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BUILDING A MACHINE LEARNING MODEL FOR ASSESSING THE EFFECT OF VIRTUAL REALITY TECHNOLOGY IN TEACHING AND LEARNING IN NIGERIA

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Abstract: **This research explored and proffered solutions based on Virtual Reality Technology, analyzed the importance of using the concept of VR technology in education and assessed the effect of VR technology on student's overall achievement in some higher institutions in Gombe state. The students were assessed based on some factors and a machine learning model was built using Logistic Regression in order to assess the effectiveness of the two techniques. Based on the data available, the model had a Ninety-two percent (92 %) accuracy in predicting which method was used in teaching the students from the confusion matrix result obtained from our Logistic Regression model.**

Keywords: **Virtual Reality, Augmented Reality, Mixed Reality, Immersion, Logistic Regression model.**

Definitions:

i. Virtual Reality: VR is an artificial three-dimensional environment created by a computer and presented to a person in an interactive way. It refers to the computer simulation displaying an environment through which one can walk and interact with objects and simulated computer-generated people (avatars). Virtual environment is usually three-dimensional, and it often attempts to replicate the real world in its appearance and physical phenomena. It simulates the user's physical presence in an artificially generated world that allows interacting with the environment.

ii. Augmented Reality: AR is an interactive experience of real world environment where the object that reside in the real world are enhanced by computer generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic,somato sensory and olfactory. AR can be defined as a system that fulfils three basic features: a combination of real and virtual worlds, real time interaction and accurate 3D registration of virtual and real objects.

iii. Mixed Reality: MR is the merging of virtual and real world to produce new environments and virtualizations where physical and digital objects coexist and interact in real time. Mixed reality does not exclusively take place in either the physical or the virtual world, but is hybrid of reality and virtual reality.

iv. Immersion: immersion into virtual reality is a perception of being physically present in a non-physical world. The perception is created by surrounding the user of VR system in images, sound or other stimuli that provide and engrossing total environment.

1. INTRODUCTION

Learning in Nigeria is becoming more complicated by the day considering the enormous security threat bedeviling the country and lack of funding for the education sector.

The increasing financial feasibility of virtual reality (VR) has allowed for educational institutions to incorporate the technology into their teaching. According to research, 96% of universities and 79% of colleges in the UK are now utilizing augmented or virtual reality in some capacity (UK Authority 2019). In addition, the rising power of personal computers and associated hardware has led to a revolution in graphical fidelity, with ever more complex and realistic simulations and virtual worlds (Slater2018). As Dickey (2005) alludes to, this has both challenged and expanded the very conceptual definition of what is defined as learning environment. Where once this would have been restricted to classroom teaching or field trips, VR's innate ability to give users a sense of presence and immersion has opened new possibilities in education if implemented appropriately (Häfner et al. 2018).

The use of technology-aided education as pedagogical method is not a modern phenomenon, and investigations into its utility have been studied for almost half a century. As far back as the 1970s, Ellinger and Frankland (1976) found that the use of early computers to teach economic principles produced comparative learning outcomes with traditional didactic methods such as lectures. However, as Jensen and Konradsen (2018) allude to, it was with the release of the Oculus Rift in 2013 that VR became synonymous with head-mounted display(HMD) based VR. This had several ramifications. First, HMDs became economically feasible for consumers and educational institutions to acquire *en masse*, due to a significant drop in price (Hodgson et al. 2015). As Olmos et al. (2018) remarks, the economic viability of VR has tackled one of the main entry barriers to adopting the technology.

And secondly, academic research into the potential benefits of I-VR in education starts to expand, as well as its applied use in pedagogical settings (Hodgson et al. 2019). One of VR's most important contributions to education is that it has allowed students to repeatedly practice complex and demanding tasks in a safe environment. This is particularly true of procedural tasks such as surgical operations or dental procedures that cannot be carried out for real until a certain level of competency has been achieved (Alaraj et al. 2011; Larsen et al. 2012). Additionally, VR has allowed for students to gain cognitive skills by way of experiential learning, such as exposing them to environments that would be too logistically problematic to visit in reality (Çalişkan 2011).

This research work explored other means of teaching contrary to the orthodox teaching method in order to find out the feasibility of using the VR Teaching Method in Nigeria. The VR teaching technique was put into use and students from various groups (Age groups, Marital status and Gender) were tested using the two methods, ultimately a machine learning model was built using the result obtained from students result. The model was able to predict which learning method was better.

2. RESEARCH OBJECTIVES

The following are the objectives of this Study;

i. To Conduct an experiment on two groups of students using VR and orthodox teaching method

ii. To build a Model using Python and Spyder Environment

iii. To Evaluate The performance of the Model

iv. To Find out the more efficient teaching Technique

3. REVIEW OF RELATED LITERATURE

Various Research works were conducted on testing the efficiency of the VR teaching technique in different continents and countries, so far no research work included building a machine learning model for predicting performance of students.

The concept of VR is not new; in the early 1990's speculation on its potential already existed. VR promised to bring an exciting future – where everyone would wave their hands to travel through strange neon geometric places, converse with virtual people, and experience adventures in perfectly simulated worlds or times (Steinicke, 2016). However, at the time, VR did not go far. Other than primarily military and industrial uses such as combat training and 3D visualizations (Cruz-

Niera, 2016.), it was Uncomfortable, not realistic, expensive and required immense amounts of computing power to render.

Today, we are greeted with a very different landscape; the technology that once was too expensive or impractical for consumers is now readily available. The popularity of several mainstream consumer products like the *Google Cardboard*, *Daydream View*,*Oculus Rift, HTC Vive*, *Samsung Gear VR*, *Playstation VR*, and *Microsoft HoloLens*are evidence that technical developments have finally resolved many of theproblems that previously doomed

VR. In addition , the ubiquity of smartphones – used by65% of the American population

A widespread problem in education is that traditional methods of lecture-based education lead to disengaged students (Delialioglu, 2012). This lack of engagement is considered a major reason for many unfavorable behaviors hindering student success, including dissatisfaction, negative experience, and dropping out of school (Delialioglu, 2012).If students' engagement with academic activities is increased, so does the students 'learning and personal development (Delialioglu, 2012; Winn et al., 1997). In this section, we describe two learning opportunities provided by VR that can complement traditional forms of teaching.

i. Opportunity: virtual reality leads to increased student engagement, Several characteristics of VR provide an opportunity to boost student engagement. As hands-on, interactive, immersive experience, it provides a novel way of learning for students, delivering powerful new experiences they may not have encountered before (Bricken, 1991).(Lau and Lee, 2015) . For example, *Google Expeditions* allows teachers to transport students to virtual field trips to Mars, the bottom of the ocean, and many other settings, which can spark new interest in subject matter, provide a shared experience for better classroom discussion, and improve overall engagement (Ferriter,2016). Experiences like these provide unique and fresh learning moments that draw in Students and pique their interest as they actively explore and exercise their curiosity.

From there, VR-specific pedagogy, can maximize the learning potential of these experiences. VR also boosts engagement by providing students with a strong sense of presence and immersion compared to traditional learning environments (Bailenson et al., 2008;Dalgarno and Lee, 2010).

ii. virtual reality allows for constructivist learning*:*VR also provides an opportunity for constructivist learning, i.e., allowing students to construct their own knowledge from meaningful experiences. In these types of experiences, students engage in authentic problems, exploring solutions and perhaps collaborating with others. In research on virtual world-building simulations, low-performing students improved academically more than those learning through traditional methods, even more so than their high-achieving counterparts (Winn et al., 1997).

Furthermore, in introductory astronomy courses, VR activities where students built 3D Solar Systems supported greater understanding of astronomical concepts (Barnett et al., 2005). This affordance of VR gives students the ability to construct visual and manipulable objects to represent knowledge, an affordance that traditional learning methods lack. *Fantastic Contraption* is another example that uses constructivist theory to reinforce principles of physics, where the player builds a machine and if it does not work properly, he or she uses problem-solving skills until it functions correctly (Porter , 2015). These types of experiences hold great potential for utilizing the constructivist principles of authentic activity and knowledge-creation environments (Dalgarno and Lee, 2010; Bailenson et al., 2008).

4. MATERIALS AND METHODOLOGIES

***4.1 Method o f Data Collection*:** Data is very essential for any research work. for this study, primary data was obtained and used from the experiment that was conducted.

4.2 Instrument for Data Collection

The instrument for the data collection will be tagged Achievement Test on Virtual Reality Technology(ATVRT) which will consist of 30 objective test items (which may comprise supply type, selection type, alternative response, matching type or multiple choice) to be developed by the researcher to cover a selected content area from Nigerian universities syllabus.

4.3 Development of instrument for data collection

This stage comprises of preparing lecture materials for both the experiment and control group using virtual reality and orthodox method of teaching for the two respective groups, then preparing a test for the two groups using multiple choice question.

4.4 Instrument for validation

The instrument will be given to 3 experts in the selected course where the experiment will be conducted for content validity, while Reliability will be established during the experiment using test re-test method.

4.5 Implementation of The Proposed Framework

The technique used for implementation is machine learning model which was built using Logistic regression.

Logistic regression is similar to linear regression because both of these involve estimating the values of parameters used in the prediction equation based on the given training data. Linear regression predicts the value of some continuous, dependent variable. Whereas logistic regression predicts the probability of an event or class that is dependent on other factors. Thus the output of logistic regression always lies between 0 and 1. Because of this property it is commonly used for classification purpose.

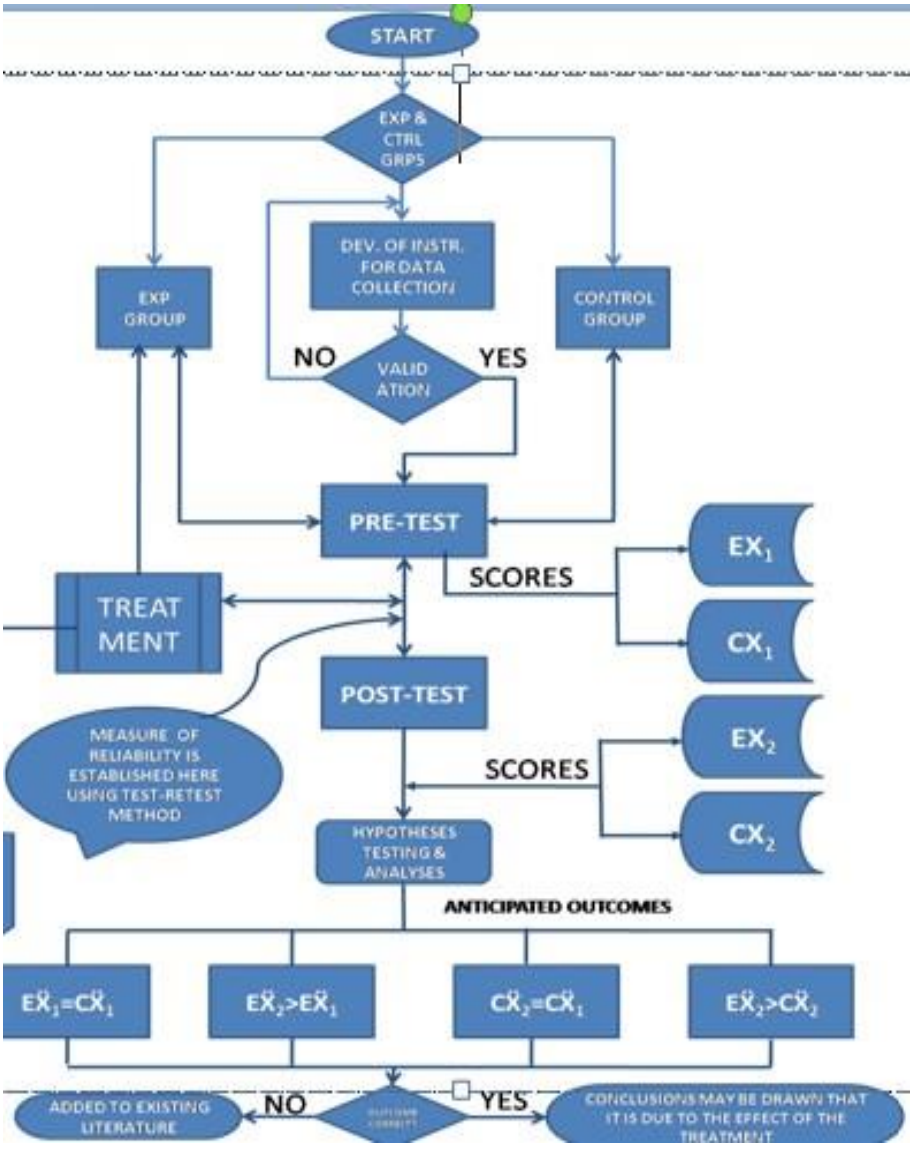

Fig.1 Conceptual Framework

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5. RESULTS

A total of 500 datasets collected was used during this study, the data set was divided into training and testing data, which was further used in the development of the model using the Logistic Regression Algorithm.

Table 1: Pre- processed data

S/No	Age	Marital	Gender	Adapt	Retent	Attent	Score	Method
1.	2	0	1	4	5	5	3	1
2.	3	1	1	4	5	5	5	1
3.	3	0	0	3	4	5	3	1
4.	3	0	1	4	4	5	2	1
	…	…	…	…	…	…	…	…
495.	3	1	1	4	5	5	3	1
496.	2	1	1	5	5	5	4	1
497.	2	0	1	4	5	5	3	1
498.	1	0	0	5	3	4	4	0
499.	3	0	1	5	5	5	5	1
500.	2	0	1	4	4	5	3	0

[500 rows x 8 columns]

5.1 Confusion matrix

A confusion matrix is a table that is used to evaluate the performance of a classification model. You can also visualize the performance of an algorithm. The fundamental of a confusion matrix is the number of correct and incorrect predictions is summed up classwise.

import the metrics class from sklearn import metrics cnf_matrix = metrics.confusion_matrix(y_test, y_pred) cnf_matrix

$$\begin{bmatrix} 15 & 2 \\ 2 & 31 \end{bmatrix}$$

Here, you can see the confusion matrix in the form of the array object. The dimension of this matrix is 2*2 because this model is binary classification. You have two classes 0 and 1. Diagonal values represent accurate predictions, while non-diagonal elements are inaccurate predictions. In the output, 15 and 31 are actual predictions, and 2 and 2 are incorrect predictions.

5.2 Confusion Matrix Analysis

Let's evaluate the model using model evaluation metrics such as accuracy, precision, and recall.

$$\begin{bmatrix} 15 & 2 \\ 2 & 31 \end{bmatrix}$$

print("Accuracy:",metrics.accuracy_score(y_test, y_pred))

print("Precision:",metrics.precision_score(y_test, y_pred))

print("Recall:",metrics.recall_score(y_test, y_pred))

Accuracy: 0.8831345

Precision: 0.9213455

Recall: 0.9143267

Well, we got a classification rate of 88%, considered as good accuracy.

Precision: Precision is about being precise, i.e., how accurate the model is. In other words, we can say, when a model makes a prediction, how often it is correct. In our prediction case, when Logistic Regression model predicted a student was taught using VR of Non- VR, the model is 92% precise.

Precision can be defined as the percentage of correctly predicted positive outcomes out of all the predicted positive outcomes. It can be given as the ratio of true positives (TP) to the sum of true and false positives (TP + FP).

Mathematically, precision can be defined as the ratio ofTP to (TP + FP).

Recall: If there are students who used a particular method in the test set and your Logistic Regression model can identify it 91% of the time. Recall can be defined as the percentage of correctly predicted positive outcomes out of all the actual positive outcomes. It can be given as the ratio of true positives (TP) to the sum of true positives and false negatives (TP + FN). The recall is also called Sensitivity. Recall identifies the proportion of correctly predicted actual positives. Mathematically, recall can be given as the ratio of TP to (TP + FN).

5.3 The Logistic Regression Model

After running running the program,we got the following;

Model intercept :Array [(-8.36929)],

Model Coefficient : Array([[0.71173747, -0.8693169 , 0.86699963, 1.35378796,

0.46976351,

-0.66525847, 0.50359915]])

Where the values in the array represents the variables use in building the model.

Age 2.03 (this is the likelihood of having a student from the Range of 17-24 using The VR technology) since we are using the first age group as our reference category.

Gender = 2.38 (this is the odd of having a male student using the VR Technology)

Marital Status = 2.379 (this is the likelihood of having a student who is single used the VR Technology)

The Logistic Regression model is

P (VR) = $\ln \frac{p}{(1-p)} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7$

Where x_1 = Age ,$_2$= Marital status , x_3 = Gender ,x_4= Attention , x_5= Information Retention, x_6 = Adaptation to method and x_7 = Score.

6. DISCUSSION

In this study, the logistic regression model was built to predict whether a student was taught using VR technology or not. The model yields a very good performance as indicated by the model accuracy which was found to be 0.9241 that is 92% accuracy.

The precision and recall values at 93 percent are pretty good for the model.

ROC AUC of our model approaches towards 1. So, we can conclude that our classifier is correctly predicting whether a person was taught using VR nor not. Using the mean crossvalidation, we can conclude that we expect the model to be around 90% accurate on average.

7. CONCLUSION

The main objective of this study was to analyze the factors that are influencing academic performance of students in tertiary institution which includes the methods and technique and find out the best method that will enhance the performance of students with respect to the variables in consideration. We found out that the Method of teaching using Virtual Reality is more effective for learning which reflected in the response variable. Thus, throughout the process of completing this research an in-depth understanding on the explanatory variables and their influence on the participating students result was obtained. The findings further reveal that all hypotheses were further supported by the ordinal logistic regression model.

Conclusively, the aim and objectives of this research have been reasonably achieved since it was conducted purposely to analyze and model the factors that influence students' academic performance in tertiary institutions and find out the best method of teaching that will enhance student performance between the two methods. The Work still has some limitations which need further research and analysis

7.1 Contribution to Knowledge

This research work contributes to the field of machine learning by Taking into consideration some factors that might be responsible for variability of individual's comprehension. The model built will be of great help in understanding the category of people that can easily fit adapt much better to each learning technique especially in Nigeria (Gombe state specifically).

7.2 Recommendation for future work

This work only considered logistic regression algorithm, we recommend that subsequent research works should consider trying other algorithms to find out which one gives more accurate result for more efficiency when eventually the work is considered for implementation by government.

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