THE USE OF ANDROID-BASED CNC SIMULATOR MEDIA ON THE LEARNING ACHIEVEMENT OF VOCATIONAL HIGH SCHOOL

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ABSTRACT

The rapid technological advancements have significantly impacted various aspects of life, including the field of Education. Among the changes that have occurred is the replacement of conventional methods previously used with computer technology as a learning medium. An example of this transformation is the utilization of a CNC simulator, which enables students to visualize models and concepts in a tangible form. A CNC simulator is a computer program that functions as a simulator, displaying three-dimensional images and equipped with operational buttons similar to an actual CNC machine. The CNC simulator is capable of simulating the setup and operation of a CNC machine, which is the process of automating and controlling the movement of manufacturing machines using digital technology. In practical CNC learning, the use of digital tools such as simulators can provide engaging, flexible, and effective experiences, especially in enhancing learning outcomes. Therefore the objective of this paper is to reevaluate the significance of incorporating Android-based 2A CNC simulator learning media in enhancing student achievement in the productive CNC subject. The method used in this study is literature review which encompasses theories, findings, and research articles conducted by previous scholars in the field.

Keywords: *CNC simulator, Educational, Vocational*

INTRODUCTION

The role of education is very important in the development of individuals, because education has a major role in shaping a person's good or bad according to normative standards. According to Law No. 20 of 2003 concerning the National Education System (SIDIKNAS), education is a deliberate and planned effort to create a learning environment and learning process so that students actively develop their potential in terms of religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed for the benefit of themselves, society, nation, and state.

However, limited practical tools and the COVID-19 pandemic have changed many things, including in the world of education. Conventional classroom learning methods have changed to

virtual learning through online classes. This change is in line with Gagne's view in learning and learning theory (2010), which states that learning is a relatively permanent change in behavior that occurs as a result of past experiences or deliberate instruction. In this context, an individual's knowledge, skills, attitudes, and behaviors can change through the interaction of new experiences with previous experiences.

There are three main levels in the learning model, namely direct experience (active), image experience (iconic), and abstract experience (Symbolic) (Suparyanto and Rosad 2020). One concept that is often used as a theoretical basis in the use of media in the teaching and learning process is the use of media used in the learning process (Suyetno 2022). Dale illustrates this concept by using a cone shape that indicates that optimal learning outcomes are achieved through direct and concrete experience. Direct experience can be achieved through various methods, such as practicum, demonstration, field practice, and other learning models that aim to improve the skills of learners (Suyetno 2022).

Technological developments also have an impact on the field of education. Learning that was previously carried out conventionally now utilizes computer technology as a learning medium. In addition, education also allows students to play an active role in developing religious strength, self-control, personality, intelligence, noble personality, and the potential they have for themselves, society, nation, and state (Ristekdikti, 2016). Today's rapid technological developments have enabled significant advances in the field of education. Many innovations are carried out to improve the quality of education, including curriculum development, learning processes, and educational facilities (Candra et al. 2019). Learning media has a great influence on the basic abilities obtained by students (Swandi et al., 2021). The use of interesting learning media can improve student learning outcomes (Emputri et al. 2019).

As professional educators, it is important for us to prepare everything that can have a positive impact on students through the learning process (Hasan 2021). In addition, educators must also have soft skills and hard skills in order to determine the right method in the learning process (Primawati, Ambiyar, and Ramadhani 2017). In this context, the use of CNC simulators becomes an effective solution. CNC simulators allow students to visualize models and concepts into reality. In addition, the use of CNC simulators can also overcome the limitations of machine availability in practice (Stephen Pierson, Josh Goss, and Han Hu in Enhancing Undergraduate Mechanical Engineering Education with CAM and CNC Machining, 2022). In an effort to link theory and practice-based learning, as well as meet industry demand for engineers ready to work in the field of design, the introduction of courses focused on computer-aided design (CAD) and the use of CAD software in the curriculum through design projects is one way that mechanical engineering programs are carried out (Pierson, Goss, and Hu 2022).

The history of CNC (Computer Numerically Controlled) machines began in 1952 when John Pearson of the Massachusetts Institute of Technology in the United States Air Force developed them. Initially, the project aimed to create a complex working component. Since 1975, CNC machine production has experienced rapid development driven by the advancement of microcomputers. This results in a more complex control unit than previous products. The operation of CNC machines is carried out by entering numerical commands through buttons located on the instrument panel of the machine. Each type of CNC machine has different characteristics according to the factory that produces it. Since the mid-20th century, Computer

Aided Design and Computer Aided Manufacturing (CAD/CAM) technologies have undergone rapid development and are widely used throughout the world. This brought about revolutionary changes in design and manufacturing (Miao Y., Liu L., Zhang X., 2016; Wang B., 2015) (Kambarov, Hoshimov, and Inoyatkhodjaev 2021).

CNC simulation machines are becoming an increasingly popular medium in engineering education. Simulation software allows students to gain hands-on experience with CNC machines without the need to use expensive machines or materials. Overall, CNC milling machine simulation is an important tool in engineering education. This provides an economical and safe learning environment, and offers a realistic and interactive learning experience. However, it is important to pay attention to the limits and ensure that the simulator used is appropriate to the learning needs of the students. CNC simulators become efficient and easy to use tools in Engineering education. Using a computer that controls the CNC milling simulator machine, users can verify tool paths and detect possible collisions. The use of CNC machine simulation in engineering education has significant benefits. First, education becomes more cost-effective because there is no need to purchase raw materials or maintain machine costs. In addition, the learning environment becomes safer because students can make mistakes and learn without the risk of damaging machines or injury. A realistic learning experience is realized because students can simulate the entire CNC process, from design to machine running. In addition, learning becomes more interactive because students can interact with machines and experiment with various settings and parameters. Thus, the use of CNC simulators has great potential in increasing the effectiveness of engineering learning. There are various simulator applications that we can use, including:

1. Simulator Swansoft CNC
2. CNC Simulator Pro
3. G-Wizard Editor
4. CAMotics
5. NC-Penampil
6. Eureka G-Kode

CNC Simulator is a computer program that resembles a CNC machine with a three-dimensional drawing display and operation buttons that function the same. This simulator is used to train and simulate the setup and operation of CNC machines. Furthermore, CNC itself is an automation process that controls the movement of manufacturing machines, both traditional and modern, to make them more efficient. In the face of new problems or potential problems, it is recommended to simulate the operation of the machine before starting production. Therefore, CNC simulation software or CNC simulators have an important role in preparing for the effective operation of the machine.

During the COVID-19 pandemic, restrictions on social activities have hampered CNC practical learning. However, CNC Simulators can act as digital tools that support CNC practical learning which is constrained by limited practical tools in schools. The use of CNC simulators as digital aids in learning CNC practices can be an effective solution. However, with the slow disappearance of the impact of the COVID-19 pandemic and the return of face-to-face learning, the question arises whether the learning media we use during the pandemic can replace the role of interoperable physical machines. Therefore, the author conducted a review of the effect of

using Android-based CNC 2A simulator learning media on student achievement in productive CNC subjects at school.

METHODS

This study uses literature review method to evaluate the use of CNC Simulator in the learning process and its impact on student achievement in CNC productive subjects. The initial stage is to search relevant literature to assess the extent of the effectiveness of using CNC simulators in learning and their effect on student achievement (Adinda Reza Wibawati 2021). Literature review is a systematic analysis method that focuses on research results, summarizes important information, and draws conclusions from previous research. This includes theories, findings, and related research articles.A particular question in this literature review is how effective the use of CNC simulators in learning is on student achievement.

The strategy used in finding relevant articles is to use PICOS (Population / Problem, Interest / Intervention, Comparison, Outcame and Study Design) which aims to formulate questions in this literature review: PICOS Analysis of factors related to the effectiveness of using CNC simulators in learning on student achievement. Table 1 shows the summary of methods used, while Table 2 shows the search criteria.

Table 1. Methodology

Population or problem	Declining student achievement after the covid pandemic
Intervention	Use of interactive learning media CNC simulator
Comparison	No comparison
Results	The effectiveness of using CNC simulators on learningachievement
Study Design	Qualitative

Table 2. Format of PICO(S) formulation of Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Population or Problems	Student achievement has decreased after the covid pandemic	Student achievement has increased after the covid pandemic
Intervensi	of interactive learning media CNC simulator	Use of interactive learning media other than CNC simulators
Result	The positive impact of using CNC simulators on student achievement.	The negative impact of using CNC simulators on student achievement.
Design	Qualitative and Quantitative	In addition to quantitative and qualitative
Year of publication	2018-2022	In addition to 2018-2022
Language	Indonesian-English	In addition to Indonesian and English

After identifying inclusion and exclusion to select research journals with the desired criteria, researchers continued by conducting an analysis process to evaluate the quality of articles that

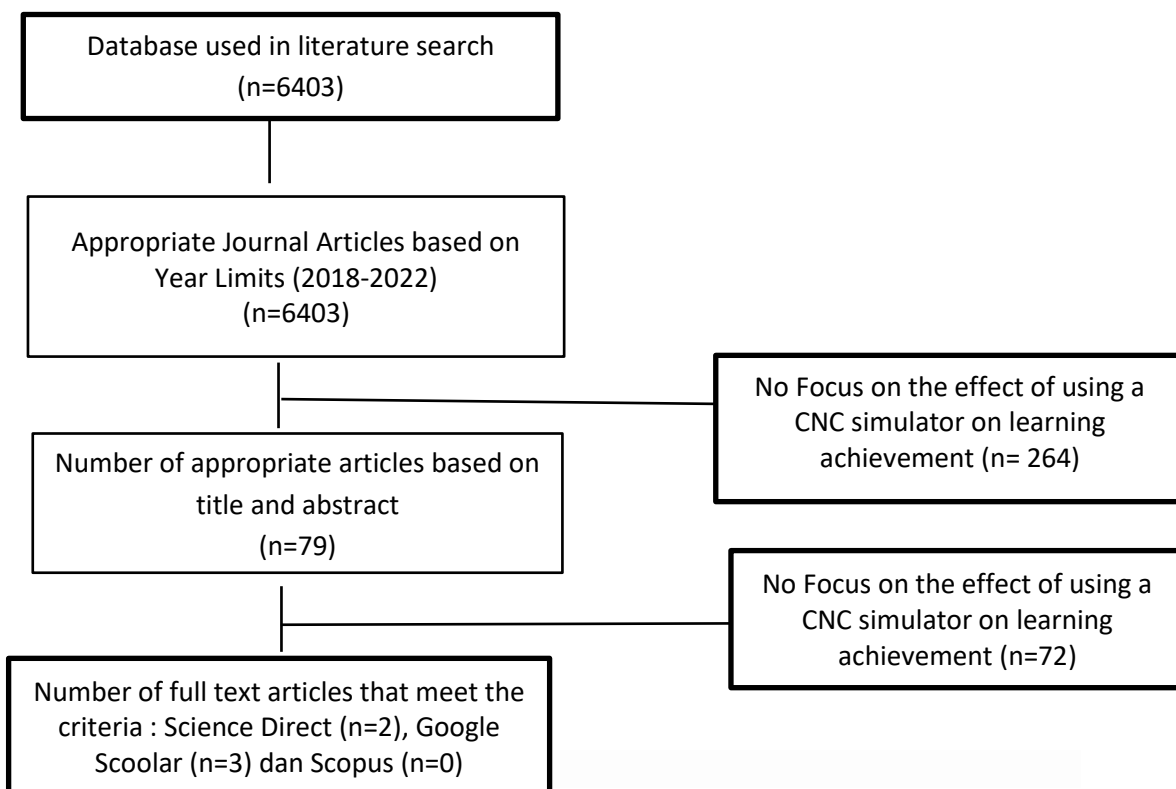had been found from three research journal data bases, namely: Science Direct, Google Scholar and Scopus.

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┌─────────────────────────────────┐
│ Database used in literature search │
│            (n=6403)              │
└─────────────────────────────────┘
                │
┌─────────────────────────────────┐
│ Appropriate Journal Articles based on │
│     Year Limits (2018-2022)     │
│            (n=6403)              │
└─────────────────────────────────┘
                │                        ┌──────────────────────────────┐
                │────────────────────────│ No Focus on the effect of using a │
                │                        │  CNC simulator on learning   │
┌─────────────────────────────────┐     │    achievement (n= 264)      │
│ Number of appropriate articles based on │ └──────────────────────────────┘
│         title and abstract      │
│            (n=79)               │
└─────────────────────────────────┘
                │                        ┌──────────────────────────────┐
                │────────────────────────│ No Focus on the effect of using a │
                │                        │  CNC simulator on learning   │
┌─────────────────────────────────┐     │    achievement (n=72)        │
│ Number of full text articles that meet the │ └──────────────────────────────┘
│   criteria : Science Direct (n=2), Google │
│   Scoolar (n=3) dan Scopus (n=0) │
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Figure 1. Article Quality Assessment Flowchart

After searching three databases (Science Direct, Google Scholar, and Scopus) with customized keywords, 6403 articles relevant to the use of CNC Simulators in vocational education were found in the last five years (2018-2022). Through an initial screening process by reading the titles and abstracts of these articles, the number was then reduced to 79 articles. Furthermore, the final screening was carried out by researchers by applying inclusion and exclusion criteria, so that the remaining 5 articles will be used in this literature review, as seen in Figure 1.

RESULTS AND DISCUSSION
Results

From the systematic search conducted, there are 5 articles that are relevant to the topic and problem of research. One of them is a study conducted by Gustimas et al. (2022). This study revealed that the use of inappropriate learning media and the lack of availability of practical equipment in schools can cause a decrease in student achievement. To overcome these problems, researchers are looking for the right learning media for CNC subjects. They choose CNC simulators as a learning medium that is attractive to students, safe to use, and can overcome the limitations of practice equipment in schools.

The use of CNC simulators in the early stages shows an increase in students' learning motivation and pre-test results compared to conventional learning. Students are also more creative and effective in using time during practical learning, because they can do practical simulations through their Android devices. In the article, it can be concluded that the application of CNC simulators is effective in improving student learning outcomes in learning NC / CNC and CAM machining techniques. The research also shows that the use of CNC simulators can improve students' understanding, master operational skills, and facilitate the exchange of ideas and knowledge both individually and in groups. The technology provided by CNC simulators has an important role in helping students' career future, both in theoretical and practical aspects (Gustimas, Yuda, and Kurniawan 2022).

According to research by Ardianto et al. (2021), the use of CNC Simulator as a learning medium shows differences in learning outcomes between students who use CNC media and conventional media. The average score of students who use CNC Simulator is 84.78 (Good Category), while those who use conventional media have an average score of 73.47 (Sufficient Category). Data analysis using the Independent Samples T-test showed that the significance value (2-tailed) for the experimental class and control class was 0.000, which is less than or equal to 0.05 (≤ 0.05). In addition, the calculated t value is 7.414 at a significance level of 0.05 with degrees of freedom (df) of 62, which yields a result of 2.65748. Thus, it can be concluded that t counts > t table (7.414 > 2.65748), and the formulation of alternative hypotheses (Ha) is accepted. The N-Gain value obtained from the use of CNC Simulator is 0.578 or 57.8%, which shows that the use of CNC Simulator media is effective as an android-based learning medium, because the value is more than or equal to 0.3 (0.578 ≥ 0.3). (Ardianto et al. 2021)

According to Suyetno's research (2022), the use of CNC Simulators has an influence on student learning outcomes in advanced CNC courses in the 2021/2022 Odd Semester. The use of Swansoft CNC Simulator is considered beneficial in increasing interaction, making learning more interesting, increasing effectiveness and efficiency, improving the quality of learning, providing flexibility in learning place and time, and creating a positive attitude of students towards learning. The use of CNC Simulators significantly impacts student learning outcomes because this simulator is able to display three-dimensional images of CNC machines complete with operation and programming buttons as in actual CNC machines (Murdani, 2016). Through Swansoft CNC Simulator learning media, students' thoughts, feelings, attention, and interests can be stimulated so that the learning process runs well and achieves learning goals and good learning outcomes (Suyetno 2022).

According to research by Valvo et al. (2012), simulators are an efficient tool for education and training. The use of efficient simulators can be a good solution to verify, modify, and optimize NC files before they are used in machines and start the machining process. As a new user, students can learn the movement of the tool, the direction of movement of the machine, and control it when there is an impact on the machine through the simulator. In addition, simulators can provide an initial overview of new devices developed from existing machines (Valvo, Licari, and Adornetto 2012)

Discussion

There is evidence of the benefits of using simulators, including: (1) as beginner students, they can safely learn about using and setting up machines, (2) virtual simulations of complex and

sophisticated processes can help users reduce production time and costs, (3) in a short time, students can find various solutions to the problems they face, and (4) they can make edits when there are errors in the program (Valvo, Licari, and Adornetto 2012).

Based on a review of the literature from the five sources above, it can be concluded that the use of CNC simulator learning media has a significant effect on student learning achievement in CNC Machining Engineering material. In addition, the use of CNC simulators also has a positive impact on students' enthusiasm in learning. This can be seen from the flexibility in learning activities, where students can easily access the application anywhere and anytime to repeat the material learned. In addition, the use of CNC simulators also provides a sense of security for students because of the lower risk of work accidents and the ability of safer machines to handle errors in compiling programs.

CONCLUSION

Based on a review of the five literature that has been investigated, it can be concluded that the use of CNC simulator learning media has a significant influence on learning enthusiasm and student achievement in CNC Machining Engineering material. Some evidence that supports this conclusion includes: First, there is an increase in student achievement after using CNC simulator learning media. Through realistic simulations, students can practice directly the concepts and techniques learned, thus strengthening their understanding.

Second, the ease of access to CNC simulator applications is one of the important factors. With the ease of access, students can quickly and easily access learning media, so as to increase their involvement in the learning process.

Third, flexibility of time and place in reviewing material is another advantage of using CNC simulators. Students can access materials and carry out exercises using CNC simulators anytime and anywhere according to their needs, thus facilitating independent learning and maximizing study time.

Fourth, the use of CNC simulators can also reduce the risk of work accidents that may occur in direct practice. By using simulations, students can learn safely without any real risk, thus giving students a sense of security and increasing their confidence.

Finally, the use of CNC simulators can also reduce student boredom due to queues in using actual machines. In hands-on practice, students may have to wait their turn to use the machine, but with CNC simulators, they can continue to practice their skills without such obstacles. Thus, based on these various evidences, it can be concluded that the use of CNC simulator learning media has a positive impact on learning enthusiasm and student achievement in CNC Machining Engineering material.

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