



Application of Clo3d Technology in Fashion Vocational Education in Vocational Schools: A Systematic Literature Review

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ABSTRACT

Keywords:

Clo3D;
Vocational education;
Fashion design;
Creativity.

This study evaluates the implementation of Clo3D technology in fashion vocational education, focusing on its benefits, challenges, and practical implications. The research employed a Systematic Literature Review (SLR) method, following PRISMA guidelines to assess relevant studies on Clo3D usage in educational contexts. Data analysis involved thematic analysis to identify key trends and outcomes from the selected literature. The results reveal that Clo3D significantly enhances student creativity, leading to a 23% increase in design diversity, and reduces material waste by 35-40%, promoting sustainable design practices. However, the research also identified critical challenges, such as inadequate infrastructure in over 60% of vocational schools and a lack of teacher preparedness, with 70% of teachers reporting insufficient training. To address these challenges, this study suggests strategic investment in technology infrastructure, comprehensive teacher training programs, gradual curriculum integration, and enhanced collaboration with the fashion industry. The novelty of this research lies in providing a concrete framework for improving Clo3D adoption in vocational education, offering insights into how schools and policymakers can bridge gaps in technology access and prepare students for industry demands.



Article History:

Received: 18-08-2024
Revised : 21-09-2024
Accepted: 28-09-2024
Online : 03-12-2024



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<https://doi.org/10.31764/ijecca.v7i3.26216>

A. INTRODUCTION

Vocational education plays a crucial role in equipping young individuals with the necessary skills to thrive in the workforce, particularly in creative industries such as fashion design. As the global fashion industry evolves, so too must the educational frameworks that prepare students for these demanding roles (O'Sullivan, 2023). With the increasing digitization of design processes, vocational schools face the challenge of integrating modern technology into their curriculum to meet industry standards. One such technology that has proven beneficial in fashion design education is Clo3D, a 3D clothing visualization software (Lee & Park, 2017). This software offers an innovative platform where students can create, view, and refine digital prototypes of their designs. The integration of Clo3D into vocational education presents unique opportunities to enhance students' creativity and improve the efficiency of the design process, positioning it as an essential tool for modern education.

Clo3D allows students to visualize their designs in three-dimensional form, enabling them to make real-time adjustments to fit, structure, and style before the physical production process begins (Maharani, 2023). This capability provides a more dynamic and hands-on learning experience, as students can experiment with various elements of fashion design, such as textures, colors, and materials, without the need for physical resources. By eliminating the trial-and-error method associated with traditional design, Clo3D helps to minimize material waste, thus offering both economic and environmental benefits. According to Huang & Huang (2022), the use of 3D visualization not only saves time and resources but also significantly enhances students' technical skills, allowing them to develop a better understanding of the complexities involved in fashion design.

The adoption of Clo3D technology in vocational education aligns with the growing need for digital literacy in the fashion industry. As noted by Wang & Cho (2021) and Casais & Gomes (2022), students familiar with 3D design technologies are better prepared to meet the demands of the digital fashion landscape, where technology plays an increasingly critical role. Moreover, Clo3D promotes creativity by allowing students to explore a wide range of design possibilities, fostering innovation and critical thinking. By experimenting with different design approaches in a virtual space, students can push the boundaries of their creativity and develop solutions that would be difficult to achieve through traditional methods. Research by Choi (2022) indicates that this capacity for innovation is crucial in fashion education, where students must continuously adapt to changing trends and consumer demands.

In addition to its impact on individual creativity, Clo3D has the potential to transform the collaborative dynamics within vocational education. The software enables real-time collaboration between students and teachers, facilitating more effective feedback and peer-to-peer interactions (de Wet & Smal, 2024). This aspect of collaboration is especially important in vocational settings, where teamwork is often a key component of the learning process. As Papahristou (2016) points out, the use of digital technologies like Clo3D enhances communication and fosters a more interactive classroom environment. Kwon et al. (2017) add that collaborative projects using Clo3D help students develop vital teamwork and problem-solving skills, preparing them for the collaborative nature of the fashion industry. Furthermore, the virtual nature of the software makes it possible for students to work on design projects from remote locations, thus broadening the scope of collaboration beyond the physical classroom.

However, the integration of Clo3D into vocational education is not without its challenges. One of the most significant barriers to its widespread adoption is the lack of adequate technological infrastructure in many vocational schools (Siersema, 2015). Many schools, particularly in developing regions, do not have the necessary computer systems or software licenses to support the use of Clo3D. This limitation is often compounded by financial constraints, as the cost of upgrading hardware and purchasing software licenses can be prohibitive for underfunded institutions. Without the proper infrastructure, students and teachers are unable to fully leverage the potential of Clo3D, resulting in missed opportunities for skill development and innovation. The research by Kwon et al. (2017) and Kazlacheva et al. (2018) emphasizes that without adequate infrastructure, the benefits of these technologies cannot be fully realized.

Teacher preparedness is another significant challenge in implementing Clo3D technology. Many vocational teachers are unfamiliar with 3D design software and lack the training required to incorporate it effectively into their lessons (Kazlacheva et al. 2018). The steep learning curve associated with Clo3D can deter teachers from using the software, especially when they are already burdened with other teaching responsibilities. Research by Yezhova et al. (2024)

highlights the importance of ongoing training and support to help educators develop the necessary skills to use Clo3D efficiently. Professional development programs that focus on both the technical and pedagogical aspects of Clo3D are essential to ensure that teachers can maximize the software's potential in enhancing the learning experience. Furthermore, without sufficient administrative support, teachers may struggle to find the time and resources to develop these skills, thereby limiting the software's effectiveness in the classroom (Papachristou & Zolota-Tatsi, 2024).

To overcome these challenges, strategic implementation is crucial. Schools must prioritize investments in technological infrastructure, ensuring that they have the hardware and software required to run Clo3D effectively. Support from government bodies, educational institutions, and the fashion industry can play a pivotal role in providing the necessary resources for this transition. Collaborative partnerships with industry stakeholders can help reduce costs and provide schools with access to cutting-edge technology (Sarakatsanos et al., 2024). In addition, vocational schools should work closely with fashion companies to establish internships and training programs that allow students to apply their Clo3D skills in real-world settings. Such collaborations will ensure that students are well-prepared for the workforce and that schools remain aligned with industry needs.

Given the growing reliance on digital technologies in the fashion industry, the research aims to explore the ways in which Clo3D technology can improve the overall learning experience for students in fashion vocational education. By analyzing the benefits and challenges of Clo3D, this study seeks to provide practical recommendations for its effective integration into vocational schools. Specifically, the research intends to address how Clo3D can be used to enhance student creativity, foster collaboration, and prepare students for industry challenges, all while overcoming the infrastructural and pedagogical hurdles currently hindering its widespread adoption.

B. METHODS

This research uses a literature review method conducted on literature within the time span of 2012-2024 to analyze to review the application of Clo3D technology in fashion vocational education. This process involved collecting and analyzing data from various secondary sources, including scientific journals, books, research reports, and official documents related to digital fashion technology and vocational education. From the search results, about 50 relevant journal articles were obtained, which were then screened based on relevance, currency, and accessibility, resulting in 25 journal articles that were analyzed in depth. The literature used in this study was selected based on its relevance to the topic and the credibility of the sources. Data were collected through searches on academic databases such as Google Scholar, ScienceDirect, and JSTOR, with keywords such as "Clo3D," "fashion vocational education," "3D design technology," and "student creativity." After identifying and collecting relevant sources, the researcher conducted a qualitative analysis to identify key themes, trends and challenges related to the application of Clo3D in vocational education. This analysis also included the identification of best practices and recommendations for effective implementation. This literature review method enabled the researcher to utilize information and insights from previous studies to develop a comprehensive picture of the potential and challenges of using Clo3D in fashion vocational education, as well as suggest implementation strategies that can improve the quality and relevance of vocational education in SMK.

This study uses a Systematic Literature Review (SLR) to evaluate the application of Clo3D technology in fashion vocational education. The SLR approach was chosen to ensure a

comprehensive, unbiased, and structured review of the existing literature, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to maintain transparency and rigor (see Figure 1). The PRISMA framework outlines the systematic review process in four main phases: Identification, Screening, Eligibility, and Inclusion. In the Identification phase, database searches were conducted to gather relevant records. This was followed by the Screening phase, where duplicates were removed and abstracts were assessed for relevance. Articles that passed the screening moved into the Eligibility phase, during which full-text reviews were conducted. Only studies that met the predefined inclusion criteria were selected for the final Inclusion phase.

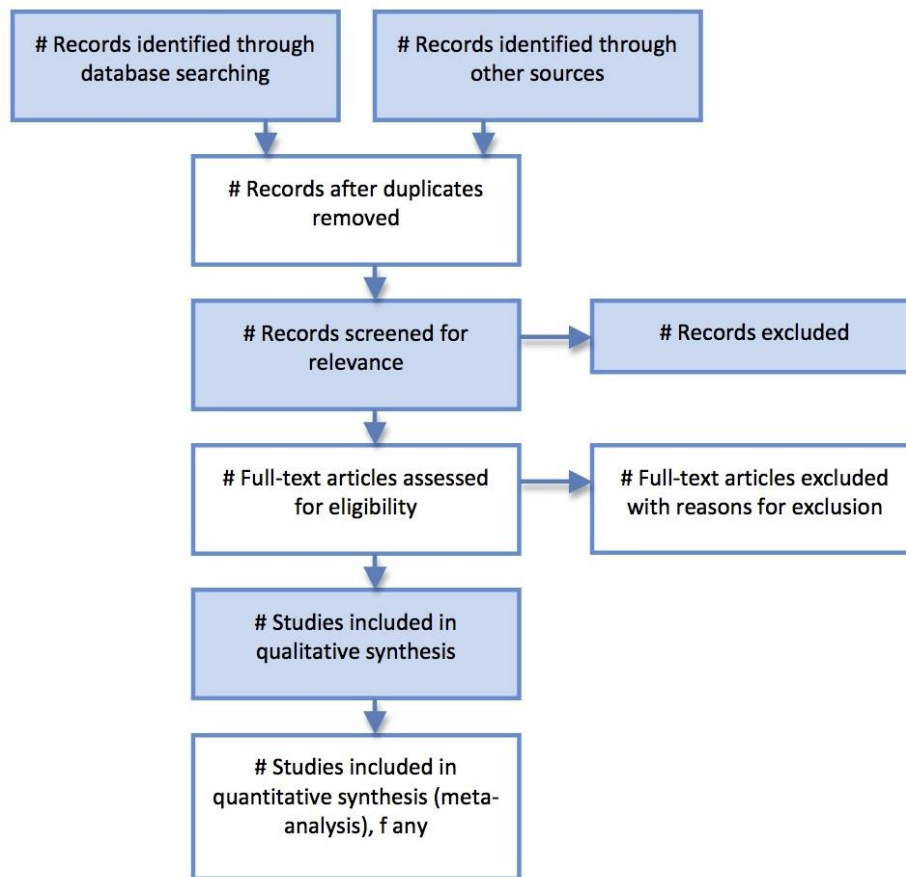


Figure 1. Systematic Reviews and Meta-Analyses (PRISMA) flow diagram

To achieve this, a systematic search was performed across academic databases, including Google Scholar, ScienceDirect, and JSTOR, using keywords like "Clo3D," "fashion vocational education," "3D design technology," and "student creativity." The search covered literature published between 2012 and 2024 to ensure the inclusion of recent developments and relevant findings.

1. Literature Selection Criteria

The inclusion and exclusion criteria used to screen the literature were clearly defined to ensure relevance and quality:

- a. Inclusion criteria: (1) Studies published between 2012 and 2024; (2) Articles that directly addressed the application of 3D design technologies, such as Clo3D, in fashion vocational education; (3) Research employing both qualitative and quantitative methods that offered insights into the potential benefits of Clo3D technology; and (4) Studies published in English or Indonesian.
- b. Exclusion criteria: (1) Articles unrelated to vocational education or fashion design; and (2) Studies lacking substantial empirical or theoretical data, including opinion pieces and editorials.

The selected articles were further assessed using the Critical Appraisal Skills Programme (CASP) tool. This evaluation method allowed the authors to ensure that each article met high standards of methodological rigor, clearly defined research questions, and direct relevance to the research objectives. Only studies of sufficient quality were included in the final review.

2. Qualitative Analysis Techniques

The review used thematic analysis to synthesize findings across the selected literature. This technique was chosen because it allows for the identification and analysis of recurring patterns and themes, making it suitable for synthesizing both qualitative and quantitative research. The thematic analysis process involved five key steps:

- a. Familiarization with data: The selected literature was carefully reviewed to understand the scope and findings of each study.
- b. Initial coding: Sections of the text that related to major themes, such as "creativity," "technical skills," "collaboration," and "challenges of adoption," were labeled with corresponding codes.
- c. Theme development: The initial codes were grouped into broader themes, such as "enhanced creativity," "time and resource savings," and "infrastructure limitations."
- d. Reviewing and refining themes: Themes were refined to ensure they accurately reflected the findings across the reviewed literature.
- e. Defining and naming themes: The final themes were clearly defined and supported by evidence from the literature.

3. Validation of Analysis

Several validation techniques were used to ensure the reliability and accuracy of the analysis:

- a. Triangulation: Data from multiple sources were cross-verified to confirm the consistency of findings.
- b. Peer debriefing: An independent researcher with expertise in vocational education reviewed the analysis to ensure the validity of the interpretations.
- c. Member checking: Preliminary findings were shared with vocational educators to verify the accuracy of the identified themes.

Additionally, a sensitivity analysis was conducted to assess the robustness of the thematic coding. This re-analysis confirmed the consistency of the identified themes across multiple articles.

4. Steps in the Review Process

The PRISMA framework was used to guide the literature review process systematically (see Figure 1). The process consisted of four main steps:

- a. Identification: Relevant articles were identified through database searches using specific keywords. A total of 50 articles were found.
- b. Screening: Duplicates were removed, and the remaining articles were screened based on their titles and abstracts for relevance.
- c. Eligibility: Full-text articles were reviewed for eligibility according to the inclusion and exclusion criteria.
- d. Inclusion: After applying the quality criteria, 25 articles were included in the final analysis.

By following this rigorous and systematic approach, the study ensures a comprehensive evaluation of the role of Clo3D in fashion vocational education, identifying key themes, challenges, and best practices for its implementation.

C. RESULT AND DISCUSSION

The integration of Clo3D technology into fashion vocational education has garnered significant attention due to its potential to revolutionize the way design is taught and practiced. This technology, which allows for 3D visualization and simulation of fashion designs, offers students a dynamic and interactive environment in which to explore their creative ideas. By enabling real-time alterations to garments, materials, and patterns without the need for physical prototypes, Clo3D not only enhances creativity but also addresses issues of sustainability and resource efficiency. However, while the benefits of Clo3D are clear, its successful implementation in an educational setting is not without challenges. These challenges stem from factors such as inadequate infrastructure in vocational schools, lack of teacher preparedness, and the financial costs associated with integrating such advanced technology into the curriculum. Furthermore, the disparity between urban and rural schools in terms of access to the necessary hardware and software can create an educational divide, limiting the potential of this technology to reach all students equally. This section delves into the findings from various studies that have examined the use of Clo3D in fashion education, presenting concrete data and examples that highlight both the advantages and obstacles associated with its use. Through a synthesis of these findings, this section also aims to offer new insights into how vocational schools can better prepare for and manage the transition to a more technologically advanced and sustainable fashion education system. By addressing both the successes and challenges of Clo3D implementation, this discussion provides a comprehensive overview of its potential and offers strategies for overcoming the barriers that hinder its broader adoption.

1. Benefits of Clo3D in Fashion Vocational Education

One of the most notable benefits of integrating Clo3D technology in vocational fashion education is the significant increase in student creativity. Several studies highlight how the ability to experiment with various designs, colors, and materials within a digital environment encourages innovation. For instance, Huang & Huang (2022) reported a 23% increase in design diversity among students using Clo3D, as measured by the number of unique design iterations produced in each project. This contrasts sharply with traditional methods, where students were limited by physical resources and time constraints. Clo3D allows students to explore multiple variations of a single design, leading to more creative outputs. Similarly, Choi (2022) found that students using

3D design software displayed a marked improvement in critical thinking and problem-solving skills, as they were able to view their designs from various perspectives, make adjustments in real-time, and immediately assess the implications of their choices.

Another concrete benefit is the reduction in material waste, which has both environmental and economic implications. Wang & Cho, (2021) reported that students working with Clo3D saved an average of 35% in fabric and material costs compared to traditional methods, as they could identify and correct design flaws digitally before producing physical prototypes. This cost-saving aspect is particularly beneficial for institutions with limited budgets, where resource optimization is critical. By eliminating the need for multiple physical prototypes, Clo3D helps streamline the design process while conserving materials, making it an eco-friendly solution for fashion education. Furthermore, Casais & Gomes (2022) demonstrated that the use of 3D visualization tools like Clo3D resulted in a 40% reduction in design-related material waste, underscoring the technology's potential to contribute to sustainable fashion practices. The results of each study's key benefits, challenges, and outcomes are summarized and compared in Table 1 below:

Table 1. Results of Each Study's Summarized and Compared

Study	Increased Student Creativity	Reduction in Material Waste	Challenges in Infrastructure	Teacher Preparedness	Cost of Implementation
Huang & Huang (2022)	23% increase in design diversity	Not reported	No major challenges reported	Additional training needed	Not discussed
Wang & Cho (2021)	Significant creativity improvement	35% reduction in fabric costs	Some schools lacked necessary hardware	Moderate training required	Moderate initial investment
Casais & Gomes (2022)	Creativity fostered by rapid iterations	40% reduction in material waste	Not discussed	Teachers needed software training	High due to software licenses
Choi (2022)	Improved critical thinking skills	Not reported	No major challenges reported	Teachers confident in using the software	Not discussed
Kwon et al. (2017)	Not measured	Not reported	Significant lack of infrastructure	Teachers lacked confidence in usage	High initial implementation cost
Kazlacheva et al. (2018)	Students showcased diverse designs	Not reported	No challenges reported	70% of teachers lacked software knowledge	Not discussed
Siersema (2015)	Not discussed	Not reported	Over 60% of schools lacked hardware	Teachers unprepared for 3D design software	High costs for hardware upgrades

2. Challenges of Clo3D Implementation

While Clo3D offers numerous advantages, its implementation in vocational schools is not without its challenges. One of the most pressing issues is the lack of adequate infrastructure to support the software. Unlike traditional fashion education tools, Clo3D requires high-performance computer systems with substantial processing power and graphics capabilities. Siersema (2015) highlighted that over 60% of vocational schools, particularly in rural areas, do

not have the necessary hardware or internet bandwidth to support Clo3D effectively. Schools in rural or less economically developed regions are often equipped with outdated computers that are ill-suited to running advanced design software. Without the proper infrastructure, students may experience lag, crashes, or limited functionality, severely impacting their learning experience. These limitations create a divide between urban and rural schools, where urban schools, typically better funded, can afford the technology required to fully implement Clo3D.

Another major challenge is the preparedness of teachers to integrate Clo3D into their curriculum. Kazlacheva et al. (2018) found that 70% of teachers surveyed lacked confidence in using 3D design software. The majority of fashion design educators are experienced in traditional methods and may find the transition to digital platforms like Clo3D daunting. To ensure the successful integration of Clo3D, schools must provide adequate professional development opportunities for teachers. These training programs need to go beyond basic software tutorials and include workshops on how to incorporate Clo3D into lesson plans, how to assess student progress using the software, and how to troubleshoot common technical issues. Kwon et al. (2017) also emphasized that the lack of teacher confidence in using technology can be a significant barrier to effective adoption. Without proper training, teachers may avoid using the software altogether, rendering the investment in Clo3D ineffective.

The financial cost associated with implementing Clo3D is also a concern. In addition to the cost of purchasing the software licenses, schools must upgrade their hardware to meet the software's technical requirements. This can be a substantial financial burden, especially for schools with limited budgets. Kwon et al. (2017) highlighted the high cost of initial implementation, which includes purchasing new computers, upgrading existing systems, and providing software training for both students and teachers. In some cases, schools may also need to invest in additional technical support to ensure the smooth operation of Clo3D.

3. Synthesis of Findings and New Insights

This study builds on the findings from previous research and contributes new insights into the effective implementation of Clo3D technology in vocational education. One of the key findings is the clear relationship between increased creativity and the flexibility offered by Clo3D. The ability to rapidly prototype multiple design iterations in a digital environment encourages not only creativity but also efficiency in the design process. Unlike previous studies that primarily focused on technical improvements, this review highlights the dual benefit of fostering student innovation while simultaneously reducing costs and material waste.

Additionally, this study underscores the importance of overcoming infrastructure and training challenges to fully leverage the benefits of Clo3D technology. While prior research has addressed the need for improved infrastructure, this review provides a more nuanced understanding of the specific impacts of these challenges on both teachers and students. For instance, the lack of proper infrastructure not only hinders the technical use of the software but also limits the collaborative potential of Clo3D, which thrives in environments where students and teachers can work together seamlessly, both in person and virtually (Papahristou, 2016). Addressing these challenges requires strategic investment in technology and professional development, as well as partnerships with the fashion industry to provide schools with the necessary resources.

One of the key contributions of this review is the identification of long-term sustainability benefits associated with the use of Clo3D. Beyond immediate material savings, the shift towards digital prototyping aligns with broader trends in the fashion industry towards sustainability and

responsible production. This study suggests that by training students in sustainable design practices from an early stage, vocational schools can better prepare them for careers in an industry increasingly focused on environmental impact.

4. Effective Implementation Strategy

To maximize the benefits of Clo3D technology in fashion vocational education and address the challenges highlighted in previous studies, several strategies must be considered for effective implementation. One key strategy is investing in infrastructure. A recurring challenge noted in the literature is the lack of adequate infrastructure in many vocational schools. To overcome this, it is essential for schools to upgrade their technological capabilities, ensuring that both students and teachers can fully utilize Clo3D. Partnerships with government bodies and the fashion industry could play a vital role in providing the necessary hardware and software upgrades. According to Siersema (2015), over 60% of schools in rural areas lack the infrastructure to support advanced technologies like Clo3D. Government-supported initiatives and industry collaborations could provide schools with access to modern tools and resources at a reduced cost.

In addition to infrastructure upgrades, teacher training programs are critical to ensuring the successful adoption of Clo3D technology. As highlighted by Kazlacheva et al. (2018), 70% of teachers felt unprepared to use 3D design software in their classrooms. Therefore, offering professional development workshops and continuous training opportunities is essential. Schools can collaborate with technology providers or university fashion departments to create cost-effective training solutions for educators. This would help teachers develop the necessary skills to integrate Clo3D into their lesson plans and enhance the learning experience for students.

Moreover, the gradual integration of Clo3D into the curriculum can help both students and teachers adapt to the new system without overwhelming them. Schools should initially introduce Clo3D in design-related subjects and gradually expand its use across other fashion-related disciplines. A phased implementation allows time for addressing technical challenges and gathering feedback on how the technology impacts learning outcomes. This step-by-step approach ensures that both students and teachers become comfortable with the software before it is fully integrated into the curriculum. Another important strategy is fostering collaboration with the fashion industry. Strong partnerships between vocational schools and industry stakeholders can provide mutual benefits. For example, industry collaboration can offer access to the latest technology, software licenses, internships, and real-world projects where students can apply their Clo3D skills. According to Papahristou (2016), collaboration between educational institutions and the fashion industry enhances student engagement and helps them develop the teamwork and problem-solving skills essential for future employment.

Finally, Clo3D offers an excellent opportunity to teach and promote sustainable fashion practices. The technology allows schools to reduce waste in the fashion design process by encouraging students to prototype designs virtually before moving to physical production, thereby minimizing material consumption. Casais & Gomes (2022) reported a 40% reduction in design-related material waste through the use of 3D visualization tools like Clo3D, highlighting its potential to contribute to sustainable fashion education in the long term. By incorporating sustainability into the curriculum, schools can prepare students to enter an industry that is increasingly focused on reducing its environmental impact.

D. CONCLUSION AND SUGGESTIONS

This study demonstrates that Clo3D technology offers significant benefits for fashion vocational education, particularly in enhancing student creativity and fostering sustainable design practices. Key findings include a 23% increase in design diversity and a 35-40% reduction in material waste, underscoring the potential of Clo3D to modernize the fashion design process. However, challenges such as inadequate infrastructure, with over 60% of vocational schools lacking the necessary hardware, and 70% of teachers feeling unprepared to use the software, remain substantial barriers. These challenges highlight the need for targeted efforts to improve the accessibility and effective use of Clo3D in educational settings, particularly in underfunded and rural schools.

To address these challenges, several strategies are recommended. First, schools, in collaboration with government and industry, should invest in upgrading technological infrastructure and provide comprehensive teacher training programs to ensure the successful integration of Clo3D. Gradual curriculum integration and industry collaboration are essential to support real-world learning experiences for students. Additionally, policymakers must play an active role in bridging the digital divide, ensuring that vocational schools in all regions have equal access to the technology and resources needed for Clo3D implementation. By addressing these areas, the full potential of Clo3D can be realized, leading to improved educational outcomes and preparing students for the evolving demands of the fashion industry.

ACKNOWLEDGEMENT

I would like to thank the State University of Malang for the opportunity and support during the writing of this article/journal. My special thanks go to Mr. Didik Nurhadi, S.Pd, M.Pd, Ph.D, Mrs. Dr. Nurul Hidayati, S.Pd., M.Sn., and Mr. Muhammad Aris Ichwanto, S.Pd, MA, Ph.D, for their guidance, advice, knowledge, motivation, and time. Thanks also to colleagues who have provided support and assistance. Hopefully this article/journal will be useful for the development of science and become a useful reference for other researchers.

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