Augmented Reality: User Perception on Effectiveness in Educational Delivery Assessment in Kaduna

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ABSTRACT

There are many different ways for people to be educated and trained with regards to specific information and skills, they need. These methods include classroom lectures with textbooks, computers, handheld devices, and other electronic appliances. The choice of learning innovation is dependent on an individual's access to various technologies and the infrastructure available in the environment where the person lives. In a rapidly changing society where there is a great deal of available information and knowledge, adopting and applying information at the right time and right place is needed to maintain efficiency in both school and business settings.

Augmented Reality (AR) is one technology that dramatically shifts the location and timing of education and training. This research paper describes AR, how it applies to education and training, and its potential impact on the future of education in the Nigeria context. This research assesses the impact of AR usage in teaching and learning among selected students in the northern central part of Nigeria. Research question was drawn, and hypotheses were formulated and tested at 0.05 level of significant. The population of the study is 40 students. The data collected were analyzed using mean, standard deviation and Chi-square test. The study shows that AR technology enhances student motivational level and engagement in learning. In addition, students experience when AR is used for teaching shows that the use of AR in education can be a key component in the learning environment of the future.

(Keywords: technology, augmented reality, AR, virtual reality, VR, teaching and learning, education)

INTRODUCTION

Technology has become a crucial part of our lives in today's society. The way people now think and apply knowledge are completely influenced by the prevailing technology. In today's world, technologies for educational delivery are developing at a great speed, influencing students, teachers, learning environments, and learning processes.

Technology has become entrenched in education and the results indicate a positive impact on teaching and learning styles. Tekedere and Göke (2016) noted that the integration of informatics technologies into education has given rise to the emergence of studies of different qualities, increase in the learning sources, differentiation in learning sources and teaching approaches. Wallace (2018) also noted that, integration of technology provides a means to enhance student learning and engagement in lectures. Lectures that are supported by technology will open up opportunities for a more innovative forms of teaching and learning. This is because the use of technology involves solving real-world problems, using informational resources that are current, able to simulate concepts for better understanding, visualization and communication with professionals in that field. In addition, it is believed that learning with technology will complement the traditional forms of teaching and learning.

The integration of technology tools into the curriculum is becoming part of good teaching. With integration of technology to teaching and learning in contemporary education, teachers not only have to spend a good deal of personal time working with computers but also their level of confidence in handling new technologies and innovation are enhanced.

One of the newest developing technologies is augmented reality (AR), which can be applied to computers, tablets, and smartphones. AR affords the ability to overlay images, text, video, and audio components onto existing images or space. AR technology has gained popularity in the educational market for its ability to bridge gaps and bring a more tangible approach to teaching and learning. The benefits of AR include incorporating of virtual and real-world experience which enhances Student-centered activities (Saidin et al., 2015). The AR technology also allows the presence of the user in two different spectra, the real and the virtual world, at the same time. In addition, AR enhances experiences by adding virtual components such as digital images, graphics, or sensations, as a new layer of interaction with the real world (Hagl and Duane, 2018).

According to Cai et al. (2014) AR technology offer a learning medium that is close to the real world and make it possible for the students to play an active role in the learning process. Another technology which shares almost the same domain with AR, is Virtual Reality (Vilanova, 2017). Virtual Reality (VR) is an artificial, computer-generated simulation or recreation of a real-life environment or situation. Unlike VR, AR offers the users a perfect interface that brings the real and virtual world together. The users may interact with the virtual objects that are placed within the real scenes around and experience the most natural and real human-computer interaction.

AR is a very efficient technology for education at all levels because it influenced the learning process in a positive way (Ibáñez et al., 2014; Cai et al., 2014; Antonioli et al., 2014). In higher education such as universities and colleges, students can improve their knowledge and skills, especially on complex theories or mechanisms of systems or machinery. AR can make complicated mechanisms and difficult theories in higher education accepted and understood by students with contextually enriched interaction using AR technology.

With the advancement in technology today, learning in traditional ways can be enhanced with AR technologies thereby removing the boredom associated with teaching and learning a complex practical topic in a traditional way without technology application. AR brings flexibility, simplicity and attractiveness to teaching and learning.

AR technology can be utilized through a variety of mediums including desktops, mobile devices, and smartphones. In any educational setting, there are often numerous limitations with available resources. They are common in the traditional classroom as a result of budget restraints or constraints on time, the means to teach students in scenarios that allow them to learn by doing can be a challenge. Therefore, with AR technology contents and instruction delivery within the traditional classroom can be enhanced, contents are extended into the world outside the classroom and instruction in the special education classroom supplemented.

Classrooms can shift from the traditional lecture style setting to one that is more lab and student-oriented (Antonioli et al., 2014). Students been naturally curious and playful, they learn and explore when they play, manipulating a wide range of real objects and getting to see the results of their actions immediately. By this way, students learn by internalizing the activities, habits, vocabulary and ideas of the members of the community in which they are. In other words, students learn best through primarily a social activity and participating in the social life of the school.

This research assesses the perception of users on the effectiveness of using AR technology in classroom for educational delivery.

RESEARCH QUESTION

Based on the research problem, the following research questions were raised to guide the study:

i. How does AR increase the motivation and engagement of learning?

ii. How does student react to the use of AR technology in classroom?

iii. How are the experiences of students when using AR?

iv. What role does AR play in the process of learning among students?

HYPOTHESES

The following null hypothesis were formulated for the study and were tested at $p \leq 0.05$ level of significance.

H_0: Using Augmented Reality technology has a positive effect on education.

H_1: There is no significant difference in the effectiveness of using AR in class rooms.

LITERATURE REVIEW

Tiwari and Patkar (2016) described AR as the reality in which virtual objects or images are mounted with the real-world objects. AR is a live view of a real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. It is a technology that supplements the computer-generated virtual objects with the real-world objects, it appears as if they co-exist in the same space as real world.

The term AR is used to describe a combination of technologies that enable real-time mixing of computer-generated content with live video display. AR is based on techniques developed in VR and interacts not only with a virtual world but has a degree of interdependence with the real world (Mekni and Lemieux, 2014).

The term AR was coined by Tom Caudell; a former Boeing researcher in 1990. The concept of augmenting the real world by virtual data was initially used by a number of applications in the late 1960s and 1970s. Since the 1990s, AR has been used by some large companies for the purpose of visualization and training. Nowadays, the rising power of personal computers and mobile devices enables the concept of AR to be applied in traditional educational environments such as schools and universities (Diegmann et al., 2015)

Lee (2012) stated that AR has strong potential to provide both powerful contextual, on-site learning experiences and serendipitous exploration and discovery of the connected nature of information in the real world. AR has been experimentally applied to both school and business environments, although not as much as classic methods of education and training during the last two decades. In addition to that, the technologies that make AR possible have become much more powerful than ever before and compact enough to deliver AR experiences to not only corporate settings but also academic venues through personal computers and mobile devices. Several educational approaches with AR technology have also become more feasible. Also, wireless mobile devices, such as smartphones, tablet PCs, and other electronic innovations, are increasingly ushering AR into the mobile space where applications offer a great deal of promises, especially in education and training (Lovreglio, 2018).

The most innovative aspect of AR is not the technology, it is the objective. Instead of replacing physical objects with a computer, we create systems that allow people to interact with the real world in natural ways and at the same time, benefit from enhanced capabilities from the computer. As Mackay (2010) stated the future we envision is not a strange world in which we are immersed in "virtual reality". Instead, we see our familiar world, enhanced in numerous, often invisible ways.

AR educational programs are student-centered and related to student interests. It allows students to explore the world in an interactive way. Constructivism also encourages students to work collaboratively, and AR provides students the opportunity to do this in a traditional school setting as well as in distance education. In any educational setting, there are often limitations in the various resources available. This is often seen foremost in the traditional classroom. Due to budget restraints or constraints on time, the means to teach students in scenarios that allow them to learn by doing can be a challenge. Desktop AR allows students to combine both real and computer-generated images (Antonioli et al., 2014).

As stated by Kesim and Ozarslan (2012), AR technology is not a new issue. It has been used in fields such as: military, medicine, engineering design, robotic, telerobotic, manufacturing, maintenance and repair applications, consumer design, psychological treatments, etc. Displaying information by using virtual things that the user cannot directly detect with his own senses can enable a person to interact with the real world in ways never before possible. We can change the position, shape, and/or other graphical features of virtual objects with interaction techniques augmented reality supports.

Using our fingers or motions of handheld devices such as shake and tilt we have an ability to manipulate virtual objects, as well as to physical objects in the real world. AR can be applied for learning, entertainment, or edutainment by enhancing a user's perception of and interaction with the real world. User can move around the three-dimensional virtual image and view it from any vantage point, just like a real object. The information conveyed by the virtual objects helps users perform real world tasks. Tangible Interface Metaphor is one of the important ways to improve learning. This property enables manipulation of three-dimensional virtual objects simply by moving real cards without mouse or keyboard (Wallace, 2018).

AR can also be used to enhance collaborative tasks. It is possible to develop innovative computer interfaces that merge virtual and real worlds to enhance face-to-face and remote collaboration. AR is predicted to become mainstream within ten years (DeLucia et al., 2012). The evolution of the technology is the result of improvements regarding machine learning, smartphones, and cameras to mention a few.

Kohn, et al. (2018) stated that with AR users can see digital overlays onto his or her surroundings through a technical device such as mobile phone or AR glasses. These overlays can be 2D/3D graphics, information and other visual enhancements. AR is expected to innovate many different fields. For instance, in medicine, surgeons could use AR-glasses to be assisted by real-time visual assistance models during a surgery procedure. Another field could be in the manufacturing industry where operators need to assemble hundreds of components in a precise sequence as quickly as possible. Instead of relying on outdated manuals the operator could be guided by AR based applications (Catalán and Gidlof, 2018). Some studies have been carried to evaluate the effectiveness of using AR in teaching and learning.

Shirazi and Behzadan (2014) designed and implemented collaborative context aware mobile augmented reality tool (CAM-ART) in classroom-scale experiments to assess the effectiveness traditional lecture-based instruction and information delivery methods. The contents of an ordinary textbook were enhanced using computer-generated three-dimensional (3D) objects and other virtual multimedia (e.g., sound, video, and graphs), and delivered to students through an AR application running on their smartphones or tablet computers. Data analysis showed that CAM-ART had a measurable and positive impact on students' learning both in short-term and long-term. Moreover, results of the feedback questionnaire indicated that students found CAM-ART to be an interesting, helpful, and motivational approach in the classroom that helped them gain more in-depth and long-lasting knowledge beyond what is normally expected from traditional lecture-based teaching methods.

Alkhattabi, (2017) in his study reviewed the main benefits of using augmented reality applications in education. user acceptance of AR applications in primary schools, within an e-learning environment from the teachers' perspective were examined and the benefits and barriers to adopting this technology was also explored.

Safar, et al. (2017) scrutinized the effectiveness of using AR applications (apps) as a teaching and learning tool when instructing kindergarten children in the English alphabet in some states in 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.

Sirakaya and Cakmak (2018) examined the effect of using AR on students' achievement, misconception and course engagement. A (matched) quasi-experimental research design with both pretest and posttest control groups was used in the study. Mayilyan (2019) carried out a study to assess the potential of AR technology in educational settings by outlining the attitude of learners towards the use of immersive multimedia content in their learning mediums. Based on the literature above which examines the use of AR in education and summarized the methods of the studies examined, this research assesses the perception of users on the effectiveness of using AR technology in classroom for educational delivery.

METHODOLOGY

The study drew samples from postgraduate students M.Sc. class of 2017/2018 session in computer science in the Nigerian Defence Academy, Kaduna, Nigeria. Questionnaires were designed and made available Online. Forty (40) students were administered with a questionnaire but 33 students were able to fill and submit back. This research used the quantitative approach which involves collecting and converting data into numerical forms so that statistical calculation can be made and conclusions drawn.

The researchers made use of descriptive and inferential statistics. The descriptive statistics were frequency count, mean and standard deviation. The inferential statistics were applied to assess the significance of the hypothesis. Chi-square test was used to test the null hypotheses formulated to further confirm the veracity of the difference in mean scores using survey monkey at 0.05 level of significance.

DATA ANALYSIS AND PRESENTATION OF RESULTS

The data collected is presented in table form and was analyzed to answer the research questions. In answering the research questions for the study, mean, standard deviation was used. The results are presented in Tables 1, 2, 3 and 4.

Table 1: How does AR increase the motivation and engagement of learning?

ANSWER CHOICES	RESPONSES	
Extremely effective	30.30%	10
Very effective	36.36%	12
Somewhat effective	33.33%	11
Not so effective	0.00%	0
Not at all effective	0.00%	0
TOTAL	**100%**	**33**

From the data 30.30% of the responses believe that AR is extremely effective in increasing the motivation and engagement of learning, while 36.36% believe it is very effective and 33.33% believe it is somewhat effective.

Table 2: How does student react to the use of AR technology in classroom?

ANSWER CHOICES	RESPONSES	
Extremely useful	36.36%	12
Very useful	42.42%	14
Somewhat useful	21.21%	7
Not so useful	0.00%	0
Not at all useful	0.00%	0
TOTAL	**100%**	**33**

From the data 36.36% of the responses believe that student react extremely useful to the use of AR in classrooms, while 42.42% believe it is very useful and 21.21% believe it is somewhat useful.

Table 3: How are the experience of students when using AR?

ANSWER CHOICES	RESPONSES	
Very satisfied	24.24%	8
Satisfied	60.61%	20
Neither satisfied nor dissatisfied	12.12%	4
Dissatisfied	0.00%	0
Very dissatisfied	3.03%	1
TOTAL	**100%**	**33**

From the data 24.24% of the responses are very satisfied with the experience using AR, while 60.61% of the responses are satisfied, 12.12% are neither satisfied nor dissatisfied and 3.03% are very dissatisfied.

Table 4: What role does AR play in the process of learning among students?

ANSWER CHOICES	RESPONSES	
Extremely important	27.27%	9
Very important	54.55%	18
Somewhat important	15.15%	5
Not so important	0.00%	0
Not at all important	3.03%	1
TOTAL	**100%**	**33**

From the data 27.27% of the responses believe that AR play an extremely important role in the process of learning among students, while 54.55% of the responses believe it is very important, 15.15% of the responses believe it is somewhat effective and 3.03% of the responses believe it is not at all important.

TESTING OF HYPOTHESES

After answering the research questions, the stated null hypotheses were tested at $p \leq 0.05$ level of significance to express significant difference.

H_0: Using AR technology has a positive effect on education.

H_1: There is no significant difference in the effectiveness of using AR in class rooms.

Research Question1: How does AR increase the motivation and engagement of learning?

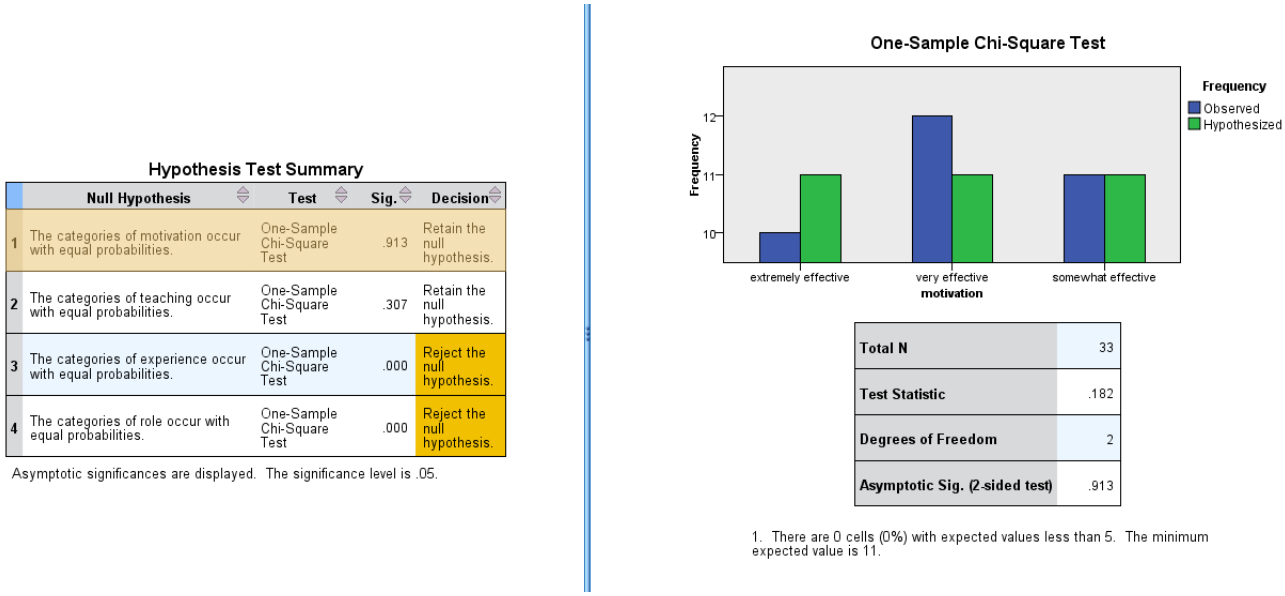
To test this hypothesis, the mean was subjected to chi-square test and summary of analysis is shown in figure 1, Since the value of Chi-square is 0.182 which is less than the tabulated value 0.913 at 2 degrees of freedom and 5% level of significance so the Null Hypothesis – using augmented reality technology has a positive effect on education is retained.

Research Question2: How does student react to the use of AR technology in classroom?

To test this hypothesis on the question, the mean was subjected to chi square test, Since the value of Chi-square is 2.364 which is less than the tabulated value 0.307 at 2 degrees of freedom and 5% level of significance so the Null Hypothesis – using augmented reality technology has a positive effect on education is retained as shown in Figure 2.

Research Question3: How are the experiences of students when using AR?

To test this hypothesis, the mean was subjected to chi square test and summary of analysis are shown, Since the value of Chi-square is 28.455 which is greater than the tabulated value 0.000 at 3 degrees of freedom and 5% level of significance so the Null Hypothesis – using augmented reality technology has a positive effect on education is rejected as shown in Figure 3.



Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of motivation occur with equal probabilities.	One-Sample Chi-Square Test	.913	Retain the null hypothesis.
2	The categories of teaching occur with equal probabilities.	One-Sample Chi-Square Test	.307	Retain the null hypothesis.
3	The categories of experience occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
4	The categories of role occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Total N	33
Test Statistic	.182
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.913

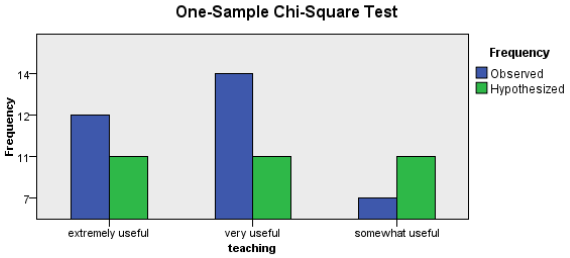
1. There are 0 cells (0%) with expected values less than 5. The minimum expected value is 11.

Figure 1: Non-Parametric One-sample Chi-Square Test Output for Research Question 1.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of motivation occur with equal probabilities.	One-Sample Chi-Square Test	.913	Retain the null hypothesis.
2	The categories of teaching occur with equal probabilities.	One-Sample Chi-Square Test	.307	Retain the null hypothesis.
3	The categories of experience occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
4	The categories of role occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	33
Test Statistic	2.364
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.307

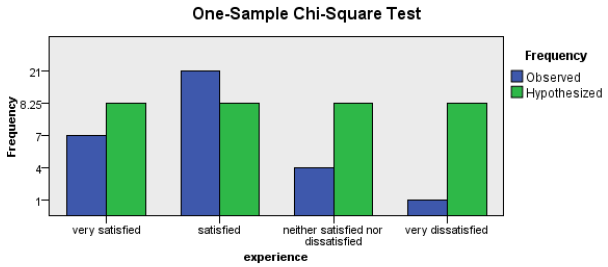
1. There are 0 cells (0%) with expected values less than 5. The minimum expected value is 11.

Figure 2: Non-Parametric One-Sample Chi-Square Test Output for Research Question 2.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of motivation occur with equal probabilities.	One-Sample Chi-Square Test	.913	Retain the null hypothesis.
2	The categories of teaching occur with equal probabilities.	One-Sample Chi-Square Test	.307	Retain the null hypothesis.
3	The categories of experience occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
4	The categories of role occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.



Total N	33
Test Statistic	28.455
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.000

1. There are 0 cells (0%) with expected values less than 5. The minimum expected value is 8.250.

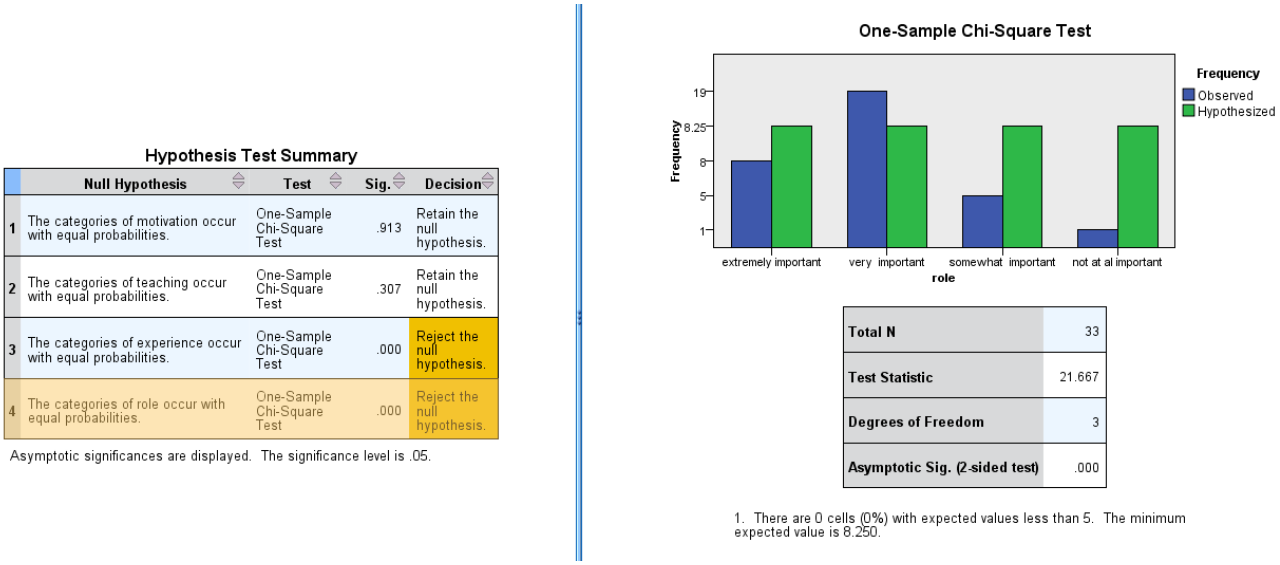
Figure 3: Non-Parametric One-Sample Chi-Square Test Output for Research Question 3.

Research Question 4: What role does AR play in the process of learning among students?

To test this hypothesis, the mean was subjected to chi square test and summary of analysis are shown. Since the value of Chi-square is 21.667 which is greater than the tabulated value 0.000 at 3 degree of freedom and 5% level of significance the Null Hypothesis – using augmented reality technology has a positive effect on education is rejected as shown in Figure 4.

SUMMARY OF FINDINGS

The findings and results, shows that AR technology enhances student motivational level and engagement of learning, this will lead to an intrinsic motivation to learn. Students motivation refers to a student's willingness, need, desire and compulsion to participate in, and be successful in the learning process, when technology integration is used correctly, it can improve students' motivation.



Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of motivation occur with equal probabilities.	One-Sample Chi-Square Test	.913	Retain the null hypothesis.
2	The categories of teaching occur with equal probabilities.	One-Sample Chi-Square Test	.307	Retain the null hypothesis.
3	The categories of experience occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
4	The categories of role occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Total N	33
Test Statistic	21.667
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.000

1. There are 0 cells (0%) with expected values less than 5. The minimum expected value is 8.250.

Figure 4: Non-Parametric One-Sample Chi-Square Test Output for Research Question 4.

Based on the finding's student reaction to the use of AR in education can be a key component in the learning environment of the future. The result showed that it has the potential to support teaching and learning and quite different from the traditional way of teaching.

Based on the findings the experience of student when using AR and the role that AR play among student have no difference with the traditional way of learning.

CONCLUSION

AR technology is an effective tool for teaching and learning which offers the benefits of integrating virtual and real-world experience into teaching and learning environments thereby enhancing Student-centered activities. With AR technology in classroom students can acquire much more knowledge and experience in learning compared to the traditional classroom learning method.

This research conducted shows that AR technology has the potential to be further developed in education. This is because AR technology can engage students in learning processes and help them improve their visualization skills. The features can also help teachers to explain complex concepts well and make the students to understand what they are taught easily.

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