The technology of augmented reality based on 3D modeling to improve special skills for vocational students in the era of industrial revolution 4.0

Tuwoso1, A B N R Putra1, A Mukhadis1, Purnomo1, Abd. Kadir Bin Mahamad5, M S Subandi2

1Universitas Negeri Malang, Malang, Indonesia
2Universiti Tun Hussein Onn Malaysia, Johor, Malaysia

E-mail: tuwoso.ft@um.ac.id, andika.bagus.ft@um.ac.id, amat.mukhadis.ft@um.ac.id, purnomo@um.ac.id, kadir@uthm.edu.my

Abstract. Currently, the development of virtual learning technology continues to increase. Virtual technology such as augmented reality is becoming a sophisticated learning innovation. On the other hand, the special abilities of vocational education graduates have decreased relatively. This study aims to: 1) map the components of the need to improve special skills in vocational education graduate students; 2) develop 3D-modeling based augmented reality learning technology; and 3) testing the attractiveness of the 3D-modeling based augmented reality learning technology. The method used is the research and development (R&D) method. Requirement component map data was taken using qualitative methods through questionnaires and observations. Informants at this stage were students in the field of vocational education at State Universities in East Java. Furthermore, expert tests were conducted by material experts in the field of vocational education and online learning media experts. The results of this study include 1) map of the components of the need to improve special skills in vocational education student graduates consisting of idea development (78%), utilization of infrastructure (82%), deepening knowledge (90%), professional organization (88%), and mental stimulation (90%); 2) the developed 3D-modeling based augmented reality learning technology has an excellent level of attractiveness and feasibility based on online learning media experts and material experts; and 3) learning technology products based on 3D-modeling augmented reality which is developed can increase the special skills of graduate vocational education students.

1. Introduction

The challenges of vocational education have begun to change in the era of education 4.0. This change changes the concept of preparing competent vocational graduates towards the preparation of graduates with capabilities. In the education era 4.0, humans are directed to take advantage of the sophistication of digital technology. Digital technology has changed the paradigm in various fields, including the field of education. The pedagogical concept of competency-based vocational education cannot be applied universally [1]. However, it refers to cultural and regional characteristics that require special skills. Learning aspects, which are translated into three main things, namely planning, implementation, and full evaluation, cannot be separated from the use of digital media. The digital technology revolution in the world continues to experience significant developments that encourage changes in the world of work.
and the skill profile of many jobs [2]. This, of course, will require the academic community to keep abreast of these technological developments. However, lately, existing jobs are taken over by machines and robots, so that jobs in the industrial world are increasingly effective and efficient because of the role of technology. Ironically, especially in the vocational world, which is a place to produce graduates who are ready to fill job opportunities, there are still many gaps that occur. One of the gaps is that vocational education institutions cannot afford the special skills and abilities required by the industrial world. The preparation of the main and integrated skills of students for digital companies and industry 4.0 must be prepared [3].

The system of vocational education should be synchronized with industrial needs. Whereas the expansion of vocational education should be able to overcome unemployment, but it will actually increase the unemployment rate because the link and match with the industrial world have not been achieved. The causes of unemployment are complex, one of which is the competence of the lecturers [4]. So that when the need for graduate students with the required special skills cannot be fully prepared by vocational education. This has an impact on the relatively low absorption of vocational student graduates in the world of work due to the assumption that industrial needs are difficult to predict. Especially in the field of mechanical engineering, technological developments are in the global realm. This is a challenge in the world of vocational education in preparing graduates who have industrial links [5].

One way that can overcome this big problem is through the use of Augmented Reality technology. Augmented Reality (AR) is a digital technology that is able to combine the real world and the virtual world that encourages increased motivation in students [6]. In the world of vocational education, a lecturer needs Augmented Reality to display the results of a new object in a real way to his students. Through Augmented Reality, students will know about the more detailed specifications about these new objects. According to experts, the use of this technology is proven to be effective in achieving learning goals [7] - [9]. In this study, researchers developed 3D modeling-based augmented reality technology to improve the special skills of vocational education students. This technology development is intended to overcome the delays of vocational education institutions in updating knowledge for their students [10].

2. Method

In this study, the method used is research and development (R&D). This research begins with an initial step, namely mapping the components of the special skill needs of graduate vocational education students. The initial activity was carried out by qualitative methods through questionnaires and observations. Informants at this stage were students in the field of vocational education at State Universities in East Java. Furthermore, the expert test was carried out by material experts in the field of vocational education and online learning media experts. This method was chosen because the focus of this research is to develop the technology. Schematically, the method implemented is presented in Figure 1.

![Figure 1. Development Stages Schematic](image-url)
In this study, the attractiveness test was carried out by two processes. The first process is material expert validation. The selected material experts are material experts related to vocational education. The second process is the validation of media experts. The selected media expert is an online media expert. The media expert was carried out by two experts. Each validator expert consists of two people who come from different institutions/agencies.

3. Results and Discussion

3.1. The component needs to improve the special skills of graduate vocational education students

This research resulted in several findings related to the need to improve special skills in graduate vocational education students. These needs consist of five main components, namely developing ideas, utilizing infrastructure, deepening knowledge, professional organization, and mental stimulation. The components of the need to improve special skills in vocational education graduate students are shown in full in Figure 2.

![Figure 2. Percentage of components needed to increase especially in vocational education students](image)

In Figure 2 it is shown that there are five components of the need to improve special skills in vocational education graduate students. The percentages of each of these components are idea development (78%), use of infrastructure (82%), deepening of knowledge (90%), professional organization (88%), and mental stimulation (90%).

3.2. The test results of the attractiveness of learning technology based on 3D-modeling augmented reality

In this study, validation was carried out by material experts. The results of processed validation data from learning material experts are shown in Table 1.

| No. | Indicator Items                                           | Score | %    |
|-----|----------------------------------------------------------|-------|------|
| 1   | Linkage of target competencies with material             | 3.50  | 87.50|
| 2   | The depth of the material on the aspects of learning objectives | 4.00  | 100.00|
| 3   | The effectiveness of material persuasion                  | 4.00  | 100.00|
| 4   | Performance standards relationship with the material     | 3.50  | 87.50|
| 5   | The power of matter to increase the stimulus             | 4.00  | 100.00|
| 6   | Presentation material relief                             | 4.00  | 100.00|
| 7   | Material update with current information                  | 3.50  | 87.50|

In Table 1, it is explained that there are five main indicator items used by material expert validators to analyze the products being developed. Furthermore, the results of the media expert validation are shown in Table 2.
Table 2. The results of expert validation of online learning media

| No. | Indicator Items                                      | Score | %    |
|-----|-----------------------------------------------------|-------|------|
| 1   | Application homepage serving model                  | 3.50  | 87.50|
| 2   | Application updates                                 | 3.50  | 87.50|
| 3   | Selection of transition effects per page             | 3.33  | 83.33|
| 4   | Ease of operation by the user                       | 3.50  | 87.50|
| 5   | Content and content attractiveness                   | 4.00  | 100.00|
| 6   | Selection of themes for content                     | 3.33  | 83.33|
| 7   | Ease of user in using media                         | 4.00  | 100.00|
| 8   | Product competency level                            | 3.50  | 87.50|
| 9   | Complete application menu options                   | 4.00  | 100.00|
| 10  | Interactive level of application                    | 4.00  | 100.00|

In Table 2, it can be interpreted that there are ten main components of validation by online learning media experts. On the five indicator points (content and content attractiveness), the score obtained is 4.00 (100%), the nine indicator items (completeness of the application menu options) the score obtained is 4.00 (100%), and the ten indicator items (interactive level of application) the score obtained is 4.00 (100%).

4. Discussion

4.1. The component needs to improve the special skills of graduate vocational education students

The first component of the need to improve special skills in vocational education graduate students is the development of ideas. In this realm, vocational education students should have capabilities related to vocational education. Vocational education is a real effort to improve the capabilities of vocational education students who must have special skills to prepare the needs of the world of work [11]. In this context, it can be concluded that vocational education should focus on developing the capabilities of its graduates. The components of these requirements are shown in Figure 3.

Figure 3. Components of the need to improve special skills in graduate vocational education students

Based on Figure 3, the second component that becomes a reference for improving special skills in vocational education graduate students is the use of infrastructure. In addition, the principles of vocational education are also guided by perceptions of industrial needs, so that the existing infrastructure in an educational institution must be able to become a replica of the industrial world in relation to the teaching factory concept [12]. This refers to the industry’s need for high adaptive abilities to work in an increasingly complex interdisciplinary work environment [13], [14].
4.2. The attraction of 3D-modeling based augmented reality learning technology

In this development research, the product developed has a fairly high attractiveness value. This is evidenced by the average percentage value of vocational and science education material experts by 95% and online learning media experts by 92%. At the validation stage, there are eight main indicators that have very good attractiveness values.

In principle, the meaning of learning technology is anything that can be used as a learning support tool that focuses on achieving learning objectives to prepare the demands and challenges of the industrial world by placing students as subjects in learning [15], [16]. In innovative learning technology, the form of learning media must be concise, simple, and attractive to users. The important thing that becomes a reference in developing a learning media is related to the quality of the material being developed. The depth of the material is related to the competencies to be achieved. Achievement of competencies is influenced by the effectiveness of the material being developed; the development of the material rests on student characteristics. The concept must be clearly delineated, easy to understand, and have good relevance to competence. The novelty of the material with the latest information developments is also absolutely manifested in the development of material in learning media. This is in accordance with the characteristics of the AR technology that has been developed. In this technology, the material is designed to precisely achieve learning objectives through meaningful messages. This is supported by the selection of relevant and appropriate content and material content to communicate competence. Although Augmented Reality is attractive, there is a need for good content, implementation, and evaluation, as in any technology integration process [17].

The development of learning media with AR technology plays a role as a learning medium, which is an important part of learning. In its development, application content must have modernity, ease of operation, and attractiveness to the content and content of the material. Learning media does not function as entertainment, but functions to improve the learning process of delivering messages, for that the level of compatibility and completeness of Augmented Reality application products is important [18]. This is certainly in accordance with the main objective of this technology, namely to improve the special skills of vocational students. The results of the analysis of the development of learning technology show that this technology has a major function in increasing the special skills of vocational students [18] - [20]. Based on this function, the increase in the special skills of vocational students will automatically increase. The function of this technology is a form of student-focused learning orientation. This technology can increase the motivation to learn in students' stimulus. This AR technology developed encourages lecturers to become creative managers in providing meaningful learning experiences, not just conveying information. So, it can be understood that students' learning experiences to improve special skills will not be effective if they don't use innovative learning media. This is because learning media is an important component of learning.

5. Conclusion

In this study, the conclusions are divided into several components. The components of the need to improve special skills in vocational education student graduates consisting of idea development (78%), utilization of infrastructure (82%), deepening knowledge (90%), professional organization (88%), and mental stimulation (90 %). The developed 3D-modeling based augmented reality learning technology has an excellent level of attractiveness and feasibility based on online learning media experts and material experts. Learning technology products based on 3D-modeling augmented reality which is developed can increase the special skills of graduate vocational education students.

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