AJVAH
e-ISSN: 2735-1165
DOI: https://doi.org/10.53797/ajvah.v2i1.1.2021

The Impact of using Augmented Reality as Teaching Material on Students' Motivation

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Available Online 08 March 2021

Abstract: The integrated technology of Augmented Reality (AR) in education is expanding rapidly due to the advancement of smartphones and fast internet access. Therefore, this study aims to examine the effect of the use of Augmented Reality learning materials on student motivation based on four motivational constructs, which are attention, relevance, confidence, and satisfaction. This research is conducted using the quantitative approach, and questionnaire instruments were applied to collect the research data. The respondents are from the first semester students that took the Basic Electrical and Electronic Course at Bagan Datuk Community College. The data were analyzed by descriptive and inference to determine the level and difference of the students' motivation before and after using Augmented Reality as teaching material. The results showed that the motivation initially at a moderate level has increased to a high level after using Augmented Reality learning materials. The study found that the use of Augmented Reality learning materials has a positive effect on student motivation based on the significant difference test results, and the percentage value of each motivational construct increased.

Keywords: Augmented reality, motivation, community college, technical education and electrical engineering

1. Introduction

The previous studies have found that the Basics of Electricity and Electronics is the least popular course among the students (Hemami, 2017; Gero et al., 2016; Becker et al., 2014; Gibilisco, 2011; Lavonen & Lavonen, 2000). This may be due to the lack of motivation, making it difficult for students to keep focused on learning (Kim & Keller, 2010). Therefore, new strategies need to be implemented to ensuring the effectiveness and significance of teaching and learning (Bhuyan, 2014). Lecturers can practice additional teaching materials through the features of digital technology so they can attract the students' interest (Chao & Chang, 2018). According to Billinghurst et al. (2015); Wu et al. (2013); Carmigniani et al. (2011), Augmented Reality is a new technology that is easy to use in conjunction with the evolution of smartphones. Augmented Reality (AR) brings the meaning of technology that upholds the virtual objects in real scenes by displaying additional information to the incomplete information into the real world (El Sayed et al., 2011). The ability to display virtual objects into Reality makes this technology become the choice of educators in creating the learning environment more exciting and explorative (Endah & Pungky, 2013). This technology is also relevant to adapt as the ownership of smartphones by most of the people makes access to Augmented Reality technology broadly.

In the context of learning, student motivation is the factor that needs to be given priority because it can affect the performance and effectiveness of teaching (Clayton et al., 2010). According to Kamus Dewan (2015), motivation can be defined as a strong desire to drive a person to strive to do something to achieve success. The motivation model, or known as the ARCS model, which was introduced by Keller (2009). ARCS mean Attention, Relevance, Confidence, and Satisfaction. The construct of attention (A) determines whether the teaching material includes the elements of diversity that can attract the attention of students. The relevance (R) construct measures whether the

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teaching materials meet the requirements of students and appropriate for their learning experience. Meanwhile, the construct of confidence (C) determines whether the teaching material can help students build a positive attitude and hope for success. The last construct is satisfaction (S) that assesses whether teaching materials can provide fulfillment to students.

Nowadays, various Augmented Reality learning applications have been developed (Mart´ın-Gutierrez et al., 2015). However, the research on the implications of Augmented Reality applications is still at an early stage, mostly related to the impact of AR in teaching (Di Serio et al., 2013). Thus, this study was conducted to identify the effects of the use of AR teaching materials by assessing the level of motivation of students before and after the use of AR applications in Basics of Electricity and Electronics learning based on the ARCS Model. The ARCS model has been used by several previous studies (Chiang, Yang, & Hwang, 2014; Khan, Johnston, & Ophoff, 2019) to examine the impact of the use of technology on student motivation using four primary constructs that are attention, relevance, confidence, and satisfaction.

Previous studies (Chiang et al., 2014; Chao & Chang, 2018) have also shown that Augmented Reality can increase student learning motivation and contribute to better academic achievement. According to Bistaman et al. (2018), Augmented Reality makes the teaching and learning process more fun, more interactive in creating learning experiences. Widiaty et al. (2017) developed ARtikon-Joyful and used AR technology as a tool in learning Batik. Two tests were conducted on Vocational Secondary School students before using the AR application and after they used the application. The study found that after using the application, students' spatial intelligence improves and helps them understand patterns more easily, more effectively, and in an interactive way. This study also extends previous studies conducted in other countries that specifically look at the impact of AR technology on student learning motivation (Chiang et al., 2014).

2. Literature Review

Nowadays, various Augmented Reality learning applications have been developed (Amin & Govilkar, 2015). However, the research on the implications of Augmented Reality applications is still at an early stage, mostly related to the impact of AR in teaching (Di Serio et al., 2013). Thus, this study was conducted to identify the effects of the use of AR teaching materials by assessing the level of motivation of students before and after the use of AR applications in Basics of Electricity and Electronics learning based on the ARCS Model. The ARCS model has been used by several previous studies (Chiang et al., 2014; Khan et al., 2019) to examine the impact of the use of technology on student motivation using four primary constructs that are attention, relevance, confidence, and satisfaction.

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3. Methodology

3.1 Sample and Research Location

A total of 31 students of the first semester from the Basics of Electrical and Electronics course in Bagan Datuk Community College were involved in this study. Respondents were selected because this learning material has been specifically designed to help students learn the Basics of Electricity and Electronics.

3.2 Research Instrument

Questionnaire instruments were designed and adapted based on the Instructional Materials Motivation Survey (IMMS) questionnaire. The selection of IMMS is based on previous studies (Chiang et al., 2014; Solak & Cakir, 2015) that also use IMMS in determining the effect of the use of Augmented Reality technology on students' motivation. In this study, IMMS is used as a guide to developing two motivational instruments, which are motivation before (pre-use) and motivation after (post-use) students (Sirakaya & Sirakaya, 2018). There are two sections in the questionnaire, the first section on the background of the respondents, while the second section assesses the level of motivation based on the ARCS motivational construct, which are attention, relevance, confidence, and satisfaction of students on the learning materials used.

3.3 Motivation

Student motivation is measured using the Augmented Reality Application. The IMMS instrument contains 32 items that represent two dimensions. The first dimension is the pre-use instrument includes 16 questions that assess students' motivation on the use of conventional notes such as teaching notes and practical guides. Simultaneously, the post-use assessment consists of 16 questions that evaluate students' motivation to learn the Basics of Electricity and Electronics through the Augmented Reality application. IMMS uses scoring based on a scale as in Table 1.

Table 1: Likert scale level of agreement

Level of Agreement	Scale
Strongly Agree (SA)	5
Agree (A)	4
Slightly Agree (SLA)	3
Disagree (D)	2
Strongly Disagree (SD)	1

3.4 Electronic Component Testing Application

Electronic Component Testing Application (ARKE) is a practical teaching material in the form of android application (apk) that integrates Augmented Reality (AR) technology (Ahmar & Rahman, 2017). This application allows students to learn 10 basic testing and measurement practices of electronic components by self-access. The practice includes resistor testing, voltage value measurement, current value measurement, induction testing, capacitance testing, forward-biased diode testing, reverse-biased diode testing, transistor base testing as well as transistor transmitter and collector testing.

To use this application, students need to install arke.apk using a mobile phone based on the android operating system. The integration of this AR-based image tracking technology requires the user to give permission to access the image from the mobile phone before the application is fully functional (Choi, 2009). Next, students will be presented with a main menu page that lists buttons such as scans, videos and practical materials. The scan button option allows students to use AR technology to scan the AR markers found in the AR practical sheets provided during the lesson. Through this scan, students can learn practical testing steps in the form of simulations using their mobile phones. In addition, ARKE also offers self-learning through a selection of video buttons that list actual recordings in the laboratory. Students can also download teaching materials by selecting the practical materials button provided in the application.

3.5 Effect of Using Augmented Reality Materials

The effect of using Augmented Reality teaching materials is measured to compare students' learning motivation through quantitative methods. With the assistance of lecturers from the course, the respondents were given the opportunity to use the Augmented Reality learning material, the application of Electronic Component Test Interactive (ARKE), for a week before being applied in the classroom. The sampling method is intended to be used for 31 respondents of the first-semester student at Bagan Datuk Community College that took the Basics of Electricity and Electronics course. This learning material has been specifically designed to help students learn the Basics of Electricity and Electronics through the test simulations displayed. Once ARKE is downloaded and installed, students can access the Augmented Reality learning material by scanning the markers found in the interactive practical sheets using the available camera on their mobile device without the internet connection.

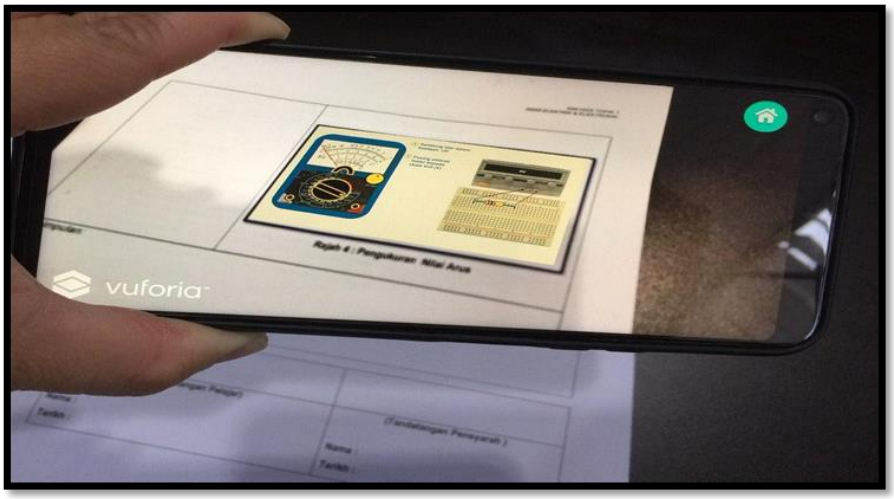

Fig. 1: Simulation test

This research was conducted to identify the effects of the use of Augmented Reality teaching materials in practical learning of Basics of Electricity and Electronics by comparing the level of student motivation with the following research hypotheses:

Ho = There are no differences between the level of motivation before and after use AR learning applications ($\mu 1 = \mu 2$).

Ha = There are differences in the level of motivation before and after the use of application ($\mu 1 \neq \mu 2$).

4. Data Analysis

4.1 Descriptive Analysis

The respondents consisted of 16 female students and 15 male students who took the Basics of Electricity and Electronics course at Bagan Datuk Community College. The data of the questionnaire is completed through Google Form and was exported and re-coded using IBM SPSS Statistics 20 software. First, the reliability value of the research is determined based on the value of the coefficient alpha obtained. The reliability value of this study was found to be at an acceptable level of 0.722 (pre-use) and 0.699 (post-use). After that, the contra-shaped questionnaire data were re-coded first before the mean value of each construct was determined in statistics descriptively to assess the level of student motivation before and after the integrated Augmented Reality teaching material was used. The interpretation of the level of motivation is evaluated based on the Mean Score Range, as shown in Table 2.

Table 2: The indicator of the mean scale scores

Mean Score Range	Interpretation
3.68-5.00	High
2.34-3.67	Moderate
1.00-2.33	Low

The Shapiro-Wilk (SW) statistical test was performed first to determine the normality of the research data. Next, the pre-use and post-use data clusters were analysed using the Wilcoxon Sign Test to compare the mean value between the differences of the groups of respondents.

5. Findings

5.1 Level of Motivation

Descriptive statistical analysis found that the overall mean score for pre-use motivation was 2.9355, while the overall mean score for post-use motivation was 4.1976, as shown in Table 3. For pre-use motivation, the construct with the highest mean score was 3.1048 confidence, followed by relevance 3.0806, satisfaction 2.9113, and attention 2.6452. The post-use motivation findings showed that the satisfaction constructs obtained the highest mean score with a value of 4.5357, followed by attention 4.5161, relevance 4.3952, and confidence 3.3145.

Table 3: Descriptive statistics of motivation levels before and after usage

	Pre-Use			Post-Use		
	Mean	**Standard Deviation**	**Level**	**Mean**	**Standard Deviation**	**Level**
Attention	2.6452	1.25793	Moderate	4.5161	0.56618	High
Relevance	3.0806	1.22200	Moderate	4.3952	0.57653	High
Confidence	3.1048	0.92144	Moderate	3.3145	0.45629	High
Satisfaction	2.9113	1.40764	Moderate	4.5645	0.52428	High
Motivation	2.9355	1.13852	Moderate	4.1976	0.38867	High

5.2 Comparison of Motivation Levels

The type of data obtained should be determined before the comparison test is conducted. Ahad et al. (2011) recommended the Shapiro-Wilk test is the best option for testing the normal distribution of data. According to him, when the normality test is performed on abnormal data, especially with small sample size, there is a possibility that the data becomes normal even though it is not. Meanwhile, Field (2009) stated that for samples over 30 or 40, the sampling distribution tends to be normal regardless of the resulting data form.

Table 4: Normality test

	Before Motivation	After Motivation
Statistic	0.846	0.903
Sig.	0.000	0.009
Skewness	0.584	-1.313
Kurtosis	1.336	2.222

Table 3 shows that the data obtained are scattered abnormally with the results of the pre-use motivational data normality is significant (p=0.000). However, the skewness value of 0.584 and kurtosis 1.336 are within the normal curve estimate. As for post-use motivation, the results of normality were also found to be significant and scattered abnormally (p=0.009) with a skewness value of -1.313 and kurtosis 2.222. These significant results (p value <0.05) indicate that there is a difference in the normality of the sample, which in turn interprets the distribution of data as abnormal (Pallant, 2011). Thus, the research data obtained as a whole is abnormally scattered.

Next, the overall mean values for pre-use and post-use motivation were analysed to identify statistically significant differences. Based on the results of the abnormal data distribution, the Wilcoxon Sign Test was used to compare the mean value differences for the groups studied. Comparative data analysis Table 4 shows that 6 data samples have a decrease in score with a mean rank of 5.58, and a total negative rank is 33.4. Only one sample did not show any difference, while the other 24 samples had a positive increase in motivation with an average mean increase of 17.98 from the total deviation of 431.50.

Table 5: Rank

		N	Mean Rank	Total Rank
After Mean - Before Mean	Negative Rank	6a	5.58	33.50
	Positive Rank	24b	17.98	431.50
	Same	1c		
	Total	31		

Note: a. Mean After < Mean Before, b. Mean After> Mean Before, c. Mean After = Mean Before

The results of Table 5 with values of Z=4.094 (Z>1.65) and p=0.000 (p<0.05) also rejected the null hypothesis. Further observation found a significant difference in terms of students' level of motivation during pre-use and post-use of AR learning applications with a positive value.

Table 6: Wilcoxon sign test based on negative rank

	Mean After – Mean Before
Z	-4.094b
Asymp. Sig. (2-tailed)	.000

Table 6 shows the mean difference in mean values for motivation during pre-use and post-use based on the four motivational constructs. Mean analysis showed that all constructs had an increase in the mean percentage with the highest difference value being the attention construct with an increasing rate of 70.72%, followed by the satisfaction construct of 56.78% and relevance construct 42.67%. The confidence construct has the lowest percentage difference value, with an increase of 6.75%. The percentage difference in the overall level of motivation had an additional percentage difference of 42.99%.

Table 7: Mean difference

	Before	**After**	**Difference Percentage**
Attention	2.6452	4.5161	Increase 70.72%
Relevance	3.0806	4.3952	Increase 42.67%
Confidence	3.1048	3.3145	Increase 6.75%
Satisfaction	2.9113	4.5645	Increase 56.78%
Level of Motivation	2.9355	4.1976	Increase 42.99%

6. Discussions

Student motivation was found to be at a high score level ($M>3.67$) after the Augmented Reality teaching material was used even though initially, the student motivation level was at a moderate score level ($3.67<M>2.34$). The statistical inference results obtained reject the null hypothesis that there is a significant difference ($p<0.05$) on the motivation of students before and after the use of Augmented Reality teaching materials used in the Basics of Electricity and Electronics. The results of the analysis showed that there was an increment of (42.9%) after the use of Augmented Reality teaching materials was used. Besides, an increment for each motivation construct with the highest percentage is the attention construct followed by the satisfaction, relevance, and confidence constructs. These findings are consistent with previous studies conducted by Sáez-lópez et al. (2020) stated an improvement in student learning performance related to motivation and confidence by experiencing in-depth experience after using the Augmented Reality Application.

7. Conclusion

The results provide an overview of student motivation before and after the use of teaching materials integrated Augmented Reality. The study found that the Augmented Reality Application can positively motivate students of the Basics of Electricity and Electronics course at Bagan Datuk Community College. Students' motivation is initially at a moderate level when conventional teaching materials such as notes and practice sheets are commonly used. However, after using the Augmented Reality application, students' motivation increases to a higher level. This is because the use of Augmented Reality makes student motivation increase to a higher level. Students were found to be more focused, confident, and satisfied with the teaching materials used. The study also found that the use of integrated learning materials with Augmented Reality is suitable for this time being. These findings are similar to the results found that Augmented Reality learning materials are relevant in helping students understand teaching better. Augmented Reality teaching materials have made the Basics of Electricity and Electronics practical learning process better than the conventional methods commonly used by lecturers. The applications of Augmented Reality that are self-accessing support more flexible practical learning not limited to a specific time and place. There are no more constraints for students to remember the practical method at home because the Augmented Reality simulation display makes the equipment in the laboratory no longer mandatory when reviewing lessons.

Overall, the results of this study were found to support several previous studies prove that there is a positive effect when Augmented Reality technology is integrated into education. Therefore, it is suggested that lecturers, especially at Bagan Datuk Community College, to master and maximise the use of Augmented Reality technology to ensure a better and more effective learning environment. However, the results of this study are limited to students of Basic Electricity and Electronics courses at Bagan Datuk Community College only because the selection of samples is objective and not random. Most community colleges in Malaysia also offer this course, but further studies are suggested with a larger and random sampling of students from several other community colleges to determine the effectiveness of Augmented Reality teaching materials among Community College students in general.

Acknowledgement

A lot of thanks and appreciation to the Ministry of Education Malaysia through the Department of Polytechnics and Community Colleges, for sponsoring the TVET Applied Research Grant Scheme (T-ARGS) Phase 2 2019.

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