (Wojciechowski & Cellary, 2013).
f. Visualize complex relationships (Wu et al., 2013).

g. Improves critical thinking and problem-solving skills by offering multi-dimensional perspectives to subjects or concepts (Dunleavy, Dede, & Mitchell, 2009).

h. Increases content understanding and Long-term memory retention (Fourtané, 2019).

i. Provides interactive experiences to the user (Lee, 2012).

j. Helps to retrieve content from long-term memory and integrate it with new ideas (Billinghurst & Denser, 2012).

Thus, augmented reality can be an effective, efficient, and robust method in the enrichment of the educational field since it helps to view and interact with the information from a different perspective during the study process. Its use in education offers enriched ways to improve knowledge concepts exposed to students.

1.5. Drawbacks and Recommendations

1.5.1. Drawbacks

AR complements physical reality with additional digital objects to enable more interactive and effective learning process; nevertheless, there are still few challenges facing the integration which need to be overcame.

The main challenge is the usability issue, Ibáñez and Delgado-Kloos (2018) have found that AR is difficult to use due to the lack of necessary training in both teachers and students' backgrounds, so the researchers suggested training both parties and guiding them to put this new technology into practice. Another restriction is the limited availability of software; it involves the lack of tools designed for education (Cubillo et al, 2014), limitation of monitoring features and assessment tools (Mota et al, 2018), financial cost (Scrivner et al, 2016) and so on. Moreover, the use of AR innovation within a learning environment requires students to multitask; they need to

interact with information to accomplish complex tasks (Wu et al, 2013) which may result cognitive overload and confusion while the real and virtual objects overlap (Akc¸ayır & Akc¸ayır,2017).

Further, using augmented reality in the classroom requires particular resource base; i.e., the dependence on hardware. For instance, not all students have smartphones capable of supporting AR applications. Also, there are content portability issues where the built AR app needs to work equally well on all platforms and devices; however, it is practically impossible to provide the same quality of AR content on any device.

To sum up, if AR systems are not planned carefully and used appropriately, they might reduce the positive educational effect of its integration, decrease learners' motivation towards the lessons, and hinder the learning process in general.

1.5.2. Recommendations

At the same time, suggestions have been proposed to solve these restrictions. Compton (as cited in Huisinga, 2017) offers recommendations to teachers who are interested in implementing AR experiences in their classrooms and taking advantage of the given medium to capture its full potential. He lists the following:

(1) Allow students to collaborate and share their AR experiences.

(2) Use field trips to optimize AR's inherent mobile capabilities.

(3) Utilize AR as an additional learning platform in conjunction with other visual, auditory, and tactile opportunities.

(4) Connect AR experiences to educational standards.

(5) Think outside the box, rather than try to fit AR to a traditional approach.

To highlight AR's features and affordances, researchers should identify effective curricular and technology traits that can be offered by AR learning environments only; i.e., not possible with other learning concepts in order to show educational values. The empirical proof from these studies could assist generating a fixed set of instructional patterns and design principles of AR environments that could provide guidance to resolve the issues involved in instructional design (Wu et al., 2013).

Further, the issues related to technicalities can be improved by developing internet portability in order to facilitate user access to AR systems for learning and teaching. Increased internet access gives learners the opportunity to use AR via a smartphone. This has the potential to make AR a powerful learning tool that can help students to gain content knowledge and maintain it through their interactions with the smartphone activities (Lamounier et al., 2010; as cited in Saidin, Abd Halim & Yahaya, 2015).

To conclude, further research is needed from the perspective of educators and learners in their experiences with AR use in educational contexts to investigate efficiency of affordances, portability, interactions and collaboration, including benefits, gains and drawbacks.

Chapter 2. Reading Comprehension and Retention

2.1. Reading Comprehension

2.1.1. Definition of Reading Comprehension

Reading comprehension is one of the essential pillars of reading; it is a critical skill in the educational success of all individuals. Harris and Hodges (1995) define comprehension as "the construction of meaning of a written or spoken communication through a reciprocal, holistic interchange of ideas between the interpreter and the message in a particular communicative context" (as cited in Moore, McClelland, Alef, & Vogel, 2016). Additionally, comprehension is complex and multidimensional because it depends on the execution and integration of many processes. Robert et al. (1988, as cited in Wilda, 2013) state that comprehension is the process of generating meaning from various sources such as directly observing a phenomenon, reading, looking a painting, listening to a lecture or discussion, viewing a film, and so on.

The RAND Reading Study Group (2002, as cited in Moore et al., 2016) define reading comprehension as "the process of simultaneously extracting and constructing meaning through interaction and involvement with written language". Similarly, RIC Publications (2006) demonstrate that reading comprehension is the ability to read in order to learn and remember the content read. On that account, readers engage in complex cognitive processes where they simultaneously use their awareness and comprehending to construct meaning from the passage.

Regardless of the source, reading comprehension is also defined as "the ability to read text for understanding purposes" (Spooner, Gathercole, & Baddeley, 2006). Spooner et al. (2006) believe that the goal of reading comprehension is to understand the information contained in texts; i.e., get an understanding of the text rather than acquiring meaning from individual words or

sentences. For instance, narrative and informational texts differ in terms of their purpose (Duran, McCarthy, Graesser, & McNamara, 2007); unsurprisingly, they also differ in terms of their structure (Best, Floyd, & McNamara, 2008).

Duke (2003) states that comprehension is an evolving process in which readers make meaning by engaging with a text through the combination of prior knowledge, the mentioned information in the text, and readers' related views to the text. When reading a text, learners depend on their ability to decode the printed material fluently, draw upon their extensive vocabulary, and utilize comprehension skills and strategies to assist their understanding. Thus, reading comprehension can be defined as a thinking process through which readers become aware of an idea, integrate it with their experiential background, and interpret it in relation to their own needs (Khoiriyah, 2010, as cited in Wilda, 2013). Simply put, the outcome of reading comprehension is the mental representation of a text meaning that is combined with the readers' previous knowledge.

More recently, the development of reading comprehension has been considered as the result of emerging expertise with lower-level (e.g., decoding, fluency) and higher-level reading skills, considering the levels of complexity that comprise reading comprehension when learners are expected to interact with a text to different degrees (Dole et al., 1991). The level of reading comprehension involves more of one active role on the part of the reader (Heilman, Blair & Rupley, 1981, p.246). The researchers identify the following four levels of comprehension:

a. Literal comprehension. Comprehension at this literal level results in a relatively shallow understanding of what the text stated directly, often termed the phrase or idea level (e.g., comprehending the main ideas, factual details, stated points of view).
b. Interpretive comprehension. This level involves integrating information and making inferences. Here, readers make connections between ideas at the literal level (e.g., to their

own lives, to the outside world, etc.) and inferences (e.g., about the relationship between speakers, the meanings of unfamiliar words from the context, etc.).

c. Critical comprehension. At this level, readers learn to analyze, evaluate and judge the information and the writer's use of language in terms of certain standards; i.e., reacting to information presented in a passage based on: fact or opinion, validity, appropriateness, comparison, cause and effect.

d. Applied comprehension. It involves using information from the text to construct knowledge (e.g., to express opinions and form new ideas based on information in text). I.e., response to a text based on author's language, values, imagery, style and purpose.

2.1.2. Theories of Reading Comprehension

2.1.2.1. Mental Representations. Van Oostendorp and Goldman (1998) express that when a learner is reading a text, he or she creates a mental representation of the text which clarifies how the reader comprehends the content. This theory is based on the idea that reader's construction of a mental model assists them in their comprehension of the text. Several studies about reading comprehension support the conclusion that "multiple levels of representation are involved in making meaning" (Van Oostendorp & Goldman, 1998). Kintsch (1998) distinguishes three levels of mental representation which are the surface component, the text-base, and the situation model.

Kintsch (1998) continues that when the words and phrases themselves (possibly together with linguistic relations between them) are encoded in the mental representation and not their meaning, this is known as the surface component of mental representation. However, text-base "consists of those elements and relations that are directly derived from the text itself [...] without

adding anything that is not explicitly specified in the text" (Kintsch, 1998, p. 103); i.e., it deals with the semantic structure of the text. This component can be expressed in different ways; a text-base can be created without any memory of the exact words or phrases from the text. In a pure text-base, the reader applies previous information to make a better and more consistent mental representation. A construction that integrates the text base and relevant features of the reader's knowledge is called the situation model. Of course, some previous knowledge is needed to create a text base, but this former is a more general one that is necessary for decoding texts in general, whereas the prior knowledge in the formation of a situation model is more specific regarding the content of the text.

2.1.2.2. Content Literacy. As defined by McKenna and Robinson (1990), content literacy refers to the ability to read, understand and learn from texts from a specific subject area. There are three components of content literacy: general literacy, content-specific literacy, and previous knowledge of content. Both the general and the content-specific literacy skills can be assumed to refer to some more general type of knowledge that is not dependent on the detailed content of a specific text. This knowledge is utilized to make a text-base in the mental representation (McKenna & Robinson, 1990). The third type, prior knowledge of content, refers to knowledge that is connected to the content of a specific text, and is thus primarily used to create a situation model in the mental representation. For instance, it is not clear to what extent mathematics in itself creates a need for content-specific literacy skills and the reading comprehension in mathematics hinges on more general literacy abilities and previous knowledge; nonetheless, the symbolic language used in mathematics seems to be a potential cause for the need of content-specific literacy skills (ibid).

2.1.2.3. Cognitive Processes. The application of semantic and syntactic rules together with the activation of more particular prior knowledge occurs automatically and unconsciously. Generally, different cognitive processes can be more or less conscious. Perception is characterized as the highly automatic unconscious process. For example, when we see a dog and directly know it as a dog; we are conscious of the outcome of the process but there are not any active and conscious thought processes for this identification (Kintsch, 1992). Problem solving, on the other hand, deals with active thinking, a more resource demanding process, such as trying to remember the name of a person you meet and recognize. Accordingly, when reading a text without experiencing any difficulties in understanding it, the process is related to perception than problem solving because comprehension is mainly unconscious. This is comprehension "is located somewhere along that continuum between perception and problem solving" (Kintsch, 1992, p. 144).

2.1.3. Effective strategies of Reading Comprehension

Reading strategies can refer to a monitoring system which involves self-reflection and awareness of what we know, what we need to know in a particular situation, what needs to be done if things go wrong, and what techniques to be used in order to achieve the highest and the best outcome (comprehension) of our text reading (Langer, 1982). Barnett (1988) defines reading strategies as "the mental operations involved when readers approach a text effectively and make sense of what they read". She refers to reading strategies as problem-solving techniques which include skimming, scanning, guessing word meanings based on context, activating general knowledge, making inferences, predicting and following references, and separating main ideas from supporting details.

Since many researchers have been studying the most effective strategies for supporting reading comprehension, they assert that the traditional methods for teaching reading do not meet diverse learners' current needs. Some of these strategies are:

2.1.3.1. Activating and Using Background Knowledge. During this strategy, learners apply prior knowledge to aid them comprehend what they are reading. Cognitive scientists expressed that effective readers permanently relate their previous knowledge to the new one they face in writings. Successful readers activate their schema when they start reading and the first schema impacts how readers grasp and respond to a passage (Pichert & Anderson, 1977). Meurer (1991) mentions that schema as patterns represents the way in which experience and knowledge are sorted in the mind and that schemata are significantly used by readers in comprehending information which is both explicit and implicit in the text. For Rumelhart (1980), schemata refer to building blocks of cognition. These schemata are used by a reader in interpreting sensory data, retrieving data from memory, organizing actions and managing the flow of comprehension processing.

2.1.3.2. Generating and Asking Questions. Questions are beneficial because they activate relevant knowledge, support active processing, and foster comprehension monitoring (Beck & McKeown, 2001). Also, question generation induces the reader to go beyond the text and forces him to think about what is already known and what needs to be learned from the text.

Generating questions can take on multiple forms and serve many purposes. As discussed by researchers, readers can generate questions about the text before, during, and after they read. The questions generated before reading help activate prior knowledge and serve as guides for checking information that the reader does not comprehend; while questions generated during and after reading can serve as a form of self-testing to assess understanding.

2.1.3.3. Making Inferences. Bridging inferences is the ability to make connections among key ideas and concepts; this process plays an integral role in helping the reader build a global representation of the text (Magliano & Millis, 2003). Through this procedure, readers can enhance their abilities to make meaning. Having the ability to make inferences is an essential factor for readers' effective reading (Anderson & Pearson, 1984).

2.1.3.4. Predicting. Through this strategy, readers are able to obtain meaning from a text by making educated guesses. Before reading, successful readers may apply what they already know about a writer to forecast what a text will be about. For instance, titles can operate memories of texts with the same content which permits them to guess content of the new text. During reading, readers can make predictions about what will occur next, or what views the writer will offer to support a discussion. Evidently, readers try to assess these predictions ceaselessly and change any prediction that is not approved by the reading.

2.1.3.5. Summarizing. Upon reading a passage, summarizing helps students learn to determine important ideas and consolidate essential details that support these ideas. Summarizing is a technique that allows learners to focus on key words and phrases of an assigned text that are worth noting and remembering. To elaborate, summary writing is a valuable learning activity because it helps readers build a coherent text base understanding, which is the foundation for learning. The ability to summarize a text is an accurate indication of how well a text has been understood (Caccamise et al., 2007).

2.1.3.6. Visualizing. Visual memory is sometimes better than verbal memory (Shepard, 1967). In a study's results, McCallum and Moore (1999) indicated that participants who are asked to visualize passage contents remembered and comprehended more than control students. Role playing or acting parts of narratives grounds the textual experience into something that is

tangible and exemplified. Likewise, comprehension through action is central to Glenberg's theory of embodied cognition.

Glenberg, Havas, Becker, and Rinck, (2005) argue that the central claim of the embodiment assumption is that symbols and language are grounded in action. In other words, comprehension and memory should improve when readers are able to experience or act out the information reported in the text; grounding the text into real experience helps readers form a more complete situation model.

Regrettably, some students find reading comprehension extremely difficult due to the delayed comprehension of reading which reflects weaknesses in decoding skills (Spooner, Gathercole, & Baddeley, 2006).

2.2. Knowledge Retention in Learning

2.2.1. Definitions of Retention

Retention, as defined by Sousa (2001, as cited in Divoll & Browning, 2013) is "the process whereby long-term memory preserves learning in a way that it can locate, identify, and retrieve it accurately in the future". Therefore, the longer information in the working memory (short term memory), the more likely it moves to long term memory. Additionally, Houston (2001, p.4) indicates that retention processes cannot be separated from acquisition and transfer of the learning process; he defined it as a relatively permanent change in behavior possibility that happens because of a reinforced practice. Likewise, Slavin (2003, p.182) agrees that "Instructional strategies that actively involve students in lessons contribute to long-term retention".

Retention of reading material is necessary for successful completion of coursework. When a student actively interacts with the content in various formats, whether orally or visually, learning

and retention of concepts is more likely to take place. As students collect new information that is unfamiliar and relate that material to prior information, they will be able to retain this new information more easily; i.e., students need to see meaning in order to remember. Nonetheless, covering the expanse curriculum does not build strong connections in student's memory due to the pressures of tests and examinations (Wolfe, 2001); thus, teachers must find different ways to teach the required educational program and assist students to retain the necessary information.

As teachers, we need to ensure that the largest possible amount of information goes from student's short-term memory to his/ her long-term memory; therefore, we apply techniques which encourage the retention of information. Kolb and Fry (1975, as cited in Pérez-Sabater et al., 2011) created an experiential learning circle that incorporates four components: concrete experience, observation and reflection, the formation of abstract concepts and testing in new situations, graphically illustrated in Figure 12:

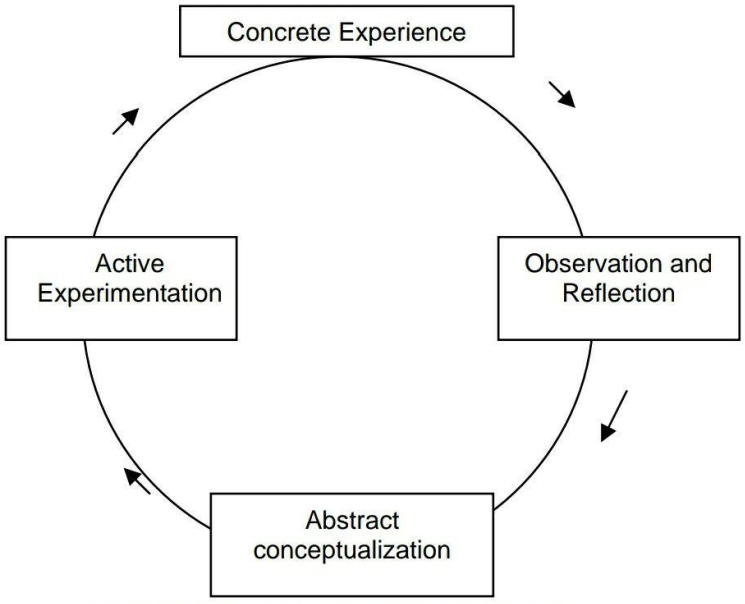

Figure 11: Kolb & Fry's experiential learning circle (Pérez-Sabater et al., 2011)

This cycle, repeated in a spiral effect, is the premise of learning and understanding which prompts retention of what has been learned.

Today's digital natives speak a different language than their teachers of previous generations (Prensky, 2001). For such reason, students of the 21st century may retain more information if it comes through a digital medium since they are inspired and motivated by different technologies. For example, online teaching tools are better for a student's memory as it promotes content creation among them (Miller, 2009). Presenting technology infused lessons may be proved to be a useful motivator for all levels. To justify, digital natives react well to this type of activities due to their familiarity with innovation (Prensky, 2001). Consequently, there is a rise in student confidence and retention rates through these adaptive learning techniques.

To sum up, improving retention is a shared priority for many institutions and this research may be helpful to direct more strategically those efforts and yield the greatest benefits for all parties (Leeds et al., 2013).

2.2.2. Traditional Retention Approaches

2.2.2.1. Atkinson and Shiffrin Memory Model (1968). Atkinson and Shiffrin proposed a multi-store human memory model that divided the human memory into three distinct stores: sensory register, short-term memory (STM), and long-term memory (LTM). Data passes from a store to another in a linear way, and has been described as an information processing model (as a computer) with an input, process, and output. As mentioned, information is detected by the senses entering the sensory memory to short term memory. If this information is rehearsed (i.e. repeated), it transfers to the long-term memory. However, if maintenance rehearsal (repetition)

does not occur, then the information is forgotten and lost from short term memory through the processes of displacement or decay (McLeod, 2017).

2.2.2.2. Dual Coding Theory of Memory (1971). It is proposed by Paivio which attempts to give equal weight to verbal and non-verbal processing. According to Paivio (1971), "human cognition is unique in that it has become specialized for dealing simultaneously with language and with nonverbal objects and events". Two cognitive subsystems are assumed in the dual coding theory; the primary one is for the representation and processing of nonverbal objects and or events (i.e., imagery), and the other is specialized for managing language. Although the theory was strongly criticized conceptually and was experimentally refuted, it initiated research on verbal and visual effects on memory.

2.2.2.3. Baddeley's Model of Working Memory (1974). Working memory, previously referred to as short-term memory, refers to the memory that is currently processing which only lasts for less than a minute and is limited in capacity. Baddeley and Hitch (1974) proposed this theory as an attempt to describe more accurately the concept and model of the short-term system in Atkinson and Shiffrin's memory model. Baddeley's original model consists of three main components: central executive, phonological loop, and visuospatial sketchpad. However, the current model adds another component that is the episodic buffer. Regardless, this model is very critical to understand how the human mind manipulates and retains information during problem solving, reasoning, and thinking.

Davidson et al. (2006, as cited in Amin & Malik, 2014) investigated cognitive control and executive functions for memory manipulation and inhibition within the visual switching task. They demonstrate that "the mind has the ability to recollect plan and other things related to the present,

future, and past" (ibid). The episodic buffer arranges the coordination of verbal sentences with the assistance of the phonological loop into a coherent sequence alongside memory.

2.2.2.4. Cognitive Load Theory (1988). This theory is outlined by John Sweller. The cognitive load is typically increased when unnecessary demands are imposed on a learner, making the task of processing information overly complex. Therefore, it can impede students' ability to process new information and to create long-term memories. This theory identifies three types of load which are known as intrinsic load (indigenous to the to-be-learned information and task that the learner finds arduous and challenging), extraneous load (the outcome of irrelevant information that comes with background noise. Nongermane instructional activities are defined as those that do not scaffold the learner to construct relevant and viable schemata, whereas germane load scaffolds the learner to construct viable and relevant schemata. These two added together make up the capacity of the working memory.

According to the cognitive load theory, working or short term memory has a limited capacity and can only handle a limited amount of data effectively at one time. Henceforth, an individual might not have the ability to process anything properly, if his or her working memory is overloaded; which consequently results in poor understanding, retention, and learning.

2.2.2.5. Cognitive Theory of Multimedia Learning (1999). This theory is based on three cognitive science principles of learning; namely, the human information processing system which includes dual channels for auditory/ verbal and visual/ pictorial processing (also known as dual-channel assumption). Each channel has a limited capacity for processing (i.e., limited-capacity assumption), and active learning that involves carrying out an organized set of cognitive processes during learning (active processing assumption).

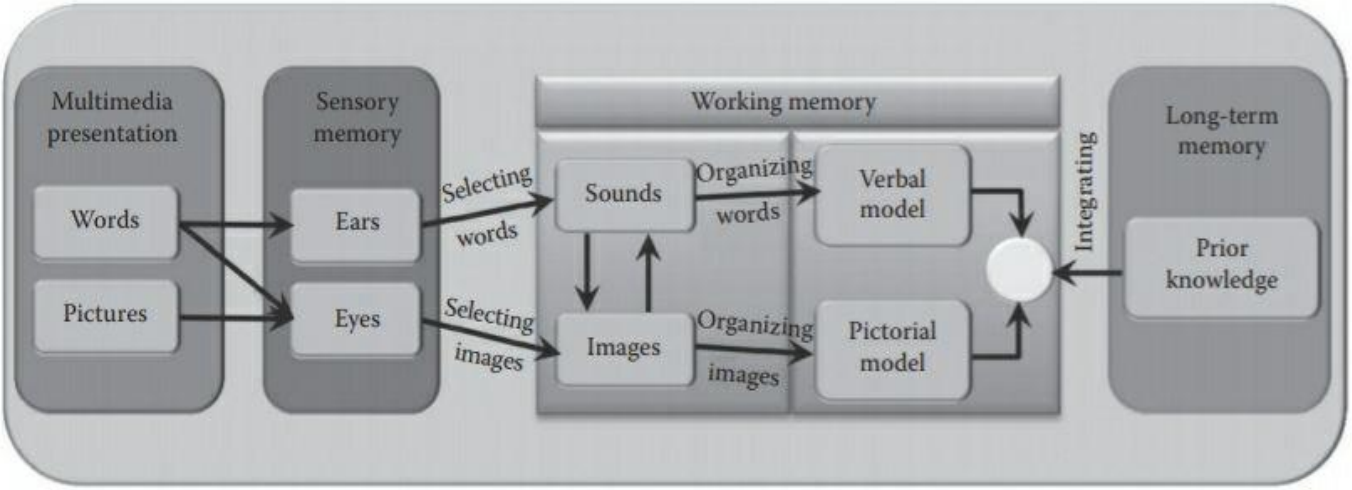

Figure 12: Cognitive theory of multimedia learning (Amin & Malik, 2014)

This theory joins several other concepts such as working memory limitation, dual code theory, and connections between image-based and text-based, as well as the transfer of information from long term memory to working one while performing tasks.

The following table was created by Amin and Malik (2014) to summarize the mentioned theories while presenting both their strengths and weaknesses.

Model	Main Objective	Strengths	Weaknesses
Atkinson and Shiffrin Memory Model	Multi-store memory system	It provides the basis for other theories. It explores the distinction between STM and LTM memory stores.	There is a lack of emphasis on unconscious processes. Intermediate-level activation between STM and LTM is missing; absence of memory subsystems.

		It emphasizes the effect of rehearsal on memory recall.	The effect of rehearsal is overstated.
Dual Coding Theory of Memory	Verbal and nonverbal information processing	It explains human behavior and experience in terms of verbal and imagery representation.	It does not consider the likelihood of cognition being mediated by routes other than words and images.
Baddeley's Model of Working Memory	Concept of working memory	It is applicable in everyday experience of processing information during problem solving. Rehearsal is not necessary to remember and recall all types of information.	The functions and capacity of central executive system are not clearly described and difficult to determine in practice.
Cognitive Load Theory	Efficient use of working memory during problem solving	It identifies the methods to reduce extraneous cognitive load in learning. It initiates research on effective instructional design strategies.	When material is presented in a way that does not relate to actual performance, then transfer of learning will be more challenging.

Cognitive Theory of Multimedia Learning	Learning from multimedia content	It suggests five principles for designing multimedia instructions that lead to learning that is more effective.	It is based on multimedia technology, which has a tendency to overwhelm the brain, and needs to be designed more effectively.

Table 2: Summary of Traditional Models (Amin & Malik, 2014)

2.2.3. Factors Affecting Retention

The role of student effort cannot be overemphasized. Indeed, students play a critical role in achieving better academic performance as they explore all opportunities presented to them by the community. Ultimately, the success of retention depends on students themselves; thus, they must be motivated to participate actively in their own learning process. Many factors can influence the effectiveness of retention.

A study conducted by Lieberman (2001) indicated three factors' categories that influence retention: individual student, family, and school factors. Under the first category, there are demographic factors such as age, gender, disabilities; and behavioral ones such as potential, readiness and technological skills, and metacognition (Lee, Choi, & Kim, 2013). Domestic factors that are cited as possible influences on retention are characteristics namely: location and relocation, family history and stability (Frymier, 1997), predominate language spoken in the home, and parents and siblings' attitudes. Substantially educational system entailed efforts and services aiming to impact student retention. School factors include: academic support (Reyes, 1997), tutoring services (Nichols, 2010), and the help that is available for the student prior to retention. Lieberman (2001)

underlined the importance of examining each of these factors prior to making decisions regarding retention and the best educational process for the students.

In another study, Lau (2003) mentioned that institutional administrators, faculty, and students are factors that have impact on the learning process, which are also most likely to result high retention rates. This is illustrated in the following figure.

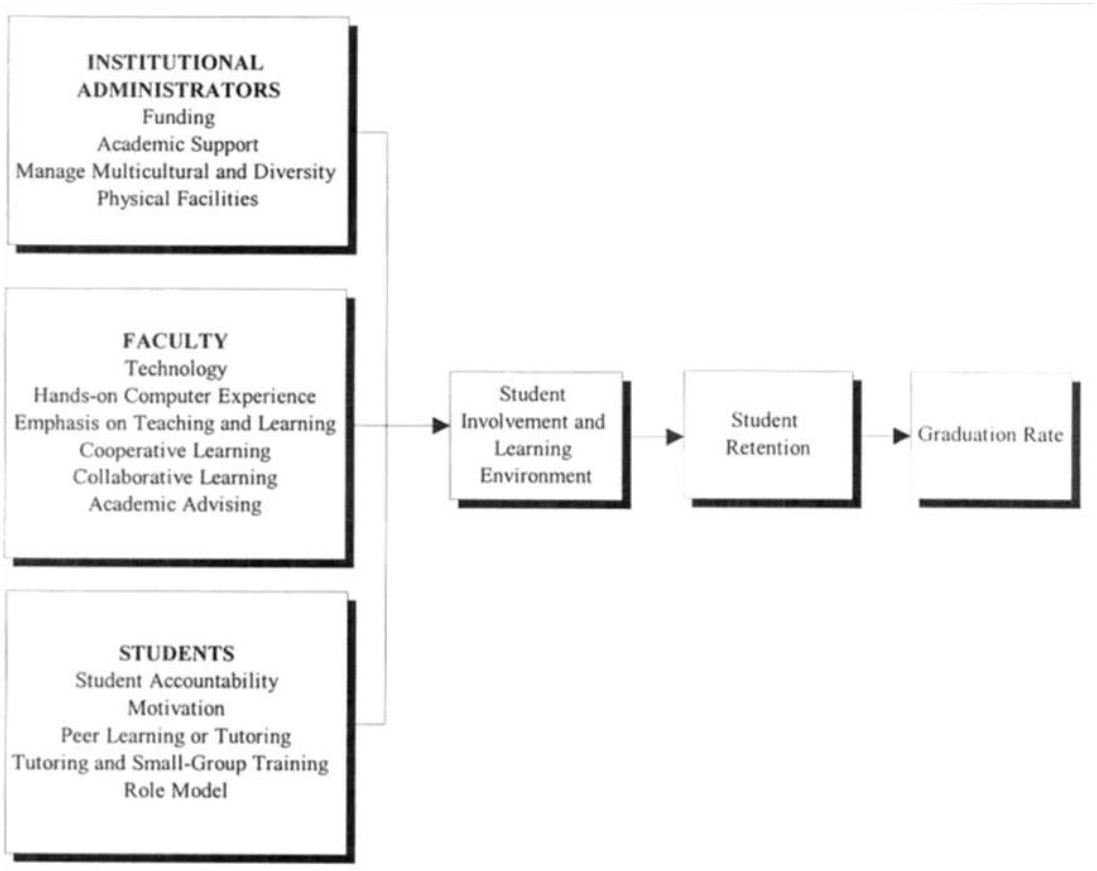

Figure 13: Institutional Factors Affecting Student Retention (Lau, 2003)

Chapter 3. Field Work

3.1. Rationale for Research Approach

As far as research in education is concerned, Dörnyei (2003, p. 130-131) defined the mixed methods approach as “a combination that has a great potential for future research as it can bring out the best of both approaches while neutralizing the shortcomings and biases inherent in each paradigm”. Henceforth, we decided to opt for this approach which involves two main approaches that have been adopted in this study. First, the quantitative (experimental) approach that aimed at answering the research question- “Can AR teaching method improve students' academic performance within classroom? _will they retain more knowledge within an AR group?” discovering and evaluating the effectiveness of the AR application integration. Second, the qualitative approach. A questionnaire has been administered to collect enough descriptive data and answer the remaining research question: “What are teachers’ and students' current perceptions about the transference of AR practices to educational settings?”. The latter method was used to have general insights regarding teachers’ opinions and attitudes towards AR integration. All in all, the present study, both qualitatively and quantitatively, describes the data gathered by means of the observation, experiment and questionnaire.

3.2. Population and Sample

In order to conduct our experiment and to prove that AR causes positive changes in students’ learning and reading achievements, an observation of the chosen sample from a population of about 372 subjects took place. The participants in our study are 60 students taken from the population of third year students of the department of English at Biskra university. As far as the quantitative method is concerned, the same mentioned sample is two classes which were

randomly allocated to be the experimental group (n= 30) and the control group (n= 30). The experimental group conducted the learning activity with AR-based learning; on the other hand, the control group studied the course using conventional ways of learning.

Furthermore, we have adopted random sampling in the mentioned method to avoid any particular bias and thus to consider that every individual in the population has the same chance of being selected for the sample as any other. Nonetheless, it should be made clear that we are dealing with human beings, so unexpected and unwanted variables may intervene and possibly skew the results of our experiments. As a matter of fact, a sampling error or differences between members are likely to occur. The main reason for the choice of third year students lies in the fact that we assume that after having studied two years at the department, these students have certainly read several books for literature sessions in order to analyze them. Therefore, this study will identify whether the AR app would increase their reading comprehension and retention.

In the qualitative method, Ross (2005, p.1 as cited in Meddour, 2014) asserted that “the information derived from the resulting sample is customarily employed to develop useful generalizations about the population”. Hence, based on a purposive sampling, 12 teachers in the English department who have taught or are teaching literature were received an online questionnaire to answer.

3.3. AR Design Methodology

In the design phase, we created a phone-based AR experience using image tracking method. This app uses smartphone's camera to track and recognize point marks from the book cover (in the physical world), then displays content video over it. It enables users to know what the book is about in a form of a storytelling video. Through the developed app prototype, students in the experimental

group are able to access the digital content for the reading activity. The Augmented interface for this application is shown in Figure 1.

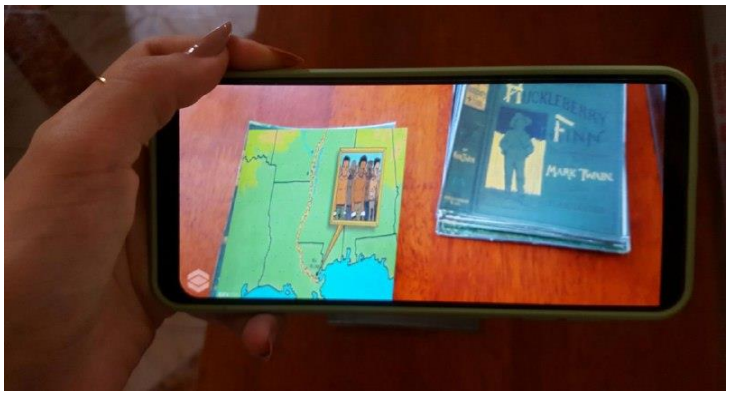

Figure 14: Application's Augmented Interface

In the development phase, we have picked the books covers which were suitable for third year students (Huckleberry Finn, Jane Eyre, The Red Badge of Courage, Sense and Sensibility) to use as image target. The development of this application requires using Unity editor software and Vuforia Engine. Through this Unity platform, we are able to create an account in Vuforia's developer portal which allows developers to create AR apps. Once logged in, developers can add and include advanced computer generated vision functionality to the application, allowing it to recognize images and objects, and interact with spaces in the real physical world. The AR app supports Android, iOS, and UWP devices and does not require internet connection to work.

3.4. Quantitative Data Analysis

3.4.1. Experiment Description

In order to examine the learners' academic achievement in terms of comprehension and retention, the scores in the control and experimental groups were collected, interpreted and analyzed statistically and graphically using the experimental research quantitative descriptions,

mainly: The Frequency, the mean, standard deviation, independent t-test and hypothesis testing. Miller (1975) states that:

> The most effective means of testing a prediction is to deliberately manipulate the independent variable and then to observe the consequential changes in the dependent variable. It is only this method of collecting data-the experimental method-which has the power to reveal cause-and-effect relationships in an unambiguous way.

Moreover, attaining the difference between experimental group and control group statistically requires applying and calculating the unpaired t-test, degree of freedom and the statistical significance. Consequently, it helps to test and whether confirm or reject our hypothesis, which is: “If students receive AR learning materials, they might report higher rates of retention and demonstrate a moderate increase in academic performance than those of a traditional one”. Also, it is important to denote that we adopted the SPSS as a measuring tool for all the needed calculations.

The simplest of all experimental designs is the two-group posttest-only randomized experiment in which there are at least two groups, one of which does not receive a treatment or intervention, and data are collected on the result measure after the treatment or intervention. Brown (1997) defines: “The posttest-only design (one type of true experimental design) is particularly dependent on random selection because it is assumed on the basis of sampling theory that the experimental and control groups are equivalent at the outset of the study”. The main goal of assigning the post tests in both groups was to demonstrate the causal relationship between the independent and dependent variables without exposing participants to ideas on how to answer to

show progress. In other words, since no pre-test is used, there can be no interaction effect of pretest and X. (Moorhead, 2006). The figure below illustrates the design of the experiment.

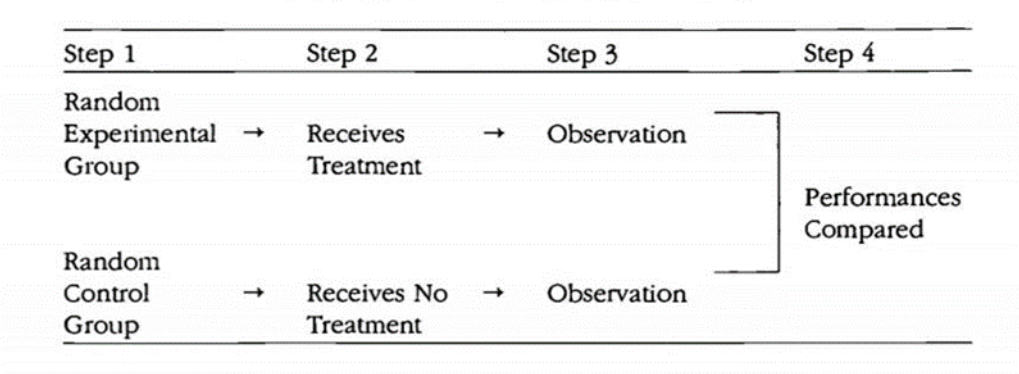

Figure 15: True Experimental Design, Posttest Only (Brown, 1997)

Since conducting an experiment in a field of human sciences like education does not always allow the experimenter to have complete control over all the extraneous variables, we tried to maximize randomization by finding two groups with similar age, achievement levels, motivation, and number of males and females. Nonetheless, even with random assignment, equal groups are not guaranteed. In our experimental design an independent t-test was conducted in order to provide evidence for the intervention effects which allowed us to determine the degree of causality between the variables in question.

3.4.2. Data Collecting Procedures

In the experimental group, students download the AR app in the beginning of the session. Then, they have enough time to watch the augmented material in their mobiles twice. Later, they have a 15 minutes' test that consists of two parts (retention and comprehension). In the control group sessions, students are given the same amount of time that the experimental group had of watching the content to read the transcribed passage. Then, they also have to answer the exact same test. During the treatment, observation is recorded by taking notes.

3.5. Qualitative Data Analysis

3.5.1. Observation

In this research, a classroom observation was used as another data collection instrument, for it supports the data collected through the t-test and the questionnaire. While taking quantitative data, observation took place in a form of note taking to cover students' attitudes during the reading activity.

The majority of students in the conventional way of reading were demotivated and lacked interest in the reading activity. In fact, they were not committed and they disliked and avoided reading or read reluctantly. However, few of them wanted to read but they did not have enough time to finish the transcribed passage. Also, they reported a difficulty in sustaining attention and were easily distracted by outside influences which led them to frequently lose place while reading.

In the AR based learning, on the other hand, students reported a significant interest in both the application and the content. Most of them were enthusiastic, focused, motivated, and cooperative. In fact, even the teacher participant had a positive reaction towards this innovation. She agreed on the idea of its integration and were opened to it as she claimed it was easy to use because it did not require internet or anything else other than a smart phone.

3.5.2. Teachers' Questionnaire

3.5.1.1. Rationale of the Questionnaire. In this study, a questionnaire was designed to identify teachers' perceptions, opinions, and attitudes regarding the implementation of augmented reality in reading tasks. McDonough and McDonough (1997, p.171) argues: "it affords a great deal of precision and clarity because the knowledge needed is controlled by the questions"; therefore, we opted for a descriptive survey design.

The elaboration of the questionnaire largely depends on the nature of the issue investigated and the objectives to be attained. Thus, after having reviewed our hypothesis and the objectives of our study, we planned and elaborated the questionnaire in order to address it to English language teachers who were in charge of the literature module at the department of English at Biskra university. According to Barr, Davis and Johnson (1953) "A questionnaire is a systematic compilation of questions that are submitted to a sampling of population from which information is desired"; henceforth, the final draft of the questionnaire was distributed to 12 teachers after it had been validated by the supervisor for content validity. The results of the questionnaire were described and analyzed, then represented by tables to help visualize data.

As far as the online distribution is concerned, not only do online questionnaires provide several advantages over traditional methods in terms of cost, speed, appearance, flexibility, functionality and usability (Lumsden, 2005); but it also has the ability to transfer responses directly into a database which eliminates transcription of errors and prevents survey alteration by the survey respondent.

3.5.1.2. Description of the Questionnaire. The developed questionnaire consisted of 22 questions including 2 information questions, 12 multiple choice questions, and 9 open ended questions. Mehiri (2016) states: "A valid questionnaire is one that involves more closed-form than open-ended questions. The former are said to be objective and easy to interpret though they are to some extent restrictive. The latter may reveal information, but they may increase subjectivity". That is to say, open-ended questions are needed when we do not know the range of possible answers and therefore cannot provide pre-prepared responses. The current questionnaire was divided into 3 sections concerning different sub-themes:

a. Teacher's profile

b. Teachers' experiences with students reading skills

c. General attitudes towards AR educational use and benefits

For ethical matters, we assured the teachers that this questionnaire is anonymous as anonymity is a property that secures released data against possible re-identification of the respondents to whom it refers. On that account, codes have been used to refer to each teacher in order to maximize objectivity, freedom, and confidence. In addition, we should acknowledge that 9 of the 12 surveyed teachers handed back the questionnaire which means 75% of the population; therefore, this percentage enables us to consider the outcomes of the research to a great degree faithful to the objectives of the questionnaire.

3.5.1.3. Questionnaire Results Analysis. As has been mentioned before, this questionnaire consists of 3 sections that will be dealt with systematically for the purpose of consistency.

Section1: Teacher's profile

Q1: Gender

Gender	Number of participants	Percentage
Male	5	56%
Female	4	44%

Table 3: Teachers' gender

This table elicits 9 total teacher participants in the current study. The majority of the respondents are predominantly male teachers with a percentage of 56% while female teachers count less than 44%.

Q2: Years of experience

Years of teaching experience	Less than 5 years	5 to 10 years	11 to 15 years	More than 15
Number of participants	2	2	4	1
Percentage	22.22%	22.22%	44.44%	11.11%

Table 4: Teachers' years of teaching experience

As far as the years of experience are concerned, teachers' teaching experience varies between 3 years to 17 years. The questionnaire revealed that most teachers with percentage 44.44% have been working from 11-15 years. Among them are 22.22% teachers who have been working from 5 to 10 years. The rest are divided into two: very experienced (11.11%) And (22.22%) with very little experience in teaching.

Q2: Which electronic device(s) do you use most during class?

*Some participants selected more than one choice. (Total=12)

Electronic devices	Number of participants	Percentage
Mobile phone	4	33.33%
Desktop computer	1	8.33%
Tablet	1	8.33%
Laptop	6	50.00%

Table 5: Most used electronic devices by teachers during class

According to the table, the preferred devices to participants are as follows: 50% laptops, 33.33% mobile phones, 8.33% desktops, 8.33%t tablets.

Q3: Do you use instructional technology tools in your classroom?

Instructional tools use in the classroom	Number of participants	Percentage
Yes	6	66.67%
No	3	33.33%

Table 6: Instructional technology tools use in class

The majority of respondents (66.67%) used instructional technologies while the (33.33%) rest were content with the conventional way of teaching. In this context, the participants who answered "Yes" were asked about the effectiveness of using these technological tools.

Q4: If yes, was it helpful for students' comprehension? Justify

All 6 respondents explained that these instructional tools were indeed helpful as they increased students' motivation and engagement during the lecture. In precise words, one of the respondents reported: "Yes, it was. It keeps their attention and increases their motivation. It also makes the lesson more interactive and easier to understand".

Section 2: Teachers' experiences with students reading skills

Q5: What is the most important educational outcome students should obtain from your class?

*Some participants selected more than one choice. (Total: 19)

The educational outcome	Number of participants	Percentage
Engagement	3	15.79%
Knowledge Comprehension	6	31.58%
Academic Achievement	2	10.53%
Knowledge Retention	2	10.53%
Autonomy	6	31.58%

Table 7: The most important educational outcomes for teachers

The majority of participants expressed that they focus on knowledge comprehension (31.58%) and learners' autonomy (31.58%). 15.7% of them indicate that the outcome they want students to obtain is engagement during class; whereas those (10.53%) chose academic achievement and the rest (10.53%) picked knowledge retention. On the whole, results show that teachers consider knowledge comprehension and autonomy as the most important educational outcome in the teaching and learning process.

Q5: How satisfied are you with teaching reading in your classroom?

Teachers' satisfaction	Very unsatisfied	Unsatisfied	Neutral	Satisfied	Very satisfied
Number of participants	1	1	6	1	0
Percentage	11.11%	11.11%	66.67%	11.11%	0.00%

Table 8: Teachers' satisfaction with teaching reading

The objective of this question item is to explore teachers' satisfaction or dissatisfaction with teaching reading in the classroom. The obtained results show that most teachers (66.67%) were neutral; while (11.11%) were satisfied, (11.11%) unsatisfied and (11.11%) very unsatisfied.

Q6: Approximately, how much time do students spend reading and/ or assigned to read?

The answers collected are reported as follows:

- 1 novel in a month and a half.
- Depending on the work. Novels 3 to 4 weeks; short stories 1 week.
- Daily.
- 30 minutes- 1 hour.

- Approximately 1 hour.
- Half an hour in class, but I do not know if they spend time reading outside class.
- No module is devoted for reading, but sometimes we give students some text to read but it does not exceed 30 minutes.
- 0.5% of the time.
- 30 minutes.

Accordingly, students have enough time to read that ranges from 30 minutes to a month depending on the works assigned.

Q7: How committed were the students' in the traditional reading activity?

Students' commitment	To a very small extent	to a small extent	to a great extent	to a very small extent
Number of participants	2	6	1	0
Percentage	22.22%	66.67%	11.11%	0.00%

Table 9: Students' commitment in the traditional reading activity

The table illustrates that 66.67% of the teachers noticed that students were committed to the reading activities to a small extent. 22.22% of them realized students were not committed at all; while 11.11% were committed to a great extent.

Q8: How do you evaluate students reading skills?

Students' reading skill	Below average	Average	Above average
Number of participants	4	5	0
Percentage	44.44%	55.56%	0.00%

Table 10: Teachers' evaluation of students' reading skill

According to the calculated data, 55.56% of the respondents evaluated students reading skill as average. Nonetheless, 44.44% believed it was less than average and no teacher evaluated it as above average.

Q9: If below average, what are the possible reasons?

Four main reasons are provided by 7 of the surveyed teachers for the low average of students' reading skills. First, lack of reading habit even in their first language. Second, lack of motivation to read. Third, Lexical difficulties that students encounter while reading. And forth, a teacher claimed that it is due to the nonexistence of a module for teaching learning strategies.

Q10: Do you face any problems in the conventional reading classrooms?

Problems encounter	Number of participants	Percentage
Yes	6	66.67%
No	3	33.33%

Table 11: Teachers' problems in the conventional reading classrooms

According to the findings in table above, 66.67% of the surveyed teachers face problems in the traditional reading environment. The rest 33.33% do not encounter any challenges when teaching reading.

Q11: If yes, what are some of these limitations?

Six teachers expressed different challenges they encounter with reading activities. Their precise words are as follows:

- Lack of interest in some reading texts. Lack of critical reading skills (inferences and evaluation of content).

- The unhealthy environment of the classroom (academically and pedagogically speaking).
- Lack of interest, boredom, demotivation.
- Low interaction due to lack of information about the text.
- Some students cannot stay focused the whole session.
- They do not read and when it comes to practice they do not answer.

Q12: What do you think about the integration of an AR assisted classroom in terms of enhancing students' reading ability?

The purpose of this question is to recognize teachers' opinions towards the implementation of the mentioned technology in classrooms. All teachers believed that it would be very helpful as it increases the interaction and adds to students' motivation. They stated that it seems more interesting and vivid than the conventional way which might capture students' attention if used correctly. One of the teachers expressed: "I do believe that today's generation is highly digital therefore we cannot escape the integration of such Apps in teaching"; and another one said: "It seems interesting and innovative. Yet, teachers and students need to be familiar with it to be properly practiced".

Q13: Would it be better than the existing conventional one? Explain your perspective

The integration of this open-ended question item aims at understanding teachers' perspectives about both conventional and technology based classrooms. Five respondents agreed that AR would be more helpful than traditional way since students nowadays know about, use, and live with their mobiles. They believe it will help encouraging them to read more as well as facilitating the process. A teacher goes further by explicitly stating: "because it is innovative, creative it would be more inviting, students are attracted to all what is real word learning

experience”. However, the rest are uncertain about the benefits of this technology since it was not put to practice. These teachers’ answers are presented in the following:

- "We cannot say because we need to use it and in order to do so, we need first to provide the necessary material".
- "I think both have advantages and disadvantages ".
- "I wouldn't say better. But I will definitely help improve the current one".
- "I am uncertain! It needs to be tried out with students over a period of time in different contexts to determine its advantages".

Q14: Did you know what an AR- based learning is before this study?

AR knowledge before study	Number of participants	Percentage
Yes	1	11.11%
No	8	88.89%

Table 12: Teachers' knowledge of AR based learning

The results of the table above show that only 11.11% of the respondents were familiar with AR-based learning. The rest 88.89% had no idea.

Q15: Would you consider adopting AR applications in different educational activities and subjects?

Consideration of AR adoption	Number of participants	Percentage
Yes	6	66.67%
No	0	0.00%
Maybe	3	33.33%

Table 13: Teachers' consideration of adopting AR apps in activities

The findings indicate that 66.67% of teachers are considering the integration of AR apps in the learning activities; whereas 33.33% remained undecided.

Q16: What is your general opinion about the prototype application?

This open-ended question aimed essentially at inviting teachers to comment about the designed AR prototype application in this study. 8 people provided answers in this item and only 1 respondent neglected it. The 8 teachers provided us with different comments:

- "I think it is an interesting one which I may personally use and adopt in my classes".
- "I think it would be more effective when used at an earlier stage before university".
- "It is really useful and might change the face of education".
- "I think it is attractive and it might increase students' motivation to read".
- " I think it is helpful".
- "I think it gives the general idea of how AR can be used in the teaching field".
- "It can be used but the problem is that we're not accustomed to".
- "Looks nice. The use of tech devices is appealing".

Q17: How effective do you think AR learning applications are?

Effectiveness of AR learning apps	Highly effective	Effective	Neutral	Ineffective	Highly ineffective
Motivation and engagement	33.33%	66.67%	0.00%	0.00%	0.00%
Attention and concentration	55.56%	33.33%	11.11%	0.00%	0.00%
Knowledge comprehension	11.11%	55.56%	33.33%	0.00%	0.00%
Memorization	11.11%	44.44%	44.44%	0.00%	0.00%
Time saving	33.33%	33.33%	33.33%	0.00%	0.00%
Object flexibility	22.22%	77.78%	0.00%	0.00%	0.00%

Clear concise information	22.22%	55.56%	22.22%	0.00%	0.00%

Table 14: Teachers' opinions about AR learning applications effectiveness

As displayed in the table above, this Likert scale question item indicates teachers' opinions on how effective the AR learning apps can be in university settings. The majority of respondents (66.67%) expressed that AR may be effective for learners' motivation and engagement; whereas the rest 33.33% selected highly effective. In terms of attention and concentration, 55.56% denoted highly effective, 33.33% effective, and only 11.11% were neutral. However, considering knowledge comprehension, 55.56% ticked effective, 33.33% were neutral, and 11.11% chose highly effective. Further, teachers responded equally for effective and neutral (44.44%) in terms of memorization of concepts with AR, while 11.11% expressed it is highly effective. However, when asked about if AR saves more time, teachers answered 33.33% for highly effective, effective, and neutral. Moreover, in terms of objects flexibility and manipulation, 77.78% believed it would be effective for learners; whereas 22.22% ticked highly effective. In respect of providing clear and concise information, the answers are as follows: 55.56% effective, 22.22% highly effective, and 22.22% neutral. All in all, teachers were positive towards AR integration and believed it had potentials in the educational field considering the fact both the highly ineffective and ineffective choices were 0% in all rows.

Q18: Compare between traditional way of teaching reading and the AR one

Comparison of AR and traditional ways	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
AR curriculum integration is better for reading	22.22%	44.44%	22.22%	0.00%	11.11%
Motivation when reading with digital content	44.44%	22.22%	11.11%	22.22%	0.00%

Enhancement of reading comprehension by AR	55.56%	11.11%	22.22%	0.00%	11.11%
Retention levels increased by AR	22.22%	44.44%	11.11%	22.22%	0.00%

Table 15: Teachers' comparison between traditional way of reading and AR one

The table above illustrates teachers answers of the traditional way of teaching and AR based one comparison. With regards to AR curriculum integration, 44.44% of the respondents agreed it would be better for reading activities, 22.22% strongly agreed, 22.22% were neutral, whereas 11.11% strongly disagreed. Motivation wise, 44.44% strongly agreed AR would enhance motivation for learners when reading digital material, 22.22% agreed, 22.22% disagreed, 11.11% were neutral. Moreover, when asked about whether AR would enhance reading comprehension, 55.56% strongly agreed, 22.22% were neutral, 11.11% agreed, and 11.11% strongly disagreed. However, in matter of retention levels, 44.44% agreed AR would enhance the latter, 22.22% strongly agreed, 22.22% disagreed, and 11.11% remained neutral. With everything being accounted for, teachers are convinced AR should not be a replacement for the conventional way of teaching but as a complement that improves the latter and provides better efficient outcomes.

Q19: What is your opinion about the factors that can affect the AR application development in university settings?

The findings of this question item reveal some factors that can affect the integration of this innovation in university settings. Most teachers believe that one of the factors is the unfamiliarity of the app and its technical aspects which might challenge students to use it. Additionally, they guessed that the crowded classes would hinder its smooth application; i.e., the lack of proper spaces (high-tech classes) in the faculty which might hinder its utility. Others claim that students' age and the type of content they take at university can be a major factor because it would be better if the

innovation was used at an earlier stage. The rest state that lack of materials availability and funding as well as lack of experience are crucial factors to the implementation. However, respondents remark that there should be time given for this technology to be applied, as well as training teachers to be familiar with it for effective use. One of the respondents added "students' possible distraction"; i.e., the overwhelming nature of new innovations in education for learners.

Q20: What role would teachers like to have in AR based learning process?

This open ended question aimed at exploring general opinions of teachers on what role they can have in the AR learning environment. The majority of teachers chose guides and facilitators as own roles. The rest picked supervisors, directors, examiners, monitors, models, and motivators as roles.

3.5.1.4. Findings Interpretation. We can conclude from the results reported by teachers' questionnaire that the respondents were 9 teachers of English at Biskra university, for the academic year 2019-2020. The survey sample is characterized by male predominance as well as a teaching experience that varies from 3 to 17 years. Furthermore, the studies revealed that most of them use instructional technology tools in their classes; mainly laptops and mobiles. They claim that these tools were extremely helpful as they gain learners' interest, increase motivation, and make the lesson more interactive.

In the second section, teachers expressed that their ultimate goal when teaching language skills is knowledge comprehension and autonomy. On that account, they demonstrated that they are not satisfied with students' reading skills as latter are given enough time (30 minutes- a month and a half) to devote for reading yet they were not very committed. Therefore, the respondents evaluated the learners' reading skill as average or below average and they stated that it was due to

several reasons such as lack of reading habit and lack of motivation. Moreover, the majority of respondents claimed that they encounter challenges when teaching reading in the traditional classroom environment; namely, low interaction, lack of interest, demotivation, and the unhealthy academic and/ or pedagogical environment.

Subsequently, when teachers were asked about their opinions towards AR integration in classrooms to improve reading, teachers believed it would be beneficial, motivating, and interesting tool to better learning. Consequently, they demonstrated it would be an effective improvement to the current way of teaching as it completes it. In the last section of the questionnaire, we noticed that most teachers did not know about this innovation before the study but they were willing to adopt it in their classes. The insights deduced from teachers' answers about the designed AR app prototype reveal their interest and attraction to its use. They demonstrated that it would be effective in enhancing engagement and concentration, facilitating knowledge, providing flexibility, and filtering clear concise information.

In comparison to the traditional way of teaching, most respondents agreed that integrating AR might help with the reading skill, students' motivation to read, reading comprehension and even retention levels. Generally, educators taking roles as guides, facilitators, and monitors in the AR based learning, summarized few factors that can affect AR development in the university settings. These factors are: unfamiliarity of the app, unavailability of the tools, and lack of proper high tech environment. Despite that, respondents concluded it was an interesting idea that they were looking forward to see put to practice. That means, the study divulged the positive attitudes of both learners and teachers towards AR and how they appreciatively reacted to it, which answers to the prior research question and confirms its proposed hypothesis.

3.6. Limitations

The current study was designed to be a case study, to introduce AR technology to university teachers in Biskra and to discover the benefits of integrating AR as an instructional tool; nonetheless, a couple of limitations were identified. Methodologically, the treatment was planned to be done in a month with 4 sessions for each group; but due to Covid19 pandemic reasons that urged the country to take restrictive public health measures for disease control such as lockdown, so we were unable to carry out the rest of the three sessions. On that account, it should be noted that the results that has been collected in that one session cannot be analyzed or generalized because they may be invalid. Additionally, it was intended to use an interview for the teachers as a means of qualitative data collection tool, yet the online questionnaire replaced the former for that it provided sufficient data concerning teachers' opinions and attitudes for quarantine reasons.

Moreover, concerning the technical obstacles which are related to the digital content and its appearance, there was a decrease in quality of image capturing and tracking; i.e., camera sensitivity, lens quality, and both position and orientation sensor quality. This is due to devices' types, price, and affordability. Another challenge was the unavailability of mobile phones and earpieces for students to be able to contribute in the experiment.

Despite participants' prior presentation to this innovation, they did not have sufficient time to be familiar with the app; therefore, they were somehow distracted from the content and overwhelmed by the new technology. Consequently, both students and teachers should be trained to use such tool. In the case of any new innovation, it is difficult to forecast the outcome for the future, as there is general over-excitement about the technology from the beginning.

Recommendations and suggestions

Since AR proved its workability and effectiveness in reading classroom activities, further recommendations and suggestions could be highlighted for later proceeding studies.

- More in-depth large-scale studies to provide sufficient positive findings of integrating AR applications among university students, and to maximize the benefits of this implementation. That is, researchers should concentrate more on the methodology to test AR technologies for better understanding.
- Since this study was limited to using AR through mobile devices, perhaps future research should investigate less intrusive ways that offer AR support and are available and affordable which may exist through lightweight displays, such as glasses.
- Institutional administrations should get aid from developers to design different AR apps for better learning experiences for struggling readers to improve their reading comprehension and retention. This will establish AR as medium for innovative technology interventions that will influence a brighter future inclusive of everyone.
- We advise learners to put effort in reading academic texts in order to develop their skills, and to compensate the traditional way's shortcomings using digital ways of experiencing the content. This will allow them to participate at a deeper level when needed.

General Conclusion

The current study examines the impact of using Augmented Reality (AR) as an instructional tool in enhancing learners reading comprehension and retention. It aimed to present AR technology and to discover its effectiveness and applicability as a new educational technology that helps to enhance the teaching and learning process, as well as keep teachers and students up-to-date with present materials. Taking everything into account, this dissertation simply longed to answer the prior research questions and test then confirm their proposed hypotheses.

To explore the effects' effectiveness of this innovation on students' learning, an experiment was conducted on third year English students in Biskra university. Particularly, the prototype app was created to test the proof of concept and demonstrate the viability of the idea. Even though, the experiment could not be carried out completely to confirm or deny that AR promotes students' learning achievements in regards to comprehension and retention during reading activities, the qualitative data results showed that the use of AR technology has received positive feedback from students and teachers. The student participants have shown their interest in actively engaging in their studies through AR tools as well as teachers who have indicated acceptance and willingness along with potential for using AR on texts to provide reading support for their learners.

Overall, these good responses are important because they indicate that AR is eligible to be used in educational environments. Nevertheless, we advise researchers to take advantage of the AR design in the previous chapter and use its accessibility and availability to create more suitable apps for students' needs. While AR offers new learning opportunities, it also creates new limitations. AR instruction has the potential to become a particularly powerful medium for students, yet there are several concerns about the future use of the technology as a part of the learning process.

Therefore, educators agree on the usage of augmented reality as an additional for the educational program but not as its replacement.

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Appendices

Appendix A. E-mail Request for Teachers to Participate in Online Questionnaire

Dear …….,

I'm Rayene Ben Aissa, a master 2 student supervised by Dr. Rezig. For my final project, I am examining the use of Augmented reality in enhancing learners' comprehension and retention. Because you have taught literature, I am inviting you to participate in this research study by filling the attached questionnaire.

The following questionnaire will require approximately 10 minutes to complete. All of the information is confidential, and your participation is voluntary, but I cannot emphasize enough how important it is that I hear from you. The questionnaire link: https://docs.google.com/forms/d/e/1FAIpQLSdbEerp7n4qY9OdjD8dZ7BwBWGl3yGcOWVhnJX0WFqHde_oxg/viewform

Please make sure to watch this short YouTube video before answering the questionnaire to get a clear idea about our app. Here is the link: https://youtu.be/XjaR_tqQYhQ

Thank you for your time and cooperation. Feedback from you is very important to the success of this research.

Sincerely,

Appendix B. Teachers' Questionnaire

Dear teachers,

This questionnaire intends to explore teachers' attitudes and opinions about the use of Augmented reality to enhance learners' comprehension and retention in terms of reading. You are kindly requested to answer this questionnaire as the information that you provide will be valuable and very important for the success of this study.

Your responses will be treated confidentially and used for academic research purposes only.

Thank you for your time and collaboration.

Researcher's name: Rayene Ben Aissa

Supervisor's name: Dr. Rezig Betka Nadia

Part A: Teacher's profile

1- Gender: ☐ Male, ☐ Female.

2- Years of teaching experience: ……

3- Which electronic device(s) do you use most during class?

☐ Mobile phone, ☐ Desktop computer, ☐ Tablet, ☐ Laptop.

4- Do you use instructional technology tools in your classroom? ☐ Yes, ☐ No.

5- If yes, was it helpful for students' comprehension? Justify

Part B: Teachers' experiences with students reading skills:

1- What is the most important educational outcome students should obtain from your class?

☐ Engagement, ☐ Knowledge Comprehension, ☐ Academic Achievement,

☐ Knowledge Retention, ☐ Autonomy, ☐ Other

2- How satisfied are you with teaching reading in your classroom?

☐ Very unsatisfied, ☐ unsatisfied, ☐ neutral, ☐ satisfied, ☐ very satisfied.

3- Approximately, how much time do students spend reading and/ or assigned to read? ……

4- How committed were the students' in the traditional reading activity?

☐ To a very small extent, ☐ to some extent, ☐ to a great extent, ☐ to a very great extent.

5- How do you evaluate students reading skills?

☐ Above average, ☐ average, ☐ below average.

6- If below average, what are the possible reasons? ……..

7- Do you face any problems in the conventional reading classrooms? ☐ Yes, ☐ No.

8- If so, what are some of these limitations? ……..

9- What do you think about the integration of an AR assisted classroom in terms of enhancing students' reading ability? (Augmented reality is an interactive experience of a real physical world environment where the objects that reside in it are enhanced by computer-generated information. This technology adds to real-world image extra layers of digital information that appear in users' scene). ……

10- Would it be better than the existing conventional one? Explain your perspective

Part C: General attitudes towards AR educational use and benefits

1- Did you know what AR- based learning is before this study? ☐ Yes, ☐ No.

2- Would you consider adopting AR applications in different educational activities and subjects? ☐ Yes, ☐ Maybe, ☐ No.

3- What is your general opinion about the prototype application? …….

4- How effective do you think AR learning applications are?

	Highly effective	effective	neutral	ineffective	very ineffective
Enhancing learners' motivation and engagement					
Enhancing attention or concentration in the lessons					
Facilitating understanding of knowledge					
Easiness of memorizing subject matters					
Saving time as it filters information					
Higher flexibility in object manipulation and visualization					
Providing the learner with clear and concise information					

5- Comparison between traditional way of teaching reading and AR one

	Strongly agree	agree	neutral	disagree	strongly disagree
I think integrating curriculum contents in AR applications is more helpful in increasing reading ability than the course books and notes.					
I think students will be more motivated to read varied reading contents available in 3D digital models rather than the fixed ones in the provided printed books.					
I think students' reading comprehensibility will be enhanced if the reading passage comes with an audio, picture or motion video.					
I think students' retention levels will increase if they were exposed to AR learning environments than the existing course materials.					

6- What is your opinion about the factors that can affect the AR application development in school settings? ……..

7- What role would teachers like to have in AR based learning process? ……

8- Is there anything you would like to add? ……

Résumé

Au cours de la dernière décennie, l'évolution rapide des applications technologiques a donné lieu à de nouvelles manières d'aborder l'éducation en plus de développer le processus d'enseignement et d'apprentissage. La réalité augmentée (RA) est un nouvel outil pédagogique qui permet aux apprenants d'être plongés dans des expériences naturelles et réalistes. Elle propose une nouvelle approche pédagogique pour aider les apprenants à développer une capacité critique et une compréhension plus approfondie des concepts. Il est donc important de la tester et de l'évaluer correctement afin que les utilisateurs se sentent plus confiants dans son utilisation. Cette étude vise à enquêter la faisabilité et l'utilité des applications de RA pour améliorer la compréhension et la rétention en lecture. Elle cherche également à mettre en évidence une meilleure compréhension du prototype conçu et à présenter les attitudes des enseignants à l'égard de la mise d'en œuvre. L'étude émet l'hypothèse que la RA a un impact positif sur l'amélioration des résultats scolaires des apprenants en termes de compréhension et de rétention. À cette fin, l'étude documente une enquête en méthode mixte, dont les fondements sont un plan expérimental composé de 60 étudiants répartis en deux groupes (groupe expérimental et groupe témoin). Parallèlement à l'observation structurée pendant le traitement. Aussi, un questionnaire a eté soumis à 12 enseignants afin de recueillir suffisamment des données descriptives sur leurs attitudes et opinions vis-à-vis de l'intégration de la RA. Les résultats 'montrent que les apprenants manquent de compétences en lecture. Ainsi, la RA est un outil efficace qui fournit un environnement d'apprentissage multimédia en présentant des matériaux dans divers formats. Bien que les étudiants aient d'abord été submergés par la RA, les résultats montrent également les attitudes positives et admiratives des enseignants envers cette technologie, ce qui a par conséquent confirmé l'hypothèse alternative.