Changing the Paradigm of Mixed Reality (MR) in Education Sector through Microsoft HoloLens

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Abstract— In this research paper, the discussion will be regarding the advance and evolutionary use of Mixed Reality (MR) experience with Microsoft HoloLens. MR is referred to as hybrid reality, in which the real and the virtual world are merged and the user's digital objects can interact with the physical world. This technology can enable the collaborative learning process in classrooms. It unlocks a dimension of understanding and exploration, which students were not able to learn by conventional teaching methods. The assortment of MR will be a great substantial product that will have a prominent effect on the pedagogical collaborative learning method. The early results of this methodology have shown some promising outcomes of this technique. Hence, bridging the gap between the complete and partial interpretation of the curriculum for a student, and professional. With the use of MR technology, a new facet is accessible to students. To fulfill the void which the traditional learning methods were not able to provide due to lack of resources and safety constraints. Hence, students were not able to completely understand the high-level concepts of their course material easily, which they are required to implement in their future.

Index Terms—Augmented Reality, COVID-19, Microsoft HoloLens, Mixed Reality, Virtual Lab, Virtual Learning System, Virtual Reality

1 Introduction

Business and trade analysts are observing a change in societies. It is primarily due to the technological advancements that enabled the society to be upgraded into a smart society. Historically, there has always been a correlation between changes in the industrial revolution and changes in society. Similarly, there is also a transition from the third to the fourth industrial revolution (also known as Industry 4.0). This transition happened because of deficiencies and requirements in the arts, agriculture, education, economy, health care, and science. For industries to cope up with the needs of the society they need a strong skilled and dynamic workforce. Generally, employers have this criticism that their employees often lack certain skills based on their profession. These recent graduates might have not received an in-depth and complete understanding of abstract and theoretical concepts in their formative academic years. For students to grasp a firm hold on these essential ideas, it would need them to have a strong, vivid imagination of things that they may have not seen or experienced. To meet the gap between inexperienced graduates and industry professionals. It would require a shift from an old to a new paradigm of learning, where Mixed Reality is employed in the education sector and the development of software applications in MR is promoted.

By using Mixed Reality, the education sector can redefine the perspective of learning. Students can experience history by visiting the key moments in history like the independence of Pakistan. They can perform various experiments like mixing different chemicals, building new circuitry, and experimenting with different things that are nearly impossible in the real world because of the availability, cost, reachability, and safety concerns. Hence, it is necessary to establish a virtual learning environment where students are given the right to do any experiment and learn, consequently this approach would give the world great minds like Abdul Qadeer Khan, Jabir-ibn-Hayyan, Avicenna, and other great scientists.

1.1 Virtual Reality (VR)

A set of a picture and audio, generated by a computer that transports a user to an artificial environment. The key elements in this technology are the image and sound which are generated from a computer that causes the participant to feel the artificial environment generated by the computer [1].

1.2 Augmented Reality (AR)

An enhanced version of reality created by the use of technology to overlay digital information onto an image of something being viewed through a device (such as a smartphone camera). This explanation perfectly captures the entire structure of this technology. As a participant is able to interact and immerse himself or herself in digital content through a computational device [2].

1.3 Mixed Reality (MR)

A medium made by computer generated elements to the real world in a way that allows them to link in the real-time. This definition understates the scope of this technology [3].

Mixed Reality merges features of both Virtual Reality and Augmented Reality. It is also known as "enhanced" AR. It would be right to call the environment of this technology hybrid as there is a marriage between real and virtual objects during the implementation of this technology [3].

1.4 Augment Reality Vs Mixed Reality Vs Virtual Reality

These technologies are distinct regarding the functions and hardware required for the working. Augment Reality layers of digital images are around the user's environment. Thus, users cannot interact or manipulate the data around the boundaries [2].

While Mixed Reality grants access to interact and manipulate with these images and information. By the use of hand gestures and command prompts [3].

Conversely, Virtual Reality does not involve any part of function interacting with real-world objects. Although, the VR system requires mapping the space where the user would be using it [4]. So, VR applications function perfectly within the parameters of the room as the difference between them is shown in figure 1.

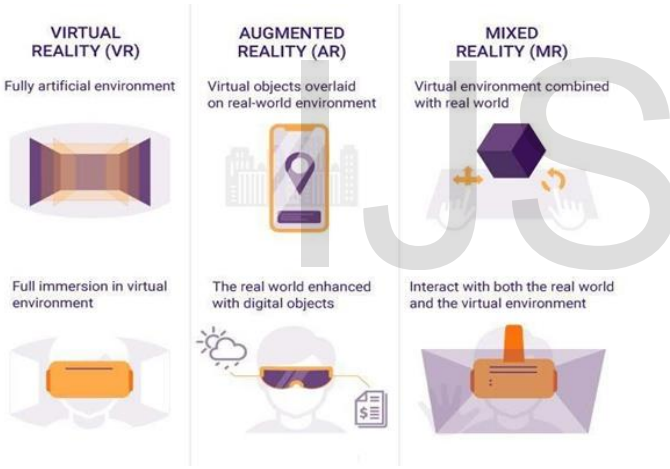

Fig. 1. Difference between Augmented Reality, Virtual Reality and Mixed Reality [5].

Additionally, VR systems require VR headsets, noiseless headphones, and motion capture. Mixed Reality equipment includes built-in microphone array, binaural sound capabilities, a camera for recording, a depth sensor, head-tracking cameras, and an inertial measurement unit which helps track your head movement as well this system requires high-speed processing. So, it is the reason the Microsoft Holographic Processing Unit is used, along with CPU and GPU, to track where the participant is viewing and decipher commands and gestures. While Augment Reality equipment requires a normal smartphone or tablet sort of device for complete functionality.

1.5 Research Questions:

RQ-1. Would you like to have an educational environment like shown in this video at your home?

RQ-2. Are you comfortable getting all the facilities that you get in the practical class (like art, archeology, biology, chemistry, and physics) in a holographic environment?

RQ-3. Do you think the controls and way of operating this device as shown in the video are difficult to understand?

RQ-4. Do you think that all colleges, schools, and universities should adopt this technology?

RQ-5. How likely are you to recommend this technology to an associate, acquaintance, friend, and family?

RQ-6. Do you think that students and teachers should be given the training to use a Mixed Reality (Microsoft HoloLens) environment in education?

1.6 Research Objectives:

Traditional learning methods in today's education environment are generating students with in-depth theoretical knowledge but lacking in critical thinking for real-time scenarios. At the same time, pandemics like COVID-19 always hinder the progress of young bright students. As they are not able to do their practical part of their coursework, and online classes are not as successful as intended, they are not able to recreate the same kind of learning environment of a classroom or laboratory. In order to tackle this issue, alternative procedures are being employed. Like, the Mixed Reality through Microsoft HoloLens applications are being used to fulfill the technical aspects of conceptual and hands-on learning experience.

The purpose of this research is to highlight how Mixed Reality applications alter the way of delivering education. As educators are immensely determined to provide a high-quality education to their respective students. So, researchers are experimenting with this new technology to enhance the quality of education. Hence, it is necessary to find out the effectiveness of such old and new methodologies by reviewing previous research studies to reach a conclusive stance on the subject matter.

2 Literature Review

As demonstrated in this document, the numbering for sections upper case Arabic numerals, then upper case Arabic numerals, separated by periods. The United States Army ordered 40,000 Microsoft HoloLens handsets for military training purposes. Military forces can use this Mixed Reality tool to train soldiers for ammunition, close combat, survival, and war-like scenarios through a stimulating environment as referred to figure 2.

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Fig. 2. Soldiers training for war like scenario with Microsoft HoloLens [6].

According to an article in the foundry, "How Mixed Reality is sending people across the solar system" as shown in figure 3. In this article, the author mentions that NASA has been using VR technology for a space training program for more than four decades. Now the MR tech is also viewed for the recreational purpose for astronauts as space missions are mentally hectic. The results for this idea are encouraging in handling the astronaut's mental health. Also, the scientist at NASA is using AR and MR tech to create an environment similar to Titan (Saturn's moon) to land robot craft landers in this environment for research purposes. As their high probability of finding life here as it has liquids in the form of rivers, lakes, and seas on its surface [7].

Fig. 3. Microsoft HoloLens to discover promising paths for a Mars rover to explore [8].

A group of researchers, at Politecnico di Milano Milan, were able to treat patients with Alzheimer's disease through use of Microsoft HoloLens. By making their own cognitive training Mixed Reality apps for treatment, they were successful in delaying the memory loss and other mental disorders related to Alzheimer's disease [9].

COVID-19 pandemic has significantly affected healthcare workers. This emergency has forced them to alter their operational protocols. To maintain minimal contact and social distancing from fellow staff members and patients, several hospitals in London are adopting Microsoft HoloLens technology. It has significantly reduced the need for multiple staff in a single ward, as higher-level interconnectivity through Mixed Reality has been very effective [10].

Microsoft HoloLens can be incredibly useful for under training doctors as they can virtually perform an autopsy, diagnosis, and surgeries on the virtual bodies. In this way, they do not have to preserve a body and not to use it for their practices. This also limits the chemicals and drugs used for practice. AR Liver Viewer by SO-FORM. It is a 3D real-time, patient communication tool featuring incredibly detailed anatomical models. 4D Anatomy another AR application related to the same area [11]. For a better understanding, can refer to the figure 4.

Fig. 4. Child birth MR simulator using Microsoft HoloLens [12].

Mixed Reality introduces a new technique of human computer interaction called Tangible User Interface (TUI). TUI is a way where through physical objects, users are able to manipulate the digital information. This novel strategy is proven to have positive effects on learners on many levels. There is improvement in their cognitive and motor skills as multiple senses were involved. This technology was able to be inclusive to people with learning disabilities because they found it more intuitive and easier to understand. It also promoted a better environment of collaborative learning [13].

A research project named Holodisaster was started under York University's Disaster, Emergency and Rapid Response Simulation (ADERSIM) initiative. Its primary motive was to design disaster simulations, like train derailment, plane crash,

terror attack, tornado, volcano eruption, mass shooting, or crowd incidents, through Microsoft HoloLens applications. In order to prepare students for disaster management and emergency protocols required in such scenarios. They believe that they would be effectively able to train individuals to become trained professionals for such events as it would let their student's crisis management skills to be tested. Students can train their basic emergency management like search and rescue operations, evacuation, mass casualty management, and provision of social services in reception centers. It will definitely polish their practical and research skills through such immersive experiences [14].

More than 250,000 deaths and their damages cost up to1 trillion dollars due to medical errors of nurses [15]. One of the reasons why these medical errors occur is because the cognitive processes of nurses are not developed properly, as they are not able to do critical thinking regarding the patient's care. These nurses' education programs already use computer human patient simulation under the supervision of a course instructor. This process is not perfect as success is dependent on the instructor's specialty, level of training and type of experience which may lead to incorrect "habitual" training and feedback [15]. Hence, Microsoft HoloLens was used in stimulation learning of these nurses and response to this training was satisfactory as the nurses were able to develop a strong cognitive skill as healthcare professionals.

3. RESULTS AND DISCUSSION

3.1 Research Methodology

The entire research methodology was designed after the analysis of previously published literature material. So, relevant questions are included in the research survey, to find out the effectiveness and wider implementation of this technology in education from the perspective of the general public. A one minute and forty-eight seconds video (compilation of applications of Microsoft HoloLens) was shown to respondents before the start of the survey, for them to know what is Microsoft HoloLens and how it works, in different domains as shown in figure 5.

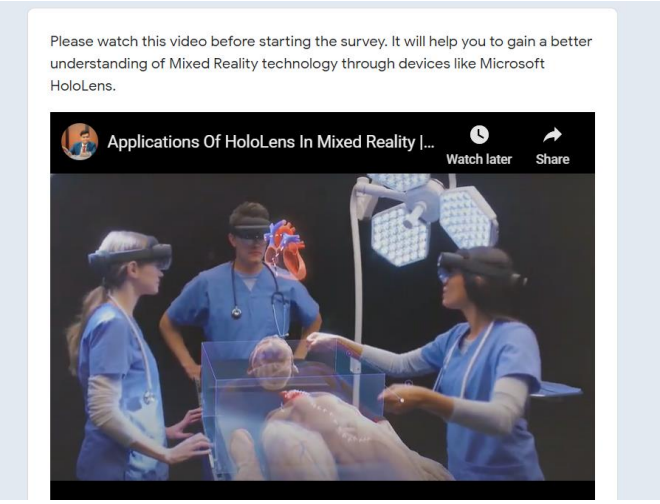

Fig. 5. Video embedded in questioner to gain a better understanding of MR through Microsoft HoloLens.

3.2 Questioner

The survey was planned as an assessment for individuals from diverse fields, to get a decent variety of responses. Sixty-five individuals responded to this assessment. There were a few people that didn't know about these advancements in Mixed Reality. The respondents viewed a video about Mixed Reality's functionalities and its applications, it provided the respondents a better context of Mixed Reality. Hence, enabling them to participate in the survey.

As this survey was carried out in Karachi during the COVID-19 pandemic. The majority of the participants were students and teachers that were engaged in online education activities due to the strict lockdown maintained by local governing bodies. Both of these stakeholders were facing predominant issues from respective ends while remote learning.

As shown in figure 6, respondents were asked if they would install this technology at their homes. 87.7% agreed to this novel idea, as this technology could successfully be able to recreate a formal and immersive class environment that online classes are not able to provide.

RQ-1. Would you like to have an educational environment like shown in this video at your home?

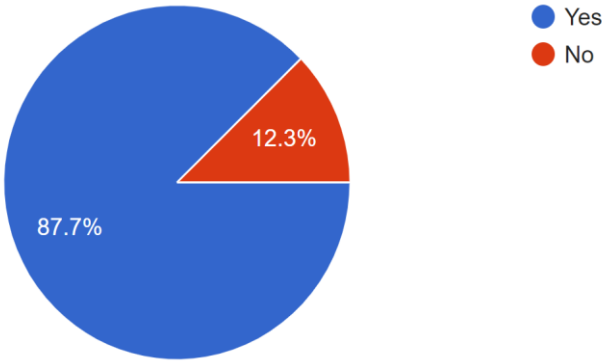

Fig. 6. First question of the questioner.

When asked that both students and teachers are willing to have their laboratory classes in a holographic environment, figure 7 illustrates 49.2% said yes as they would have a complete laboratory experience without any physical contact during the health pandemic. While 30.8% were not sure about this idea. One of the possible reasons that this technology has difficulty in controls, procedures, and settings to understand.

RQ-2. Are you comfortable getting all facilities that you get in the practical class (like art, archeology, biology, chemistry, and physics) in a holographic environment?

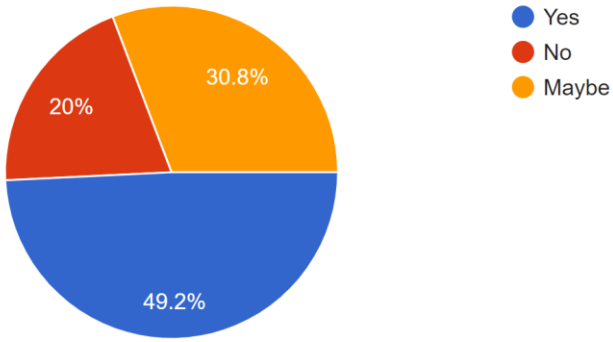

Fig. 7. Second question of the questioner.

So, the question was asked from the interviewees were they able to easily understand the controls and functions to operate this technology. Figure 8 shows, 38.5% of the respondents were not sure about the controls of this device. While 36.9% of participants found functions of this technology not difficult to comprehend.

RQ-3. Do you think the controls and way of operating this device as shown in the video are difficult to understand?

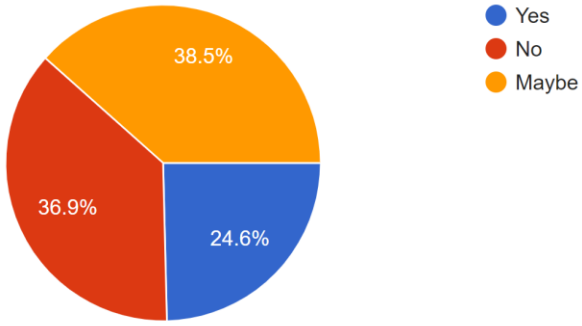

Fig. (8). Third question of the questioner.

Another question was asked, should all educational institutes adopt this technology. Figure 9 states, 30.8% strongly agreed with this proposition while 46.2% agree with this thought.

RQ-4. Do you think that all colleges, schools, and universities should adopt this technology?

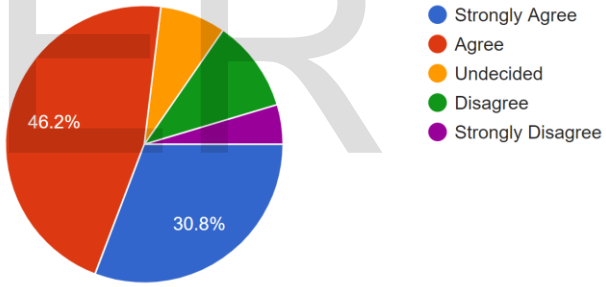

Fig. (9). Fourth question of the questioner.

Further, the question was asked whether they recommend this to their associates. Figure 10 provides that 36.9% strongly recommended this to their friends and family while agreeing to the argument.

RQ-5. How likely are you to recommend this technology to an associate, acquaintance, friend, and family?

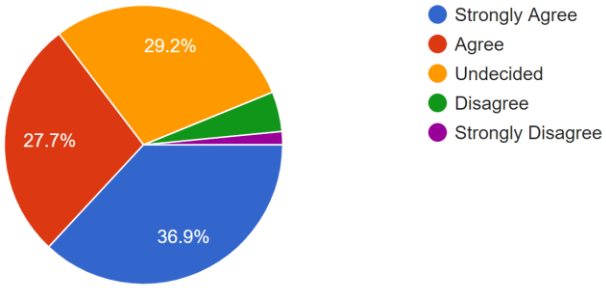

Fig. 10. Fifth question of the questioner.

The final question was asked whether there needs to be training programs regarding the Mixed Reality platform; Figure 11 proves the 86.2% of the participants of the survey are willing to engage in such kinds of programs.

RQ-6. Do you think that students and teachers should be given the training to use a Mixed Reality (HoloLens) environment in education?

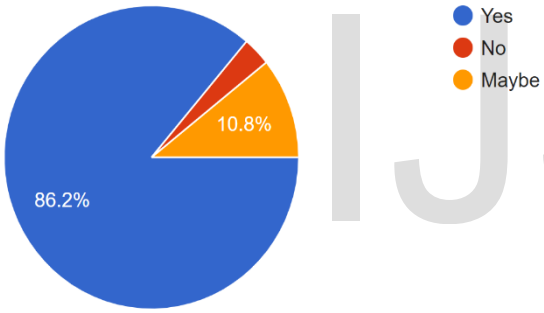

Fig. 11. Sixth question of the questioner.

3. LIMITATIONS

The research survey might also have few biased samples. As the participants that answered the questions, English was not their first language. It is possible that they may have not properly understood what was asked from them. It is also possible they might not completely understand the technology, as they were not using Mixed Reality devices themselves before answering the question.

There are many hurdles that need to be addressed while implementing Mixed Reality on a huge scale. Cost of this revolutionary technology is very high to purchase this equipment for educational purposes due to this technology being restricted for developers only up till now. At the same time, all stakeholders require some sort of training before using the equipment. The way that this technology's working was confusing to 38.5% (as given figure 8) of the respondents.

4. CONCLUSION AND FUTURE WORK

In this paper, an exceptional method for creating a Mixed Reality environment has been proposed for the educational sector. By the use of Microsoft HoloLens for conducting classes and labs virtually. It would be a great addition to the online education system. As it is not enough for the students to grasp the whole understanding of the topic by simply watching the teacher and taking notes of any lecture or practical in an online class. This technology provides an attentive and immersive environment while learning abstract theoretical concepts in the classes.

The quantitative and qualitative evidence presented in the research proves that this Mixed Reality is beneficial for all educators and pupils. So, there is an encouraging response from all educational stakeholders to use this setup on a larger scale. It can be incorporated with the current MOOCs (Massive Open Online Courses) offered by many top institutes of the world. To counter a situation where another pandemic outbreak happens in the future. Everyone in the educational sector is comfortably able to function effectively and smoothly from home without a compromise on the quality of education being risked. As the students would be experiencing Mixed Reality through Microsoft HoloLens. Each pupil would be having his or her augmented laboratory to discover new things and also to help them to discover themselves. Through this way, students are allowed to follow their passion and to experiment with things to get more in-depth knowledge of that particular subject. Hence, this innovation in the educational sector would open new dimensions of learnings and opportunities that would be helpful in revolutionizing the world.

The findings of this study suggest that students and teachers have a positive response towards shifting their entire lab work for the course digitally. A virtual science laboratory application by using Mixed Reality can be made for students. If any student has the bug of curiosity or the desire of creating, experimenting, or understanding highly difficult scientific concepts, like nuclear fission, hydrogen bonding or DNA analysis, can potentially reshape the entire world of knowledge. Students can simply use this Mixed Reality application to get an in-depth understanding of these concepts.

Additionally, using the laboratory in groups may not be effective as each member may not be performing experiments. So, the students may not be able to fully understand the chief purpose of the topic. Hence, this technology allows them to learn without any logistical or physical problem, so the students can explore freely and learn with ease.

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