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Developing Skills To Use Augmented Reality (AR) Technology In Teaching Technical Subjects For Improving Memory Retention And Self Motivation Among Higher Technical College Teachers In Katsina State, Nigeria

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ABSTRACT
This study aimed at canvassing the usability and effectiveness of augmented reality technology (AR) on self motivation and memory retention for higher technical teachers in Katsina state. A quasi experimental design was employed consisting of thirty higher technical teachers derived from four technical colleges in the state as the research sample; the tools engaged for data collection were self-motivation questionnaire (SMQ) and memory retention test. The two instruments were validly and reliably tested to ascertain their level of consistency and usefulness in generating the desired data. Cronbach alpha internal consistency values of 0.78 and 0.88 were calculated for the two respective instruments after the pilot study indicated that they are all reliable and valid to serve the purpose. Pre and post experience test were administered to the sample before and after the treatment which spanned for a two weeks period to enable the researcher compare the two successes in order to make inferences. The data generated from the two tests were analysed by descriptive statistics of mean, standard deviation and paired sample t-test. The result revealed that the intervention has little impact on self motivation and does a moderately increase in the memory retention of the experimental group after treatment. It was concluded that AR tools has little impact on increasing trainees memory retention and self motivation, therefore it was recommended that more attention should be paid towards integrating blended learning approaches that include the use of AR tools along with other techniques.
Keywords: Augmented reality, memory retention, self motivation.

INTRODUCTION

The fast growing of technology has effectively customized the overall education sector, providing new tools to augment teaching and learning processes, among these tools is the augmented reality (AR).

The technology (Augmented reality) has emerged as a transformative technology that offer learners an immersive and interactive learning opportunity that can essentially influence their educational achievements. (Ronald, 1997; Wiegand, Hollander, Mai & Hussmann, 2019)

In the field of technical education, augmented reality has the prospect to close the gap between the theoretical knowledge and the practical applications created due to the shortage of practical infrastructures, thereby making the abstract concepts more understandable and accessible to the learners. This research focuses on developing the necessary skills to use augmented reality in the teaching practices for higher technical college teachers in Katsina state, Nigeria, with a vision to

facilitate instruction and improve academic performance and self motivation among the technical college teachers.

Teaching technical subjects often marred with challenges in terms learners engagement and understanding due to their ambiguity and epitome nature. Moreover, the familiar traditional methods may not adequately address the varying instructional needs of the learners in this fields, thus augmented reality provide a promising solution by offering teachers opportunity to produce dynamic visualisation of complex technical concepts that enable the learners to interact with them in a 3D models, simulations and in real-time. This interactive approach significantly enhances learners' comprehension of the concepts, stimulates their interest and motivation as well as encourages them to deeply explore and interface with the material.

In Katsina state technical colleges, where teaching and learning resources are grossly inadequate to manage the large class size in place, the adoption of augmented reality technology may provide a unique opportunity to improve the quality of the instruction provided, by equipping the teachers the necessary skills to incorporate augmented reality tools effectively into their teaching practices.

Problem of the research

In Katsina state, Nigeria, the teaching of technical subjects in higher technical colleges faces serious challenges regarding the use of modern teaching and methods and materials especially augmented reality technology. Inspite of the prospect of the technology to convert the complex and abstract concepts into more accessible and engaging to the learners; majority of the technical teachers lack necessary knowledge, skill and training to effectively use augmented reality in their teaching practices; This proficiency gap lead to traditional, less engaging training methods to become more popular and adopted technique by the technical teachers, which does not adequately capture the interests of the learners or tailored to a deeper comprehension and consequently lead to low academic achievement and motivation of the learners.

Moreover, the needed infrastructure needed to scaffold the use of augmented reality technology is either inadequate or totally not available in the technical colleges, also the compatible devices and technical support for its adoption is not available.

Addressing these challenges is critical in order to improve the quality of technical education in Katsina state. Developing a comprehensive training program in augmented reality development skills for higher technical college teachers and providing the adequate infrastructure will engender educators to provide an effective and engaging instruction that will lead to achieving an improve academic achievement and self motivation among the technical college teachers.

Objectives of the research

The general objective of this research was the design and implementation of a comprehensive training program that equipped higher technical college teachers with the necessary skills to use augmented reality technology into their teaching practices. Specifically:-

1) To determine the effect of using augmented reality technology on developing cognitive and performance skills among higher technical college teachers in Katsina State, Nigeria
2) To determine the effect of using augmented reality technology on self motivation among higher technical college teachers in Katsina State, Nigeria.

Significance of the research

The significance of this research depends on its possibility to contribute to the broader discourse on educational innovation and technology integration in Nigeria by highlighting the benefits and challenges associated with the adoption of augmented reality technology in the teaching of technical subjects, as well as informing government and stakeholders in technical education about the transformative potentials of augmented reality technology in technical education sector.

Research hypothesis

This research was guided by the under listed hypotheses

1) There is no statistically significant difference at the level ($p \leq 0.05$) in teachers' proficiency and competency in using augmented reality technology before and after participating in the professional development training in higher technical colleges in Katsina state.

2) There is no statistically significant difference between self motivation levels ($p \leq 0.05$) among higher technical college teachers who participated in the professional development training program in augmented reality development skills in higher technical colleges in Katsina state.

Literature Review and Theoretical Background

Augmented reality technology as a constructivist, is generally believed to be a learner centred learning technology capable of arousing and withholding interests of the learners, and allows them to explore information in an interactive manner, in this view, Constructivists encourage learning through cooperation and collaboration and provide learners with an opportunity to practice it in a physical and virtual learning space. (Azuma, (1997) in Wigand, Hollander, Mai & Hussmann, 2019)

Accordingly, constructivism approach alters the teacher's role in the classroom from a mere indoctrinator to a facilitator, moderator, mentor or coach, where the responsibility to organise, synthesize, and analyse instructional contents are shared between the teachers and the learners. (Antonioli & Blake, 2018)

Augmented reality technology can also be described in a situated learning theory, in this view, learning occurs in a situation, i.e. naturally when learners are engaged in an activity, to this end some AR situations provide learners with an opportunity to use real life experiences to acquire new knowledge, thus learning occurs naturally as learner progress through problem solving in an interactive and collaborative environment. (Summeraver, 2018)

In the principles of self determination theory (SDT), the theory defined learning as an occurrence through persuasion or motivation, thus learners has the natural tendency to learn in a clinical, interesting, functional and effective environment, Khamis & Monawar, (2013) opined that an immersive learner can create a virtual world related to his study concepts with full determination, since they are engaged and in charge of their own learning.

Augmented reality (AR) is a hybrid technology that combines different technologies and worlds or environment into a single technology in order to enhance the vision and perception of the user, Indrastoeti, Tribudiharto, (2018) opined that it is also known as mixed reality, since it mixes two or more worlds in the form of audio, video, graphical images to form an augmented world.

It enables real interaction between the user, the real object and the virtual objects. It embeds 3D graphics into a video in such a way as if the virtual elements were part of the real environment, thus the system augment the images, video, audio, graphics with digital data. (Antonio & Blake, 2017)

Augmented reality has also been viewed as a system that fulfils three basic features listed below by Maqdeen, (2019):-

- An amalgamation of real and virtual objects/world (reality)
- A real-time interaction and accurate 3D registration of virtual and real objects
- The sensory information obtained as a result of some addition to the natural phenomena

Types of augmented reality

Augmented reality technology has been classified differently in many literatures, however, the four main types reported and described by Maqdeen, (2019) are as follows:-

Marker – based augmented

Marker based augmented reality are also called vision or image based augmented reality, this type of technology recognises an object and provides a real data about it, it detects the object in front of the camera and displays its information on the screen in 3D version, so that the user can view the object in detail from different angles.

Marker – less augmented reality

Marker less augmented reality is also known as location based augmented reality; it allows the user to locate interesting places within his location using mobile GPS, digital compass, and accelerometer, it is all about adding location information about object that can be seen from the user's camera on a screen.

Projection augmented reality

This type of augmented reality technology projects light on a surface, the light is blown onto a surface and then the surface is touch by hand to cause the interaction, it use to create deception about the position and depth of an object.

Superimposed augmented reality

This type of technology provides replacement view of the object in focus; this is achieved when some part or the entire view of the augmented object is replaced with the virtual object super imposed on it.

Importance of augmented reality

The primary importance of augmented reality as outlined by Bacca, Baldiris, Fabregat, Graf, & Kinshuk, (2014) include mixing components of the real world with the computer generated objects to enhance the people's perception of the real world, providing educational experience by scanning, viewing image using personal computers (PC) and mobile devices like smart phone, tablets etc

Characteristics of augmented reality

According to Ronald, (1997), Azuma, (2015) all AR technologies are characterized by the integration of concrete and ghosts objects (real and virtual world), compatible with real world, delivered in a 3D format, possess high number of link sources, (hypertextuality), interactive, modifies contents (modality), allow for many users to access the resources (connectivity) and portability.

Procedural guides for the implementation of augmented reality in education

For the teaching and learning to be effective, AR technologies implementation in the classroom should follow the procedures below as described by Khamis & Monowar, (2013), Rizov & Elena, (2015), Baratalli, Abdurrahim, Parhizkar, Gebril, 2016), Sommerava, (2018), Wallace, (2018); Supriadi & Kom (2019) as follows:

- *Specify the instructional goals*

Here the instructor need to determine and describe what he intends to use AR for his students. AR should be able to support these goals of the instruction, such as explanation of some ambiguous concepts, visualize abstract ideas or increase students' engagement.

- *Select appropriate AR technology*

Here the instructor is required to make appropriate selection among many regarding the type of AR technology to be adopted for his instruction, the technology should align with his instructional goals and characteristics of his students, these include, Hp reveal, merge cube, Google expeditions etc. The technology should be user friendly and compatible with the learners' devices like android phones, tablets, smart phones headsets and PDAs.

- *Develop the AR content*

Here the instructor is required to create or access the instructional experiences in 3D models, videos and interactive power point using the AR pre-existing contents or the user can create his own through alliance with expertise. The instructional experiences should be organised in the order of lesson content progression, such as in units or topic in a specific digital repository.

- *Pilot test the technology*

Here the user is required to pilot test the device and the AR technology selected as well as the lesson contents to ensure that all work smoothly in the classroom setting. Thus internet connection should be appropriately ascertain, check all other related functionality issues that may hamper the effectiveness of the technology work, moreover, the user should prepare a back up option in order to address any impending technical failure.

- *Design the lesson flow with AR technology*

Implement the lesson in such a way that the adopted AR technology is incorporated to perform the specified function in the teaching process, like illustrations of a complex process or visualization of some parts of a machine or its working principles, the lesson should be engaging, fun and challenging and that curiosity should be enhanced.

- *Guide the students on how to use the AR tools*

Here the instructor is expected to demonstrate how to use the AR applications by himself with the trainees physically watching (imitation) highlighting all the necessary steps and features of the technology, the sage will assist the novice trainees who have never use AR tool in teaching or learning activities. He should describe the procedures properly, explain all the instructions and hazards (if any) and focus fully on how the AR relates to the subject matter under review.

- *Stimulate active learning*

Here the instructor is expected to foster learning through engagement cooperation and interaction between the trainees and AR contents in a small group work, discovery of facts and discussion about and exploration by challenging the trainees to explore more details and complete a task within the AR experience.

- *Conduct formative assessment to measure the level of trainees achievement*

Here the instructor is expected to measure the degrees of his trainees periodically during the training session in order to determine their level of achievement at the moment and at the same time clarify all misconceptions or contents that the trainees seem to struggle.

- *Evaluate the overall instruction*

Here the instructor is required to conduct a summative test to determine what worked well and what did not on the trainees experience in working with AR experiences, the instructor should identify the areas that need adjustments or improvement in the next AR- integrated training and should provide feedback on the general effectiveness or otherwise of the whole instruction.

It should be noted that integrating AR in education is an iterative process that whenever its incorporated to teach, there is an opportunity to adjust and make improvement in the next presentation for more learning efficiency, however the overall process is challenged by some hindrances which are highlighted below:

Challenges of using augmented reality in education

Upon all the enormous and fringe benefits of augmented reality (immersive training environment) in the teaching and learning, there are also some pitfalls that hamper its application in education as pointed by Azuma, (2015), Muzaffer & Sahin, (2018) which includes insufficient necessary training of teachers to use augmented reality technologies, overdependence on hardware where all AR users heavily relied on smart phones, and not all the trainees possess these devices and content portability issues in which the quality of AR contents differs from device to device, which is another disadvantage since there is need for uniformity on all the contents shared between the trainers and the trainees.

Research reviews and empirical evidences proved the effectiveness of augmented reality in education, Idrastoeti and Tribudiharto, (2018) revealed that augmented reality technology is the best instructional media that can enhance learning in University education.

Risov and Elena, (2015), Muzzafer & Sahin, (2018) noted that augmented reality technology enhances learning and instructional process and that, research evidences proved its effectiveness in increasing achievements, interests and internalization of learning materials, however lack of teachers proper review of the technology in the areas of its applications, benefits, features and challenges, causes a setback in its usage in the teaching and learning system. (Bacca, Baldris, Fabregat, Graf & Kinshuk, 2019).

When the technology is adopted in the teaching and learning for children and adults courses, results indicated positivity in terms of attitude and usability in the classroom and more learners interaction with the course contents, Dello, Rochell, Mcworter and Camp, (2015), Safar, Ali and Yousefi, (2017) opined that understanding of learning concepts presented in an immersive training environment is enhanced.

Additionally Swensen, (2016), Kiryakova, Angelova and Yardanova (2018), hinted that augmented reality technology has a higher potentiality to transform the overall educational system into a technology, interactive, collaborative, and kinaesthetic approach that will always yield more positive cognitive, motivational, inquiry and situated training outcome of students' learning if implemented.

Experimental design

The design for this research is a mixed method combining both qualitative and quantitative approaches to provide a comprehensive understanding of the impact of augmented reality on teaching technical subjects. Moreover, quasi experiment with an extended one group pre test - post tests design was adopted to determine the effect of treatment to the sample of the experimental group.

Area of the study

The research location was the higher technical colleges in Katsina state, Nigeria.

Research subjects

The primary participants were the overall teachers and students of the technical colleges in Katsina state who are presently teaching and learning technical subjects, from which thirty teachers were purposively sampled from various technical disciplines to participate in the research.

Table 1. Attribute statistics of the sampled subjects

		Frequencies	Percentages
Gender	M	30	100%
Level	GL; 7-12	30	100%
Age	22-30 years	11	36%
	31 - above years	19	64%
Discipline	Voc & tech educ.	30	100%
Qualification	Bsc/Bed/HND	30	100%

From table 1 above, the sample size consisted thirty male trainees, indicating that 100% of the audience were male, out of which eleven representing 36% were between the ages 22-30 years and nineteen representing 64% were 31 years and above. All the participants were between grade levels 7 – 12 and belong to vocational and technical education profession, and that all the participants 100% possess Bsc, Bed or HND certificates in vocational and technical specialization.

Research tools

The researcher developed two instruments that were used for data collection, these instruments are:-

1) Self motivation questionnaire (SMQ)
2) Memory retention test

Validity and reliability of the research tools

To ensure the validity in terms of content and construct as well as the reliability of two research tools to ascertain their credibility and accuracy, the researcher adopted the steps below;

1. *Content validity*; To ensure that the items of the two research tools adequately cover all the units and contents of the training for the memory retention test; also the contents covers and matches all the axis of the self motivation questionnaire, the tools were taken to the experts in educational technology field for their inputs and all suggestions made were strictly implemented.
2. *Pilot testing*: The researcher conducted a three days pilot study with a small group of technical teachers who were not among the selected sample in order to detect any unclear question and ensure that the tools and the training environments have adequately reflected the intended contents.
3. *Construct validity*: The development of the self motivation questionnaire items were grounded through the established theoretical background and relevant literature on augmented reality in education.
4. *Reliability of the memory retention test and self motivation questionnaire*: Cronbach's alpha coefficient was calculated for the two research tools after the pilot study to assess their internal consistency; the Cronbach's alpha values of above 0.78 and 0.88 were obtained for each of the two respective instruments which indicated that the two instruments were acceptable to measure the intended traits.

Data collection methods

The researcher adopted the following methods for data collection:

A) Scrutiny: Pre- and post-training examination administered to the research sample to assess their awareness, attitude and competencies regarding AR technology before and after the intervention using forty five items multiple choice (MCQ) memory retention test.
B) A structured forty five items self motivation questionnaire was developed to assess trainees' current skills, motivation, awareness and attitude towards augmented reality technology.
C) Qualitative data was derived from reading articles from different journals, books and Google searches related to the application of augmented reality technology in education through search from digital repositories.

Pre- training assessment

Before the training program commenced, the trainer applied the two research instruments as a pre-test, the purpose was to determine the level of the samples' skills, confidence and enthusiasm regarding the use of augmented reality (AR) so as to compare and be able to evaluate the impact that occur after intervention in order to make inferences.

Intervention

A comprehensive training program was developed and implemented to equip research selected sample with the necessary knowledge and skills on how to incorporate augmented reality technology into teaching and learning practices. The training program include the theoretical sessions, hands-on practices, continues support and formative assessments using mobile immersive training environment (aurasma), in both face to face and virtual training environment (Immersive training environment e-portfolio) the training last for the period of two weeks.

Table 2: Plan for the intervention program: **duration: two weeks, begins from 1st - 15th October, 2024**

Week	Treatment/ activity	Assessment
Week one (1) 1st – 7th October 2024	- General guidelines and objectives of the training 1. Introduction of the first module: introduction to augmented reality technology (concept, characteristics, components, benefits in training). - Activities. (hands-on-activities) 2. The second module: Application of AR in education, (examining how AR technology is used to facilitate learning technical subjects like, electrical engineering, automobile technology, construction, carpentry etc.) - Activities. (hands-on- activities)	Formative assessment and feedback
Week (2) 8th – 15th October ,2024	1. The third module: comparison between AR and VR (characteristics, application, pros and cons of each) - Activities.(physical view of how AR and VR works, use of VR headset) 2. The Ethics and challenges for using AR in training (Discussion about data privacy, analysing user performance data in AR environment, accessibility, barriers to AR adoption in education) - Activities.(Hands-on- activities using aurasma, uniAR apps)	Formative assessment and feedback.

Training ethical considerations

- *Enlightenment:* The participants (research sample) were enlighten about objectives, procedures and their rights in the training exercise, their consent were obtained prior to the commencement of the training; and were fully informed about immersive training environment.

- *Anonymity*: The participants were assured that their identities would be anonymized in the overall discussion of the research findings; moreover, all data generated from the participants were solely used for the research purpose alone.

FINDINGS AND DISCUSSION

This section tackled the research results that have been determined through statistical analysis of the data obtained from the application of post - test of the research tools. Furthermore, it includes results explanations in the light of what have been mentioned in the literature review including previous studies and learning theories.

To test the research hypothesis, the researcher used SPSS version 23 to make the following statistical calculations:

- Descriptive statistics (mean, standard deviation)
- Paired sample t-test
- There is no statistically significant difference at the level ($p \leq 0.05$) in teachers' proficiency and competency in using augmented reality technology before and after participating in the professional development training in higher technical colleges in Katsina state.

Table 3: Mean scores, standard deviation and paired sample t-test in respect of the experimental group concerning pre-test and post –test responses on the memory retention test

Experimental group	Test type	No	Mean	Standard deviation	Mean difference	t-value	2 tailed sig p-value	Remark
	Pre-test	30	14.500	7.9035	4.433	1.553	0.131	Not Sign.
	Post-test	30	18.933	11.945				

Table 3 above, revealed a low statistically significant variation between pre –test and post – test average scores of the experimental group in favor of post application, this disposed the consequence of using AR technology (immersive training environment) on academic success of technical teachers.

The average scores were 14.500 (SD, 7.9035) pre –test and 18.9333 (SD, 11.945) for the post – test. The scores shows a mean difference of 4.433 in favor of post application, p – value of the average scores for the two administration of the test materials was 0.131 at 95% confidence level, this value has been considered to be not significant, since 0.131 is greater than α value 0.05, it implies that there is no statistical significance difference and therefore the hypotheses is upheld, meaning using AR tools (immersive training environment) has no positive impact on the memory retention of the research subjects.

In Constructivists perspective low results in an AR-based instruction is a reflection of mismatch between the technology and the principles of active, meaningful, and situated learning. They opined that for AR to be explicitly effective in teaching technical subjects, it has to encourage learning via active participation, provide support, enhance collaborative work, and should be in line with learners' prior knowledge and should reflect real-world environment. Moreover, trainees are expected to prepare well, design and aid the training contents in such a way that it support and align with constructivist learning principles. (Antonioli & Blake, 2018)

Furthermore, this might be attributed to some technology challenges such as hardware and software problems experienced by the trainees during the instruction, lack of trainees adequate experience related to the AR tools especially in the area of teaching and learning technical courses, cognitive overload and trainees diverse attention between search of the virtual experiences and comprehension of the real course content and the lack of adequate time to adapt and master the virtual training environment.(Azuma, 2015; Muzaffer & Sahin, 2018)

- There is no statistical significant difference in self motivation levels ($p \leq 0.05$) among higher technical college teachers who participated in the professional development training program for augmented reality development skills in higher technical colleges in Katsina state.

Table 4: Mean, standard deviation and paired samples t – test concerning self motivation questionnaire

Experimental group	No	Mean	Standard deviation	Mean difference	t – test	2 tailed p-value	Remark
Pre-test	30	100.82	3.90	2.89	0.733	0.465	Not sig.
Post-test	30	101.18					

As gleaned from table 4 above, participants from the experimental group revealed that they have a positive feeling towards immersive training environment (augmented reality) during both the pre-test where the average scores were 100.82 (SD,15.29) and 101.18 (SD, 19.61).

These results can formally be interpreted that the research sample has expressed a slight variation in motivation feelings regarding AR tools (immersive training environment) during post-test, meaning that the intervention has little impact on self motivation among the sample. The computed 2 tailed p – value was 0.465 higher than α values 0.05 significance level, therefore since the computed 2 tailed p – value is greater than 0.05 threshold, the hypotheses is accepted, meaning that participants were less motivated to use AR (immersive training environment).

Though constructivists, the social cognitive theory and self determination theorists opinions supported the idea that immersive training environment positively impacted self motivation by fostering trainees learning autonomy, self efficacy, and active engagement and aiding the trainees to appreciate the values and learning objectives set as well as developing a strong internal drive towards learning Eccles & Wigfield, (2002), Lock & Lathan, (2002), the participants decline to demonstrate a greater impact of the training in motivating them towards learning

However, the training might still be valid in terms of practical skills and knowledge regarding the use of augmented reality in teaching and learning, from the researcher's experience, it should be noted that developing a novel skill like augmented reality requires more time, latest technology devices, strong internet signal and uninterrupted power supply and trainees prior experience for it to be effective in influencing self motivation; therefore shortages in any of the above factors may hinder its immediate effect.

CONCLUSION AND RECOMMENDATIONS

The research findings revealed that AR technology has little positive effect on the trainees self motivation, which further divulged insufficient positive drive and engagement towards learning. It further suggests that an interactive learner centred learning stimulates personalized and self regulated learning, increase trainees self confidence and perseverance. However individual self esteem, training needs, experiences related to the use of AR technology, compatibility and connectivity issues might be some of the factors led to low memory retention outcomes revealed in this research.

In the light of the above, it's recommended that more attention should be paid to support trainees to adapt their training path through blended training strategies that combine immersive training environment and other approaches which will be geared towards enhancing more academic success and maximize motivation among the trainees.

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