

AUGMENTED REALITY IN FACILITATING LEARNING: A REVIEW

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ABSTRACT

The present study reviews the augmented reality application in the education area. Justification of the use is to improve the learning motivation and outcome of students through the use of a deep learning approach. A deep learning approach is associated with better academic performances. Augmented reality provides a tool to motivate learning and understanding in the student. In the medical domain, augmented reality may serve as replacement of cadavers especially during online learning. The main aim of the current review is to reflect the use of augmented reality as a teaching and learning tool to motivate and promote the deep learning approach process which includes life-long learning and possible research areas that warrant and assess the impact of augmented reality on academic performance. Augmented reality may be a tool in complementing the learning aids of the conventional methods of teaching and learning.

Keywords: augmented reality, learning motivation, deep approach.

INTRODUCTION

“Learning style” or “learning approach” is defined by Hussman and O’Loughlin (2018) as a student’s consistent way of responding and using stimuli in the context of learning. Distinctive learning styles have been observed to significantly impact students’ academic performance as concluded by Din (2018). According to the model of learning based on the understanding of Biggs 1987, students can be classified into two groups based on their learning approach consisting of a deep approach and superficial approach. Deep approach learning among students aims to comprehend the concepts and associated ideas. Meanwhile, a superficial approach learning focuses on memorization as they are mainly concerned with obtaining marks and passing (Zakaria et al., 2018).

A deep approach is feasible when linked with the use of augmented reality as a teaching tool amongst medical students. It creates a deeper understanding and increases the awareness of the anatomical features of the selected organs three-dimensionally. A study by Hung et. al. (2016), which was done among seventy-two fifth-grade children in Taiwan learning bacteria, showed that when the augmented reality was used in teaching, the students are able to retain the knowledge obtained longer in memory compared to the conventional method and increases the interest and motivation to learn more (Hung et al., 2016).

In the field of higher education, augmented reality technology is used to encourage student learning, such that it becomes a tool that enables you to experience physical components of reality through multimedia devices through a fun and interactive interaction that

encourages content analysis. Augmented reality also offers the student greater retention of knowledge, thereby serving as a teaching and learning tool, and offers the opportunity to carry out sustainable practices with the goal of enhancing the understanding of complicated information. Augmented reality has a high potential to be used in educational contexts, to facilitate learning and to assess the skills gained. By using augmented reality technology, students thus check that what they learn is not only important, but can also be implemented in the real world that can be used in real circumstances immediately. (Abad-Segura et al., 2020).

In education, augmented reality applications make an essential contribution to the field of information by helping to promote the teaching of didactic materials that would otherwise be more difficult to express. The inclusion of this technology in educational activities therefore favours the achievement of higher levels of quality (Billinghurst, 2002; Miller, 2015; Martín-Gutiérrez et al., 2015; Dioh & Shih, 2019). Most researches regarding augmented reality in education are focused on theories of learning, particularly on theories of constructional and situational learning (Joe, 2011; Tzima et al., 2019). It is pivotal to note that the approach to building learning allows students to use the data they interpret from the outside world to understand and develop their knowledge. (Azuma, 1993) which is in concordance of the principles used deep learning approach.

LEARNING STYLE

Learning style encompasses every activity a student does, her or his study activities and behaviors, all summarized into that particular student's approach to learning (Biggs, 1987; Biggs 1993). "Learning style" is defined by Keefe (2008) as "composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment". It is an approach that contributes to learning, with unique qualitative differences that exist between strategies taken and the resulting standard of learning.

According to Cassidy (2004), in the last four decades, many studies have been conducted on learning styles. Also, in the last few years, there has been a surge of interest in the effects of learning styles in education which also resulted in various criteria and categorizations of learning styles. Different categorization or models are based on sensory input (Flemming & Baume, 2006) and approaches to learning (Baykul et al., 2010). These theories received considerable critical attention, and in most cases, they correspond to questionnaires, applied on a large scale by the industry, to identify students' learning styles, the relationship between students' and teachers' learning styles (Awla, 2014; Massa & Mayer, 2006; Naimie et. al., 2010; Tuan, 2011).

Marton and Saljo (1976) had conducted an experiment that required a group of students to read a 1500-word article prior to an interview given. An interview is conducted thereafter by assessing the score based on the study material provided prior to the test. Analysis of the results classified the student into two distinct groups that are deep approach and superficial approach. The actual learning processes and styles students prefer may be able to predict the quality of learning outcomes based on their academic performances. Despite having a wide range of factors affecting a student's academic performances, several studies had shown that deep learning approaches are in general significantly associated with better academic performances (Ebrahim et al., 2017, Hisham et al., 2014).

Besides the study on superficial and deep learning techniques there is another learning style formed by Riechmann and Grasha (1974). The study considered learning styles as socially intuitive and characterized them as diverse parts which involves understudies having different interaction with classmates, instructors and course content. These factors will determine the outcome during an assessment or examination. Learning styles were classified into six categories, with each having its own specific characteristics. These include independent, dependent, collaborative, competitive, contributive and avoidant types of studying methods. It is assumed that the actual learning processes and styles students prefer are generally an overview of the quality of learning outcomes shown by their academic performances. Despite having a wide range of factors affecting a student's academic performances, several studies (Beneshi et al., 2017; İlçin et al., 2018)) had shown that collaborative, participant, and dependent learning styles are in general significantly associated with better academic performances. These studies are in concordance with the research by Azarkhordad and Mehdinezhad (2016) which concluded similar findings.

A. DIFFERENCES BETWEEN DEEP AND SUPERFICIAL LEARNING STYLE

According to Entwistle (1998), a deep approach is defined as an intention to extract ideas for own self, by comparing newly learnt theory with old knowledge and practical experience or those who took an understanding approach to learn. They tend to be more actively involved in finding the rationale behind a treatment. Students are more likely to obtain evidence before coming to a conclusion. Deep learning approaches are important because students using these approaches continue to receive higher grades and maintain, incorporate, and pass knowledge at higher levels (Biggs et. al., 2001; Entwistle & Ramsden, 2008).

The superficial approach, in contrast, is defined as the intention to cope with the course task or those who took a reproduction approach to learn (Entwistle & Ramsden, 2008). Students emphasize more on memorizing facts and procedures with little attempt to reflect the aim. This type of students focus mainly on memorizing, production of information, and commonly see the learning process as acquiring knowledge merely for passing any assessments or tests, with little or no interest in the actual path of learning. Superficial approaches are less preferable in the actual daily learning process of encouraging the students to cherish the importance of getting knowledge (Biggs et. al., 2001; Entwistle & Ramsden, 2008).

B. SUPERFICIAL LEARNING APPROACH

Even Though having a superficial learning style is thought to be inefficient in most, in some situations it is possible associated with the current educational procedure that is designed to encourage the students to become more competitive towards each other thus they had no choice but to practice superficial learning (Hisham et al., 2014). Several examples include assessment styles that create stress and quite frequently require the students in recalling or application of their knowledge. Some students may realize that memorizing a trigger or key word is more convenient in coming out with a correct answer to a question within a limited period (Vashe et al., 2016). It is not encouraged to do so but it is considered as an easier way to practice.

A student who prefers deeper learning styles, may decide to work superficially in a module that is overloaded with content and assessment (Biggs et al., 2001). Especially so for medical students who have an excessive amount of material in the curriculum to memorize, from molecular level up to an actual process of consulting a patient. A fear of failure in examination and having to repeat the year course puts even more weight on them (Vashe et al., 2016; Mohammed et al., 2019). Having the same period of studying time with any other courses but with heavier workload encourages them to take the shortcuts in achieving better scores.

The outcome is damaging in the long run but fewer people lack that mindset in controlling themselves well. They mostly have poor or absent feedbacks on their academic progress. Thus, these students opt for an easier and faster method which is the superficial approach. Augmented reality may help to facilitate the superficial learning approach especially when it comes to memorizing facts during examinations. The augmented reality technology would be a trigger in remembering the facts associated with it and would be smaller and easier to hold and read through as compared to a textbook.

C. DEEP LEARNING APPROACH

A deep learning style serves various pivotal roles in the process of producing highly qualified undergraduates. A qualified undergraduate student in whatever field with a deep approach to learning is more likely to be lifetime learners and more willing to seek further specialize training and future success than those who follow a superficial approach (Newble et. al., 1990). In the medical fraternity, for example, a well-trained physician that is ever-ready to learn and update is what we hoped to produce especially when dealing with patient's lives. Millions of unknown possibilities can happen anytime in a year which includes new viruses or new pandemics. All of that can be stopped when it is contained. This is when the skilled practitioners by methods via a deep learning approach come into place.

Deeper approaches to learning are applied when a student has a full interest and curiosity in understanding the material thoroughly (Mohammed et. al., 2019) and thus increasing learning motivation. To achieve this level of understanding, a student tends to have more self-tendency to search for extra references and titles, whatever makes it comprehensible. Those who prefer deep learning may be linked to their sense of purposeful interaction with the learning material, their propensity to assignments, and evaluations throughout the time of lecture (Ebrahim et al., 2017). Generally, it really applies to whether the students are really interested to learn that particular module or topic, to begin with.

Consequently, this approach is one of the most common features of the education system (Ebrahim et al., 2017). One of the very well-known examples is the implementation of problem-based learning. It works by giving students some opportunities to be involved in a stimulated physician-patients program. Problem-based learning has effectively enhanced the number of students who approach with deeper learning and reduces the number of students who previously preferred the superficial approach (Diana et. al., 2016; Mohammed et al., 2019) as analysis of problems is used as the primary instrument for the acquisition and application of knowledge. Augmented reality may be a tool in increasing the learning motivation of the students which is an integral part of defining a deep learning approach. This would help to instil the objective of lifetime learners.

D. GRASHA-RIECHMANN STUDENT LEARNING STYLES

Tony Grasha and Sheryl Hruska-Reichmann developed this inventory to identify and categorize student learning styles preferences as avoidant, dependent, participant, independent, competitive, and collaborative. Of course, no student follows any one style that they use in every situation.

Hoffmann and Liporace (2020) suggests that Grasha-Reichmann based their definition on personal qualities, interactions with peers, and the teacher and learning experiences. In other words, this model focuses on students' interactions amongst their peers, the instructors, and learning in general. The Grasha-Riechmann Student Learning Styles Scale (GRSLSS) also has

a teaching style survey that instructors can complete to see how their instruction matches or conflicts with their learners so they can adapt and diversify to meet more learner's needs, which is an interesting area for future study. The survey itself consists of 60 items, with ten questions each that are averaged together to measure dominance in one or more of the six measured learning styles. (Lewis, 2017).

Their classification is based on three pairs of dichotomies that classify learners based on their social interactions, namely competitive-collaborative; avoidant-participant; dependent-independent (Beneshi et al., 2017). Collaborative learners are ready to share ideas, prefer group or pair work rather than individual work which is a preferred interaction pattern of competitive learners. Avoidants on the other hand do not want to communicate neither with the peers nor with the teacher. They are not interested in the content or activities performed in the class and are not motivated to take part in them. The dichotomy pair is a participant, a learner who is eager to help everybody and to do more than expected even without being noticed and overpraised. The last pair of learning style is dependent and independent and simply can be characterized as those who learn what they have to and what they are said to (dependent) or students intrinsically motivated, autonomous learners who are ready to work on their own (independent) (Beneshi et al., 2017).

Using augmented reality as a teaching tool may facilitate the types of learning that could increase their academic performance which are collaborative, participative and dependent learning styles which are associated with a better academic performance. Augmented reality would be able to stimulate the interest of students to ask question and working in group, thus facilitating collaborative, participative and dependent type of learning.

AUGMENTED REALITY

Augmented reality is images developed through computer-generated technology in enhancing the object which is incorporated into the real-world realm. The characteristics of augmented reality include simulating the real and virtual worlds together with intercommunicating actions and having three-dimensional capacity. The principle idea is to merge the computer graphic image in the form of three-dimensional content which will intertwine into the real world. This will enhance the perceptual senses of the human being which are sight, hearing, touch. and smell (Raisamo et. al., 2019). A computer device with a software application is needed to immerse the virtual image to reality (Azer & Azer, 2016).

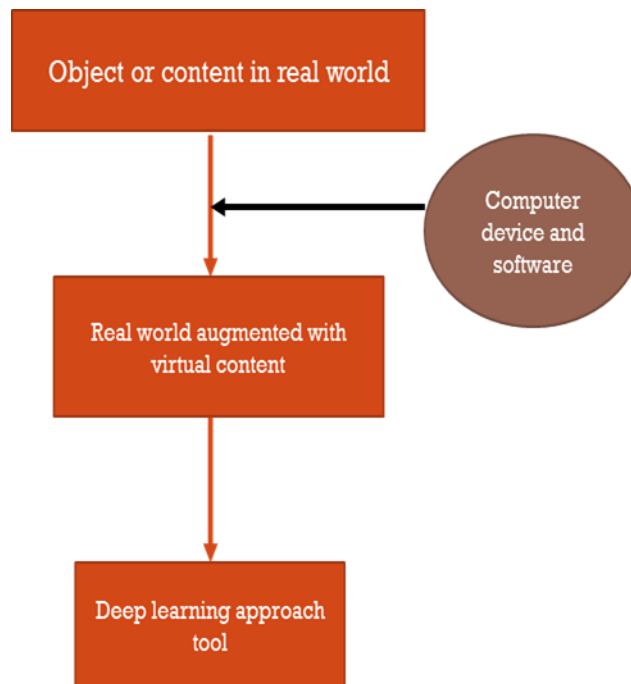


FIGURE 1. Real-world Object Conversion to Virtual Image and Used as A Learning Tool.

Even though augmented reality have been around and used for the past four decades, systematic evaluation on the use of augmented reality was started for the past ten years (da Silva et. al., 2019). A knowledge deficiency about how to correctly test augmented reality interactions and design tests may be one of the possible reasons why it took so long to provide user assessments. It is also vital to determine the effect of learning technologies and the viability of integrating them into the classrooms when using augmented reality as a teaching tool. Many variables are entangled in this process ranging from price tag to acceptance by users (da Silva et. al., 2019)

In summary, augmented reality is distinguished by the ability to replicate objects, animations and informations that are not present in this world, combining the actual environment with virtual content (Tom Dieck et. al., 2018). The diversification of contact spaces beyond the machine is now one of the key causes of the elevated usage of augmented reality, especially when it only needs an interface that uses augmented reality in handphones (Kim et. al., 2018).

A. AUGMENTED REALITY APPLICATION IN MEDICAL TEACHING

With the introduction of reformed curriculum in medical, dental and other allied health schools, most schools have reduced the total hours allocated for anatomy teaching and laboratory practical hours. These changes have been a continuous debate and triggered the emergence of innovative teaching and learning strategies in order to maximize students' learning of anatomy in the new context (Azer & Azer 2016). In the traditional method of learning and teaching, many of the medical lecturers adapt the two-dimensional (2D) method through lecture slides, white board, medical books reference and others, which is of limited value in exposing three-dimensional (3D) dynamics of anatomical structures labelling such as in augmented reality application. 3D may confer certain benefits to anatomy learning and supports their use and ongoing evaluation as supplements to 2D methods of teaching (Lim et. al., 2016).

Augmented reality applications of the anatomical organs can be made accessible to students no matter where they are especially for online learnings (Khan et. al., 2019) during a pandemic

such as in COVID-19, where the access to cadavers are virtually zero. This will likely improve the students learning experience.

B. AUGMENTED REALITY IN FACILITATING LEARNING MOTIVATION

Instead of the traditional method in which teachers use wooden objects, augmented reality is a new way to enhance the learning of three-dimensional shapes (Saidin et. al., 2015). There are many benefits of using augmented reality methods for educational purposes, as stated by Cerquiera and Kirner (2012). For instance, since augmented reality allows thorough visualisation and object animation, augmented reality may reduce the misconceptions that occur due to the inability of students to visualise concepts such as chemical bonds. Augmented reality also has the benefit of allowing objects and ideas that cannot be seen with a naked eye to be macro or micro-visualised. In various ways, augmented reality shows objects and concepts and different viewing angles that allow students to better understand the subjects. (Cerquiera & Kirner, 2012). Furthermore, much of the research on augmented reality to date shows that learners are motivated and involved in learning when using the technology. For example, students gave good feedback on their experience of using augmented reality technology in studies conducted by Klopfer and Squire (2008). A similar outcome was also documented by Burton et al. (2011), with the participants in their study obviously excited about the potential of this technology to exchange knowledge and learn about new concepts. Due to the interactivity of its applications, augmented reality encourages and engages students to collaborate and participate in discussion during the learning process (Lamounier et. al., 2010). It also helps students to think critically and creatively, improving their perceptions and understanding in turn.

Some architecture students demonstrated, as an example of augmented reality's usefulness, that the use of 3D modelling techniques along with augmented reality and virtual reality makes complicated groups of structures more open to information. (Tereliansky et. al., 2019; Liarokapis, 2006). In these cases, the technological resource of augmented reality enables the development of information-rich interactive 3D environments that, coupled with immersive applications, allow the construction techniques used in each historical era to be recognized. Thus, the exploration during the implementation of augmented reality has the benefit of evolving the creative capacity of an environment in real time for interactivity (Abad-Segura et. al., 2020).

A study by Kelly et al. (2018), showed that physiotherapy students gained better learning experience and increased the facilitation of communication between students and teachers by using projection mapping Augmented Studio which enables the display of anatomy such as skeletons and muscles on the body in real-time as it moves. In support of this statement, a study conducted by Khan et al. (2019) amongst 78 undergraduate health science students from the University of Cape Town using the anatomy augmented reality mobile application indicated that it significantly increased the learning motivation of students which comprised of attention, satisfaction and confidence factors. A study by Budiman 2016, also showed similar findings amongst the 32 students from SMP Harapan Ananda Kubu Raya which indicated an increased motivation towards learning. However, Khan et al. (2018) also noted that further research should be conducted to assess the impact of AR on academic performance.

A study conducted by Weng et al. (2020) amongst 68 ninth-grade students which investigate the effects of augmented reality technology on students' learning outcomes (measured according to Bloom's cognitive levels) and attitude toward biology showed

evidence that using augmented reality technology may have the potential to enhance students' learning outcomes at the analyzing level and their learning attitudes toward biology. This indirect connotation with the deep learning approach which substantiates the use of augmented reality as a tool to apply and facilitate the process of learning by using a deep approach. In addition, a study done by Ewais and Troyer (2019) amongst 50 Palestinian students, concluded that the students had a positive attitude towards the use of augmented reality applications in their learning process. However, Ewais and Troyer (2019) noted that most of the students were focusing on the use of the new technology rather than focusing on the learning process itself. As, Pérez-López and Contero (2013), confirmed curiosity was a driving factor towards learning motivation. But, this can act as a hindrance to the learning process.

A purposive sampling study in one of the primary schools in Taiwan significantly showed that AR improved the practicality and hands-on of the pupils via graphic book, picture books, and physical interactions. The pupils manifested higher learning performances as by the memorization skill (Hung et. al., 2016). Furthermore, a study in the UK also demonstrated an enhanced knowledge acquisition, motivated to continue learning, and the ability to identify their preferred learning style of the schoolchildren of the AR museum learning (Weng et. al., 2020). Mobile application augmented reality is a current method to be applied especially in the secondary and tertiary education settings. A model guide to assessing the effectiveness of augmented reality on students' motivation has been implemented. Attention, relevance, confidence, and satisfaction were significantly increased among the undergraduate medical students upon exposure to Anatomy four-dimensional (4d) mobile applications (Khan et. al., 2019).

C. LIMITATIONS REGARDING THE USE OF AUGMENTED REALITY IN TEACHING

A lot of aspects of augmented reality techniques need to be explored, many potential studies are still going to be done in this relatively new field. According to Hsu and Huang (2011), for instance, some of the participants in an augmented reality learning activity decided that the augmented reality tools are great and interesting. However, most participants did not consider the tools to be as efficient as reading texts. They actually discovered that it was not easy to use the augmented reality tools to get information. The answer may be that while the augmented reality program itself is simple to run, it is however too time consuming for the process to initiate which include sending out images, recognizing text, and extraction of data. The main reason behind this, involves the use the internet.

The prerequisite needed for the use of augmented reality as a teaching tool is the internet. If the teaching is in an unsuitable teaching environment with poor internet connectivity, this will deter the use of augmented reality technology. The identification of this weakness is confirmed by the findings of a study by Folkestad and O'Shea (2011) in which the participants were dissatisfied with the use of augmented reality technology in areas with poor internet provider. However, the findings showed that while the students experienced technical difficulties, they sought support, continued with the assignment and participated successfully in the specific learning process. The level of involvement in outdoor augmented reality operations was still very high, considering all the difficulties (Folkestad & O'Shea, 2011).

The above-mentioned drawbacks often illustrate the problems related to the technological aspects of using augmented reality in the learning process. In order for augmented reality to be widely implemented in education, certain technical problems must be strengthened in the future. In order to promote user access to augmented reality systems for

learning, Lamounier et al. (2010) have pointed out that changes in Internet portability need to be made. Increased access to the Internet would give students the ability to use augmented reality via a smartphone. This has the potential to make augmented reality a powerful learning tool that can help learners acquire knowledge of content and retain that knowledge through their experiences with the activities of smartphones.

CONCLUSION

With the advent of new knowledge through the use of computer science and technology, the art of learning is forever changing. The use of augmented reality as a tool in teaching may be what the future holds for the newer generation of students to come. Through this review, the use of augmented reality in the aspects of teaching and learning indicates better outcomes in the form of learning motivation, initiation of continuous life-long learning, and increasing the depth of understanding of the subject taught which defines the deep learning approach. The use of augmented reality especially in the teaching of medicine, may help to provide a sustainable form of medical knowledge that is dependable. Augmented reality application may be valuable as a complementary teaching method in instilling deep learning approach and cultivating continuous life-long learning and does not aim in replacing the conventional teaching and learning methods.

While augmented reality has been shown to be helpful to teachers, it can also be concluded that its use can decrease the teacher's position as the only source of information in certain cases, because it may allow learners to be supported and dependent on their peers or even their parents. In addition, augmented reality can help foster student freedom and engagement, which can lead to more student-centered approaches, where students are the object of their own learning and can apply it in more realistic ways. The use of augmented reality has also helped students to experience more concrete situated learning experiences and, together with mobile technologies, can help to contextualize learning across different environments.

In education, augmented reality technology is still novel, so there are still some constraints. However, the bulk of these restrictions are related to technical problems. As research on the incorporation of augmented reality in education is strengthened, such limitations can be conquered with time.

Further research in evaluating the outcome of the academic performance amongst students based on the use of augmented reality in the education field has to be established as this topic is still in the early stages which may hopefully produce better, brighter, and innovative students.

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