A Critical Review on Increasing Student's Motivation in Science Subject Using Augmented Reality

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Abstract
A critical review of literature was conducted to examine the student's motivation level in science subject using Augmented Reality (AR). Augmented Reality technology is used widely because it allows enhancing the understanding of complex concept at most educational levels. The two main primary approaches used to review of literature are the topical and critical review approaches. This article mainly discusses about the critical review that was carried out using 5 steps method. The methods are (1) exhibiting a research objective and research question, (2) evaluating sample of sources in the literature observed, (3) analyzing the data that was collected, (4) interpreting the findings from critical analysis using descriptive statistics and finally, (5) discussing effects and implications from these results that were identified. The author collected total number of 45 articles from index journal and 14 articles are chosen after sorting. The critical review made the author to determine 4 main themes which were constructed into a conceptual framework based on continuity. This critical review gives benefit to learners to improve the level of motivation in learning using AR. Overall, the result shows Augmented Reality in teacher education is considered very valuable and should be

implemented in pedagogical problem-solving skills, such as mathematics, physics, chemistry and biology in future studies.

Keywords: Critical Review, Augmented Reality (AR), Motivation, Science, Learning

Introduction

Augmented Reality (AR) was found to have a huge potential for pedagogical application where it has been chosen to be one of educational tool in a number of purposes such as collaboration, cultural exploration, digital storytelling and interaction (Acosta et al., 2014). The learning environment can be extraordinary and more interactive, as Augmented Reality can enable teachers to explain a concept in creative way. The role of learning media is important in science subject to visualize an abstract consist of concepts.

AR is a technology that visually augments the real world environment by projecting computer-generated information into the eye (Azuma et al., 2001). While the Malaysian Education Blueprint 2013-2025, incorporated of ICT was under Shift 7. The integration of technology is important for developing appropriate learning media which can help students to understand a complex concepts easily. AR techniques are used extensively in various real world applications for education, training, entertainment, tourism, and cultural heritage (Poux et al., 2020). AR techniques have completely changed the design and method of learning especially in the education field (Quintero et al., 2019). AR is a field which had spark interest among researcher that aims to fully integrate the virtual with the real environment. The final outcome of AR can be in the form of three-dimensional (3D) models, audios, videos, images and text content for education.

According to a study perform Divjak & Tomić (2011), techniques utilizing AR results in a better understanding of the concepts. Augmented Reality enables the integration of 3D virtual objects into the real world simultaneously (Azuma, 1997). AR technology aims to change people's interaction and experience with the real world by enriching the context with virtual objects including images such as pictures, texts and animations. In a study, the author found that AR applications rise students' performance and educational achievement in the learning procedure as compared to traditional methods (Muzaffer, 2018). AR learning techniques have several positive impressions on the students in comparison with traditional methods of learning. AR techniques increase students' motivation for learning, teamwork in group tasks, and understanding of the learning content for an extended period (Radu, 2012).

Critical review, which is a systematic review of literature, plays vital role in a process of evaluating material. Systemic review can be divided into critical and meta-analysis. They help researchers to obtain findings in specific area based on specific criteria. Critical review can provide strong evidence for description; interpretation and deep analysis regarding certain topics, which will make the readers, capture the value with credibility. Moreover, the systemic review can be a guide for future studies and previous studies regarding Augmented Reality to be referred.

Our research presents the increasing student's motivation in science subject using Augmented Reality describing the scholarly values of this technology. To facilitate decision-making by educators on specific didactic aspects in this field, a systematic review of the literature has been carried out with the aim to bridge the existing gap in the literature by analyzing all educational studies found in various databases such as Scopus and Science Direct. From the identification results,

1) What journals are used in this literature study?

2) What are the positive changes after implementing this technology during the teaching-learning process?

3) What are the effectiveness of the Augmented Reality in increasing motivation of the students?

Methodology

This review employed a data-based convergent synthesis design, a type of mixed method systematic review synthesizing evidence derived from quantitative and qualitative studies (Hong et al., 2017). This study analyzed and synthesized articles regarding the use of Augmented Reality technology in science learning from the year 2019–2021. The researcher used keywords "Augmented Reality Science Education" to collect articles from respected databases. Scopus databases provides a larger abstract and citation in various subject areas of science, technology, language and many more. The researcher retrieved twenty-eight articles from Scopus database. The keywords used for searching articles are 'AR in Education', 'Teaching Science using AR technology', 'Efficiency of AR' and 'Effectiveness of AR'. The obvious first step is to search for articles related to your study and to select the relevant ones. The second step is to extract important points from the selected articles. The third and final step is to report on the contribution of these articles. The researcher ensures articles fit the theme of research to access them. The result of the information search are as in the summary in Table 1.

Table 1
The Total Articles Classified by the Databases

Databases	Keywords			
	AR in Education	Teaching Science using AR technology	Efficiency of AR	Effectiveness of AR
Scopus	15	14	7	9
Total	45			

Based on Table 1, the researcher retrieved primary articles consisting of 45 articles from the SCOPUS database. Subsequently, he carried out inclusions and exclusions criteria to retrieve documents that are more relevant. The documents are in good quality and values that fits the theme of the topic. Irrelevant articles were filtered after reading the abstract, which can give overall view clearly.

Then, the researcher carried out the systematic critical review. First, publication years from 2019 and above were included and publications below the year 2019 were excluded to ensure the articles apply to most recent 21st century learning environment. The technology used before year 2019 might be older and not be effective in this modern age of learning. New research regarding Augmented Reality technology in education is important to gain an accurate result.

Second, the researcher ensured that collected articles were peer-reviewed. These articles offer valid research that are based on multiple expert's knowledge in discipline, which in return prevents falsified work from being adapted within an area of study. Articles that did not meet the peer-reviewed criteria are removed in this inclusion and exclusion criteria filter. Moreover, the filter excluded all writings in the form of conference and book chapters as well.

Third, the exclusion criteria were the following: (1) describe Augmented Reality in areas of knowledge other than educational field, (2) report Augmented Reality on gamification, (3)

the technology used to support the teaching-learning process was not AR, (4) the focuses on collaborative and cooperative learning styles, and (5) unable to find the full article and more relevant to cognitive load theory and skills in medical field.

Lastly, all empirical research approaches involving qualitative, quantitative and mixed method were included in this study. This is to ensure that the topic discussed was effectively surveyed and analyzed by previous researchers with accepted methods. Quantitative data collection and analysis method provides complete verification of statistical data obtained from various kind of survey. Mixed-method research designs used when measuring application analysis, perception and research validity. The qualitative data collection and analysis is used widely to determine the frequency of traits or characteristics. The three major research methodologies were important to gain a valid and accurate result for data interpretation in the field of Augmented Reality as a technology to improvise the educational motivation among the students.

Results and Discussions

The researcher use four inclusion and exclusion criteria in the analysis. First, publication years ranging from 2019 and above. Second, peer-reviewed articles. Third, studies focusing on a wider use of Augmented Reality in learning in the place of a particular use of visual media. Fourth and last, using the three-research design, which are quantitative, qualitative and mixed-method. A total number of fourteen articles remained relevant to the theme of this study out of the forty-five articles searched initially. Two articles were published in Malaysia on 2020. Reports on the details of the fourteen remaining articles are as in Table 2.

Table 2
Report of the Critical Analysis of Literature (Scopus)

Authors	Year	Journal	Country	Data Collection Methods	Conclusion
Cevahir et al	2021	Participatory Educational Research (PER)	Turkey	Survey Questionnaires	The achievement and motivation levels of the students studying on AR increased significantly compared to those studying on traditional way.
Krüger & Bodemer	2022	Information	Germany	Online Survey Questionnaires	AR improve students effects on cognitive load, task load and the resulting knowledge.
Han et al	2022	Applied Sciences	China	Survey Questionnaires and Interview	AR-supported instruction turned out to be trial-and-error and

|					experiential learning, which are effective approaches.
Jesionkowska et al	2020	Education Sciences	United Kingdom	Case Study	AR technology increases the motivation of workshop participants to learn and how they perceive STEAM subjects
Enzai et al	2021	Asian Journal of University Education (AJUE)	Malaysia	Survey Questionnaires	AR is well received and perceived as having potential to engage students more in the teaching and learning process
Bakar et al	2021	GAAR: Gross Anatomy using Augmented Reality Mobile Application	Malaysia	Survey Questionnaires	The use of AR in this research is to motivate students to take care of their bodies that would lead to a healthier living styles as well as easy memorizing of the subject contents.
Fu	2021	Hindawi Wireless Communications and Mobile Computing	China	Survey Questionnaires	AR enable better experience and motivation in teaching via technology and 5G networks
Nugrohu et al	2020	AIP Conference Proceedings	Indonesia	Survey Questionnaires and Interview	Teaching materials based on augmented reality technology are declared valid and suitable for use in learning activities at school and independently during pandemic

Fitriah et al	2021	AIP Conference Proceedings	Indonesia	Test Analysis Questionnaires	AR based teaching material on chemical bonding can help students to improve the understanding and motivation.
Marques & Pombo	2021	Education Sciences	Portugal	Case Study Questionnaires	AR, and game-based approaches are considered just for the fun they provide, to perceptions that these approaches can effectively support deeper learning, and hence changing mentalities on how people can learn.
Abad-Segura et al	2020	Sustainability	Spain	Survey Questionnaires	The use of AR favors more motivating and interactive activities for students, in addition to promoting a more sustainable, equitable and equal education.
Wyss et al	2021	Multimodal Technologies and Interaction	Switzerland	Survey Questionnaires and Interview	The use of AR is very useful in teacher education and that prospective teachers are not averse to this technology's integration
Tuli & Mantri	2020	Procedia Computer Science	India	Survey Questionnaires	AR applications increase students' educational achievement in the learning procedure.
Alizkan et al	2019	Journal of Physics: Conference Series	Indonesia	Analyzing and Synthesizing	The results show that the research trend of using AR in science learning

					from 2012-2019 is on the topic of attitude and achievement that can have a positive impact on science learning

Teachers use various types of technology in education (Table 2) for their teaching purposes. Most of the articles collected in this study, discussed about the usage of Augmented Reality to improve the motivation level of students. According to most of the research, the education style is facing drastic changes after the pandemic of Covid-19. The Augmented Reality technology is an alternative for the classroom to present information to students in a more three-dimensional and intuitive way. These features help in improving the traditional learning system (Akçayır et al., 2016). This technology will probably not only increase student interest in learning but also improves the learning experience and cultivates core literacy.

School, Institutes and Universities are using technology when teaching their students. The augmented technology aims to be an alternative method for educators and learners that offer for interactivity as compared to traditional methods. Using technology is most capable way to build a full interest among educators and learners. Since augmented reality is an emerging technology, it is important to get an idea of the progress and real impact of its use in education especially on science learning. Science learning become more fun and creative when there is an innovative way to learn. Participation and understanding of the learners can be improved drastically when there is an innovative way of learning.

Figure 1 shows a proposed framework, which consist of four stages in learning science subject using Augmented Reality. It is based on IPOO model or also known as the input, process, output and outcome model. The perspective of the IPOO-model, which is a new theoretical approach to creative school learning (Mező, 2011). First input stage is identifying the lack of Augmented Reality application on learning. Second process stage is developing Augmented Reality as a teaching material. Third output stage is apply Augmented Reality as a teaching material in science topic. Fourth outcome stage is describing productive learning which increases student's motivation through Augmented Reality. The proposed model can be a proper reference to carry out the research.

Input	Process	Output	Outcome
Identifying the lack of Augmented Reality application on learning.	Developing Augmented Reality as a teaching materials.	Apply Augmented Reality as a teaching material in science topic.	Increases student's motivation through Augmented Reality.
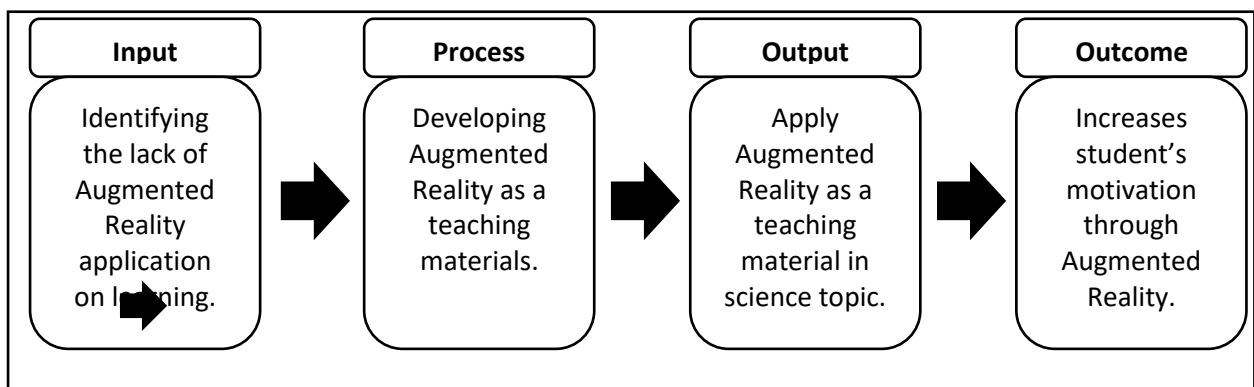
Conclusions

The development of critical review in this study of Augmented Reality provided with two implications. The first implication is the study agreements, and the second implication is the study gaps. The articles critically reviewed in this paper agrees that the use of Augmented Reality play a major part in learner's motivation, understandings, participations, experiences and cognitive load. Moreover, Augmented Reality used as an educational technological tool which improve the teaching-learning process by influencing it in a multidimensional way. AR in education can turn out to be a very exciting and useful intervention that will change the education system tremendously for the upcoming years. The research gap shown from this study can be observed through the lack of number of studies that solely focus on Augmented Reality as modern technologies are known to develop mass amount of software with identical functions, features and uses. Furthermore, as the grey shaded cell in the country column showed in Table 2, only two study was found which was carried out in Malaysia. There are very few articles can be found in Scopus database regarding Augmented Reality on learning material. Therefore, future work shall focus on guidance on how to make effective use of AR and more developers that support the teaching process are needed, together with the promotion of its use through, for example, competitive projects or awareness of higher education institutions towards this technology. Further research is required, particularly the integration of Augmented Reality for enhancing the long-term memory retention in science subject because visualization improvise memory power.

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