Augmented Reality, Virtual Learning Environment and Mobile Learning in Education: A comparison

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***Abstract*— This paper discusses the trends of technology in education and comparison between three types of technology: Augmented Reality (AR), Virtual Learning Environment (VLE) and Mobile Learning (ML). This paper aims to encourage educators and learners to incorporate the technologies in the teaching and learning process. The integration of these technologies in the teaching and learning process is able to provide new learning environment and improve the teaching and learning quality. The learning process becomes enjoyable and interesting with technologies. Although technology has a lot of benefit to the education field, educators must be creative and innovative to implement technology in the teaching and learning process. Therefore, educators and learners need to select the appropriate technology according to the lesson taught.**

Keywords—augmented reality; virtual learning environment; mobile learning; education

I. INTRODUCTION

Most educators use traditional teaching method [1] to conduct the teaching and learning activities in the classroom by the face-to-face method via verbal communication [2]. However, the teaching and learning environment has grown beyond classroom. The integration of technology in the teaching and learning process is the new trend in education [3], with positive outcome [4]–[6]. According to [7], technology infused teaching and learning process enables educators to diversify by providing real world issues and current information resources in various fields. The use of technology in education positively influences the performance of students in their studies. [8].

This paper illustrates that technologies provide an environment for learning activities to occur anytime and anywhere that benefits the educators and learners across the global [9]. Several technologies show great potential in the education field, such as the augmented reality (AR) [10], virtual world learning [9] and mobile learning [5].

II. TRENDS OF TECHNOLOGY IN EDUCATION

In this century, educators and learners are perceived to be technological savvy [11]. Technology influences the transformation of the teaching and learning approach among educators and learners [12]. Meanwhile, technology also decreases the barriers or restriction in education [12], and promote freedom in the teaching and learning process [9]. The technologies are discussed below.

A. Augmented Reality(AR)

The development of augmented reality started in the 1950s by Morton Heilig, a cinematographer, who created a virtual reality system which had the relevant elements such as an environment but without interaction [13]. In 1968, Ivan Sutherland developed the first augmented reality system was by using an optical see-through head-mounted display which could see the computer-generated object variegated with real life physical object [14].

Augmented reality technology has been used in several fields, such as medicine, robotics, manufacturing, machine repair, aircraft simulations, entertainment, gaming and education [15]. Augmented reality is a technology that connects the computer world to the human world [16]. Besides that, augmented reality is also defined as a technology that allows users to see the real world with computer generated objects superimposed [17], [18]. According to [13], initially, the augmented reality was used for military purpose to develop an advanced flight simulator by the US Air Forces Armstrong Medical Research Laboratories in 1982. Nowadays, augmented reality is also implemented in the education field [4], [17], [19].

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Several studies show that augmented reality is able to enhance the teaching and learning experience [17], [20]. Integrated augmented reality in the education field engages the learner to explore the real world by using multimedia elements such as texts, videos and pictures as supplementary elements to conduct investigations of the surroundings [21]. Augmented reality is also able to extend the integration of the real world with digital learning resources in three dimension (3D) form [20]. For example, the usage of augmented reality enables learner to learn difficult scientific phenomena in Chemistry such as chemical bond [22]. Chemistry is a conceptual subject that requires abstract concepts for in depth understanding. Therefore, augmented reality reduces the problem to understand the abstract concepts by visualizing the fundamental concepts of covalent bonding in the topic of Chemical Bond. Another example where the augmented reality helps learners is in learning the solar system. Kerawalla et al. [23] found that virtual materials engage learners to explore certain topics in depth especially in 3D form. Kaufmann et al. [24] also found that virtual materials in 3D not only provide learners with a real world setting to collaborate together, but also reveal virtual 3D object to enhance the understanding of the topics.

B. Virtual Learning Environment (VLE)

Originally, virtual environments were established for online games since 40 years ago, whereby, the Multi User Dungeon (MUD) was developed in the virtual environment [25], [26]. By the 1990s, MUD was fully integrated with graphical multimedia Object Oriented system, and developed to Multi Player Online Games (MMOGs) [25]. Apparently, virtual environments were developed for entertainment purpose. Nowadays, video and computer games are widely used by the younger generation [27] and almost all modern video and computer games are integrated with 3D technologies such as multiplayer online games (MMOGs) [28]. In MMOGs, players interact and communicate with other players around the world, and they are transformed into an avatar and action in a virtual world [9], [27]. Virtual environment was also created for education such as the virtual classroom and virtual learning environment (VLE) [27]. The use of virtual learning environment in education is making its mark because virtual learning environment increases interaction and communication opportunities between teachers and students [9], [27].

Virtual learning environment allow educators to conduct teaching and learning process virtually and conduct learning activities which are difficult to be implemented in classroom [29]. Virtual learning environment also promotes collaborative learning, and the key element for collaboration is social interaction [30]. The students can interact or communicate with their peers in the virtual world and are able to partake in group activities virtually. Moreover, virtual environment also inspires innovative learning strategies, which are suitable for each individual. Thus, students are comfortable with this learning pattern because as they can control their learning process based on their pace [9], [31].

C. Mobile Learning(ML)

Mobile learning is a new trend in the education field [32]. In the past decade, the technology of mobile phone has been enhanced from a simple cell phone to a high technology device with touch screen and other features, with more than 1.7 billion users [33]. Mobile learning provides collaborative interaction and learning opportunities for individual or groups [32]. Besides that, mobile learning also provides information or knowledge through mobile technology such as the mobile internet at learner's pace[33], [34]. This technology is integrated in the teaching and learning process because mobile learning is an effective tool for integrate learning strategies accessible via mobile device, which provides accessibility of the content and saves time [35], and lack restriction to the learning environment [36]. Therefore, mobile learning is more flexible and available to different teaching and learning materials.

III. COMPARISON USAGE OF AR, VLE AND ML IN EDUCATION

Three types of technology were discussed in this paper, which are augmented reality, virtual learning environment and mobile learning. There are some differences between the aforementioned technologies in the context of equipment, mobility, place, interaction, connectivity and display.

First, augmented reality can be defined as a technology which combines the virtual computer-generated object with physical object in the real-world environment [14]. According to [18], augmented reality is able to run in mobile devices with flashcard that consist of marker. Besides that, this technology can be used anywhere and anytime if the mobile device downloads the application such as the augmented book [37]. Augmented reality does not require internet service to load the information because the marker registers the position of a virtual object to be displayed into the real world [38]. According to [37], augmented reality also supports collaborative viewing and allows two or more people to explore the same content in the product known as "The Magic Book". Augmented reality also displays the content in 2D or 3D form which is more interesting compared with the traditional learning method [37], [38].

Second, virtual learning environment is a designed information social space where educational interactions occur in the environment and the virtual space is displayed in the 3D's immersive world such as Second Life [9], [39]. The virtual learning environment requires computer for operational [25]. Thus, the teachers and students are only able to appear in the virtual learning environment by using computer. The teachers and students may login their account in the school's computer lab or classroom. Virtual learning environment also uses the internet to link with users in the virtual space and each users are represented in an avatar [25]. The teachers and students are able to conduct the lesson or classroom activity in the virtual space [39], and the teachers are able to share the information or task in a virtual learning environment [25].

Third, mobile learning is defined as a kind of learning model allowing learner to access the learning material using mobile technologies and internet [40]. According to [40], mobile devices such as mobile phone or PDA is required to conduct mobile learning among the teachers and students . The advantage of mobile learning is the teaching and learning process does not require specific place and time, the size of mobile device is small, and it is easy to carry anywhere [41]. Thus, the learning process can be conducted without the restriction of time, space and distance among the learners. Nowadays, mobile device has better connectivity and communication function which is integrated with Bluetooth, infrared and wireless, and offers variety of communication tools such as email, short messaging service, multimedia messaging service and video call [42]. Table 3.1 illustrates the differences between augmented reality, virtual learning environment and mobile learning.

Table 3.1 Comparison among Augmented Reality, Virtual Learning Environment and Mobile Learning

	Augmented Reality	**Virtual Learning Environment**	**Mobile Learning**
Equipment	Mobile device and flashcard	Computer	Mobile device
Mobility	Moveable	Statics	Moveable
Place	Anywhere and anytime	Classroom or lab	Anywhere and anytime
Interaction	Many users	Many users	Many users
Connectivity	Stand-alone	Online	Online and Stand-alone
Display	3D	3D	2D

Based on the table 3.1, the table shows the differences of three type of technology implemented in the teaching and learning process. Therefore, the usage of these three technologies in the education that in table 3.1 is discussed in the next section.

IV. Implementation of AR, VLE and ML in Education in Education

Few of studies were conducted to show the impact augmented reality, virtual learning environment and mobile learning in education. In the past decade, emergent technologies such as augmented reality, virtual learning environment and mobile learning has been on the rise to improve the learning experience in different learning environment [43]. In fact, the positive impact of augmented reality, virtual learning environment and mobile learning shown by several studies posits that these technologies are able to motivate the students, enhance the interaction and collaboration between the students [43], [44]. Table 4.1 illustrates the previous studies that show how these technologies were implemented in education and the impact towards students.

Table 4.1 Meta-Analyze of Implement AR, VLE and ML in Education

Author	**Tools**	**Summary of Finding**
Nor Farhah, Noor Dayana, and Noraffandy [10]	Augmented Reality	AR shows greater potential in the education field because the advantages and benefits of AR enable students to engage in the learning process, and make learning simple in several field such as Medicine, Chemistry, Physics and Biology.
N. Danakorn, Mohamad Bilal Ali, and Noor Dayana [38]	Augmented Reality	Utilizing collaborative AR in educational can help to improve critical thinking skills, problem solving skills and communication skills through collaborative activities. This is because AR can help the students who lack the ability to visualize complex learning concepts such as phenomenon that cannot be viewed in real world.
Mohd Hishamuddin, Noraffandy, and Noor Dayana [9]	Virtual Learning Environment	Virtual learning environment is akin to a game-like environment and the study found that the learning process in the VLE are interesting, and engage students. This is because younger generations prefer playing video games. Moreover, by using the correct collaborative strategy, VLE is a good application for online collaborative learning with large number of students and allow conducting learning activities, which is difficult to implement in classroom.
Can [45]	Virtual Learning Environment	The finding shows that the interactions of the students are natural when they participate in the task via VLE. Importantly students are interested in VLE and the involvement is high.
Conejar, Chung, and Kim [46]	Mobile Learning	The study stated that mobile learning could be conducted in formal learning and

		informal learning where students can access the information and personalize learning materials from the internet or the database from at the learner's convenience. Besides, mobile learning allows students to have their learning autonomy. Learning process can be conducted through several methods such as game-based learning, virtual and remote learning platform, digital textbook and mobile application.
Parajuli [47]	Mobile Learning	The findings show that students have positive attitude towards mobile learning and are well versed in using the mobile to obtain information such as finding meaning of words, browsing the web and accessing multimedia for educational purpose.

As shown in table 4, augmented reality, virtual learning environment and mobile learning can assist in the learning process in many ways. Most studies demonstrated positive effect after implementation of these technologies in the education field. Based on table 4.1, mobile learning is slightly superior to augmented reality and virtual learning environment in education. This is because the functionality of mobile technologies allows mobile learning to cover all the advantages and benefits of another two technologies. Mobile learning can be conducted in game-based learning, virtual and remote learning platform digital textbook and mobile application. The learning process can be diversified by using different platform.

V. Discussion

This paper discussed three trend of technology used in the education field, which are augmented reality, virtual learning environment and mobile learning. These technologies have different strength to improve the teaching and learning environment. Among these three technologies, mobile learning is slightly convenience in the teaching and learning process. Mobile learning only uses mobile device as the equipment in the teaching and learning process. As aforementioned, the ownership of mobile device in this world is increasing and mobile device has become an important gadget in human's daily life. Although there are some limitations for mobile device such as small screen, limited storage and battery life [33] but the mobile learning still has the significant result in teaching and learning process especially the increase of interest to learn among the students [48].

Since mobile learning uses mobile device, the advantage of the mobile device is that it has good mobility. The teachers and students are also able to facilitate learning activity outside the classroom [49]. Mobile device is lighter than book and the students are able to search all the information just using mobile internet. This is aligned with [49]'s study that mobile technologies offer strong information search ability and deliver information ability for the students when they conduct their learning activities. Besides that, the advantages of mobility also allow teachers to conduct situated learning in the teaching process. Situated learning is the learning that takes place in the context corresponding to the learning materials and it provide suitable learning material for the students' learning context [49]. The teachers are able to use the mobile device and search the learning material from the internet for better explanation of subject. Thus, mobile learning achieved the concept that the learning process can be conducted at learner's convenience.

Mobile learning enhances the learning process and becomes more interesting through the ability of connectivity with mobile devices, such as mobile internet, Bluetooth and Wi-Fi (local area wireless computer networking) [40]. These functions enable students to conduct mobile learning without the limitation of location and time [11]. Besides that, mobile learning also allows the students to conduct group discussion on cloud, social network application, without meeting each other and there does not limit number of participants [11]. Thus, the teachers and students are able to provide instant respond when the discussion or lesson is ongoing. On the other hand, the teachers can share information such as picture or video in the group to enhance the student's social work.

VI. Conclusion

This paper discussed the trend of technologies used in the education field. Three types of trends were identified, which are augmented reality, virtual learning environment and mobile learning. Besides that, this paper also discussed some of the characteristics of each technology to be used in the teaching and learning process. The characteristics mentioned in this paper are equipment, mobility, place, interaction, connectivity and display. Some comparison between augmented; reality, virtual learning environment and mobile learning was conducted. The comparison may help the teachers who are planning to integrate technology in the teaching and learning process. The teachers can differentiate the advantage of each types of technology and decide the technology to be integrated in their teaching and learning process.

This paper also discussed about the implementation of augmented reality, virtual learning environment and mobile learning in education field. The previous studies shown that all the three technologies have different strength to enhance the learning process through improvement the motivation, involvement in activities, interaction, collaborative and interest. However, mobile learning is slightly better than

augmented reality and virtual learning environment. This is because mobile learning can help teachers and students to conduct more types of teaching and learning pattern comparative to augmented reality and virtual learning environment through the advancement of mobile technologies. In conclusion, mobile learning was recommended to be integrated in the teaching and learning process. Augmented reality and virtual learning environment have several advantages but mobile learning is preferred to be used and suitable to be integrated in the classroom or outside the classroom teachers and students need a mobile device and downloadable application to conduct mobile learning session. Besides that, certain subjects such as physical education that require the teacher to walk around the classroom or on the field to observe the students' performance. Besides that, the functions of mobile devices such as playing video clip or related animation allow teachers to show the correct action or posture to the students on the spot. Thus, mobile learning is recommended to be used in the teaching and learning process.

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