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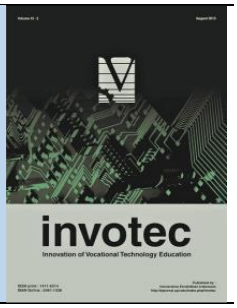

SIMULATION-BASED DIGITAL LEARNING FOR VOCATIONAL SCHOOLS

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ABSTRACT

Students in vocational schools are generally faced with difficult material accompanied by learning facilities that are not optimal in attracting their attention. Simulation models can be done for students to practice appropriate skills in learning activities, the demands of the times in the era of the COVID-19 pandemic urge educators to produce digital simulation media that are suitable. Systematic Literature Review by analyzing documents and articles searched through an electronic database search engine use as method to be discussed. Simulation-based digital learning facilities require software in making simulation learning tools. Several simulators have been designed and applied to electrical learning in the automotive sector with the result that they can improve the quality of learning. Simulation-based digital technology provides practicality and completeness to user needs, especially those related to practical skills in vocational education. Meanwhile, there are still few simulators in the form of digital or software for learning electrical systems in the automotive sector.

1. Introduction

Digital technology has been implemented in a variety of contexts, including in the realm of vocational school education. The digital era is a feature of the 21st century which is an important information and communication technology for vocational schools (Winiasri et al., 2020). Educational achievement is very important for students success in the learning process, this is influenced by the teacher (Coman et al., 2020), so that vocational school teachers must be literate with digital learning (Prieto et al., 2020). This is certainly a demand, because technology in the automotive sector also continues to develop, especially in the management of the electrical system (Samedov et al., 2020). Vocational school teachers in the automotive field are required to be creative in delivering lessons. To achieve this goal, the implementation of learning needs to be supported by the availability of information and sources of adequate digital facilities in accordance with the learning objectives to be achieved (Liu et al., 2020). However, there are still some obstacles to achieving the learning objectives of both educators and students.

Students in schools are generally faced with difficult material accompanied by learning facilities that are not optimal in attracting their attention (Pardjono et al., 2020). One of the barriers to learning in vocational schools is the problem of integrating practical and theoretical lessons (Shearer et al., 2020). To overcome such problems, an effective and attractive digital technology is needed, which requires a navigation system with clear sequences and instructions so that it can be understood by students as users (Esteve-Mon et al., 2016). Simulation models can be done for students to practice appropriate skills in learning activities (Campos et al., 2020). In this Paper the author assumes that to maximize the simulation model, it can be collaborated with digital technology. This paper aims to review learning facilities with simulation-based digital technology applied to vocational schools, especially in automotive electrical systems.

Digital simulation is actually not a new thing, this technology was introduced in the early 90s. Digital simulation is defined as a technology-based program that contains a model, either system or process (De Jong & Van Joolingen, 1998). Digital simulations are becoming increasingly popular in professional training to develop complex cognitive skills (Helle et al., 2011; Mayer et al., 2016; Rogers, 2011). However, despite its widespread appeal, the instructional characteristics that make digital simulation effective remain uncertain (Gegenfurtner et al., 2014). The most common uncertainty from digital simulations is that they are not compatible with the original media, especially the electrical system in the automotive sector. Sophisticated media are needed to represent learning activities. Besides, the demands of the times in the era of the COVID-19 pandemic urge educators to produce digital simulation media that are suitable and as needed (Adedoyin & Soykan, 2020). Vocational education must refer to theoretical knowledge and practical skills that students must possess, such as practical teaching content (Lin & Zhang, 2020).

Simulation-based learning mainly involves positive emotions in students' enthusiasm (Keskitalo & Ruokamo, 2021). Although the simulation results are not realistic representations in the real world (Peres et al., 2021).This means that based on these statements, Vocational High School Teachers need to apply the right technology to improve students' learning experiences according to their learning needs. This study aims to examine learning facilities with simulation-based digital technology applied to vocational schools, especially in automotive electrical systems.

2. Methods

2.1 Searching method and criteria

The research method uses a Systematic Literature Review by analyzing documents and articles searched through an electronic database search engine using Google Scholar. The search results of several journals published obtained then identified and analyzed starting from the title, abstract, research objectives, data analysis and content represent keywords such as simulation based, digital learning, digital simulation, especially in vocational high schools. Based on these

keywords, the boundaries are determined, and only selected articles will continue to be discussed, so articles that are outside the scope of the review will be excluded, including:

- Articles that discuss digital simulations in learning but cannot be accessed
- Articles that mention digital simulations in the learning process, but do not show results that match the title shown
- Articles that do not discuss the process of digital simulation in learning
- Articles that mention vocational high schools but do not discuss digital simulations then provide conclusions from the results of the analysis at the final stage of the study

2.2 Screening for eligibility

Of the 35 source include articles, book, thesis and international journals that the author met regarding digital simulation-based learning referred to in this discussion, the authors decided to review 19 source that contain digital simulation-based learning processes according to the titles and contents discussed. The limitations for the search criteria for journals to be discussed are shown in Table 1. Finally, the author got 19 articles that were selected and passed for a detailed review which is shown by the schematic in Figure 1.

Table 1. Limitations of searching criteria

No	Searching criteria	:	Limitation
1	Database	:	Google Scholar
2	Type of access	:	All type (open source and paid source)
3	Year	:	2016 – 2021
4	Subject area	:	Education, vocational education
5	Document type	:	Article, book section, thesis
6	Publication	:	Final
7	Source type	:	Journal, book, thesis
8	Leanguange	:	English, Indonesian
9	Data acces	:	1 September – 20 November 2021
10	Search within	:	Article, abstract, keyword
11	Search document	:	Digital simulation, digital learning, simulation based

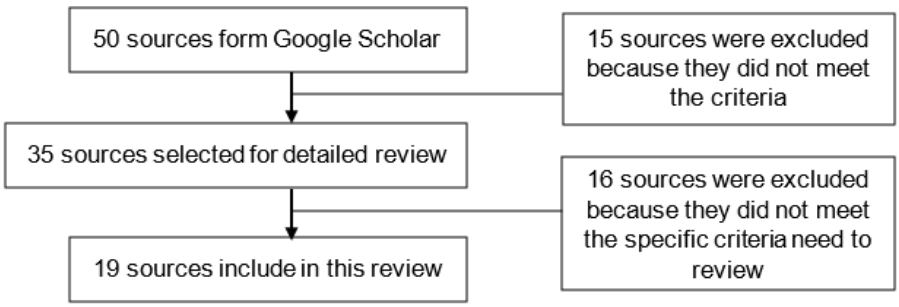

Figure 1. Content selection process and criteria

3. Results and Discussion

Based on the analysis of the literature review that has been collected, that simulation-based digital learning facilities require software in making simulation learning tools (Elbashti et al., 2020; Shen et al., 2020). Simulation-based digital learning facilities in the application of digital learning are by using a simulator (Dobricki et al., 2020; Esteve-Mon et al., 2016; Gönenç & Sezer, 2019; Igwe et al., 2020). The use of simulators is found to be relevant for digital learning content (Damasceno et al., 2017).

3.1 Software used to create simulation-based digital learning tools

Production Learning tools can be operated on Windows and Mac OS then publish applications to Windows, Mac, iPhone, WebGL, Windows phone, and Android platforms (Wahlqvist et al., 2021). Simulation-based digital learning facilities require software in making simulation learning tools to the use of computer software such as Vuforia, Unity, 3DsMax is used as a means of carrying out the design phase which is needed to support simulation-based digital learning in vocational education (Elbashti et al., 2020; Shen et al., 2020).

3.2 Application of simulators in vocational education

Simulators allow students to strengthen knowledge and to gain practical implementation skills in situations that simulate reality. In addition to the formation of expert skills, computer simulators successfully develop creativity in learning (Makarova et al., 2019), because the simulation system is operated in the form of software that is safe to use (Bobka et al., 2016), skill learning with a simulation system is more efficient, especially for early practice to avoid tool damage (Chang & Kuo, 2018), the combination of simulation technology and multimedia makes the simulation system more realistic, has a strong appeal to students (Makransky et al., 2019), have a higher interest and initiative in learning and the simulation teaching system is also suitable for the combination of individual teaching (Lin & Zhang, 2020).

Use simulators for both theoretical and practical learning allow for a significant improvement in the quality of vocational education. The teacher's role in integrating digital technology is important in addressing the learning needs of students, as well as the need for international teacher training with adequate digital technology to bridge the teaching practice (Amhag et al., 2019). The quality of using simulators in vocational education is shown in Table 2.

Table 2. Simulator quality in learning

No	Simulator	Source
1	Practical Simulation	(Bobka et al., 2016; Damasceno et al., 2017; Shen et al., 2020)
2	Safety	(Campos et al., 2020; Keskitalo & Ruokamo, 2021; Liu, 2018)
3	Efficient	(Chang & Kuo, 2018; Lin & Zhang, 2020; Peres et al., 2021)
4	Realistic	(Igwe et al., 2020; Makarova et al., 2019; Makransky et al., 2019)
5	Individual Learning	(Gegenfurtner et al., 2014; Rogers, 2011; Samedov et al., 2020)

The use of simulators in learning has good qualities such as being able to do practical simulations, safe to use during learning, easy to use by users, display resembling real objects, and can be used for independent learning. Simulator as a means of learning to support simulation-based digital learning in vocational education.

3.3 Simulators used for electrical systems learning in automotive

The simulators used for learning in the automotive sector were developed for various types of learning objectives, such as simulation software used for learning activities on the application of simulations in light vehicle electrical maintenance training courses that seek to improve the quality of learning (Cahyo, 2016). However, there are still shortcomings in the application of the simulation software obtained from the results of the assessment of student response aspects. The simulator used in electricity learning is shown in Table 3.

Table 3. Simulator in automotive electrical system learning

No	Simulators	Form	Source
1	Lighting System Trainer Simulation Software	Digital	(Cahyo & Wailanduw, 2016)
2	Electric Mirror Simulator	Not Digital	(Puradimaja et al., 2019)
3	Wiper and Washer Simulator	Not Digital	(Santoso et al, 2019)
4	Electronic Spark Advance Ignition System Simulator	Not Digital	(Tafakur & Solikin, 2018)
5	Lighting Device Simulator	Not Digital	(Chae, 2016)

Several simulators have been designed and applied to electrical learning in the automotive sector with the result that they can improve the quality of learning, such as the electric mirror simulator (Puradimaja et al., 2019), wiper and washer simulator (Santoso et al., 2019), electronic spark advance ignition system simulator (Tafakur & Solikin, 2018), lighting device simulator (Chae, 2016), but the shape of the simulator still in the form of props or in the form of a trainer board. Meanwhile, there are still few simulators in digital form or software for electrical system learning facilities in the automotive sector.

4. Conclusion

Digital technology has been implemented in the form of computer software in the field of vocational school education. Simulation-based digital technology provides practicality and completeness to user needs, especially those related to practical skills in vocational education. Meanwhile, there are still few simulators in the form of digital or software for learning electrical systems in the automotive sector. This research can be the basis for teachers, educators and further researchers in designing and developing digital learning facilities in the form of more creative and innovative simulator software for vocational schools, especially in learning electrical systems in the automotive sector.

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