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AUGMENTED REALITY TECHNOLOGY APPROACH TOWARDS ENGINEERING DRAWING

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Abstract: *The technology of the gadgets shows the wave of evolution "Industrial Revolution 4.0" or known as "Industry 4.0" has begun. There are 9 pillars of revolution 4.0 and fundamentally, augmented reality is one of the important pillar. Moreover, the Industrial Revolution 4.0 is an innovation that moves from the digital age to the physical cyber era. Consequently, the new field will dominate the world that will focus more on the field of computer science or computing engineering. With the launching of Malaysia Education Development Plan 2015-2025 for higher education steps have been taken to push the Technical and Vocational Education and Training (TVET) which includes special intervention in teaching and learning in this field. Correspondingly, augmented reality being the interactive method of technology that has been hypnotize peoples especially generation Z. In this regard, 21st Century Learning Methods are subjected to the technology based in order to attract the student. Therefore, the researchers have made a study on augmented reality technology approach towards engineering drawing subject among the Mechanical engineering students at Politeknik Tuanku Syed Sirajuddin, Arau, Malaysia in order to study about the impact of AR technology. Pre and post-test has been conducted through this study among 36 first semester students who taking for engineering drawing course. As a result, students have shown an improvement in understanding and assessment performance. Results analysis showed 22% increase in student achievement for excellent grades (90-100), while 39% improvement for Good grades (70-89) whereas moderates grades (40-69) reduced by 58% and weak grade (0-39) grades were abolished 100%. Hence, this study shows that augmented technology was suitable to adapt in 21st century learning method that can be impacted to the students.*

Keywords: *Augmented Reality Technology, Engineering Drawing, Industrial Revolution 4.0*

Introduction

The rapid development of Information Technology today has given a new impetus to the use of technology, especially in the field of education in line with industry 4.0. One of the developments that are increasingly popular nowadays is Augmented Reality (AR) which use a scanning technology as a medium of learning. Fundamentally, industry 4.0 represents the fourth industrial revolution in production; manufacturing and industry. The first industrial revolution (1.0) introduced mechanical production systems using water and steam power. With the second industrial revolution (2.0), mass production was brought about with the help of electric power. In the third industrial revolution (3.0), production was further automated by the use of digital revolution, use of electronics and development of information technology. The purpose of Industry 4.0 is to provide an interaction between people, machines and products by using network-linked intelligent systems (Aydin, 2018).

The change in teaching methods is in line with time circulation. The rapid change of technology also affects the way of nowadays teaching and learning. It is undeniable that Information and Communication Technology (ICT) has contributed significantly in the education world especially in engineering where the delivery of education needs to be in line with technological advances (Haris, Hasan and Talip, 2018). Meanwhile, according to Klingenberg (2018), the transformation of the technology of the gadgets reflect to the wave of evolution "Industrial Revolution 4.0" or known as "Industry" 4.0 has begun. Therefore, the educator need to be aware of the current technological change so that students can cope with the current learning method while lead to enhancement of student performance.

Subsequently, it requires skills and knowledge of learning techniques in order to achieve excellence especially in higher education institution. To study in higher education institution require students to be study smart and study independently. The basic knowledge should be mastered so that students can be survived until finish their study. Therefore, the suitable technique and strategy should be on point and reliable. According to Mohr & Mohr (2016), generation Z interested to learn or study comply with the current technology. In fact, generation Z can be defined as those who were born in the era of mobile computing which is proficiently share the information through social media and interest in learning new things online. However, students need to have the initiative to create a new learning experience for the Gen Z students.

Besides, in 21st century learning method, there were three steps that lead to success in the study. Firstly, understand the Gen-Z students and the way they learn. Secondly, redefine the conventional teaching concepts based on instructional content in preparing students for the future. Then, the last one is to improve the learning of the 21st century with the suitable of Gen-z's needs (Mohr & Mohr, 2016). Hence, Augmented reality technology is appropriate to be implemented towards generation Z which is always surfing the internet all the time. Augmented Realty is a visual effect created by a computer where pictures or videos will be displayed in the real world through a smartphone or certain gadgets. In conjunction to that, engineering's subject well known as a tough course. Therefore, it is suitable to use AR technology to help students to enhance their understanding and enhance their performance. In fact, AR technology can provide relate interesting and fun way of learning.

Nowadays, the learning styles should suitable with current needs. For example, the previous generation such as gen X and gen Y, using the conventional way of learning. Nonetheless, Gen-Z need the learning of the 21st century which more to technology usage. Therefore, engineering

drawing subject need to be exposed to the interesting method in order to attract the students because this subject required the skill and deep understanding in order to complete the assessment given. Currently, the students cannot perform for the engineering drawing subject due to conventional learning method. From the observation in the classroom, the level of understanding and skill of the students in engineering drawing subjects is different where 20% of students are able to follow the learning quickly, 50% are at medium level and 30% are students who feel the engineering drawing is a difficult subject.

Aforementioned, the technology approach that can provide interesting way of learning like Augmented Reality technology approach was tested to this study in order to determine the impact of implementation to the students as Mohr & Mohr (2016) mentioned that Augmented Reality technology is suitable to be a learning tool medium. Hence, this study intended to the impact of augmented reality approach towards engineering drawing teaching and learning. A survey was conducted at Polytechnic Tuanku Syed Sirajuddin among students who taking for engineering drawing subject.

Literature Review

Augmented Reality

Utilization of Information Technology (IT) in the process of delivering information is experiencing rapid development. Currently, the latest technology used in delivering information is the technology Augmented Reality (AR). In AR technology, users can visualize objects or historical objects in a 3-dimensional form. AR has the advantage of being interactive and real time so AR is widely implemented in various fields. In the field of education, AR is used as a medium for introducing historical objects that are cultural heritage (Noh, Z., Sunar, M. S. & Pan, Z. 2009). Historical objects that become cultural heritage fall into the category of cultural heritage. Cultural heritage objects have a special meaning for history, science, education, religion, and culture. In addition, cultural heritage objects also have cultural values for strengthening the nation's personality (Wardani, 2015).

Augmented Reality is an image technology that will appear on the LCD screen, computer, tablet or smartphone if an object is identified. For example when a smartphone user scans the contents of a book, the animation will appear in 3D. Post Malaysia Berhad uses this technology when selling “Card Raya” in 2017. When users scan the bar code on the card, they will be able to watch video, music and images on the card. A popular "shocking Pokemon Go" game of the past is an example of Augmented Reality. The IKEA company also uses this technology when customers can identify the size of the furniture to be purchased and match it to the indoor space where the placement of the furniture will be matched only by using a tablet or smartphone (Klingenberg, 2018).

Learning Methods

In order to be in sync with modern technology development, learning method should be transformed in ways that will enable students to acquire the sophisticated thinking, flexible problem solving, collaboration and communication skills they will need to be successful in work and life. New conceptions of educational standards and assessment, the subject of this white paper, are a key strategy for accomplishing the necessary transformation. Such standards and assessment can both focus attention on necessary capacities and provide data to leverage and evaluate system change. Technology also serves as both a driver and lever for the transformation.

Table 1: Difference between Conventional and 21st Century Learning Methods

Conventional Learning Method	21st Century Learning Method
• Learning or studies refer to the teaching using chalk and board. • Searching by book. • Learning by themselves without cooperation.	• Learning in their WIFI world • Learning using Technology which is searching by internet. • Example searching in Google, Mozilla Firefox, Explores and etc. • Learning or study by grouping.

Table 1 above shows the difference between Conventional and 21st Century Learning Methods that the Conventional Learning Methods is learning by using old methods and the 21st Century which is learning methods has transformed from the conventional to the modern learning methods.

Revolution Industry 4.0

The term Industrial 4.0 was born from the idea of the 4th industry revolution. European Parliamentary Research Service in Davies 2015 conveys that industrial revolution takes place four times. The first industrial revolution took place in the United Kingdom in 1784 where the invention of vapour engines and mechanization began to replace human occupation. The second revolution occurred at the end of the 19th century where power-powered production machines were used for production activities effectively. The use of computer technology for the third manufacturing automation. Today, the rapid development of these technologies into various industrial areas. This is what is predicted to be the next industrial revolution. The number four on Industrial 4.0 terms refers to the 4th revolution. Industry 4.0 is a unique phenomenon if compared to the three industry revolutions that precede it. Industry 4.0 was announced in advance because the actual occurrence has not occurred and is still in the form of ideas (Drath and Horch, 2014).

The term 4.0 Industry itself was officially born in Germany precisely when she hosted the Hannover Fair in 2011 (Kagermann et al, 2011). Germany has a great interest in this regard as Industry 4.0 is part of its development design policy called High - Tech Strategy 2020. The policy aims to defend Germany to always be the forerunner in the manufacturing world (Heng, 2013). Some other countries also participate in the Industry 4.0 concept but use different terms such as Smart Factories, Industrial Internet of Things, Smart Industry, or Advanced Manufacturing. Despite having a different term but has the same aim of increasing the competitiveness of the country's industry in the face of a very dynamic global market. The situation is due to the rapid development of digital technology users in various fields. Industry 4.0 is predicted to have great potential benefits.

Methodology

This study was conducted through pre and post-test and using ADDIE model approach. The ADDIE model is the generic process traditionally used by instructional designers and training developers which has five parts, Analysis, Design, Development, Implementation and Evaluation. ADDIE model has been developed by Rosset in 1987 and became the basic for the

design of other models. Referring to Embi et. al. (2010) ADDIE model is a teaching model that is often used as the basis for instructional design models.

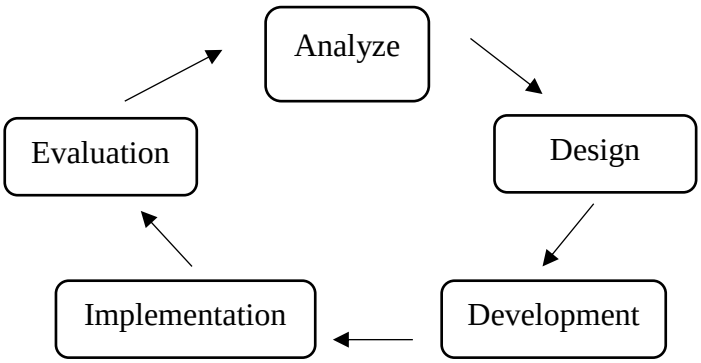

Figure 1: Model of Teaching ADDIE (Source: Module Header Design Educational Technology and Instructional Model 2012)

Analysis Phase

The first phase in the ADDIE model of instructional design is the analysis phase. Analysis phase is to determine the selection of input that underlie the development of a product (Embi, et. Al., 2010). Phase Analysis is the foundation of all phases in the instructional design model. Assessment of the needs of teaching aids in the process of learning undertaken in order to make the development of teaching aid better planned. Some analysis has been made by researchers which is regarding the problem of low academic performance of engineering design subject. This phase also analyses the feedback from the questionnaires that distributed to the students about augmented technology.

Design Phase

The design phase is the second phase in making teaching aids in ADDIE model. This phase is implemented after Phase 1 is completed and become 'blue print' or backbone of planning in the process of designing (Embi, et. Al., 2010). Engineering drawing book has been design acquainted by augmented technology approach.

Figure 2: Design Engineering Drawing book

Development Phase

This phase 'translate' the activities specified in the Phase 1 and Phase 2 of the prototype so it's easier to understand (Embi, et. Al., 2010). Researchers developed an engineering book according to Polytechnics Malaysia syllabus acquainted by augmented reality approach. These aspects should be applied to create an interesting teaching aids, portable and user-friendly.

Implementation Phase

Implementation phase is any training materials and related materials evaluation carried out temporarily in order to determine the impact to the real world (Welty, 2008). This phase involved the development of teaching aid as planned in the development phase. In this phase, testing was carried out. Testing will be made against the teaching aid that are developed by researchers. This phase will also involve students where the they will use the teaching aid prototype before the teaching aid were publish. This phase conducted involving 35 Tuanku Syed Sirajuddin Polytechnic students with the aim of testing the suitability of the design, the effectiveness of the technology used and the user-friendly. Then, pre-test and post-test tests were also conducted among students of the 1st Semester of Mechanical Engineering, PTSS.

Evaluation Phase

The last phase, which is the phase of evaluation. In this phase, the prototype that was repaired in phase 4 will be evaluated from two aspects of assessment, namely (i) assessment of usability, and (ii) assessment of suitability (Embi et. Al., 2010). From the aspects of usability evaluation, three experts will evaluate the teaching aid that was developed by experts in engineering drawing. While on the other hand, from the aspect of suitability will be assessed by the lecturer who teaches the subject of engineering drawing in terms of effectiveness against the target user (students).

Pre-test

Pre-test has been conducted among semester 1 students in Mechanical Engineering Department at Politeknik Tuanku Syed Sirajuddin who taking for Engineering Drawing subject. Geometrical and tangent topics have been selected and conventional learning methods are used together with the discussion. After completing this topic, students are given 7 days to review before pre-test. After 7 days, test pre done to these 35 students. The researchers found the marks obtained from the pre-test were low and not satisfied.

Post Test

After pre-test, researchers continue teaching and learning assisted by Engineering Drawing book acquainted through AR technology. Students are given the opportunity to use the book for revision and exercise for 7 days before seat for post-test. Post-test is done after completing a teaching and learning session.

Result and Discussion

Pre and Post-test was carried out involving 35 Tuanku Syed Sirajuddin Polytechnic students for the first semester with the aim of understanding and the impact of the book acquainted augmented reality technology approach. As a result, Pre and post test shown improvement of student performance (assessment) after using the Engineering Drawing book with Augmented Reality technology as shown below in figure 3.

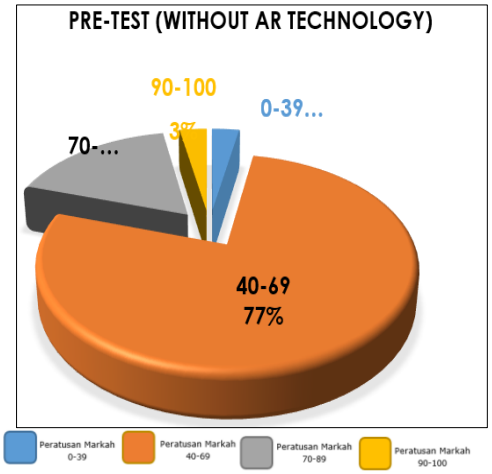

Figure 3: Student Achievement Distribution Statistics Semester 1 Session June 2018 For Engineering Drawing Courses

There are 80% of students earning an average percentage score of 0-69. This is particularly troubling to lecturers as students need to master this course before using software such as Autocad, Autodesk Inventor or Google sketch in the coming semester. Many constraints need to be considered such as inadequate dependent learning time, lecturers cannot afford to pay attention to all students and teaching & learning will be difficult if the students do not master the basic concept from the beginning.

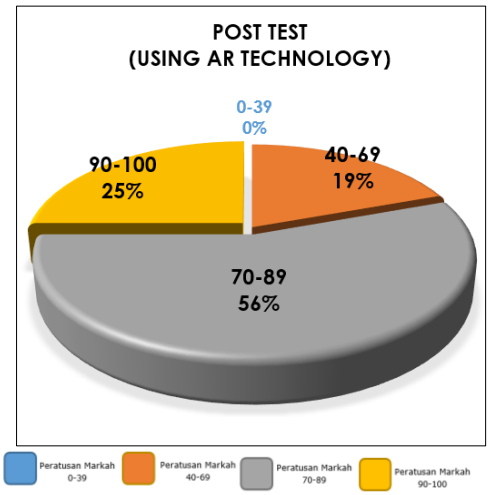

Figure 4: Percentage Of Performance After Using AR Drawing Assisted Engineering Training Book

Figure 4 shows the post-test result which is illustrated the improvement in assessment score among the students. Weak grade (0-39) has been eliminated 100 % while grade 90-100 has been increased from 3% to 25%. Meanwhile, moderate grade which is marks from 40-69 also decreased from 77% to 19%. Overall the students can score in a good grade which is marking score 70-89 which is 56%.

Table 2: Different Between Pre And Post-Test

Marking Grade	Types of test	
	Pre-test	Post-Test
90-100 (Excellent)	3%	25%
70-89 (Good)	17%	56%
40-69 (Moderate)	77%	19%
0-39 (Weak)	3%	0%

Table 2 above shows the result of pre and post- test which is indicate the impact of using augmented reality technology in engineering drawing. From the result, it can see the improvement of the student in assessing their assignment. It proved that the augmented reality able to help student to score higher marks compared to conventional learning method which is using the static notes and also chalk and board.

There was an increase in 61% of Engineering drawing (assignment) for average 70-100 scores after using Engineering Drawing book acquainted through AR compared to traditional methods only 20%. Our educational world is becoming increasingly challenging where we are entering the 21st Century Learning. This Engineering drawing exercise book acquainted through AR can be used as a tool to support 4C (Collaborative, Communication, Creative, Critical Thinking) in teaching and learning sessions. This book can encourage collaborative learning that smart and weak learners can work together using this book where the engineering drawing method helps to explain the one-to-one steps in completing the exercise (assignment) given if they do not understand it.

Furthermore, class segregation has been abolished to put together students with multiple abilities to equally help to enhance excellence in a conducive environment. Furthermore, through the application of AR technology will enhance the communication relationship between students and students as well as educators. Inayatullah & Milojevic (2014) agreed that an acticipatory action-learing could be increased through augmented reality approach. Additionally, the application of AR technology is also creative and Critical to produce creative and critical thinking students. Besides, Joshi (2018) revealed that Augmented Reality is the real-time direct or indirect view of a physical real world environment that has been enhanced/augmented by adding virtual computer-generated information. Consequently, the use of AR technology is used to build the imagination of students as well as memory as well as enjoyment experiences using AR-assisted Engineering drawing exercises.

Malaysia is also no exception in the acceptance of the Industrial Revolution 4.0. However, its use in education is poorly limited and limited. Therefore, this Engineering Drawing book acquainted through AR technology was created by applying AR Technology to improve the students' mastery of Engineering Drawing. In fact, alluding to Upadhyay & Khandelwal (2018), with AR, the cognitive burden of the task is reduced and thus allows the users to complete the task with higher accuracy. AR technology is immersive, and thus, it leads to higher engagement among the trainees. It is hoped that this Engineering Drawing book acquainted through AR will focus on raising Malaysia's rankings in international assessments, The IEA's Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA).

Conclusion

As a result, technology is increasingly advanced. Researchers afraid that younger generation will refuse to continue Engineering, Technology, Science and Mathematics due to expectation of the students that engineering/technical subject is so difficult to learn and master. As such, this the implementation of AR technology through educational books has been developed with the help of a smartphone which helps students in providing medium of augmented reality technology in accordance with the 21st century learning method. Consequently, the level of the students' understanding towards subject engineering drawing by evaluate the performance of assessments given has been increased. Therefore, Mohr & Mohr (2016) mentioned that AR is a suitable medium to use as a learning tools is proved. Researchers hope that the students and educators will be able to help with raising the spirit of studying the engineering course as well as experiencing the fun of doing the exercises and completing the assignment given on the basis of an AR technology implementation. As a consequence, the enhancement of excellence in the world of Engineering, Science and Technology will be rapidly growth by implementation of AR technology.

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