Mobile app-based learning media to facilitate student learning

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ABSTRACT: The aim of this research was to find the acceptability of augmented reality (AR) learning media using a unified theory of acceptance and use of technology (UTAUT) model. The AR media was accessible through a wide area network (WAN). The hypothesis is that students will be more understanding using AR with 3D animation and video. Data were collected by questionnaire and was analysed using path analysis. The results show the following: 1) contribution of performance expectancy on interest in media usage of 15.46%; 2) contribution of social influences on interest in media usage of 12.7%; 3) contribution of performance expectancy on behaviour of 8.41%; 4) contribution of social influences on behaviour of 8.48%; 5) contribution of interest in media usage on behaviour of 9.59%; 6) contribution of performance expectancy and social influences on interest in media usage of 26.3%; and 7) contribution of performance expectancy and social influences on behaviour of 23.0%.

INTRODUCTION

Information and communication technology (ICT) affects many aspects of life, such as the economy, politics, culture, arts and education. In education, ICT changes the roles of conventional books, teachers and learning systems. Innovations developed to bring the advantages of ICT to education include computer-based presentation media [1], e-learning to increase learning motivation and smartphones to assist learning [2][3].

Smartphones are considered a necessity for students, from senior high school through to higher education. This is in line with a survey that 87 percent of college students use a personal smartphone [4]. The smartphone can assist a student to learn anytime and anywhere [5].

The smartphone as a learning medium improves access to education and encourages learning [6]. One of the innovations in learning media is augmented reality (AR) on a smartphone. Augmented reality is a combination of virtual and real things displayed in two dimensions that can be touched, seen and heard. The AR technology allows the user to interact with the digital world, of real and virtual life [7]. The AR can assist students to improve their learning and knowledge retention [8].

There are five reasons why AR-integrated media is important in education:

1) Interactive learning: students can better understand the subject material through interactive learning [9];
2) Portability and low cost: low cost for physical learning material, including illustrations with animation [10];
3) Flexible and easy to learn: students can access the material anytime and anywhere [11];
4) Complete learning: complete learning cycle integrated with other devices connected to the Internet [8];
5) Improved critical thinking: interactive learning can improve a student's critical thinking [12].

The use of AR-based learning media can stimulate the student's critical thinking, since it assists learning with or without a teacher and encourages self-learning.

The AR needs to be optimised: it has entertainment aspects that can increase the student's interest and involves interaction with most senses. There are three participants who have responsibilities for learning media development, viz. the teacher or lecturer, researcher and ICT-designer. The development of AR-based learning media should be undertaken at university as a benchmark and showcase for this learning technology. The results from the research show that the most important factor that affects the learning using AR is content with a 3D perspective. An example is a pop-up book that is interactive and can display motion effects (see Figure 1). The AR-based pop-up book can be displayed on a smartphone and has interactive 3D.

Figure 1: The display of an AR-based interactive pop-up book.

The AR-based media accommodate the learning style of current students who are typically so-called generation Z (born 1997 or later) or digital natives (fluent in the digital world). This generation is familiar with digital devices and comfortable with learning assisted by ICT [13]. The students of generation Z are better at multitasking and are more productive than previous generations [14]. This is because ICT infrastructure, including the Internet, can be accessed easily, increasing the ability to acquire and process information [15]. The implementation of AR on a learning platform can help students to improve their cognitive and technical abilities.

The focus of this research was on the acceptability of AR facilitated by a wide area network (WAN) based on the unified theory of acceptance and use of technology (UTAUT) model. The research hypothesis is that improvement in students' self-learning is contingent upon awareness of developments in technology. With the use of AR, students can better understand material through 3D simulation, animation and video. In addition, the student's interaction with the lecturer is facilitated by virtual online consultations. Therefore, the AR-based pop-up book is an important ICT-based learning medium to encourage self-learning.

The UTAUT technology acceptance model was developed by Venkatesh et al [16]. This model is a description of factors that influence the individual acceptance of the use of media devices. There are five main constructs of UTAUT [16]:

1) Performance expectancy: how much a person believes that the use of a system will help them to improve their performance.
2) Effort expectancy: the easier it is to use, the less effort that is required and *vice versa*.
3) Social influence: an individual who uses the system and is trusted by others will influence them to use the new system.
4) Facility: how much an individual believes that organisational and technical infrastructure supports the system.
5) Actual system usage: the use of the system by the user.

RESEARCH METHOD

This research was quantitative using path analysis. The research had two exogenous variables, viz. performance expectancy (X1) and social influence (X2). An intervening variable was interest in media usage (Y) and the endogenous variable was behaviour (Z).

The research population were 150 undergraduate students studying informatics engineering or informatics engineering education. The data collection was gathered through purposive random sampling. The instrument used for data collection consisted of a questionnaire to obtain a data of performance expectancy and social influence on interest of use. In addition, documentation was used to collect qualitative data to support the quantitative analysis.

Two main factors (performance expectancy and social influence) are direct determinants of intention of use. Behaviour, gender, age, experience and voluntary use mediate impact of the factors on interest in use and behaviour. Figure 2 represents the relationship among the research variables.

A questionnaire was used to gather the quantitative data for the investigation into the relationship between the research variables. A qualitative descriptive data analysis was used to obtain information to support the quantitative analysis. The next step was to pick a sample from each sub-population using a proportional sampling technique. The number of samples picked from each sub-population was determined, based on Slovin's formula. The samples from each sub-population was 120 students. From the total of 240 students, the sample was 150 respondents.

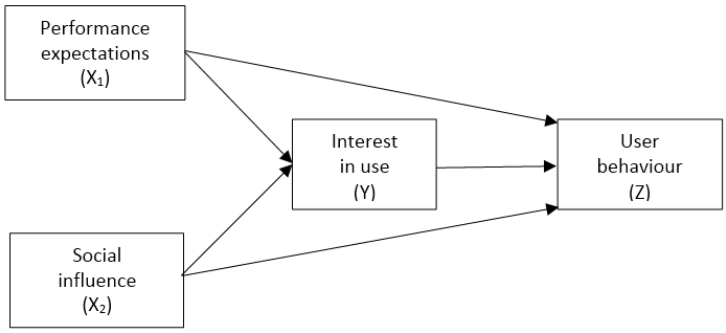

Figure 2: Modified UTAUT model's path diagram [16].

RESULTS AND DISCUSSION

A prerequisite analysis should be done before the hypothesis test. This is to determine that the data qualify for regression analysis. There are basic and classical assumptions for regression analysis. The basic assumptions are normality and linearity, while the classical assumptions are multicollinearity and heteroscedasticity. The test results with the contributing variables are shown in Figure 3.

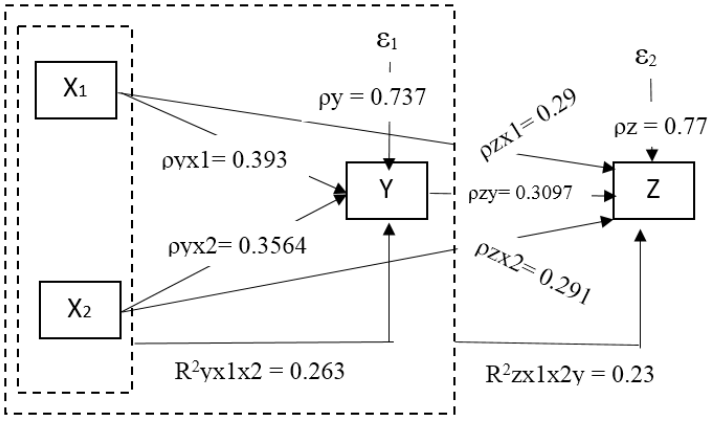

Figure 3. Results of analysis of causal relations between X_1, X_2 and Y against Z.

Contribution of Performance Expectancy on Interest in Media Usage

The performance expectancy on interest in learning media usage resulted in a significance of 0.000 which is lower than 0.05, with the path coefficient $(0.393)^2 = 0.1546$. Therefore, the contribution of performance expectancy on interest in learning media usage was 15.46%. While, the indirect contribution of performance expectancy on interest in learning media usage through environment influence was 6.69%. This result is based on the following calculation: (ρzx1) x (ρzx2) x (rx2x1) = 0.290 x 0.291 x 0.792 obtained a value of 0.0669 x 100% = 6.69%. This result is supported by previous research, which shows that there is a significant positive influence between exogenous and intervening variable of 6.776% [17]. Therefore, educational institutions need to improve the provision of infrastructure [18], which affects the learning environment for people in that environment.

Contribution of Social Influence on Interest in Media Usage

The social influence on interest in media usage has a significance of 0.000, which is lower than 0.05, with the path coefficient $(0.356)^2 = 0.127$ (12.7%); it can be said that the contribution of social influence on interest in learning media usage through performance expectancy is 6.69%. This result is based on the following calculation: (ρzx2) x (ρzx1) x (rx2x1) = 0.291 x 0.290 x 0.792 and the value is 0.0669 x 100% = 6.69%. It is supported by previous research, which shows that there is a significant positive influence between exogenous and intervening variables of 9.55% [17].

As shown in Figure 3, the substructure of the relationships the first variable shows that indirect effects can be known from ρyε1 or (1 - R_{square}) = 0.737. This explains that 73.7% of interest (Y) is affected outside of the indicators of performance expectation variables (X_1) and social influence variables (X_2) such as talent, school background, and so on.

The student's interest in learning media usage is influenced by the social environment during learning. The learning will go well, if supported by a lecturer who has the skills to teach using the latest media. Current education that is influenced by social media can decrease the student's motivation and achievement. The implementation of appropriate learning media improves learning and understanding. This is related to previous research that job satisfaction is a significant factor in a working environment [19].

A learning process is an interaction pattern between student and lecturer [20]. Students have learnt when they can understand something that had not been understood before. The lecturer has taught when it helps students to achieve the desired understanding.

Contribution of Performance Expectancy on Students' Behaviour

Performance expectancy on student behaviour has a significance of 0.019, which is less than 0.05. The path coefficient was $(0.29)^2 = 0.0841$. So the contribution of performance expectancy on student behaviour was 8.41%. The indirect contribution of performance expectancy on students' behaviour through interest in media usage was 2%, which is obtained from the calculation: (ρzx1) x (ρzy) x (ryx1) = 0.29 x 0.3097 x 0.223, the obtained value of 0.020 x 100% = 2.0%. This result is related to a previous result that shows there is a significant relationship between performance expectancy and student behaviour [21].

The performance expectancy results show that using practical tools is the best indicator of student behaviour. The ICT skills to use a computer network are a necessity for students. Information and communications technology is concerned with architecture and computer system performance. Slow responses of a computer network have a negative impact on practical learning. To solve such problems requires better management, including problem identification and resolution, which will involve having information about the availability of, and requirements for, infrastructure.

In order to support learning, maintenance of computer network devices is also needed. If the devices are in good condition they can be used for a long time and give better results [22].

Contribution of Social Influence on Students' Behaviour

The path of social influence on students' behaviour had a significance value of 0.016, with the path coefficient $(0.291)^2 = 0.0848$. Therefore, the contribution of social influence on student behaviour was 8.48%. The indirect contribution of social influence on student behaviour through interest in media usage was 7.0%, which is obtained from the calculation: (ρzx2) x (ρzy) x (ryx2) = 0.291 x 0.3097 x 0.777, the obtained value of 0.070 x 100% = 7.0%. This result is consistent with another result that social influence has a significant effect on student behaviour [23][24]. The student behavioural changes are influenced by educational background and the teacher's experience [25]. Therefore, the higher the level of a teacher's teaching skills through learning media, the bigger the effect on learning outcomes.

The social environment influence results show that the biggest indicator was involving friends on social media. Learning is not only to memorise, but also to construct and internalise knowledge, and also to actualise the learning experience by problem solving.

Contribution of Interest in Media Usage on Students' Behaviour

The path of interest in learning media usage on student behaviour had a significance value of 0.009, with the path coefficient $(0.309)^2 = 0.0959$. Therefore, the contribution of interest in learning media usage on student behaviour was 9.59%. While the indirect contribution of interest in learning media usage on students' behaviour through performance expectancy was 2.0%, which is obtained from the calculation (ρzy) x (ρzx1) x (r x1y) = 0.3097 x 0.29 x 0.223 obtained value of 0.020 x 100% = 2.0%. The value was obtained from indicators, such as physical evidence, reliability, responsiveness, assurance and empathy on infrastructure, administrative services and the professional competence of lecturers. This is in line with motivation theory that holds satisfaction encourages achievement and passion for learning [26]. The social influence results show that the biggest indicator was learning media devices quality.

Contribution of Performance Expectancy and Social Influence on Interest in Media Usage

Based on the hypothesis test, it can be concluded that there is contribution of performance expectancy and social influence on interest in learning media usage. This is indicated with the value of significance 0.000 lower than $p = 0.05$. The determinant coefficient of $R_{squared}$ or R^2_{YX1X2} was 0.263 (26.3%). This shows that performance expectancy and social influence has a contribution on student's interest in learning media usage of 26.3%.

Contribution of Performance Expectancy and Social Influence on Interest in Media Usage and the Impact on Behaviour

There is a contribution between performance expectancy, social influence and interest in learning media usage on behaviour with a significance value of 0.000, which is lower than 0.05. The determinant coefficient R^2_{YX1X2} was 0.23. Therefore, the performance expectancy, social influence and student's interest in learning media usage contributed to improve student's behaviour by 23%.

CONCLUSIONS

Using UTAUT, a path analysis was undertaken of performance expectancy, social influences and facilitating conditions to describe the factors affecting the implementation of AR-based learning media on a computer network. The analysis results for relationship variables show the following contributions:

1) performance expectancy on interest in media usage - 15.46%;
2) social influences on interest in media usage - 12.7%;
3) performance expectancy on behaviour - 8.41%;
4) social influences on behaviour - 8.48%;
5) interest in media usage on behaviour - 9.59%;
6) performance expectancy and social influences on interest in media usage - 26.3%;
7) performance expectancy and social influences on behaviour - 23.0%.

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