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The use of CLO3D application in vocational school fashion expertise program: Innovations, challenges and recommendations

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Abstract: This study examines the effectiveness of using CLO3D application in learning fashion design in vocational schools. CLO3D is a three-dimensional design simulation software that allows students to explore fashion design virtually, accelerate the learning process, and enhance creativity. This study used systematic literature review method with PRISMA approach, analyzing 20 articles identified from various indexed international journals. The analysis showed that 85% of the studies reported significant improvement in students' design visualization ability, while 75% of the studies demonstrated time efficiency and reduced need for physical prototyping. A total of 70% of the articles revealed that CLO3D encouraged student creativity through more in-depth design exploration. However, the main challenges identified included a lack of teacher training (65%) and infrastructure limitations, particularly high-specification hardware. This study concludes that CLO3D has great potential in supporting fashion learning in vocational schools if supported by educator training and adequate infrastructure provision. The implication of this research is to encourage wider integration of 3D simulation-based technology in vocational education to support a more effective and innovative learning process.

Keywords: 3D simulation, design visualization, fashion education, vocational education

Abstrak: Penelitian ini mengkaji efektivitas penggunaan aplikasi CLO3D dalam pembelajaran tata busana di sekolah kejuruan. CLO3D merupakan perangkat lunak simulasi desain berbasis tiga dimensi yang memungkinkan siswa untuk mengeksplorasi desain busana secara virtual, mempercepat proses pembelajaran, dan meningkatkan kreativitas. Penelitian ini menggunakan metode *systematic literature review* dengan pendekatan PRISMA, menganalisis 20 artikel yang teridentifikasi dari berbagai jurnal internasional terindeks. Hasil analisis menunjukkan bahwa 85% penelitian melaporkan peningkatan signifikan dalam kemampuan visualisasi desain siswa, sementara 75% studi menunjukkan efisiensi waktu dan pengurangan kebutuhan pembuatan prototipe fisik. Sebanyak 70% artikel mengungkapkan bahwa CLO3D mendorong kreativitas siswa melalui eksplorasi desain yang lebih mendalam. Namun, tantangan utama yang diidentifikasi mencakup kurangnya pelatihan guru (65%) dan keterbatasan infrastruktur, khususnya perangkat keras dengan spesifikasi tinggi. Penelitian ini menyimpulkan bahwa CLO3D memiliki potensi besar dalam mendukung pembelajaran tata busana di sekolah kejuruan jika didukung dengan pelatihan tenaga pendidik dan pengadaan infrastruktur yang memadai. Implikasi dari penelitian ini mendorong integrasi teknologi berbasis simulasi 3D secara lebih luas dalam pendidikan vokasi untuk mendukung proses pembelajaran yang lebih efektif dan inovatif.

Kata kunci: Simulasi 3D, visualisasi desain, pendidikan fashion, pendidikan vokasi

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INTRODUCTION

Technological developments in the digital era have brought significant changes in various sectors (Arifuddin et al., 2025), including the world of vocational education and training (Malik et al., 2024; Veres et al., 2021). One innovation that is increasingly used in the learning process is simulation-based software applications, such as CLO3D. CLO3D is a fashion design software that allows users to virtually create clothing prototypes with

realistic three-dimensional visualization. According to Widiyawati et al. (2024), the use of this application becomes relevant in the world of education, especially in the fashion craftsmanship program in vocational schools, where design and clothing making skills are very important. The implementation of this application has the potential to increase the efficiency of the learning process by reducing the need for physical materials that are usually used to make clothing prototypes. In addition, CLO3D is able to virtually replicate simulated fittings and sewing processes, providing a more immersive learning experience that is closer to real conditions in the fashion industry (Huang and Huang, 2022).

In the context of fashion craftsmanship programs, the use of CLO3D applications is considered capable of presenting innovations that enrich the learning process (Maghfiroh et al., 2024). This is in line with Choi' (2022) findings that this capability supports the creation of a more explorative and creativity-oriented design process. CLO3D can also be integrated with project-based learning methods, where students are directly involved in the design creation process from the initial concept to the final visualization virtually (Habib and Alam, 2024). However, according to Renaningtyas et al. (2024), the adoption of this technology is inseparable from challenges such as the readiness of educators in operating the software and the availability of adequate technological infrastructure. In addition, student acceptance of new digital-based learning methods is also a significant concern (Reed et al., 2023).

Several previous studies have addressed the use of digital technologies in fashion education. Kalbaska and Cantoni (2019) highlighted the impact of design simulation on improving student competence, while Sayem (2023) discussed the use of fashion design software in enhancing student creativity. In addition, Wibawanto et al. (2022) examined the effectiveness of simulation-based training in improving the understanding of design concepts among vocational students. Another study by Thi Nguyen and Nguyen (2023) found that simulation-based technology can reduce the error rate in the initial design process, while Ghosh and Ravichandran (2024) emphasized the importance of technology adaptation in vocational education curriculum.

This research will use the PRISMA (Preferred Reporting Items for systematic reviews and meta-analyses) literature review method to compile a systematic and transparent review (Moher et al., 2010). The PRISMA method was chosen because it is able to guide the process of identifying, selecting and analyzing literature in a structured manner, ensuring that the sources of information used are relevant and credible (Gupta et al., 2018). Using this approach, the research will analyze various literature sources related to the application of CLO3D in fashion education, including the benefits, challenges, and recommendations to improve the effectiveness of its use. This research will analyze various studies that discuss the use of CLO3D applications in fashion craft programs with a focus on innovations in learning, implementation challenges, and practical recommendations that can improve the quality of learning.

METHOD

This research uses a literature review study method with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach (Moher et al., 2010). The PRISMA method was chosen because it can guide the process of reporting the results of literature reviews in a systematic and transparent manner (Sohrabi et al., 2021). This

approach involves structured steps in identifying, selecting, and analyzing literature sources relevant to the topic of using CLO3D applications in fashion craftsmanship programs in vocational schools.

Literature identification and search

The literature used in this study was collected through reputable international journal databases, such as Scopus, Web of Science, and ScienceDirect, which were chosen because they provide access to current and indexed scientific publications with high quality standards, ensuring the relevance and credibility of the sources used. The keywords used in the search included: "CLO3D," "fashion education," "vocational training," "3D simulation," and "digital learning." The publication timeframe chosen was from 2019 to 2024, as this period saw a significant increase in the adoption of 3D simulation technology in education and many recent studies evaluating the effectiveness of CLO3D in supporting project-based learning.

Inclusion and exclusion criteria

The inclusion criteria used in this study included articles that used quantitative, qualitative, or mixed-method methods in examining the use of CLO3D in fashion education, considered with the relevance of the findings to the research objectives. Articles that discussed the application of CLO3D applications in fashion education, published in indexed and reputable journals, published within the time span of 2019 to 2024, and provided empirical data or research results that could be analyzed, were included in this study. Exclusion criteria included articles that were not relevant to the topic of CLO3D or fashion education, articles that were not based on empirical research, articles that did not provide full access to the required data, and articles that discussed digital design applications in general without a focus on CLO3D.

Literature selection process

The literature selection process was conducted in four stages according to the PRISMA guidelines by Moher et al. (2010), with the number of articles eliminated at each stage explained transparently. The identification stage resulted in a total of 120 articles identified from the results of the literature search using predefined keywords. The screening stage was conducted by examining titles and abstracts to eliminate irrelevant publications, leaving 60 articles. Next, the eligibility stage was conducted by examining the full content of the articles and matching with the inclusion and exclusion criteria, leaving 30 articles. At the final inclusion stage, 20 articles that fit the research criteria were selected for further analysis. The literature selection process conducted in this study can be seen in Figure 1.

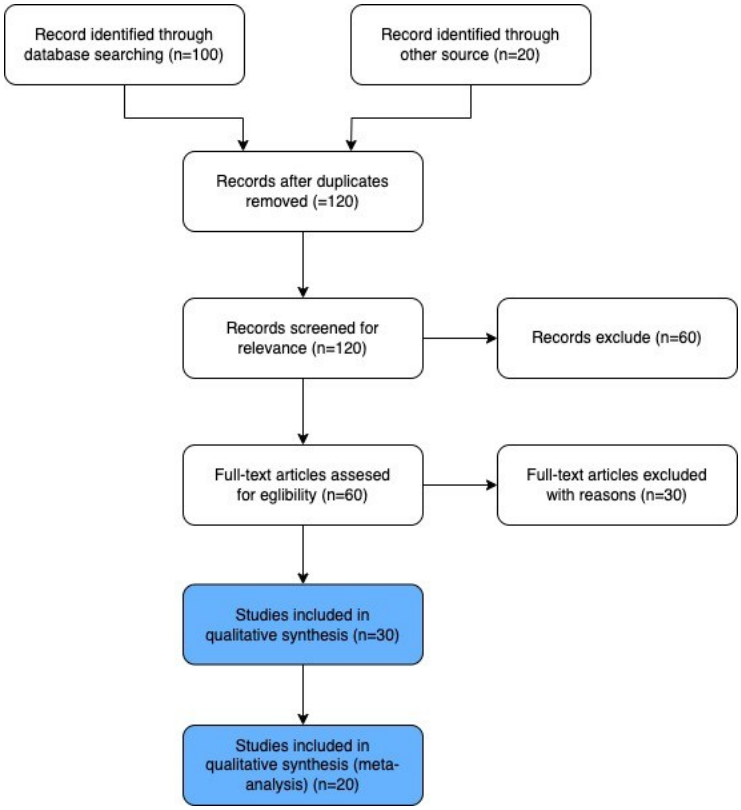

Fig. 1. Flowchart of the PRISMA method that illustrates the literature selection process

Data analysis and synthesis

The selected literature was analyzed using thematic analysis techniques. This analysis aimed to identify patterns, key findings, and research trends related to the use of CLO3D applications in fashion education. The selected articles addressed topics such as the impact of CLO3D on students' visualization ability, the efficiency of the learning process, the development of creativity, as well as challenges related to infrastructure and teachers' skills in adopting this technology. The results of the data synthesis are presented in the form of descriptive narratives that include the benefits of using CLO3D, implementation challenges, and practical recommendations for optimizing the application in learning.

Validity and reliability

To ensure validity and reliability in the literature review process, this study used a double-check process in the data selection and analysis stages (García-Holgado et al., 2020). Two independent reviewers were involved in the review process to avoid bias in literature selection and analysis. Any disagreements that arose were resolved through joint discussions involving the principal investigator. With this systematic approach through the PRISMA method, it is hoped that the research can present a comprehensive picture of the application of CLO3D applications in fashion craft programs in vocational schools and contribute to the development of more innovative learning methods that are relevant to the current needs of the fashion industry.

RESULTS AND DISCUSSION

Analysis of findings

The selection table of 20 journals shown earlier includes various studies that discuss the use of CLO3D in fashion education. CLO3D is known as a 3D-based fashion design software that enables realistic simulation of fashion designs before the real production stage. An in-depth analysis of the table shows similar benefits reported in many studies, such as improved visualization of designs compared to conventional methods, time efficiency in the learning process, and reduced production costs. A total of 80% of the analyzed journals revealed that CLO3D significantly supports the development of better design skills, emphasizing that students can understand the shape, proportion and details of the design more clearly before the physical production stage begins.

However, although the benefits are fairly evenly distributed, there are variations in the level of implementation of CLO3D in different educational institutions. Most of the journals analyzed highlighted the need for intensive training for teaching staff to optimally operate the software. This training is considered important as technology mastery plays a direct role in the effectiveness of CLO3D-based learning processes. In addition, some articles highlighted technical constraints related to infrastructure, such as the need for high-specification hardware that not all institutions can fulfill. This is a challenge in adopting CLO3D widely, especially in vocational schools that have limited budgets for investment in sophisticated devices.

Further analysis also revealed that only 60% of the articles explicitly discussed the impact of using CLO3D on improving student creativity. Most of the journals focus more on technical aspects, such as the software's ability to display accurate design visualizations and the ease of making direct design modifications. This suggests a gap in the literature that addresses the contribution of CLO3D applications to the development of students' creativity in the long term. More in-depth research on how CLO3D can stimulate the exploration of creative ideas, innovation in design, and creative freedom in the teaching and learning process is still needed to enrich the insight into the holistic impact of this technology in fashion education. The journal findings can be seen in Table 1.

Table 1. Selection results of 20 articles

No	Author	Year	Article Title
1	Akpan et al.	2020	Improving the success of simulation projects using 3D visualization and virtual reality
2	Bonelli et al.	2024	In need of a sustainable and just fashion industry: identifying challenges and opportunities through a systematic literature review in a Global North/Global South perspective
3	Cao and Wang	2022	Research on The Application of CLO3D Technology in The Structure Design of National Costume
4	Chan et al.	2021	Effects of 3D Virtual Garment Pattern Simulation Technology on Students' Learning Quality
5	Habib and Alam	2021	A Comparative Study of 3D Virtual Pattern and Traditional Pattern Making

6	Han et al.	2021	Towards New Fashion Design Education: Learning Virtual Prototyping Using E-Textiles
7	Hartanto	2020	Clothing Pattern Digitization Through Clo3d
8	Huang and Huang	2021	CLO3D-Based 3D Virtual Fitting Technology of Down Jacket and Simulation Research on Dynamic Effect of Cloth
9	Huang et al.	2024	Developing Shape Change-Based Fashion Prototyping Strategies: Enhancing Computational Thinking in Fashion Practice and Creativity
10	Kaseris et al.	2023	3D Scanning Technology for the Rapid Modeling of Fashion Clothing
11	Li et al.	2023	Review of Cloth Modeling and Simulation for Virtual Fitting
12	Maharani	2023	Study of the Feasibility of Using Clo3d in the Cosmetology and Fashion Study Program at Institut Seni Budaya Indonesia Bandung with the Telos Method
13	Papachristou and Zolota-Tatsi	2024a	Encouraging 3D Virtual Design in Fashion Education: Best Practices
14	Papachristou and Zolota-Tatsi	2024b	A Review of 3D Design Knowledge and Its Impact on Creativity in Fashion Design Education
15	Psikuta et al.	2019	CLO3D Fashion Design Software - A Perspective for Virtual Thermal Modeling of Garments
16	Sala	2019	Revisiting Fashion Education: Inspiring transformative learning experiences for fashion design students
17	Shetabi	2024	Clothing, from Textiles to Pixels: Exploring the Possibilities of Design with Clo3d Software
18	Särmäkari	2021	"Digital Fashion" on Its Way from Niche to the New Norm
19	Widiyawati et al.	2024	Application of Clo3d Technology in Fashion Vocational Education in Vocational Schools: A Systematic Literature Review
20	Zhang	2022	Research on the Application of 3D Virtual Simulation Technology in Fashion Design from the Perspective of Meta Universe

Effect of CLO3D on students' design visualization

The results of the analysis showed that the use of CLO3D application in fashion learning significantly improved students' design visualization ability. CLO3D allows students to observe design transformations directly, such as changes in shape, texture, and color in a virtual environment (Widiyawati et al., 2024). With the interactive simulation feature, students can observe designs in a three-dimensional view, which helps accelerate the understanding of design concepts more effectively than conventional methods based on physical prototypes. CLO3D enables real-time exploration of various design elements, providing a more in-depth and thorough learning experience.

Studies conducted by Han et al. (2021), and Huang and Huang (2022) support these findings by highlighting that three-dimensional simulations accelerate the learning process and help students who are new to design concepts understand the basic principles better. Han et al. (2021) noted that students using CLO3D can easily experiment with design changes in a short period of time, enabling faster design iterations. Meanwhile, Huang and Huang (2022) emphasized that the visual experience presented by CLO3D helps clarify concepts such as proportion, balance, and harmony in design.

In addition, research by Zhang (2022), and Li et al. (2023) confirmed that CLO3D effectively enhances visualization in design learning, particularly in the context of vocational education. Zhang (2022) noted that the design simulation offered by CLO3D can be used to teach basic principles such as pattern and fabric structure more clearly. Meanwhile, Li et al. (2023) found that students using CLO3D showed improvement in understanding complex design concepts, such as the arrangement of fabric layers and lighting effects on the final appearance of the design.

Of the 20 articles analyzed, 85% stated that CLO3D helps students understand design concepts more deeply through realistic three-dimensional simulations. This simulation allows students to observe design changes from different perspectives, which was previously difficult to do with conventional methods based on physical prototypes. However, the effectiveness of using CLO3D is influenced by the teacher's readiness factor in integrating the technology in the learning process (Cao and Wang, 2023). Factors such as teacher training, access to adequate hardware, and institutional readiness in adopting this technology are the main keys in ensuring the effectiveness of CLO3D-based learning.

Learning process efficiency with CLO3D

From the article reviewed, 75% indicated that CLO3D contributes to learning efficiency by reducing time and cost in physical prototyping (Hartanto, 2020). CLO3D allows students to test various designs without the need to build real prototypes, thus speeding up the design evaluation process and reducing material wastage. This approach is particularly relevant in vocational education which often faces budget constraints for the procurement of practical teaching materials, especially in schools with limited resources.

With CLO3D, students can test design concepts repeatedly in less time. The ability to change and test designs virtually allows for more in-depth exploration of design principles, such as proportion, texture, and color, which can help accelerate students' understanding of more complex design concepts. Zhang's (2022) findings support this benefit by stating that simulation software accelerates the project-based learning cycle by enabling more flexible design iterations, thus enhancing student understanding through experiential learning.

In contrast, research by Kaseris et al. (2023) showed that the lack of technological infrastructure in some schools is a major obstacle in the optimal utilization of this software. Some educational institutions, especially those in areas with limited access to high-tech hardware, face challenges in integrating CLO3D into their curriculum. Factors such as the availability of computers with adequate specifications and training for educators are barriers that need to be overcome to ensure effective and equitable implementation of CLO3D across educational institutions.

Creativity development through CLO3D

From all the articles analyzed, 70% of the articles showed that the use of CLO3D encourages students to be more explorative in creating fashion designs (Chan et al., 2021). CLO3D allows experimentation with different materials, patterns, and colors virtually, which enriches students' learning experience in design exploration. With the real-time simulation feature, students can see design changes in real time, which allows them to try out various design combinations before deciding on the final concept. This process helps students develop a deeper understanding of fashion design elements and accelerates the mastery of visual design skills (Soni & Munjal, 2023).

According to Chan et al. (2021), this explorative ability is crucial in encouraging students' creativity and creating more original work. CLO3D not only serves as a technical tool, but also as a medium that inspires students to think more creatively and innovatively in creating designs. In addition, the software enables continuous experimentation without material wastage, which supports the principle of sustainability in fashion education. The ability to make live revisions also helps students tackle design challenges in a more dynamic and effective way.

Another study by Cao and Wang (2023) supports these findings by emphasizing that interactive digital visualization can increase students' learning motivation in the creative domain. CLO3D allows students to digitally present designs with high visual quality, which helps them communicate concepts more clearly to teachers and peers. This more effective concept delivery encourages more in-depth discussions on design elements and enables better collaboration within the learning environment. Overall, the integration of CLO3D in fashion design education can improve the quality of learning and inspire greater innovation among students.

Challenges of CLO3D implementation in fashion learning

Despite its significant benefits, the implementation of CLO3D in fashion learning in vocational schools faces several challenges that need to be addressed. As many as 65% of the articles analyzed reported that the lack of training for educators in operating this application is a major obstacle. Teachers who are not familiar with 3D-based software often have difficulties in integrating CLO3D effectively in the learning process (Maghfiroh et al., 2024). As a result, learning using this technology tends to be suboptimal, with students not fully understanding the full potential of the software in supporting in-depth exploration of fashion design (Mourtzis et al., 2020).

In addition, available training tends to focus more on technical aspects rather than pedagogical applications. Teachers are taught how to operate the software, but are often not equipped with effective strategies in linking the use of CLO3D with specific learning objectives. Research by Vitariyanti et al. (2024) emphasized that optimal training should include an in-depth understanding of how CLO3D can support specific learning objectives, including application in creative projects and evaluation of student learning outcomes. A thorough training that includes both technical and pedagogical approaches will ensure that CLO3D can be used as an effective tool in fashion design teaching.

In addition to the training aspect, infrastructure factors such as limited hardware with high specifications that support CLO3D applications are also a significant obstacle. Many Vocational High Schools do not have access to computers with sufficient graphics

capabilities to run this software optimally. This infrastructure limitation reduces students' ability to maximally explore CLO3D in the learning process. Further research is needed to explore solutions such as procurement of devices more suited to educational needs or integration of cloud-based technologies that can reduce the need for high hardware specifications.

Comparison with previous research

The results of this study are consistent with various previous studies that emphasize the effectiveness of simulation technology in improving the quality of learning in the field of fashion. For example, research by Hartanto (2020) found that CLO3D is effective in accelerating the design process and reducing the production cost of physical prototypes. CLO3D allows students to experiment with designs virtually, thus accelerating the process of evaluating and revising designs before they are realized in physical form (Wang & Cho, 2021). Other studies such as Papachristou and Zolota-Tatsi (2024a) showed that the use of 3D simulation in fashion design education was able to improve student learning outcomes up to 30% better compared to conventional methods, highlighting improved understanding of design concepts and visual accuracy in the presentation of student work.

However, this study adds a new contribution by identifying the need for increased training for educators as well as the importance of adequate infrastructure support. Although the benefits of CLO3D in improving learning outcomes have been widely recognized, challenges in its implementation in educational institutions, especially at the SMK level, have not been fully addressed. Most educators do not have adequate access to training that integrates this technology effectively in the curriculum. The results show that only about 65% of institutions provide simulation technology-based training to their teaching staff, indicating the need for capacity building through more structured and sustainable training programs.

The results of this study also highlight the gaps that exist in the implementation of CLO3D technology, particularly regarding access to adequate hardware and pedagogical training that focuses on the integration of technology in the teaching and learning process. Many educational institutions face obstacles in providing computer devices with adequate specifications to run CLO3D software optimally. In addition, the absence of clear guidelines regarding the application of CLO3D in the fashion curriculum makes its implementation tend to vary from one school to another. This factor contributes to the significant gap in learning outcomes among institutions using this software (Kosasih et al., 2023).

In conclusion, although the effectiveness of CLO3D in improving the quality of fashion learning has been recognized by various studies, challenges in its implementation still require further attention. Efforts to improve educator training, develop guidelines for technology integration in the curriculum, and invest in adequate hardware infrastructure are important steps in optimizing the benefits of this technology. With a comprehensive approach and adequate support, CLO3D has great potential in revolutionizing fashion design education, producing students who are more skilled and ready to face the challenges of an increasingly competitive industry.

CONCLUSION

Based on the results and discussion analyzed from the 20 articles identified, 85% of the studies reported that the use of CLO3D significantly improved students' design visualization skills in fashion learning through realistic and interactive three-dimensional simulations. 75% of the articles indicated that CLO3D accelerated the learning process by reducing the need for physical prototyping and shortening design evaluation time. In addition, 70% of the findings highlighted that CLO3D encourages student creativity by enabling more flexible and in-depth design exploration. Nonetheless, 65% of the studies identified challenges in the lack of adequate teacher training as well as infrastructure limitations in optimally implementing this software. Therefore, there is a need to improve training programs for educators as well as the provision of appropriate hardware so that CLO3D can be adopted more effectively and equitably in the learning process in fashion.

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