



# Inquiry-based Augmented Reality Activities for Enhancing Reading Comprehension and Engagement of EFL Secondary School

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## Abstract

The present study investigated the effectiveness of using Inquiry based augmented reality activities for enhancing reading comprehension and engagement among first year secondary school students. For this purpose, sixty-six secondary school students were assigned to an experimental and control group, 33 students each. During the implementation, the participants were engaged in various inquiry based augmented reality activities. Pre and post-tests of reading comprehension skills and an engagement scale were administered to examine the effectiveness of these activities on students' reading comprehension and engagement. Results revealed that Inquiry based augmented reality activities had a significant effect on students' reading comprehension and engagement

**Keywords:** Inquiry, Augmented Reality, Reading Comprehension, Engagement, EFL

## Article History

**Receive Date:** 2024/10/20

**Accept Date:** 2024/11/1

**Publish Date:** 2024/11/2

Volume 4 / Issue2, December, 2024

**DOI:** - 10.21608/IJAHHR.2024.321315.1045

## CITATION:

Rehab, M., & aliweh, A. (2024). Inquiry-based Augmented Reality Activities for Enhancing Reading Comprehension and Engagement of EFL Secondary School Students. International Journal of Advanced Humanities Research, 4(2), 29-40. doi: 10.21608/ijahr.2024.321315.1045

## Introduction

Reading is an active mental process which includes reasoning to derive meaning from a written text and understanding it effectively and comprehensively (Nakamoto, Lindsey, & Manis, 2008). It is a process of getting a message from a text. In other words, understanding a written text and extracting the information from the text as efficiently as possible. Also, reading is a process of combining textual information with the information the reader brings to the text. It means that the reader is not simply extracting information from the text, but also activating a range of knowledge in his/her mind (Saropa, 2009).

Similarly, different types of reading comprehension are often distinguished according to the reader's purposes in reading and the type of reading used. In reading comprehension, the key element for students to identify the message conveyed in the text, as the main purpose of reading is to get and understand the ideas presented in the reading text (Westwood, 2004).

### Statement of the problem

Although reading is an indispensable language skill, many Egyptian students seem to encounter serious difficulties when handling various texts. This has been supported by relevant literature and previous studies; e.g., Khalaf (2022), Ezz Alarab (2012), Hussein, and (2007).

A pilot study was conducted on 23 first year secondary students and the results showed that students have serious problems in reading comprehension and its sub-skills (literal, inferential and critical ); e.g., inability to comprehend vocabulary, lack of familiarity with the subject matter (content), inability to guess and predict the meaning of difficult words, and lack motivation to handle textbook activities.

Therefore, is a real need for some innovative approaches that may help Egyptian secondary school students overcome these problems. To be more specific, inquiry based learning (IBL) may help activate students' prior knowledge and make them engaged in learning material, (Coffman, 2011).

So, this study attempts to investigate the effectiveness of using inquiry based augmented reality activities to enhance reading comprehension skills . To this end, the current study will address the following questions:

### 3. Study Questions

1) What is the effect of using Inquiry- based Augmented Reality activities on first year secondary school students' reading comprehension?

**1.a** What is the effectiveness of using Inquiry- based Augmented Reality activities on first year secondary school students' literal reading comprehension?

**1.b.** What is the effectiveness of using Inquiry- based Augmented Reality activities on first year secondary school students' inferential reading comprehension?

**1.c.** What is the effectiveness of using Inquiry- based Augmented Reality activities on first year secondary school students' critical reading comprehension?

2. What is the effectiveness of inquiry -based augmented reality activities on students' engagement in reading comprehension?

3. How do Inquiry based augmented reality activities affect students' reading comprehension skills?

#### **4. Definition of Terms**

Reading comprehension: It refers to the cognitive processes involved in understanding and extracting meaning from a text. It involves the execution and integration of various processes. (Burns & Astriani 2007: 8).

Inquiry-Based Learning is an approach for teaching and learning that places students' questions, ideas, and observations at the center of the learning experience. (Bybee et,al., 2006).

Engagement: refers to level of attention, interests, and curiosity a student shows while they are learning (Abbott, 2016).

#### **5. Significance of the Study**

The present study attempts to develop reading comprehension of first year students in secondary schools throughout using inquiry based augmented reality activities as a new learning tool providing the opportunity for learners to engage in learning and increase students' engagement in reading. As a result this study is significant for students, teachers, supervisors and curriculum developers.

#### **6. Review of the Literature and Related Studies**

##### **6.1-Reading comprehension as a process**

Reading is the most important skill which makes differences between literate and illiterate. It helps readers to navigate through the target language to gain linguistic input and language proficiency. It increases students' concentration and develops critical thinking(Gu, 2003.p.6).

Without comprehension, reading is nothing but tracking sounds, words and sentences to sound them out. Students can read words and text on their books as parrots but if they do not have comprehension skills, they cannot predict what will happen next, gain information, illustrate events, monitor their understanding of content, sequence or characters, clarify confusing parts of the text, or connect what they are reading to their own experience or prior knowledge(Fukkink and Glopper, 2000).

##### **6.2 Reading sub-skills**

According to Harmer (2001, p.202), reading comprehension has different sub-skills to achieve total comprehension. Some of the reading comprehension sub-skills are as follows: Skimming, scanning, questioning, making connections, distinguishing facts from opinions, summarizing ,inferences, and prediction.

Yet, various treatments on the reading skill in FL classrooms. Among others, Mohamed (2002) examined the effectiveness of using Egyptian first year secondary student's questions in developing their critical reading skills in the light of schema theory. The sample of the study randomly assigned to (40) students as an experimental group and another (40) students as a control one. The findings showed that there were significant differences between the two groups in the favor of the experimental group due to the use of students' generated questions.

Also, Gabl et al (2007) examined the effect of using a guided reading program increasing student's reading comprehension and fluency. The targeted sample consisted of the second and the fourth grade students. The study showed that multiple factors contribute to the problem of low reading fluency and comprehension scores. These factors include students, school curriculum and classroom environment, teacher training and family involvement. The experiment lasted for sixteen weeks. The students were assessed using district provided comprehension and fluency assessments. The results showed an increase in students' reading fluency and comprehension throughout the course of the intervention.

Hussein (2007) investigated the effectiveness of proposed program based on reciprocal teaching strategy in developing reading comprehension and summary writing for first year secondary school students. The results revealed that the proposed program has been effective in developing students' reading comprehension and summary writing.

### **7. Augmented Reality**

Over the last two decades; modern information and communication technology has been rapidly integrated into various fields of learning and instruction. In Particular, using mobile-based learning has been widely used as it enhances students' learning process, gives them the opportunity to understand the material and reduces their boredom. It makes the learning material more effective, efficient, attractive and accessible to all learners (Ifadah & Aimah, 2020).

In recent years, augmented reality (AR) has become a popular technology that has become a major topic in research of education. It is a 3D technology that seamlessly blends the physical and digital worlds in real time. It is a medium in which digital information is superimposed over the physical world in both spatial and temporal registration, and is interactive in real time (Craig, 2013).

Augmented reality has various advantages. Among others, providing accessible learning materials anytime, does not need the purchase of expensive hardware. As most of teenagers own a smartphone, AR technologies are immediately accessible to the majority of them, applicable to any level of education and training as AR isn't limited to only one use case or field of application, and through it students have an in-depth understanding of the material.

Yet, numerous studies were conducted to examine the effectiveness of using augmented reality on developing EFL learning among others, Tsai (2013) conducted an exploratory case study which investigated using augmented-reality-based mobile learning material in EFL English composition. This study adopted a mixed method (quantitative and qualitative) to collect and analyze data. The findings indicated that the augmented reality based mobile learning material provides linguistic and content knowledge in English composition for the participants.

Perez-Lopez & Contero (2013) investigated the effects of using augmented reality as a learning tool on preschool pupils. A quasi experimental design based on a nonequivalent groups posttest-only design was used. The results asserted

that augmented reality technology is useful and renders the learning process easier as it helps students to become familiar with AR at an early age makes it easier to future learning of new technologies.

### **8. Inquiry Based Learning**

Yet, a variety of techniques and learning strategies have been developed to assist students in boosting their interest, creativity, during learning. One of them could be inquiry based learning as it is an approach for teaching and learning that puts students' questions, ideas, and observations at the center of the learning experience (Coffman, 2009). According to Bybee et al., (2006) the steps of inquiry-based learning include five stages which are:

a) Engagement which refers to the use of short activities that encourage curiosity and prompt prior knowledge; b) Exploration in which learners use prior knowledge to generate new ideas; c) Explanation in which learners use their own words to provide concepts and explanations; d) Elaboration in which students gain a deeper and broader understanding, more information, and adequate abilities as a result of new experiences; e) Evaluation in which students are encouraged to gauge their comprehension and skills and offers chances for instructors to assess students' progress throughout the educational objectives.

Yet, numerous studies were conducted to examine the effectiveness of inquiry based learning in developing EFL learning among others, Yi Lee (2014) investigated inquiry-based teaching in second and foreign language pedagogy. A questionnaire was used to explore the effectiveness of and students' attitudes toward the inquiry-based teaching. It was revealed also that inquiry based teaching improved students' classroom engagement and raised an effective and meaningful learning experience.

Prisila (2017) investigated using inquiry based learning in improving 10 students in reading comprehension on recount text that was done in three cycles. The data were derived from observation checklist, field notes and field records, and test. The result revealed that the implementation of inquiry based learning improved students' reading comprehension on recount text and also indicated that students' critical thinking was evident in posing and solving the problem in reading comprehension on recount text because the students need to pose and solve the problem by themselves.

### **9. Engagement**

Student engagement is crucial because it helps students achieve their learning objectives. It is defined as a students' willingness to participate in routine school activities, such as attending classes, submitting required work, and following teachers' instructions in class. It includes participating in the classroom activities in learning English (Kuh, 2003, p. 25).

Fredricks and Paris (2004) identify three aspects of student engagement which are: a) Cognitive engagement, which shows the extent students are attending and expending mental effort in the learning tasks encountered; b) Behavioral engagement which shows the extent in which students are making active responses to the learning tasks presented; c) Affective/emotional engagement,

which refers to the level of students’ investment, and their emotional reactions to, the learning tasks.

Various studies were conducted over the two decades on engagement in various stages. among others, Sandy (2020) explored EFL students’ engagement during interactive read-aloud activities. Students’ engagement was observed in two meetings (Mean= 70 minutes). Students’ engagement during interactive read-aloud were explored through observation as they participated in interactive read-aloud activity. The result showed that in behavioral engagement, the students were very much engaged during the classroom activity.

Also, Thao (2022) aimed to explore EFL students’ learning engagement and their problems in English listening comprehension. The research was conducted at a high school in Vietnam with the participation of 180 tenth grade EFL students in answering the questionnaires. The findings revealed that EFL students got engaged in listening comprehension emotionally rather than behaviorally and cognitively, and their emotional engagement tended to be the most influential.

### **10.Method**

This section includes relevant information about the participants, study design, instruments as well as the conclusions and recommendations.

#### **10.1 Participants**

Participants in the present study were 66 first year secondary school female students. The study was conducted on two groups, a control and an experimental group. The experimental one was selected purposefully (students who had the ability in dealing with mobiles and Internet applications) from Kasim Amin Secondary School

#### **10.2 Instruments**

After reviewing relevant literature, the researcher developed the following instruments:1)Reading comprehension pre- and post-tests; 2) An observation checklist; 3) An interview; 4) Students' engagement scale

#### **10.3. Implementation**

This treatment included six units from students' book, Hello: English for secondary school students, (Second term - 2022/2023) besides some other extra reading topics and activities for reading e.g., stem subjects, cars without oil, and today's street children. The treatment lasted for 30 sessions, 40 minutes each. Then ,a post –test of reading comprehension was administrated at the end of the treatment.

### **11. Results and Discussion**

#### **H1**

There is no significant difference at 0.05 level between the mean scores of the experimental and control groups students on the post reading comprehension test.

**Table (1) : The t values of the differences between mean scores of the experimental and control groups on the post -reading comprehension test**

Test	Group	N	Mean	Std. Deviation	t	df	Sig.	η2	Effect Size
Reading comprehension	Experimental	33	12.03	1.79	4.34	64	0.01	0.23	Large
	Control	33	9.63	2.60					

Table 1 shows that the mean scores were 12.03 and 9.63, the SD were 1.79 and 2.60 for the experimental and control groups respectively; ( $df=64$ ,  $\eta^2=0.23$ ,  $p<0.01$ ). So, there was a statistically significant difference at 0.01 level between the mean scores of the experimental and the control groups in the post reading comprehension test in favor of the experimental group. Consequently, hypothesis one was rejected. And Table (1) shows a high effect size ( $\eta^2= 0.06$ ) of inquiry-based augmented reality activities on reading comprehension.

**H<sub>2</sub>**

There is no significant differences at 0.05 level between the pre and post -tests mean scores of the experimental group and control groups on reading comprehension sub-skills (literal, inferential and critical). Relevant data to H1.b are provided in table (2) below:

**Table (2) The t values of the differences between mean scores of the experimental and control groups on the post sub-skills of reading comprehension test.**

Reading comprehension	Group	N	Mean	Std. Deviation	t	df	Sig.	η2	Effect Size
Literal reading	Experimental	33	4.54	0.66	2.09	64	0.05	0.06	medium
	Control	33	4.12	0.96					
Inferential reading	Experimental	33	4.03	0.68	4.37	64	0.01	0.23	Large
	Control	33	3.18	0.88					
Critical reading	Experimental	33	3.45	0.97	4.63	64	0.01	0.25	Large
	Control	33	2.27	1.09					

Table 2 showed that the mean scores were 4.54 and 4.12, the SD were 0.66 and 0.96 for the experimental and control groups respectively; ( $df=64$ ,  $\eta^2=0.6$ ,  $p<0.01$ ). Also, the mean scores were 4.03 and 3.18, the SD were 0.68 and 0.88 for the experimental and control groups on inferential reading respectively ; ( $df=64$ ,  $\eta^2=0.23$   $p<0.01$ ).The mean scores were 3.45 and 2.27, the SD were 0.97 and 1.09 for the post test of the experimental and control groups on critical reading respectively; ( $df=64$ ,  $\eta^2=0.25$ ,

$p < 0.01$ ). So, there was a statistically significant difference at 0.01 level on the post reading comprehension sub-skills test in favor of the experimental group.

**H<sub>3</sub>**

There is no significant difference at 0.05 level between the mean scores of the experimental group students on the pre-and post-application of the reading comprehension test (as total score). Relevant data to hypothesis two are provided in table (3) below:

**Table (3): The t values for the pre-and posttests of the experimental group on the reading comprehension test (as total score) and effect size.**

Reading comprehension	Application	N	Mean	St. D	t	df	Sig	$\eta^2$	Effect Size
Total score	Pre-	33	8.72	2.44	12.23	32	0.01	0.82	Large
	Post-	33	12.03	1.79					

Table 3 shows that the mean scores were 8.72 and 12.03, the SD were 2.44 and 1.79 for the pre-posttests of the experimental group respectively ;( $df=32$ ,  $\eta^2=0.82$ ,  $p < 0.01$ ). So, there is a statistically significant difference at 0.05 level between the mean scores of the experimental group students on the pre-and post-application of the reading comprehension tests (as total score) in favor of the post test. Consequently, Inquiry-based Augmented Reality Activities is effective in developing the reading comprehension.

**H<sub>4</sub>**

There is no significant difference at 0.05 level between the mean scores of the experimental group students on the pre-and post-application of the engagement scale. Relevant data to hypothesis three are provided in table (4) below:

**Table (4): The t values for the pre-and post of the experimental group on the engagement scale and effect size**

Dependent variable	Application	N	Mean	St. D	T	df	Sig	$\eta^2$	Effect Size
Engagement	Pre-	33	77.91	5.78	6.93	32	0.01	0.60	Large
	Post-	33	86.15	4.36					

Table4 shows that the mean scores were 77.91 and 86.15, the SD were 5.78 and 4.36 for the pre-post administration of engagement scale respectively ;( $df=32$ ,  $\eta^2=0.60$ ,  $p < 0.01$ ). Consequently, inquiry-based augmented reality activities are effective in developing students’ engagement.

H.5 There is no significant difference at 0.05 level between the mean scores of the experimental group students on the pre-and post-application of the engagement sub-levels scale. Relevant data to hypothesis three are provided in table (5) below:



**Table (5): The t values for the pre-and post of the experimental group on the engagement sub-level scale and effect size**

Dependent variable	Application	N	Mean	St. D	t	df	Sig	η <sup>2</sup>	Effect Size
Affective engagement	Pre-	33	27.78	1.91	5.68	32	0.01	0.51	Large
	Post-	33	30.72	1.90					
Behavioral engagement	Pre-	33	31.72	4.17	3.71	32	0.01	0.31	Large
	Post-	33	34.87	2.44					
Critical engagement	Pre-	33	18.39	2.45	4.31	32	0.01	0.37	Large
	Post-	33	20.54	1.93					

Table (5) showed that inquiry-based augmented reality activities are effective in developing students' sub-levels of engagement.

Yet, the improvement of students' reading comprehension may be ascribed to different factors. Among others, using augmented reality AR and aura content whether (images, video, and audio, or other links) might have helped students to memorize the meanings of new words and deepened their understandings of the reading contents by enriching textbooks with the meaning, definitions and example sentences for difficult words. Also, AR might have enabled teachers to repeat the process of learning over the challenging parts as many times during reading. Also, These results may be also due to using the inquiry based learning approach which made students get engaged in reading.

Yet, generally speaking, current findings are consistent with those previous studies of Julis (2022); Hung (2015); and Alzahrani (2020) who pointed out that using mobile applications had significant effects on enhancing students' reading comprehension and achievement. Students became more active in conducting learning activities in class, and the quality of teaching and learning process improved significantly.

Also, these findings align with those Alsowat (2017), and Wu et. al (2013)who emphasized the usefulness and effectiveness of using augmented reality in enhancing reading skills. They reported that AR offers visual and auditory materials, dynamic interactions and real-life situations that facilitated students' learning and assisted them to gain the required learning competencies easily.

**Conclusion**

To sum up, the current study provided evidence for the effectiveness of inquiry based augmented reality activities on enhancing reading comprehension skills ( literal- inferential and critical ) and students' engagement in reading.

**Recommendations**

Based on the results of this study, the following recommendations are offered:  
 1-FL instructors should use augmented reality technology in teaching reading in order to engage students in reading and become active participants in their learning.  
 2-Teachers should give a special attention to extra-curricular activities in order to help learners improve their reading comprehension skills.

3-There should be in –service training programs that focus on promoting teachers’ digital literacies necessary for the 21st century.

### **Suggestions for Further Research**

Yet, there still remain several research issues to be explored:

1-More research is needed to replicate this study on different stages (primary, preparatory, college) and on major fields of study.

2- Similar studies are needed to examine the effectiveness of inquiry based augmented reality activities on enhancing students' motivation and self-efficacy.

3- Exploring the effect of using augmented reality applications and inquiry based learning on developing other EFL skills; listening, speaking and writing is worth investigation.

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