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A Study of Students' Motivation Based on Ease of Use, Engaging, Enjoyment and Fun Using the Augmented Reality Science Textbook

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Abstract

Science plays a major role in assisting Malaysia to achieve the developed nation status by 2020. However, over a few decades, Malaysia is facing a downward trend in the number of students pursuing careers and higher education in science related fields. Since school is the first platform where students learn science, a new learning approach needs to be introduced to motivate them towards science learning. The aim of this study is to determine whether the intervention of the enhanced science textbook using augmented reality contributes to the learning process of lower secondary school students in science. The study was carried out among a sample of 70 lower secondary school students. Pearson Correlation and Regression analyses were used to determine the effects of ease of use, engaging, enjoyment and fun on students' motivation in using the augmented reality science textbook for science learning. The results provide empirical support for the positive and statistically significant relationship between engaging, enjoyment and fun and students' motivation for science learning. However, ease of use does not have a positive and significant relationship with students' motivation for science learning.

Key words: Augmented Reality Science Textbook, Science Learning Motivation, Perception Study

1. INTRODUCTION

Science learning involves many dynamic concepts which are difficult to be explained simply by using text and images alone. Thus, supplementary learning materials are required since some dynamic concepts are difficult to explain in the traditional method of teaching (Hwang et al, 2012). Sometimes students failed to imagine and understand the actual meaning of a scientific process (Phon et al, 2014; Hwang et al, 2012; Aziz et al, 2011). Thus, science learning requires a new method that allows students to understand dynamic science concepts more easily compared with the conventional learning method. In doing so, an enhanced science textbook using Augmented Reality (eSTAR) has been designed and developed for this purpose and a correlation and regression study has been conducted among a sample of the form two secondary school students. Augmented Reality (AR) provides a unique experience in a learning environment. This technology is currently popular and well-known in the education field. AR can be applied in science learning to motivate students to be more interested in science and to pursue their careers in science related areas.

Nowadays, advances in technologies make it feasible to use AR for learning (Specht et al, 2011). AR enhances the senses (vision, aural, and tactile) with virtual or naturally invisible information superimposed on top of the real world by digital means (Azuma, 1997). AR is like 3D virtual world which offers different degrees of immersion and interaction that might help to engage students in the learning activities. Majority of knowledge is gained through seeing (75%), listening (13%) and other senses (12%) (Laird and Schleger, 1985). Hair et al (2006) claim that learning through seeing and listening enhances the student's understanding in a learning process. Other than that,

learning is a prominent process and it would be more effective and long lasting if certain senses, such hearing, sight, touch and emotions are involved (Rasalingam et al, 2014).

The advancements of new technologies have led to the adoption of a plethora of new tools and techniques in teaching and learning. AR and Multimedia (MM) are examples of the technologies that hold a lot of potential in science learning. Scientists, researchers, and teachers agree that students who are motivated to learn are more likely to engage, persist, and expend effort for task completion than those who are unmotivated (Sevinc et al, 2011; Yen et al, 2011). Thus, the enhanced science textbook using augmented reality (eSTAR) with the addition of multimedia elements which include text, audio, video, graphic, animation and 3D object has been proposed in enhancing the students' motivation towards science learning.

2. THE eSTAR CONCEPTUAL MODEL

A conceptual model depicts the employed principle, theories and model (Churchill, 2011). It supports the researcher to decide the relationship among those components in enhancing the understanding of the research problem and solution (Zulkifli et al, 2013). The conceptual model is a huge asset in a research study because through the use of the model, researcher, designer and developer are able to visualize a project from their perspective (Zulkifli et al, 2013). Several important models, theories and principles have been employed namely; the ARCS (Attention, Relevance, Confidence and Satisfaction), the Cognitive Theory of Multimedia Learning (CTML), the Intrinsic Motivation Theory and Multimedia Learning Principles. The eSTAR conceptual model comprises of three design components namely; design for interaction, design for information and design for presentation (Valarmathie et al, 2015). Each of the design components adapts several elements in order to make the model more ample and useful. The design for interaction adapts the User Centered Design; the design for information adapts the Macro Design Strategies and the design for presentation adapts the Micro Design Strategies. The eSTAR conceptual model as shown in Figure 1 is essential in the design and development of the eSTAR application (Valarmathie et al, 2015).

3. METHOD

3.1. Participants

The data for this study were collected from a sample of 70 Form Two students of a secondary school in Kuala Kangsar, Perak utilizing the purposive sampling technique. The sample size satisfies the requirement stated by Coakes and Steed (2003) whereby the minimum number of samples must be at least 30. 32 (45.70%) of the respondents were male and 38 (54.30%) were female. Prior to the evaluation, a brief explanation regarding the usage and the user interface of the eSTAR application was given to the respondents. They were given a week to use the eSTAR application for their out of the class science learning on their own.

3.2. Measurements

Motivation is the dependent variable of this study. Motivation is an act which encourages someone to do some action (Guay et al, 2010). Previous studies have proven that AR is able to motivate students to be more interested in science learning (Yen et al, 2013). Motivation is an important element in science learning because it leads to conceptual changes, critical thinking and enables students to perform well in the respective subject (Tuan et al, 2005). Students should be academically motivated in order to engage and invest the effort towards learning and achieving good grades in science. In this study, the independent variables used were ease of use, engaging,

enjoyment and fun. Ease of use is defined as the ability to navigate an application or the system without any second person's guidance (Davis, 1989). Meanwhile, engaging is defined as fully focused on certain activity and not easily distracted (Neo and Neo, 2004; Beeland, 2002). Engaging is among the most used variable by researchers in previous studies related to AR-based projects. Engaging enables the students' learning process to be converted into a great learning process (Beeland, 2002). Enjoyment is defined as the action which makes a person pleasure (Ainley and Ainley, 2011). It is a good feeling which able to reduce the tension and boost up the motivation in learning process (Liao et al, 2008). Enjoyment assists students to go through the process naturally and not under any compulsion. Finally, fun is defined as an inherent process that gives people a reward for learning new things. The feeling of fun enhances the ability of understanding and knowledge retention (Rambli et al, 2013). Several previous studies have proven that AR is fun to use in the learning process (Rasalingam et al, 2014; Rambli et al, 2013; Yusoff et al, 2010; McKenzie and Darnell, 2003).

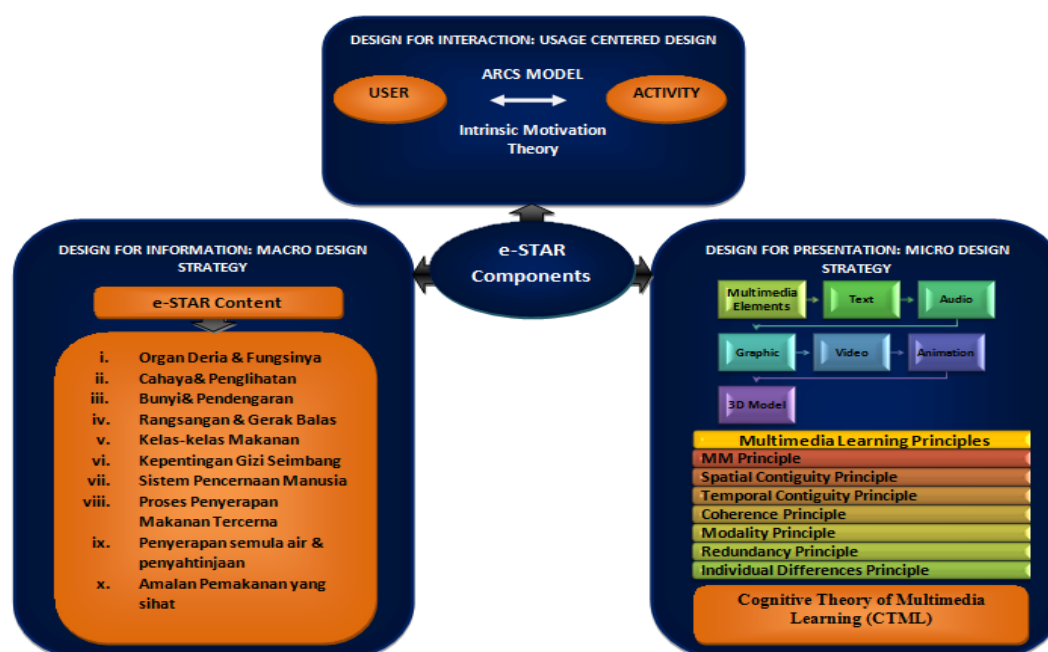


Figure 1. The eSTAR Conceptual Model

3.3. Instrument

The instrument used consists of a set of questionnaires which includes measurements that were taken from previously validated instruments and modified based on the AR learning environment context. The measurements are Ease of use, Engaging, Enjoyment, Fun and Motivation. The questionnaires adapted most of the items from the Instructional Material Motivational Survey (IMMS) which have been modified by Huang et al, (2006) and Science Motivation Questionnaire II (SMQII) (Glynn et al, 2011). Among these measurements, the items for Fun were cited from Glynn et al, (2011); Van Kleef et al, (2010); Nilsson and Johansson (2008). The evaluation questionnaires consist of two sections namely; user's demographic data and user's perception of the application. A 5-point Likert scale anchored by "Strongly Disagree" (1) and Strongly Agree (5) was used.

3.4. Procedure

Prior to the evaluation, a brief explanation regarding the usage and the user interface of the eSTAR application was given to the respondents. They were given a week to go through the eSTAR application and use it for the purpose of science learning out of the class on their own. Then they were given a set of questionnaires for the evaluation.

4. RESULTS

Descriptive statistics, correlation, and regression analyses were used to analyse the data. The Cronbach Alpha values were calculated using the SPSS version 22 as shown in Table 1. Since all the Cronbach alpha values are greater than 0.7, thus all the measurements and items are interrelated and reliable (Nunally, 1978).

Table 1. Cronbach Alpha Values for All Measurements

Measurement	Number Of Items	Cronbach Alpha α
Motivation	6	0.865
Ease of use	6	0.780
Engaging	4	0.836
Enjoyment	4	0.802
Fun	4	0.774

4.1. Descriptive Statistics

Means and standard deviations of all the measurements and items are shown in Table 2. The results showed that the mean scores are 4.10 for Ease of use, 4.03 for Engaging, 4.11 for Enjoyment, 4.25 for Fun and 4.15 for Motivation. Fun has the highest mean score of 4.25 while Engaging has the lowest mean score of 4.03.

Table 2. Descriptive Statistics for All Measurements

Measurement/Item	Mean	Std. Deviation
Ease of use 4.10		
1. eSTAR is easy to use.	4.03	0.659
2. eSTAR is suitable to apply in Science subject.	4.23	0.802
3. eSTAR is suitable to use as a revision tool in the Science subject.	4.01	0.732
4. Augmented Reality is suitable for personal use.	4.09	0.864
5. The step to use the eSTAR is easy to remember.	4.11	0.790
6. eSTAR has made the revision process easy	4.14	0.767
Engaging 4.03		
7. eSTAR attracts my interest in studying science for a long time.	4.03	0.851
8. eSTAR makes me repeatedly revise science subject.	4.03	0.916
9. eSTAR makes me involve in science learning for a long time.	4.00	0.742
10. eSTAR increases my involvement in science learning.	4.07	0.822
Enjoyment 4.11		
11. I really like and enjoy the eSTAR application for science learning.	4.00	0.681
12. eSTAR makes me deeply enjoyed the uniqueness of science.	4.14	0.785
13. I enjoy learning science by using the eSTAR.	4.09	0.676
14. eSTAR cultivates the interest in learning science.	4.23	0.765
Fun 4.25		
15. eSTAR is fun to use in science learning.	4.26	0.674

Measurement/Item	Mean	Std. Deviation
16. Content of the eSTAR adds more fun in science learning.	4.29	0.705
17. I enjoyed using the eSTAR as a revision tool in science.	4.23	0.663
18. eSTAR learning is fun compared with the conventional textbook with normal text.	4.24	0.731
Motivation	4.15	
19. eSTAR is really easy to use.	4.19	0.708
20. eSTAR increases my involvement in science learning.	4.13	0.779
21. I enjoyed the process of learning science for a long time.	4.01	0.712
22. Learning science is more fun with the use of eSTAR.	4.17	0.780
23. eSTAR increases my motivation to achieve high in science.	4.20	0.651
24. eSTAR encourages me to pursue higher education and careers related to science in the future.	4.21	0.657

4.2. Correlation

The Pearson correlation coefficient (r) statistical evaluation is to measure and determine the relationship between the independent variables (ease of use, engaging, enjoyment and fun) and the dependent variable (motivation). The value of the correlation coefficient measured between +1 and -1 (Pallant, 2013). Table 3 presents the Pearson correlation coefficient (r) between Motivation and Ease of use, Engaging, Enjoyment and Fun. First of all, Ease of use, Engaging, Enjoyment and Fun have positive and significant correlation with Motivation. The correlation Coefficients for Ease of use, Engaging, Enjoyment and Fun are .61, .78, .78 and .79 respectively. All the values indicated that they are strongly correlated to Motivation and the correlation for each variable is significant at the 0.01 level.

Table 3. Pearson Correlation Coefficient Analysis

Variables	Motivation	Ease of use	Engaging	Enjoyment	Fun
Motivation	1				
Ease of use	.613**	1			
Engaging	.777**	.711**	1		
Enjoyment	.775**	.789**	.829**	1	
Fun	.790**	.617**	.618**	.655**	1

Note: Correlation is significant at the 0.01 level (1-tailed) **

4.3. Regression

Table 4 depicts the regression analysis for estimating the relationships among variables and to test the hypotheses. The R^2 value is 0.775 which depicts the changes in students' motivation regarding to science learning through the intervention of eSTAR. The predictors in the analysis are the independent variables of this study which include Ease of use, Engaging, Enjoyment and Fun. Moreover, one tailed test was utilized in order to measure the relationship between the variables in order to verify the hypotheses. The acceptable significant t-value should be more than 1.645 and p-value should be less than 0.05 (Cohen, 2008). Moreover, the purpose of F ratio in the ANOVA table is to determine whether the overall regression model is fit for the data or not. The independent variables statistically significantly predict the dependent variable $F(4.65) = 55.985$ and the regression model is fit for the data.

Table 4. Regression Analysis

Variable	Beta	Std. Error	t-value	Sig (p-value)
Ease of use	0.10	0.09	1.055	0.30
Engaging	0.29	0.09	3.187	0.00**
Enjoyment	0.22	0.11	2.052	0.04*
Fun	0.49	0.84	5.797	0.00**

** Significance level; $p < 0.01$

* Significance level; $p < 0.05$

Dependent Variable: Motivation

N=70; R Square, 0.775; Adjusted R^2 , 0.761; F = (4.65) 55.985

5. HYPOTHESES TESTING

In this study, hypotheses testing were conducted to determine the relationship between Ease of use, Engaging, Enjoyment and Fun and Motivation. Therefore, the following null hypotheses have been formulated.

Hypothesis H_{01} : There is no significant relationship between Ease of use and motivation in the eSTAR application.

Hypothesis H_{02} : There is no significant relationship between Engaging and motivation in the eSTAR application.

Hypothesis H_{03} : There is no significant relationship between Enjoyment and motivation in the eSTAR application.

Hypothesis H_{04} : There is no significant relationship between Fun and motivation in the eSTAR application.

As hypothesized in H_{01} , there is no significant relationship between Ease of use and motivation in the eSTAR application. Based on the results of the regression analysis as in Table 4, Ease of use does not have a positive and significant relationship with Motivation with Beta = 0.10, $t = 1.06$ and $p = 0.30$. Thus, this null hypothesis is supported. Ease of use is not significant, but it is positively correlated to Motivation as shown in Table 3. As hypothesized in H_{02} , there is no significant relationship between Engaging and Motivation in the eSTAR application. Based on Table 4, Engaging has positive and statistically significant relationship with Motivation with Beta = 0.29, $t = 3.19$ and $p = 0.00$. Thus, this null hypothesis is not supported. As hypothesized in H_{03} , there is no significant relationship between Enjoyment and Motivation in the eSTAR application. Based on Table 4, there is a positive and statistically significant relationship between Enjoyment and Motivation with Beta = 0.22, $t = 2.05$ and $p = 0.04$. Thus, this null hypothesis is not supported. So, respondents will be more motivated if the enjoyment using eSTAR is increased. As hypothesized in H_{04} , there is a significant relationship between Fun and Motivation in the eSTAR application. Based on Table 4, there is a positive and statistically significant relationship between Fun and Motivation with Beta = 0.49, $t = 5.80$ and $p = 0.00$. Thus, this null hypothesis is not supported. So, it has been proven that more fun will make the respondents more motivated towards science learning.

6. CONCLUSIONS

The continuous decline in the number of students pursuing science and technology related professions are worrisome. There are many external factors that influence the students' attitudes towards science learning and lack of interest is one the factor which can lead to students' lack in motivation. This paper has looked into the possibility of utilising the AR technology by enhancing the existing science textbook through the

development of the eSTAR application. It also provides an insight into the attributes of the eSTAR namely; Ease of use, Engaging, Enjoyment and Fun towards science learning motivation among the Form Two students. The results provide empirical support for the positive and statistically significant relationship between Engaging, Enjoyment and Fun and students' motivation for science learning. However, Ease of use does not have a positive and significant relationship with students' motivation for science learning.

The results of the study are in harmony with the statement of Pribeanu (2012). Based on previous evaluation results, AR with multimedia based learning was able to provide engaging (Pribeanu, 2014; Abhishek et al., 2013; Dunser et al, 2012; Rambli et al, 2012; Abas et al, 2011), enjoyment (Pribeanu, 2014; Cai et al, 2014; Ibanez et al, 2014; Abhishek et al, 2013) and fun (Rasalingam et al, 2014; Rambli et al, 2013; Yusoff et al, 2010; McKenzie and Darnell, 2003) in enhancing the motivation. However, in this study, ease of use is not significantly related to motivation. This is in line with Pribeanu (2012) where users may not find AR as easy to use since new users to AR need to get used to the new learning environment and be comfortable with it.

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