JOURNAL OF TVET AND TECHNOLOGY REVIEW
e-ISSN: 3036-0269

JTTR

Vol. 1 No. 1 (2023) 30-35
https://publisher.uthm.edu.my/ojs/index.php/jttr

Designing An Augmented Reality Teaching Framework for Mechanical Students at College Vocational in Malaysia

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DOI: https://doi.org/10.30880/jttr.2023.01.01.004

Article Info

Received: 14 November 2023
Accepted: 19 December 2023
Available online: 31 December 2023

Keywords

Augmented reality, AR, teaching framework, mechanical student, college vocational

Abstract

With the impact of advanced technologies, people at a young age have started using smartphones in their daily lives. In the education sector, most researchers have started developing new teaching styles that can adapt to technology nowadays. This also includes augmented reality technology that can be used as a teaching aid. However, there are no sufficient studies that analyze the suitable construct that can be formed as a framework as a reference for a mechanical teacher in College Vocational, Malaysia. In order to design a teaching framework to apply AR technology to the mechanical student, the researcher performs a systematic literature review. This review analyses nine studies in the field. Based on the result that has been conducted, there are six constructs that have been explored: preparation, process, device, teaching approach, AR type, and purpose. From this construct, several items have been extracted.

1. Introduction

The government's strategy for transforming the national education system is through implementing the Malaysian Education Development Plan (PPPM) 2013 - 2025. There are several shifts that have been presented in PPPM 2013 – 2025 to transform the national education system. One of those shifts is the seventh shift which is to utilize ICT in order to improve quality learning in Malaysia. In this shift, the government plans to maximize the use of ICT for self-learning and distance learning by expanding access areas to give a maximum opportunity to gather knowledge. The environment of teaching and learning with the help of technology has become the norm for teachers and students in the classroom. The common type of technological teaching aids can be formed into various kinds, which are devices like smartphones, smartboards, and also interactive applications such as educational games, teaching applications, and video tutorials. Nowadays, the use of technological devices has become a must for everyone in their daily lives. This is actually the effect of the development of technology in the era of industrial revolution 4.0 followed by the formation of education 4.0 [1].

AR-based learning is also one of the technological features that have the potential to improve the quality of teaching in the aspect of education 4.0. Based on a study conducted by researchers Sáez-López et al [2], the use of AR provides many advantages to students such as can increase motivation, level of involvement, and creativity of students while learning in the classroom. This statement is similar to a study conducted by researchers A/L Eh Phon et al., [3] who studied the effect of the use of AR in improving students' spatial abilities, they said the ability to describe a space also showed positive findings like students can reduce the burden of imagining three object's dimensions during the teaching and learning process. In Vocational Colleges, teachers and college management implement the curriculum system as a module system. The main focus of this module is technical skills related to

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the programs provided, such as Industrial Machining, Refrigeration and Air Conditioning, Automotive, Welding, and many more programs. The duration of studies in all programs is four years, and the percentage of a theory session and hands-on learning is 30% academic and 70% skills.

However, there are also some issues in using AR technology, such as students' focus being disrupted as they need to take time to understand the teaching environment and new procedures while using AR technology applications, although instructors need to optimize time with teaching content filling [4], [1]. In addition, Barroso-Osuna et al., [5] also stated in their study that the implementation of AR technology teaching is not only due to the quality of the application developed or the level of student readiness but also due to teaching methods, instructor quality, and flexibility in curriculum delivery. Therefore, in the context of this study, to further improve the quality of teaching and further optimize the use of AR technology, an appropriate teaching framework needs to be designed. Thus, the purpose of this systematic survey paper developed is to design the constructs and gaps found in the teaching framework of AR technology for teachers of mechanical and manufacturing subjects in KV.

2. Methodology

This survey was carried out using a systematic literature review (SLR) method. This method is a survey technique that needs to go through several protocols so that the survey conducted is a more comprehensive and systematic description and search [6]. In addition, a systematic literature review also gives researchers ideas to obtain research gaps and deficiencies in a given knowledge [7]. This study also refers to the flow chart and reporting guidelines of a systematic literature review developed by PRISMA as described by Page et al. [8]

2.1 Developing Research Question

The first step before start searching for a good article over a vast amount of databases, the researcher will develop a research question as a search guide. To list the search criteria in more detail, the researcher used the PICO model, the acronym for Population, Intervention, Control and Outcome. This method is suitable for further improving studies' quality, especially in systematic review studies [9]. Therefore, the researcher has developed a research question based on the PICO model: What suitable constructs or elements are available to design the teaching framework of AR technology for the instructors of mechanical and manufacturing subjects in Vocational Colleges? For the following questions, the items to represent the population (P1) were mechanical and manufacturing vocational college instructors. For the intervention item (I), it is a teaching construct, while for the Control item (C), it is AR technology. Finally, the teaching framework is an appropriate item to be used as an outcome item (O).

2.2 Data Gathering

Once the research questions were developed, appropriate items to represent each PICO acronym were selected. Next, the researcher will create a table of search criteria. This table will further elaborate on the items to form keywords to use at the article search stage. The purpose of these stated keywords is to obtain articles with different titles and abstract descriptions but perform a similar study, for example, an analysis of developing a framework related to AR technology. The following is Table 1 of the PICO model applied in this study.

Table 1 *PICO model adaptation to related keyword*

Model		Item	Related Keyword
Population	P	Vocational Mechanical student	Engineering, Vocational, Institute
Intervention	I	Construct	Construct, element, item
Control	C	AR technology	AR, Augmented reality
Output	O	Framework	Model, Framework, education

Once the keywords are developed, the researcher will use them to conduct an article search. The databases to be used by the researchers are the SCOPUS and Science Direct databases. To start the search in the selected database, the researcher will use the entire list of keywords that have been specified in the previous phase. For each keyword used, the researcher will use boolean search operations that are AND and OR and put quotation marks such as "mechanical teacher" in each appropriate word. For databases with more access to search settings, the researcher will select the only title (TI), an abstract (ABS) search to improve search accuracy. The following Fig 1 shows a keyword used for searches in each database.

SCOPUS
(TITLE ("augmented
reality" OR "AR") AND TITLE ("model" OR "framework" OR "education") AND TITLE-ABS-
KEY ("engineering" OR "Vocational" OR "Institute") AND TITLE-ABS
KEY (construct OR element OR item))

ERIC
("augmented reality" OR "AR") AND ("model" OR "framework" OR "education") AND (
"engineering" OR "Vocational" OR "Institute") AND (construct OR element OR item)

Fig. 1 *Generated keyword for database searching*

Next, the researcher will use those keywords and place them in the predefined search section of each database. Each database will list the number of relevant articles specified to the keywords and be summed for the identification phase. Some articles have not been acquired from the database but have information relevant to the study. Once the number of articles has been recorded, the researcher will begin the screening phase by stating the criteria to be excluded and included. The exclusion characteristic of this review is the year of publication must be five years at the latest. This is because this study is related to the development of technology. For that reason, researchers will focus on studies that have used the latest facilities and equipment in their research to be used.

In addition, the researcher also excluded articles that do not use English in writing, publishing books, government reports, theses, and incomplete texts. While the criteria that can be included in the study are studies related to AR, involving engineering students, and involving education or teaching methods. After several articles have been screened according to the criteria that have been stated, the researcher will implement the eligibility criteria process. The main criteria in this process are that two researchers will conduct an evaluation based on abstracts that will see the same methodology and research findings stated are sufficient or not. The value of agreement in determining the final number of articles will be obtained to strengthen the value of validity in this study. The following is Fig 2, which is a flow chart adapted from PRISMA to be used as a guide in selecting the appropriate article for this study.

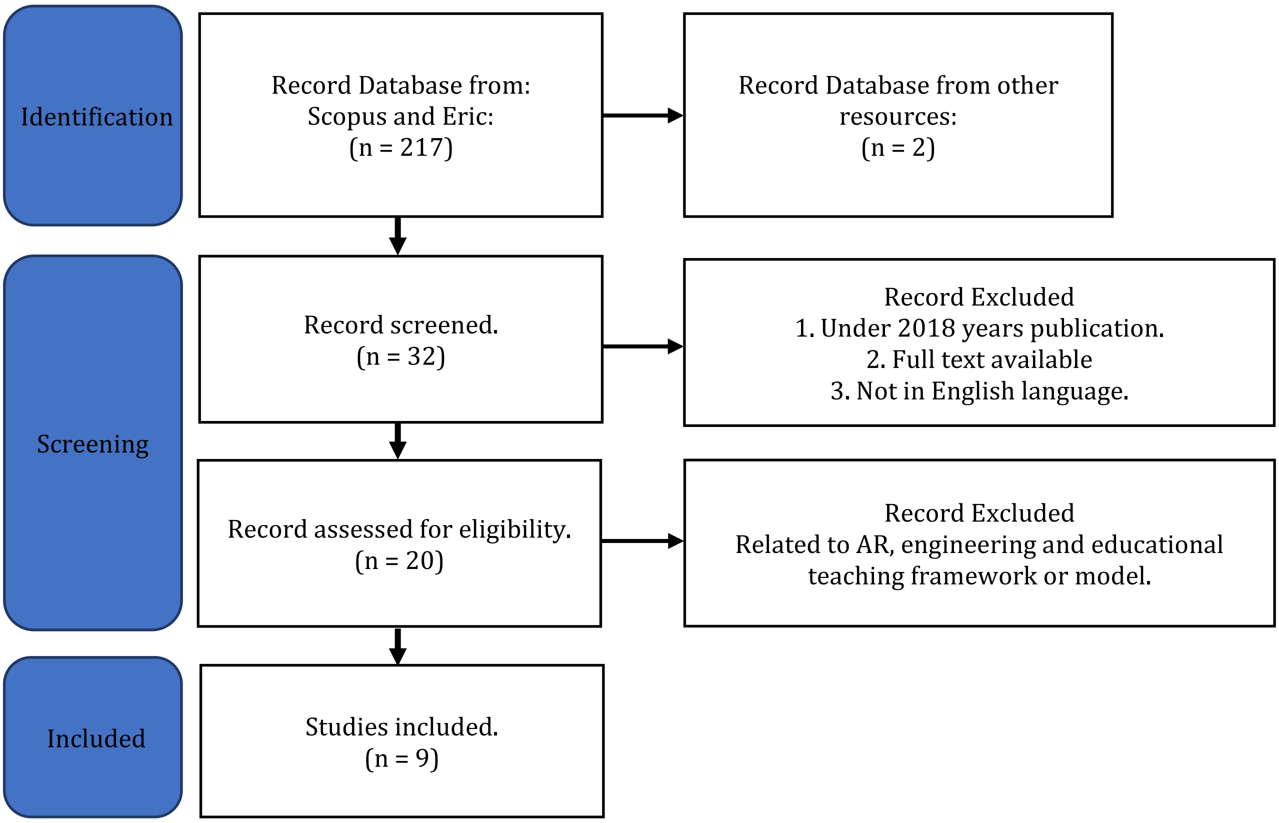

Fig. 2 *Flowchart to select appropriate article by referring Page et al [8]*

3. Findings

Based on the review conducted on the selected articles, the researcher produced several items that can be collected to be used as construct proposals in the framework of teaching AR to mechanical students. The following is Table 2, which is the article that the researcher has selected.

Table 2 *Total selected articles*

ID	Title	Method	Reference
R1	Acceptance of dance training system based on augmented reality and technology acceptance model (TAM)	Quantitative	[10]
R2	Augmented Reality in Education: Three Unique Characteristics from a User's Perspective	Quantitative	[11]
R3	Augmented Reality in Science Classroom: Perceived Effects in Education, Visualization and Information Processing	Qualitative	[12]
R4	Augmented Reality Interactive Learning Model, using the Imagineering Process for the SMART Classroom	Quantitative	[13]
R5	Augmented Reality Model Framework for Maritime Education to Alleviate the Factors Affecting Learning Experience	Quantitative	[14]
R6	Intention to use an interactive AR app for engineering education	Quantitative	[15]
R7	Learning Management STEAM Model on Massive Open Online Courses Using Augmented Reality to Enhance Creativity and Innovation	Quantitative	[16]
R8	STEAM-GAAR Field Learning Model to Enhance Grit	Quantitative	[17]
R9	Step-by-step augmented reality in power engineering education	Quantitative	[18]

Based on a study of nine selected articles, the researcher has collected constructs that can be adapted into the AR teaching framework. The item can serve as a guide, especially to teachers, in ensuring that they can use AR applications in the classroom more optimally. There are six items that have been cited, namely Preparation, Teaching Approach, Process, AR-type, Device and Purpose. The following is Fig 3, showing the constructs and items for the AR teaching framework proposed by the researcher.

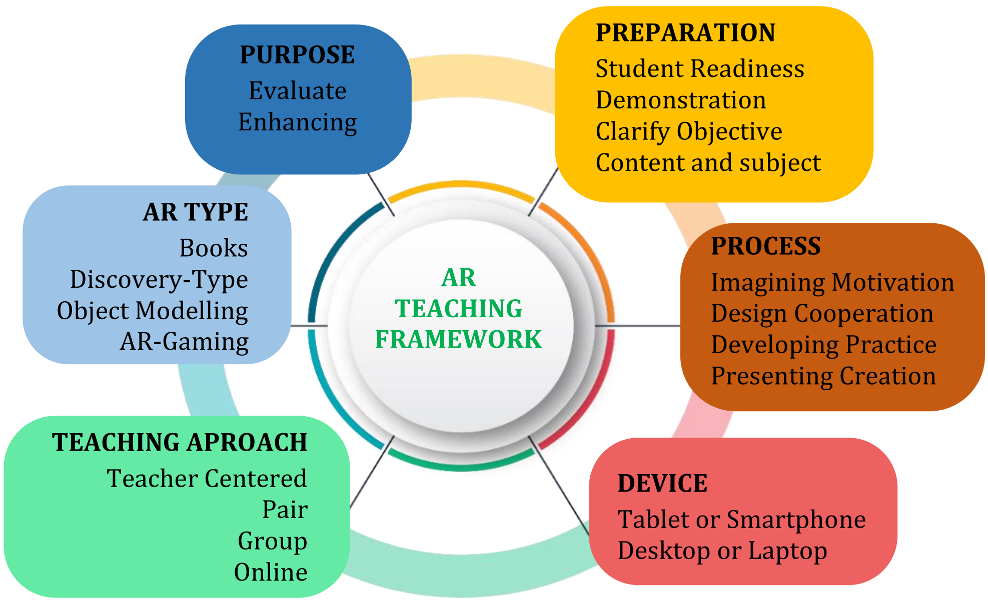

Fig. 3 *Proposed AR teaching framework*

For the preparation construct, there are four items, namely student readiness, demonstration, clarify objective and content and subject. Based on the R7 survey, teachers need to identify whether students are ready before learning, adequate teaching equipment and student motivation. In addition, from the study in R4, a demonstration is also among the important items, such as giving initial exposure to students and initial training to students. Another important preparation is the description of the teaching objectives and the purpose of using the AR application for the topic (R4, R7 and R8). Content preparation for the subject is also something that needs to be implemented by teachers before teaching.

As for the process construct, six items can be used to guide teachers in using AR applications as teaching materials. The first item is Imagining Motivation: Increase student motivation by arousing curiosity and generating student imagination. Design Cooperation: This process is a process that requires cooperation between groups of students or between teachers and students in classroom activities. Developing Practice: This process involves students developing something through teaching materials provided in the form of projects or developing innovative products. Presenting Creation: This item is a process in the form of a presentation such as a show, competition, suggestion, or opinion that focuses on getting the participants' attention and enhancing the presentation's creativity.

As for the device construct, a smartphone or tablet was the first item obtained from the overall survey of the articles studied. In addition, some applications are suitable for use using a computer. This is because some subjects, such as in R1, require special devices such as human limb movement sensors and complex systems to develop such applications. In addition, for the following construct which is the teaching approach, there are four approaches namely, teacher-centered, paired, group and online. The teacher-centered approach meant that teachers use AR applications in delivering their lessons along with live explanations. For AR Type constructs, the appropriate items mentioned in this AR teaching framework are AR books, Discovery-type, Object-modeling and AR gaming. Based on the survey from the selected articles, the researcher found that the type of AR chosen should follow the readiness of students as well as the suitability of the topic to be taught. As for the last construct, it is purpose. Items for this construct are stimulating or enhancing and evaluating. Before a teacher decides to choose an AR application or develop such an application, the teacher should know the purpose of the application either to improve students 'comprehension or to want to test students' comprehension.

4. Discussion

Overall, from this study, the AR technology teaching framework has been designed and fulfilled the study's objective, which is to identify suitable constructs and items to be adapted and used as a proposed teaching framework. This designed construct is suitable for mechanical students' environment, needs, and readiness at the Vocational College, Malaysia. This is because the teacher can present a new 21st-century learning experience by using AR technology as a teaching aid [19]. In addition, Ahmad Zaki Amiruddin et al. [20] also stated in their study that among the factors that influence learning with the help of digital games are students' knowledge, skills, and attitudes. The factors in question are the same results as the findings that have been analyzed.

5. Conclusion

In conclusion, this systematic literature review aims to design and propose a framework for teaching AR technology to mechanical students in KV, Malaysia. Researchers have designed six constructs such as preparation, process, device, teaching approach, AR-type, and purpose. This also shows that referring to just one teaching strategy is not enough to improve the quality of teaching and student motivation in the classroom. This framework has the potential to guide teachers in carrying out their duties as educators to impart knowledge especially for mechanical and manufacturing subjects optimally and effectively. There are various further studies that can be implemented based on the findings of this survey such as the development of a framework with empirical research techniques, testing the usability of the framework to users, and adapting the construct to existing teaching models to improve the quality of the construct further to be applied more comprehensively.

Acknowledgement

The authors would also like to thank Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, Johor, Malaysia to support this research.

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