



# The Effectiveness of Using Augmented Reality Apps in Teaching the English Alphabet to Kindergarten Children: A Case Study in the State of Kuwait

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## ABSTRACT

This experimental research study scrutinized the effectiveness of using augmented reality (AR) applications (apps) as a teaching and learning tool when instructing kindergarten children in the English alphabet in the State of Kuwait. The study compared two groups: (a) experimental, taught using AR apps, and (b) control, taught using traditional face-to-face methods. A total of 42 (i.e., 21 in the experimental group and 21 in the control group) preschoolers enrolled in the public educational system participated in this study in the second semester of the 2015-2016 academic year. The findings of this research are coherent and consistent with the results of other studies conducted over the past 5 years as well as with the postulated hypotheses. The results revealed the following: (1) there were statistically significant differences between the control group (traditional group) and the experimental group (AR group) in their degrees of interaction with the English alphabet lesson in favor of the experimental group; (2) there were statistically significant differences between the control group and the experimental group in their scores on the English alphabet test in favor of the experimental group; and (3) there was a very strong linear relationship/correlation between the children's interaction with the English alphabet lesson and their scores on the English alphabet test in the AR group. The study concludes with relevant proposals and recommendations regarding the implementation of AR technology in education and suggests undertaking further studies on this interesting topic.

**Keywords:** augmented reality (AR), information and communication technology (ICT), use of augmented reality apps, educational effectiveness, kindergarten children

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### **State of the literature**

- AR technology is utilized in several disciplines, such as medicine, manufacturing, tourism, and education. The number of AR apps in the market has increased in recent years due to the advances in ICT. Educational researchers have scientifically acknowledged new opportunities for teaching and learning through the use of AR technology.
- In 2012, an empirical research was implemented in Bulgaria on 26 children at the primary stage to investigate whether children who are learning a language through AR technology gaming comprehend more than children who learn languages by conventional means. The findings asserted that AR technology helped to promote the learning of vocabulary and that children show satisfactory results after educational experiences derived from AR technology environment.
- A recent experimental research study was implemented by Lin et al. (2016) in an elementary school in Taiwan on 21 students with different disabilities. AR technology was used in this study to aid in the teaching and learning of geometry. The main objective of the research was to enhance students' self-confidence so that they could endeavor to finish the puzzle games by themselves. Students attempted to solve the games either traditionally (without AR materials) or with the help of AR aids. The results indicated that with the use of AR technology participants' ability to complete the puzzle games by themselves were improved significantly—their performance was significantly better—and that the support times was shorter than anticipated. The findings also affirmed that AR technology could enrich students' learning motivation and their frustration tolerance.

### **Contribution of this paper to the literature**

- The objective of this study was to investigate the effectiveness of using AR apps as a teaching and learning tool when instructing kindergarten children in the English alphabet in the State of Kuwait.
- Three research questions regarding the effectiveness of AR technology and its related apps were used to compile the study's instruments and guide analysis of the data. Various methods of analysis were applied to the data, such as Cooper equation, Mann-Whitney test, and Spearman test.
- Because the literature regarding the use of AR technology and its related apps in education is only now emerging, and knowledge of this topic in the State of Kuwait in particular and in the nations of the Gulf Cooperation Council (GCC) and the Middle East in general is not widespread, a study of the efficacy of AR technology is beneficial to educators and administrators alike. Such research could encourage the adoption of new methods that may contribute to improving the quality of education.

## **INTRODUCTION**

The role of information and communication technology (ICT) in our lives is very clear, particularly in the lives of children, where it combines both play and learning. ICT helps to develop curiosity, observation, and experimentation in children. It is quite clear that children are very interested in ICT and need to experience its different tools, apps, and services. AR technology has become one way to combine play and learning, and children can use it to develop both their mental and cognitive abilities. It is gaining importance due to its positive effects on the growth of children's memories, thinking skills, and imaginations.

ICT tools, apps, and services have become accessible to children, who are using them increasingly often; they serve as effective learning tools in many of the developmental aspects of early childhood and are one of the first things to attract children's attention (Skeele &

Stefankiewicz, 2002). When ICT is integrated with the curriculum as a vital element in education, children acquire the ability to use natural tools for learning (Abdulraheem, 2006), and these tools can have a positive effect by increasing children's motivation to learn in a way that supports their developmental needs. This integration requires all state bodies and institutions to strive toward progress via the development and modernization of the educational process to meet the needs of early childhood by investing in the enormous potential of modern technology. With this in mind, there should be a comprehensive change in the educational process, including the exclusion of traditional methods of education due to their inability to keep pace with the contemporary information revolution (Almousa, 2005).

The above argument, the importance and role of ICT in the educational process, and the accelerating evolution of ICT have all helped to support the emergence of a new reality, or what is known as AR technology, which made its first appearance in 1970. This technology is considered to be one of the modern applications of e-learning; it is an extension of virtual reality (VR), which is a sophisticated technology that enables the individual to experience a semi-real environment based on a simulation between the individual and the three-dimensional e-environment (Sabri & Tawfeeq, 2005). AR technology has continued to develop and to establish its superiority over VR technology; it is now the most current technology available. AR is an advanced technology used in classrooms and provides real views as well as virtual views of realistic environments. Thus, AR technology can be employed in education to help learners approach information and its visual perception. Because of its active role in improving children's perceptions and their deeper understanding of information, AR technology can also be used in educational games provided to kindergarten children to increase their interactions with the material presented to them. We note that AR technology has significant benefits for education at the kindergarten stage, in particular, and at other educational stages in general (Lin et al., 2016). The most important applications on computers and smart devices invest in real-time multimedia audio as well as static and animated images in either two or three dimensions.

As explained above, many AR technology apps have been developed, and they are ideal for supporting educational material. This technology has become widely available, much easier to use, and less expensive (Kerawalla, Luckin, Seljeflot, & Woolard, 2006). To encourage the employment of this modern technology, which can provide excellent educational opportunities suited to the modern technological world, there is a crucial need for scientific and academic studies on the use of AR technology apps. Therefore, this study aims to focus on the use of AR technology in teaching kindergarten children to investigate its effectiveness in teaching the English alphabet and its impact on the educational process.

#### PROBLEM OF THE STUDY

Despite the efforts of kindergarten curriculum developers at the Ministry of Education (MOE) in the State of Kuwait, the learning process is still limited to traditional methods and the teacher's discretion in the presentation of information. Current practices in education do

not exploit the many types of modern ICT tools, apps, and services, nor do they deliver information to the child in a concrete form that is close to the reality in which he/she lives. Although the education of children at this stage requires teaching methods that focus on use of the senses and inclusion in the learning process (Wardle, 2000), the use of ICT tools, apps, and services at the kindergarten stage is very low compared to traditional methods. This problem can be addressed through the introduction of AR technology into the kindergarten child's teaching and learning environment and using it appropriately, so that the teaching and learning processes become fun and beneficial while also achieving their desired goals.

Hence, it is necessary to shift the traditional format for presenting information to an AR approach. This approach is characterized by suspense and fun, and it works to consolidate the presented information in the child's mind. AR technology may provide an opportunity for the child—according to his/her abilities—to develop mental and cognitive skills that are not encouraged by traditional methods. Accordingly, this study sought to learn about the effectiveness of AR apps for teaching and learning the English alphabet at the kindergarten stage in the State of Kuwait.

### OBJECTIVES OF THE STUDY

In the current study, the researchers introduce a new teaching method presenting information using modern technology and to determine the extent to which the child interacts with AR software. The researchers aim to improve the teaching methods used in kindergarten by employing modern educational technology and thus assess the effectiveness of AR apps in teaching kindergarten children the English alphabet. Finally, the researchers offer proposals and recommendations based on the results regarding the use of AR apps for teaching and learning. To that end, in this research study, we address the following questions:

1. Are there statistically significant differences between the AR group and the traditional group in their degree of interaction with the English alphabet lesson?
2. Are there statistically significant differences between the AR group and the traditional group in their test scores on the English alphabet lesson?
3. Is there a relationship/correlation between the AR students' interaction with the English alphabet lesson and their scores on the English alphabet test?

### ASSUMPTIONS AND LIMITATIONS OF THE STUDY

In this research, the researchers hypothesize that AR apps used in kindergarten for teaching and learning the English alphabet significantly affect the children's interaction with the lesson as well as increase their scores on the English alphabet test. We also postulate a correlation between the interaction levels and test scores for the experimental group. The limitations of this research study can be classified as follows: (1) human limitation, which is represented by the children being at the first level of kindergarten in the State of Kuwait; (2) spatial limitation, as the study is confined to a kindergarten located in the Mubarak Al-Kabeer Educational Area in the State of Kuwait; (3) time limitation, as the study was conducted during

the second semester of the 2015-2016 academic year; (4) technical limitation, as the study used tablets, and in particular iPads (due to their wide availability), for the purpose of presenting the AR software; and (5) literary limitation, as the results of a search for reliable sources during the preparation of this study clearly demonstrated the scarcity of educational studies on this topic in the State of Kuwait (locally) as well as in the Gulf Cooperation Council (GCC) and the Middle East (regionally). The researchers also noted the lack of studies on the use of AR technology in kindergarten; accordingly, this can be assumed to be one of the vital limitations of this research study.

### SIGNIFICANCE OF THE STUDY

The importance of this study lies in its focus on a modern and emerging trend in the development of the kindergarten curriculum: AR technology. The researchers employed AR apps in an innovative teaching and learning environment. The results of the study can help decision makers provide AR software as a new educational teaching and learning method in kindergarten. In addition, the study provides information that increases teachers' awareness of the role of technology in the education of the child, thus contributing to the adoption of new methods that contribute to improving the quality of education. We also address those global and local trends that highlight the need to take advantage of modern ICT tools, apps, and services and to employ them in educational systems. The results of this study may provide schools with a new teaching style that helps kindergarten teachers to instruct their students using a new and interesting method. Finally, the current study represents an important addition to the literature in the field of AR technology, especially in light of the scarcity of scientific studies in this area, particularly in the Middle East region in general and in the State of Kuwait and the GCC in particular.

### LITERATURE REVIEW

#### **ICT in kindergarten**

Despite the great variety of technological tools that can be used in early childhood education, the increase in their number, and the diversity of their roles, we must first address the fact that personal computers and tablets receive the most attention and use in early childhood (Abdulraheem, 2006). The past decade has witnessed a significant increase in the number of ICT tools, apps, and services used at the kindergarten stage. This increase has contributed to the improvement of teaching methods and learning outcomes due to the effectiveness and appropriateness of such tools at this developmental stage, i.e., when children are able to interact with them (Robinson, 1999).

Attempts at integrating ICT tools, apps, and services into the kindergarten curriculum should not be considered a type of prosperity or fad. Many studies have pointed to the crucial role played by ICT tools in early childhood; one of the most important learning goals at this age is to prepare children to use the ICT tools and services available in the modern world. ICT devices, apps, and services can be employed as effective teaching and learning tools and

thereby can be beneficial for many of the developmental facets of children in kindergarten. ICT can play an effective role in facilitating various dimensions of cognitive growth, including the abilities to focus, understand, and remember. It can also contribute to multiple aspects of social and emotional growth, collaboration in learning and children's motivation to learn (Pierce, 1994).

### **The importance of e-learning for kindergarten children**

The importance of using of e-learning in early childhood lies in its being one of the most important and most current trends in the educational process. Education seeks a variety of approaches to avoid traditionalism, provide a different image of educational thought, and produce improved benefits from the educational process. E-learning, enriched by different ways of connecting with others, can provide the child with a variety of ways to communicate, which contributes to his/her social growth. It also gives children the ability to transfer new information to another child and to exchange opinions about problems they encounter in a practical and more effective manner (Almaraghi, 2007).

E-learning in early childhood helps prepare preschool children for the community in which they live and helps them to understand the world around them so that they can acquire cooperative learning skills. E-learning can thus be used as a social tool that allows the emergence of learning in most social contexts. The use of ICT tools, apps, and services in kindergarten provides children with an excellent environment where they can learn to work together in groups, as it creates an opportunity for them to experience genuine cooperation as opposed to just working in parallel and at the same time. During their interactions with the material at hand, children act as teachers for each other and help their peers who are less efficient at learning and mastering various skills (Scoter, Ellis, & Railsback, 2001).

The use of educational software enriches kindergarten activities and motivates children through various experiences (Alreemawi & Alshahreri, 2008). It also contributes to the development of mental skills and the ability to understand, focus and remember. Educational software transfers the educational process from the teacher to the child by making the child central to his/her own learning, which makes the child more positive and effective. It is also a means of stimulating the child's self-learning and the development of his/her senses and skills.

E-learning in kindergarten adopts multiple techniques to help develop knowledge and skills. These technologies and their distinct educational natures as represented in multimedia elements (e.g., texts, videos, audio, graphics, and animations) support the process of explaining and clarifying information, and they bring information closer to the child. E-learning can also be characterized as an interaction between the teacher and the child that facilitates the ability to easily store and retrieve experiences while taking into account individual differences among children, as e-learning allows each child to choose and control the processing of information (Cascales, Pérez-López, & Contero, 2013). E-learning, with its multiple techniques and its flexibility, also allows the child to repeat educational content,

which is consistent with the innate tendency to repeat among kindergarten children. Multiple ICT tools, apps, and services help to improve the skills and abilities of the child through a combination of visual presentations and animated shapes that attract the child and increase the effectiveness of education, the love of learning, and thereby the child's ability and achievement.

### **Definition of AR technology**

In recent years, there has been a major breakthrough in AR technology. It has moved from a theoretical framework to an actual application and has received increased attention as a result of its widespread use. The uses of AR technologies are not limited to a specific area, and the application of this technology is useful in many areas of modern living.

AR technology is different from VR, in which the user enters a virtual (computer-generated) environment. In contrast, AR is characterized by interaction and integrates a part of the virtual world with the real world, adding a three-dimensional form to AR (Cascales et al., 2013; Mullen, 2011). Etmeezi (2010) defined AR as computer technology based on the integration of images, scenes, and clips of the real world with the virtual world through three-dimensional computer graphics, where the computer controls these components.

Chen (2006) described AR as a technology that integrates three-dimensional virtual objects with the outside world, allowing the user to simultaneously interact with virtual objects and with reality. Yuen, Yaoyuneyong, and Johnson (2011) identified AR as a form of technology that enhances the real world through content produced by the computer. AR technology enables the seamless addition of digital content to the user's perception of the real world. Two-dimensional and three-dimensional shapes can be added in addition to audio, video, animation, and/or text. These enhancements work to expand individual knowledge and understanding of what is happening around them.

Nowfal (2010), in contrast, defined AR as a system that merges VR environments and actual environments using special techniques and methods. Examples include the possibility of lighting the landing pathways of aircraft in real airports or showing a surgeon virtual information during surgery that actually shows him/her the areas that must be removed. Dunleavy and Dede (2006) identified AR as describing a technology that allows a realistic synchronous integration of digital content from computers and software with the real world.

Based on the above ideas, it is clearly possible to combine real and virtual experiences through AR technology and to use appropriate information from the external environment juxtaposed with a digital world that simulates reality. The goal of this technology is to reduce the difference between reality as witnessed by the user and the content provided by AR technology.

### **How does AR technology work?**

The term “AR” refers to the potential to merge virtual information with the real world. This technology works by adding a range of useful information to human visual perception. When someone uses this technology to look at the environment around him/her, the objects in the real environment are equipped with information that swims around and integrates with the image seen by that person. AR has multiple forms, and to understand how AR technology works in general, one should keep in mind its different types (Shelton, 2002). There are two ways in which AR works: the first is through the use of markers. This is the most famous method and is the method used in this research study. A two-dimensional programmed marker shows digital content with either black and white or colored tags. The marker can be printed and placed in front of a webcam so that the camera can capture and integrate the tags, allowing you to see the three-dimensional integration and to view the related information. Notably, the digital object discovery of a black and white marker is faster than that of colored images and tags due to the multiplicity of shades or similarities in the colorful signs, which may cause an error in the emergence of the digital object or make the camera unable to identify the image correctly. The second method does not use markers (markerless) but rather uses geographical positioning sensors (GPS) and associated techniques. It is similar in that each default element is associated with an index tracked by the camera and then interacts with this object (Etmeezi, 2010).

The steps involved in the work of AR technology are identical regardless of whether it follows a marker or a geographic location identification (markerless) technique. In the case of a marker, identification appears on the marker and then a three-dimensional shape appears on the surface. In the absence of a marker, the surrounding location is detected, and digital information is allocated to a set of coordinates on the network (Kipper & Rampolla, 2013). The AR technology mechanism depends on the marker to divide the image (El Sayed, 2011), which is the process of separating the object from the background. This can be performed using dimensional measuring methods. The degree of quality in the separation process is determined by how successfully the objects are extracted from the image. Next, the extraction process begins, which means finding the well-known image elements. These elements are mainly composed of corners, lines, shapes and curves. This phase includes other secondary phases, beginning with exploring the dimensions and ending by detecting and surrounding the marker square. This phase specializes in finding the location of each cell on the image. Because the marker dimensions are available, the issue of drawing a square or a four-line square shape becomes simpler.

It is worth mentioning that the markers used in AR technology have evolved; they are now colorful images instead of black and white. Once the marker is successfully identified, the last step in this process is to identify the marker in the spatial location because compact objects are reflected on the image to suit the scope and direction of the detected mark. In addition, an integrated and embodied three-dimensional object is developed and included on the marker within the scene. The possibilities for AR technology are not limited to the appearance of three-



dimensional objects; the technology has surpassed this to include most multimedia forms. Perhaps the most important aspect of the process is to ensure that all of the different digital objects are linked to the marker in a manner that is compatible with the actual camera; otherwise, the digital content will not appear correctly.

### **Features and characteristics of AR technology**

Some of the advantages of using AR technology in education can be summarized in the following points: (1) provides education in a simple and attractive form that integrates fun and entertainment and that allows interaction with information; (2) offers the potential for learner-directed interaction with the experience that he/she wants to have; (3) enriches the educational process with modern expertise and technological capabilities; (4) is characterized by simplicity and effectiveness; (5) provides the learner with clear and concise information; (6) allows seamless interaction between the teacher and the learner; (7) is effective in terms of cost and the ability to expand easily; (8) provides practical room to quickly gain experience; (9) offers the possibility of innovation and updating at any time; and (10) creates an atmosphere of fun, excitement and thrill and is considered an attractive element of the school of the future (Cai, 2013; Rambli, Matcha, & Sulaiman, 2013; Sommerauer & Müller, 2014).

It is clear from the above list of important features that AR technology serves the educational process in general and students in particular. This makes AR technology the optimal choice for the future of education, meaning that it is imperative for educational institutions to employ this technology for the benefit and interest of the students and teachers as well as for the benefit of educational institutions.

### **Justifications for the use of AR technology**

There are many justifications for using AR technology in education, as mentioned by Radu (2012) and Yuen et al. (2011). These justifications are as follows: (1) increases the understanding of scientific content in certain subjects – AR has the highest impact on student learning compared with other tools, such as books, videos, or desktop computers; (2) generates high enthusiasm among students when AR technology is applied in education – they feel more satisfied, enjoy learning more, and want to re-experience AR applications; (3) improves cooperation among group members and between students and their teachers; (4) leads to longer retention of information, as the content acquired through the use of AR applications by the student is more deeply rooted in the memory compared to that learned through conventional means; (5) motivates students to explore educational materials and information from different perspectives; (6) helps students learn subjects that cannot be accessed or easily recognized except through direct experience, for example, astronomy, geography and other subjects; (7) spurs student creativity and expands the student's imagination to help him/her grasp facts and concepts; (8) helps students learn to control their education according to their level of understanding and their preferred learning method; and (9) creates a teaching and

learning environment suitable for multiple methods of teaching and learning, and for different ages.

In addition to the above justifications, there are others, including the need for our schools to keep up with accelerated progress in the field of ICT. The traditional methods used in our schools are not keeping pace with modern ICT tools, apps, and services, and they do not encourage the learner or deliver information to him/her in a modern and efficient way. Therefore, it is necessary to develop educational tools that are commensurate with the technologically advanced society in which we live, especially because these techniques contribute to improving the productivity of the teacher and the learner alike. In addition, AR technology's rapid development and progress has made it suitable for many subjects. It also supports required educational goals and innovation in educational activities. There is no doubt that AR technology could be considered the educational technology of the future.

### **Obstacles to using AR technology**

Despite the effective advantages of using AR technology in teaching and learning, many restrictions and obstacles limit the use of this technology, as reported by Azuma (1997). The most obvious obstacles to using AR technology are the technical problems of tracking the appearance of digital content and in the improper appearance of objects; objects may also appear optically deformed (Sommerauer & Müller, 2014).

According to Lee (2012) and Radu (2012), the most important obstacles include the following: (1) the limited availability of specialists and experts in the field of AR technology; (2) the lack of confidence on the part of institutions and schools in the effectiveness of AR technology compared with traditional methods; (3) a lack of conviction from learners regarding this type of education and a failure to interact with it as required; (4) a deficit of material resources when beginning a project that uses AR technology; and (5) the fact that AR might not constitute an effective teaching and learning strategy for some students.

Accordingly, the difficulties and obstacles of using AR technology can be classified into four groups: (1) physical obstacles: these are related to infrastructure, the level of penetration of computers and other ICT tools, apps, and services, as well as the use and speed of the Internet; (2) human obstacles: these are related to the specialized roles of teacher and student; (3) technical obstacles: these are related to the digital content and its appearance; and (4) social obstacles: these are related to AR's acceptance by the community, teachers, students, and parents.

The obstacles to using AR technology are quite varied; some involve its relative novelty and some stem from its association with multiple factors, such as human factors, hardware and software infrastructure, and others. We also note the similarity between obstacles hindering AR technology and those hindering e-learning technology because AR technology is one type of e-learning and relies on personal computers or tablets in its programming and operation. Despite the obstacles to using AR technology, which could delay its use, the

potential of its technical applications may contribute to overcoming many of these impediments.

### **The use of AR technology in education**

An empirical research study – was the first of its kind – employed in the State of Kuwait with 24 children from Al-Khairat kindergarten as study participants aimed to determine the effectiveness of using AR technology to teach the English alphabet to kindergarten children. The study used an experimental method to compare two groups: the control group, taught in the traditional manner, and the experimental group, taught using AR technology. The results led to five significant conclusions: (1) There were no significant differences between the experimental group and the control group in terms of test scores; (2) There were significant differences between the experimental group and the control group in the degree of interaction stemming from the interest of the experimental group; (3) There were no statistically significant differences between males and females in terms of test scores; (4) There were no statistically significant differences between males and females in the degree of interaction with the lesson; and (5) There was a strong relationship between the AR technology students' interaction with the lesson on the English alphabet and their score on the test. Using these conclusions, the study produced a set of recommendations regarding the use of AR technology and its applied software in teaching and learning processes, as well as some suggestions for future studies (Al-Yousefi, 2015).

A similar study was conducted by Barreira et al. (2012) that aimed to investigate whether children who are learning a language through AR technology gaming comprehend more than children who learn languages by conventional means. Actual experiences were used (via a computer device) to teach children from Bulgaria at the primary stage. The study included 26 children and reached positive conclusions; it also found that the audio and video accessories associated with the technology helped to promote the learning of vocabulary and that children show satisfactory results after educational experiences derived from sensory reality.

Shea (2014) conducted another experimental research study that aimed to investigate students' comprehension after the use of a mobile AR game, as well as its effect on their language and its impact on communication. The research sample consisted of nine students in a Japanese language course in their second year at the Institute for Higher Education in California. The results showed that the mobile AR game provided a successful means of learning the language outside the classroom, with a positive impact on students.

A different study was conducted by Pérez-López and Contero (2013). They used AR technology to deliver multimedia content to support education about the digestive and circulatory systems at the primary school level in Spain and to evaluate its impact on the retention of knowledge. The study sample consisted of 39 male and female students from the fourth grade, and the results showed greater preservation of knowledge by students who used multimedia content via AR technology, in contrast to students who followed the traditional

approach. This shows that AR technology is a promising tool for improving the motivation and interest of students and supporting the educational process in various fields of education.

Chen (2013) conducted a research study that aimed to detect the effect of AR technology and its ability to facilitate chemistry education for students. She also tested the effect of AR in a collaborative learning environment. The study used a semi-empirical approach. The sample consisted of 96 organic chemistry students at Washington University divided into three groups: 26 students studied through books only, 26 studied by AR only, and 22 students studied by AR in cooperative pairs. The results showed that the performance of students who studied using AR only was much better than that of both the students who studied alone without AR and those who studied using AR in cooperative pairs.

Another experimental research study was carried out in New Zealand by Dünser, Walker, Horner, and Bentall (2012) with 10 female students from secondary schools; this study evaluated the effectiveness of AR books in helping students learn. Half of the group used books supported by AR technology, while the other half used books without AR technology. Students were tested prior to and then after the learning session. They completed a final test to evaluate their level of information retention. The results showed the superiority of the experimental group to the control group; on the retention test, both teams had low scores, but the scores of the experimental group were stronger. The results indicated that the loss of information was due to the natural loss of memory over time.

Ivanova and Ivanov (2011) carried out a study that aimed to evaluate the support of AR technology for teaching and learning and to explore the potential of combining traditional learning methods and AR technology to help students understand complex concepts. The sample was divided into three groups, and each group included 20 students. The research results showed that more than 75 percent of the students felt that AR technology helped them to understand different concepts in the field of computer graphics, that AR technology is a promising and efficient technology, and that it supports thinking and enhances the retention of facts.

Another research study was conducted by Freitas and Campos (2008) to design and evaluate an educational system using AR to teach concepts to second grade students at school. It also explored the use of AR technology in a positive manner and form that supports student learning. Two games called "SMART" were designed and evaluated for use in school; there was a knowledge test on the classification of animals and another on means of transport. The sample consisted of three different classes within three local schools in Portugal. The students' ages ranged between 7 and 8 years, including 22 male students and 32 female students in each of the three schools. The results of the study showed that good students did not benefit much in improving their level of learning, but that the impact of SMART was significantly greater within the ranks of middle-level and weak students. The conclusion was that the good students were inherently strong learners, so the potential for improvement for weaker students was higher.

A recent experimental research study was implemented by Lin et al. (2016) in an elementary school in Taiwan on 21 students (14 boys and 7 girls, age 6-12 years) with different disabilities who were enrolled in two classrooms with Wi-Fi connectivity. The study used Aurasma, a free interactive mobile AR app, and smartphones with 3G or Wi-Fi Internet connectivity as tools to aid in the teaching and learning of geometry. Six puzzle games were used in this study, three were traditional Chinese tangram and three were square puzzle games. Students attempted to solve the games either traditionally (without AR materials/clues/videos) or with the use/help of AR aids. The objective of this research was to enhance students' self-confidence so that they could endeavor to finish the games by themselves. The findings showed that with the use of AR technology participants' ability to complete the puzzle games by themselves were improved significantly – their performance was significantly better – and that the support times was shorter than anticipated. The results also indicated that AR technology could enrich students' learning motivation as well as their frustration tolerance.

## METHODOLOGY

### **Research design**

This study adopted an empirical research methodology based on the random appointment of groups. The experimental approach studies the impact of one variable on another variable, relying on the quantitative control and isolation of variables that can inadvertently interfere during the experiment. Experimental research enables the researcher to test hypotheses about direct causal relationships (Creswell, 2014; Jackson, 2016; Levin, Fox, & Forde, 2013). This research study aimed to measure the effectiveness of AR technology software, the impact of using this technology in the presentation of educational content to children, and their reaction and achievement; the experimental method was determined to be the most suitable for achieving this objective.

The research sample was divided into two groups: control and experimental. The experimental group used tablets and AR software to study the English language using scientific content during a specific period of the daily program when all children meet with their teacher for teacher-led organized activities. The scientific material was introduced to the control group using traditional educational methods for public kindergartens in the State of Kuwait. Post- activity measurements were taken for both the control and the experimental groups to determine the effect of using the AR apps for the presentation of scientific material (independent variable) on children's interaction with the material and to determine their achievement on a test of the English alphabet (dependent variable).

INSTRUMENTS

**First: observation card**

A note card was created to measure the child’s interaction with the AR program and the traditional method of presentation. The observation card contained special items related to the child physical interaction with the tablet and the educational tools and comprised two major themes. The first theme was communication, referring to verbal statements and nonverbal behaviors in reaction to what the child hears and sees. This theme contained five items to measure the child’s interaction with the educational tools. The second theme concerned employment of the senses. It contained three items to measure the child’s interaction with the educational tools; see **Table 1**.

**Table 1.** Observation card for kindergarten children’s interaction during the English alphabet lesson.

| Theme         | Observation Items                                       | Evaluation |   |   |   | Other Remarks |
|---------------|---|------------|---|---|---|---------------|
| Communication | Interacts verbally with peers.                          | 1          | 2 | 3 | 4 |               |
|               | Participates in educational activities.                 | 1          | 2 | 3 | 4 |               |
|               | Co-operates with peers in learning activities.          | 1          | 2 | 3 | 4 |               |
|               | Experiences fun and excitement during the presentation. | 1          | 2 | 3 | 4 |               |
|               | Uses notions to express his/her feelings.               | 1          | 2 | 3 | 4 |               |
| Use of Senses | Interacts with tools via touching.                      | 1          | 2 | 3 | 4 |               |
|               | Focuses on displayed tools.                             | 1          | 2 | 3 | 4 |               |
|               | Listens attentively to letters and sounds.              | 1          | 2 | 3 | 4 |               |

**Validity and reliability of the observation card**

Validity is considered one of the underpinnings of any designed tool. It refers to the degree to which the tool measures what it is actually designed to measure (Alasaaf, 2010; Healey, 2016). The researchers relied on measuring “face validity,” which captures the extent to which the tool appears to be appropriate and suitable for measuring what it is intended to measure (Levin et al., 2013; Walsh & Betz, 2000). Ebel and Frisbie (1991) stated that to measure face validity, the tool is presented to a group of specialists who assess the extent to which the items represent the trait to be measured. Therefore, the researchers introduced the tool (the observation card) to a number of specialized professors in the College of Education at Kuwait

University, who provided feedback through comments and notes. The researchers implemented the proposed amendments and presented the card again to the specialists, who granted their final approval. The card was then adopted in its final form.

Reliability is also considered one of the main pillars of any designed tool. A tool is considered reliable if it leads to the same results in the event of repetition (Adams & Lawrence, 2014; Alasaaf, 2010). After confirming the reliability of the tool (the observation card), it was pilot tested on 10 first-level kindergarten students to calculate its degree of reliability. To determine the card's stability, the researchers used the observers' agreement method to calculate stability. This method requires each observer to work independently and to finish at the same time or at the end of the observation period. The number of agreements and disagreements between observers during the entire observation period is then determined, and the ratio (coefficient) of agreement between observers is calculated by comparing information collected by the first observer with information collected by the second observer using the "Cooper" equation. The percentage of agreement between observers is shown in [Table 2](#).

**Table 2.** Frequency and percentage of agreement and disagreement between observers.

| Child No.              | Themes | Number of Agreement | Number of Disagreement | Agreement Percentage |
|------------------------|--------|---------------------|------------------------|----------------------|
| 1                      | 8      | 7                   | 1                      | 87.5%                |
| 2                      | 8      | 8                   | 0                      | 100%                 |
| 3                      | 8      | 7                   | 1                      | 87.5%                |
| 4                      | 8      | 6                   | 2                      | 75%                  |
| 5                      | 8      | 8                   | 0                      | 100%                 |
| 6                      | 8      | 7                   | 1                      | 87.5%                |
| 7                      | 8      | 8                   | 0                      | 100%                 |
| 8                      | 8      | 8                   | 0                      | 100%                 |
| 9                      | 8      | 8                   | 0                      | 100%                 |
| 10                     | 8      | 7                   | 1                      | 87.5%                |
| Total Card Reliability |        |                     |                        | 92.5%                |

After using the Cooper equation, the agreement percentage between observers on the same sample was 92.5 percent; this agreement rate indicates the reliability of the tool (the interaction observation card), as any agreement ratio higher than 85 percent indicates high reliability (Almofti, 1984; Levin et al., 2013).

## **Second: achievement test**

A test was designed and prepared by the researchers with the assistance of some supervisors of English language education at the kindergarten stage. The objective of the test was to measure the achievement of both the children taught using the AR app and those taught through the traditional method. The test consists of six letters, divided into two parts: three letters for predators (L-Lion, T-Tiger, S-Snake) in Part I and three letters for pets (C-Cat, D-Dog, F-Fish) in Part II. The test consists of five questions for each letter. The questions varied between connecting the matches, circling the correct answer, and repetition. Thus, there were 30 questions in the test in total.

### **Validity and reliability of the achievement test**

Validity is one of the foundations of any designed tool and refers to the degree to which the tool actually measures what it was designed to measure (Alasaaf, 2010; Healey, 2016). For the test, the researchers relied on a type of validity called "Content Validity", which is based on the extent to which the parts of the tool properly represent the field to be measured (Alhuwaidi, 2004; Creswell, 2014; Levin et al., 2013). Abu Allaam (2005) mentioned that the most important source of the significance of the validity of the test content would be the teachers overseeing the test, as they are responsible for comparing the questions with the content they aim to measure. Therefore, the test was introduced to a group of kindergarten teachers, and they were asked to give their perspective about the clarity of the test questions and the scientific relevance of the content. Any necessary adjustments to the test were made and it was adopted in its final form.

Reliability is also considered one of the underpinnings of any designed tool. A tool is considered reliable if it leads to the same results in the event of repetition (Adams & Lawrence, 2014; Alasaaf, 2010). The researchers used the "split half" division to measure the reliability of the test; this method is commonly used to measure reliability, especially in circumstances where the test cannot be applied more than once due to time considerations or lack of material resources (Cohen & Swerdlik, 2009; Levin et al., 2013). The test is conducted once on a group of people, and then the questions are divided into two halves. The correlation coefficient between the two halves is then calculated. The test was conducted on a group of 10 children. Each test was divided into two halves, and the correlation coefficient between the two halves was calculated. The correlation coefficient was 0.91, and pursuant to the guidelines of Cohen (1988), the correlation value is small if it is less than 0.29, medium if it is between 0.30 and 0.49, and great if it is more than 0.50. Thus, it is clear that the value of the correlation coefficient is very high, and this gives us confidence in the tool's reliability for conducting the study.

### **Third: AR apps**

To conduct this study, "AR Flashcards Animals-Alphabet" and "AR Alphabet Flashcards" apps were selected after reviewing a wide range of AR software available at the online App Store and designed to be viewed using iPad tablets. These two apps present the



English alphabet initials of pets and predators using AR by displaying a three-dimensional letter accompanied by the sound of each animal and some animated movements, so that the child can use it in the session to learn the letters of the English alphabet. The apps offer an element of thrill and provide the child with new experiences and knowledge.

### **Sample**

The study included children in kindergarten in the second semester of the 2015-2016 academic year who were enrolled in the public educational system in the State of Kuwait. The study sample included 42 children selected in a simple random manner. The Mubarak Al-Kabeer Educational Area was drawn randomly from six possible educational areas. Then, "Al-Kuwait" kindergarten, affiliated with this educational area, was also drawn randomly. Al-Kuwait kindergarten is one of the kindergartens using the new curriculum system (Arabic Language - English Language - Mathematics) applied at the first and second levels. The study sample was selected from the classes of the first level (KG-1) of Al-Kuwait kindergarten. One of the classes was randomly selected as the experimental group (AR group), while the other class was also randomly selected and served as the control group (the traditional group).

### **Data collection**

The experiment took seven weeks during the second semester of the 2015-2016 school year, during which the experimental group was taught using the AR apps. The control group was taught in the traditional way. To facilitate the research procedures and implementation of the experiment, the researchers met with the director of Al-Kuwait kindergarten and with the technical supervisors before the actual employment of the study to explain how to implement the experiment, the choice of classes, and how teachers could help in the application of the experiment. The researchers explained the experiment and the two selected presentation programs to the class teachers, in addition to explaining how to use the observation card. There were eight classrooms in Al-Kuwait kindergarten, four of them for the first level and four for the second level. Two classes were randomly selected from the first level, and one of these was randomly selected as the experimental group and the other as the control group.

The researchers equipped the classrooms and through a draw selected a teacher to help during the lesson period, which lasts for 20 minutes. Then, the researchers observed the behavior of the children and discussed what had been learned. The experiment lasted for seven weeks, during which the children in the experimental group learned using AR apps while the children in the control group learned through the traditional methods used for kindergarten in the public education system.

### **Methods of analysis**

After completing the study and collecting the required data using the observation card and test as appropriate tools, the collected data were entered into the statistical analysis software SPSS version 22 to be statistically treated and to extract necessary statistical data,

analysis, and comparisons. Specifically, this research study required the use of the following statistical methods. (1) The Cooper equation was used to calculate the percentage of agreement (for the observation card). Due to the unavailability of one of the most important conditions for the use of laboratory tests (parametric), which is the sample size (Conover, 1999; Jackson, 2016; Levin et al., 2013), (2) nonparametric (non-laboratory) tests were used for this study as follows: (a) the Mann-Whitney test to measure the differences between the experimental and control groups, and (b) the Spearman test to measure the relationship between interaction and achievement. Notably, these statistical tests have been applied for evidentiary purposes to answer the study questions and that, upon application, the alpha value was determined to be 0.05.

### Data analysis: results and discussion

The findings of this research study are coherent and in compliance with the results of other studies (presented throughout this document) conducted over the past 5 years, as well as with the assumptions initially postulated. Below is a presentation and discussion of the results obtained from the study’s research questions.

#### Research question no. 1: interaction

The first research question was stated as follows: Are there any statistically significant differences between the AR group and the traditional group in terms of their degree of interaction with the English alphabet lesson? To answer this, the researchers used the Mann-Whitney test to determine the differences between the control and experimental group in their interactions with the lesson. **Table 3** shows the results of this analysis.

**Table 3.** Results of the Mann-Whitney test for finding differences between the control and experimental groups in the degree of interaction with the English alphabet lesson.

| Class/Group                      | N  | Mean Rank | Sum of Ranks | Z-Score | Asymp. Sig. (2-tailed) |
|----------------------------------|----|-----------|--------------|---------|------------------------|
| Experimental (Augmented Reality) | 21 | 30.48     | 640.00       | -4.772  | 0.000**                |
| Control (Traditional)            | 21 | 12.52     | 263.00       |         |                        |

Note:\*\*. The difference is significant at the 0.01 level.

**Table 3** shows that there are statistically significant differences on the 0.05 level between the control group (the traditional group) and the experimental group (AR group) in their degree of interaction with the English alphabet lesson, with an advantage for the experimental group. The average interaction degree of the experimental group was 30.48 and of the control group was 12.52. This indicates that the AR technology succeeded in providing elements of suspense and thrill for the kindergarten children. This result has its justifications. In addition to the fact that the children in the control group are familiar with the traditional method as a daily way of teaching and learning and as a routine that is devoid of any new elements, we found that teaching and learning through the use of AR technology added a group of elements

that disrupted the traditional teaching and learning routine. It also offered other elements that surpassed the technologies normally used by the children. The capabilities of AR technology add suspense and thrill to the capabilities offered by other ICT tools, apps, and services, making interaction between the children and the technology inevitable. This result is consistent with the studies of Al-Yousefi (2015) and Barreira et al. (2012), who explained that the interactive traits of the iPad and AR apps, including multimedia, attract children's attention more than still images and texts and therefore increase the level of the children's interaction.

### Research question no. 2: achievement

The second research question was stated as follows: Are there any statistically significant differences between the AR group and the traditional group in their scores on the English alphabet test? To answer this question, the researchers used the Mann-Whitney test to determine the differences between the control and the experimental groups in terms of their test scores. **Table 4** shows the results of this analysis.

**Table 4.** Results of the Mann-Whitney test for finding differences between the control and experimental groups in the English alphabet test score.

| Class/Group                      | N  | Mean Rank | Sum of Ranks | Z-Score | Asymp. Sig. (2-tailed) |
|----------------------------------|----|-----------|--------------|---------|------------------------|
| Experimental (Augmented Reality) | 21 | 27.57     | 579.00       | -3.244  | 0.001**                |
| Control (Traditional)            | 21 | 15.43     | 324.00       |         |                        |

Note:\*\*. The difference is significant at the 0.01 level.

**Table 4** shows that there are statistically significant differences on the level of 0.05 between the control (traditional) group and the experimental (AR) group in their scores on the English alphabet test, in favor of the experimental group. The average of the experimental group was 27.57 and that of the control group was 15.43. This result is highly consistent with the previous results of many studies, such as those of Shea (2014), Pérez-López and Contero (2013), Chen (2013), Barreira et al. (2012), and Dünser et al. (2012), all of which showed statistically significant differences in achievement in favor of AR technology. This result, however, does not match the result of Al-Yousefi (2015); this difference could be attributed to the size of that study's sample ( $N = 24$ ), which is almost half of the sample of the current study ( $N = 42$ ). The difference may also be attributed to the duration of the study (4 weeks) compared to the duration of the current study (7 weeks). The result can also be justified in view of the social and economic nature of the educational area where the study was conducted, as it is considered one of the largest geographical areas in the State of Kuwait and contains a blend of all sectors of Kuwaiti society.

### Research question no. 3: correlation

The third research question was stated as follows: Is there any relation/correlation between the interaction of the AR group with the English alphabet lesson and their score on the English alphabet test? To answer this question, the researchers used the Spearman test to find the correlation between the level of interaction and the test score. **Table 5** shows the results of this analysis.

**Table 5.** Results of the Spearman test for finding the relation/correlation between interaction and the test scores of the AR group.

| Class/Group                      | N  | Spearman's Correlation Coefficient | Sig. (2-tailed) | Correlation |
|----------------------------------|----|------------------------------------|-----------------|-------------|
| Experimental (Augmented Reality) | 21 | 0.742**                            | 0.000           | Very Strong |

Note:\*\*. The correlation is significant at the 0.01 level.

As is clear from **Table 5**, and pursuant to the directions of Cohen (1988), there is a very strong linear relationship/correlation between the children's interaction with the English alphabet lesson and their score on the English alphabet test in the AR group. The value of the correlation was 0.742. This result can be attributed to a group of factors: an increase in the child's interaction with the lesson, his/her participation in the teaching and learning processes using all of his/her senses, and the AR's attracting his/her attention, all of which increase the possibility of the information becoming deeply rooted in his/her mind and therefore increasing his/her achievement. This result reinforces the necessity of involving learners in the teaching and learning processes and of verifying their interaction with the lesson, rather than letting them assume passive roles that do not extend beyond simply receiving the information. Assuring the children's interaction and their positive engagement in educational activities is considered the guarantee of learning, regardless of the media used in teaching. This result largely agrees with the study of Al-Yousefi (2015).

### CONCLUSIONS AND RECOMMENDATIONS

In summary, in light of the tremendous and growing developments/advances in ICT tools, apps, and services; because of their impact on the effectiveness of educational processes (both teaching and learning); and based upon the outcomes of the current study indicating that AR technology and its related apps should preferably be adopted at the primary stage of education (pre-school and kindergarten) in particular as well as in G1-G12 education in general; the researchers strongly recommend increasing the awareness of officials in the MOE of the importance of using AR apps in the teaching and learning of kindergarten children as well as endowing kindergarten schools with teaching and learning environments (e.g., classrooms, halls, and laps) equipped with modern teaching and learning technologies that allow teachers to use AR programs. The researchers also propose emphasizing on the e-

learning skills and competencies of kindergarten teachers. Indeed, they strongly endorse offering training courses, workshops, and seminars for kindergarten teachers and technical supervisors on how to use and employ AR apps in education. In addition, the researchers urge conducting extra in-depth research studies – with larger sample sizes – examining the effects of using other AR apps – such as Aurasma – on academic achievement in other grades such as elementary, middle, and high school; also, study the impact of the use of this technology on academic achievement in other subject areas. Finally, the researchers encourage translating the proposals and recommendations resulting from this study into policies or strategies and effective practical actions in the field of education in the State of Kuwait to reap rewards as soon as possible.

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