

Effects of Coronavirus Pandemic Spread on Science, Technology, Engineering and Mathematics Education in Higher Learning Institutions.

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Abstract— The traditional pedagogical methods of delivering content for Science, Technology, Engineering and Mathematics (STEM) related subjects have been shaken to their core. Normal delivery under ideal conditions was a face to face approach with the tutor in front of the class. Practical subjects that have laboratory exercises are carried out in the designated laboratory areas with the assistance of technicians or technologists. With the advent of coronavirus pandemic, where isolation and social distancing has been implemented to stop its spread and transmission, these modes of content delivery are not feasible. To fill in the gap and ensure the much needed STEM education continues despite the fear of coronavirus pandemic spread, online delivery mode of various subjects offered has been adopted. This is done using such platforms as Learning Management System, Zoom Meeting and Google Scholar. However, solving the problem of practical laboratory exercises requires much more than online teaching. This paper proposes the use of virtual reality, simulation and modeling platforms as a substitute of face to face laboratory exercises in training STEM related subjects, especially in institutions of higher learning in developing countries. Pre-recorded versions of practical experiments will be offered to students and related assignments given for practice purposes. Short webinars with details recorded will guide recipients in carrying out experiments without the need for neither technicians nor technologists. The students will then be able to attend the laboratory session virtually and submit the required reports. Several other types of content deliver exist and a combination of them can also be used depending on the areas to be covered. The exploitation of the suggested content delivery will resolve change of the attitude in learning behavior, thereby ensuring high quality and effective understanding of the subject area.

Keywords—STEM Education, Content Delivery, Online Teaching, Practical Exercise.

I. INTRODUCTION

What are the effects of the novel Coronavirus pandemic on STEM subjects in higher learning institutions? STEM subjects unlike other subjects have an aspect of hands on requirements through laboratory experiments. The students are graded based on the combination of the theoretical work which is learnt in class and practical work which is done through experiments designed to verify the theoretical principles [1]. This approach makes the student able to apply the knowledge gained in school in providing optimal solutions for the societal problems.

The industrial revolutions have always led to a change in how things are done. From the first one that brought steam engines to the scene to the looming fourth industrial revolution that is knowledge and skill based [2]. This revolution comprises of technologies like block chain, internet of Things, Artificial Intelligence, virtual reality/augmented reality, additive manufacturing and more recently 5G, an enabler and catalyst for the revolution. The main aim of the fourth industrial revolution is to better lives of people in the society.

With the outbreak of coronavirus (Covid-19), social distancing has been enforced as one of the ways of curbing the spreading of the novel virus [3]. This means that having face to face classes is highly discouraged by the World Health Organization (WHO). Thus, for education to continue, nations have to find an alternative way of delivering content to the learners. One of the major ways that have been instrumental is through online platforms and e-learning. Learners need only two things to access the platform, a computer/mobile phone and an internet connection. These, however helpful, are challenging when it comes to STEM courses. This is because of the nature of practical exercises that STEM subjects have [1].

Countries have been locked down due to Covid-19 as a measure of infection prevention. This has made their citizens to be indoors and the only access they have to the outside world is the internet. Governments have responded to this by increasing the internet bandwidths supplied to their citizen as well as reducing the cost of data. Some countries like Kenya are focusing in improving connectivity by all means possible which includes using of internet balloons [4]. All these efforts are enablers of online learning and with the looming 5G technology, internet speeds will increase by a very big factor and latency will be as low as one millisecond! This will make concepts like virtual reality a real.

With virtual reality, practical exercises in STEM can now be taken online and thus no need for face to face classes. Simulation and modeling can now be done online with very small latencies using cloud computing technology and ultra-reliable and low latency network such as 5G. This means that learners will only need a computer/mobile phone and an internet connection to attend laboratory exercises.

This will change how STEM subjects are taught and even introduce a possibility of having 100% online STEM degrees. Universities could collaborate and invest on the infrastructure thus creating a pool of resources for learners making all courses in a country accredited since all resources are available. It will be easy to collaborate in research and any other advancement too.

II. LITERATURE REVIEW

A. Virtual Reality

Virtual reality (VR) is a technology that is part of the 4th industrial revolution. It relies on the synthesis of computer graphics, human- machine interactions, artificial intelligence to produce real vision, listen and smell. This lets human and virtual world to interact [5]. The first virtual reality gadget was created in 1968 by Ivan Sutherland [6]. Ever since, the technology has been evolving at a very high speed. Big technology giants like Google, Intel and Nvidia have all participated greatly in shaping the landscape of virtual reality. Virtual reality involves setting the user into a virtual world usually through visual, audio and touch senses [6]. With the adoption of 5G, this technology will be cheaper and readily available since 5G will provide the necessary bandwidth and speeds for its utilization. [7] proposes an integrated environment that can be coupled with virtual reality to assist learners of STEM. [5] proposes the use of VR in training mining engineers.

B. Modelling and Simulation

Modelling is the process of representing a model which includes its construction and working. The model is usually similar to the real system. Simulation on the other hand is the operation of the model in terms of space or time, which help analyze the performance of a proposed/existing system [8]. Simulations software help learners visualize a practical scenario. Some of the common ones include SIMULINK from MATLAB and Proteus.

III. METHODOLOGY

A survey was conducted among STEM students through an online survey platform, using Google forms. Random sample was used to identify participants of the survey. Users filled the form online and submitted it back. The questions asked hid the user identity and had only one aim of finding out the user experience with the current online learning systems.

The survey was sent to STEM learners in Kenya. In the first phase, the questions aimed at finding out the users experience with the current online platforms and their experience with virtual reality and simulation and modelling software.

In the second phase, some students were exposed to a 3D online platform called PXLREALM where they attended a demonstration session. Then students were able to move, maneuver and interact in the online session. Later, a survey was taken on the sample that was exposed to the platform. The aim of the survey was to find out the reaction on that platform.

The second sample was aimed at students who had interacted with virtual reality platforms. The aim of the survey was to find out their experience and preferences in these platforms.

IV. RESULTS AND DISCUSSION

After collecting survey from the sampled groups the following results are discussed below

A. Status quo

All the participants agreed that COVID-19 has interfered with learning greatly and has made universities to resolve to online learning. Some of them find it hard to adapt to this new reality. When asked about what platforms they have access to for online training, they responded as below;

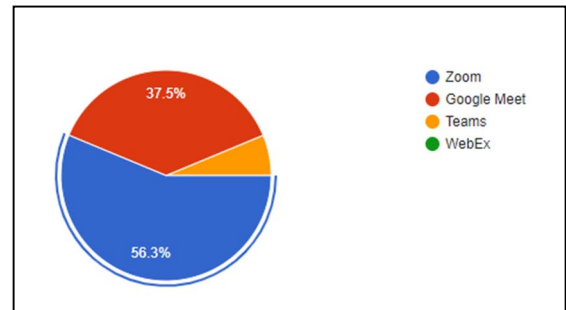


Fig1: Responses on preferred online learning platform.

Zoom was the most preferred online learning platform. This was because of its added features that makes it look and seem like a face to face class.

B. User satisfaction

Users were asked if the current experience on the online platform was satisfactory. Majority of them mentioned that the main reason they attend is because the university says that they have to. Most of them feel like its not suitable in teaching STEM courses. They miss the class experience of one on one interaction with the tutor. Some of them gave concerns that

solving and writing equations is somehow not easy on current platforms. Below is an analysis of the data;

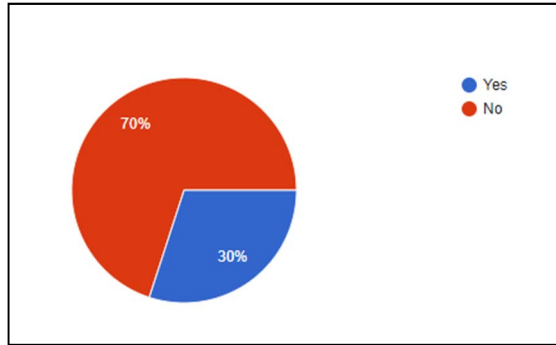


Fig 2: Responses on user satisfaction

C. Conversant with the emerging technologies

The following analysis shows how conversant the users were to emerging online technologies.

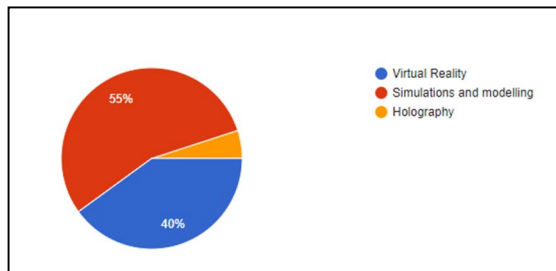
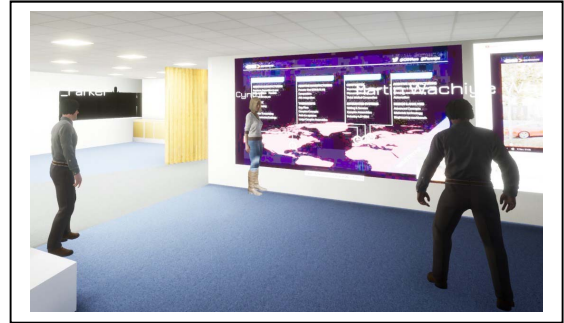


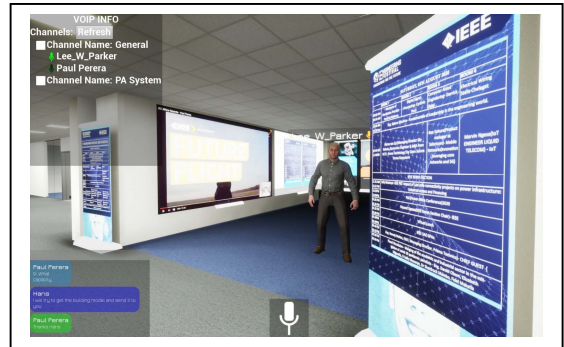
Fig 3: Responses on technology conversance

The majority of the users were conversant and had tried simulation and modelling and preferred it to virtual reality and holography. The majority felt like simulation and modelling was the best tool for STEM learning, but this might be because most of them were not exposed to virtual reality and holography. Also, simulation and modelling takes less network bandwidth than the two. This might be another reason.

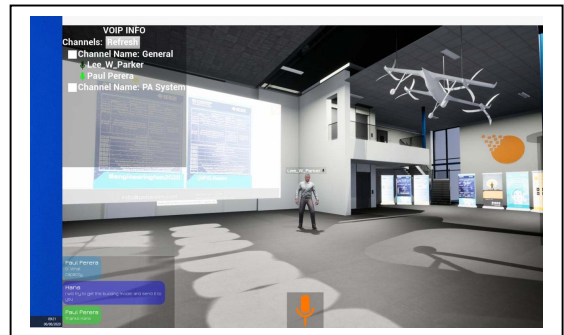
The users were exposed to the PXLREALM platform and most of them felt like that was the way to go in online training of STEM programs. Below is a photo of users in the 3D learning platform.



Pic1: Users making a presentation in the online platform.



Pic 2: The PXLREALM platform



Pic 3: The waiting area of the 3D platform.

V. CONCLUSION

The results of the study are presented. The learners from the sampled group are exposed to two methods of online learning for STEM subjects. The first one is the classical one and the second one is the one proposed in this paper. Students in the new proposed way of learning are able to interact with the tutor and the lab experiments in a way that is very close to the real world. The learners prefer this way to the classical online meetings that current platforms provide.

COVID-19 has provided us with an opportunity to innovate around most aspects of our lives and the education sector has really been challenged. This might be the new reality and this paper proposes the integration of emerging technologies with

learner training to ensure better learning experience at the lowest cost and highest convenience.

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