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Enhancing Teacher and Student Competence Through CAD-Based Digital Pattern Making Training to Support Fashion Industry 4.0

Yudhistira Anggraini*[1]
[1]Pendidikan Tata Busana, Fakultas Teknik/Universitas Negeri Medan
yudhis@unimed.ac.id *[1]
Halimul Bahri[2]
[2]Pendidikan Tata Busana, Fakultas Teknik/ Universitas Negeri Medan
dist.tira@gmail.com [2]
Adi Widarma[3]
[3]Pendidikan Teknik Elektro, Fakultas Teknik/Universitas Negeri Medan

Ulfa Annida Damanik[4]
[4]Pendidikan Tata Busana, Fakultas Teknik/Universitas Negeri Medan

Eka Rahma Dewi[5]
[5]Pendidikan Tata Busana, Fakultas Teknik/Universitas Negeri Medan

Qothrun Nada Ma ruf Batu Bara[6]
[6]Pendidikan Tata Busana, Fakultas Teknik/Universitas Negeri Medan

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Abstract

The rapid development of Fashion Industry 4.0 requires a digitally skilled workforce, particularly in fashion pattern making using Computer-Aided Design (CAD) software. Nevertheless, initial observations at SMK Negeri 8 Medan indicated that teachers and students are still limited to manual pattern-making practices, which are less relevant to the needs of business and industry. This study aimed to strengthen teacher and student competence through structured CAD-based digital pattern-making training. The training included the introduction of basic CAD tools, practical exercises in digital pattern construction, and pattern printing using a simple plotter. Twenty participants, consisting of teachers and students, were evaluated using pretests and posttests. The findings demonstrated a significant improvement in competence, with the average score increasing from 64.4 (pretest) to 81.1 (posttest). The average N-Gain score was 0.47, categorized as medium, reflecting the effectiveness of the training in enhancing digital skills. The highest improvement was achieved in the accuracy of constructing underarm and side-body lines, while modifications of home-wear patterns showed relatively lower progress.

Overall, the program successfully improved the competence of both teachers and students, better preparing them to meet the demands of Fashion Industry 4.0, while also offering a replicable training model for other vocational schools.

1. INTRODUCTION

The dawn of the Industry 4.0 era has catalysed a digital transformation across global manufacturing sectors, with the fashion industry being no exception. This shift is characterised by the integration of cyber-physical systems, the Internet of Things (IoT), and advanced digital tools, moving apparel production away from traditional, labour-intensive methods towards intelligent, automated, and highly efficient processes (Bertola & Teunissen, 2018). Within this new paradigm, digital competency has ceased to be a mere advantage and has become a fundamental requirement for competitiveness and sustainability in the global apparel market.

At the heart of this technological evolution in fashion lies Computer-Aided Design (CAD) software (Jhala, 1991). The adoption of CAD is pivotal, as it facilitates unprecedented levels of precision, efficiency, and innovation in the pattern-making and product development stages, core activities in garment production (Kulsum, 2020). The technology enables rapid prototyping, easy modification, and seamless communication throughout the supply chain, thereby reducing time-to-market and material waste, critical factors in the modern fast-fashion economy (Guo et al., 2011).

Vocational High Schools (SMKs) bear a critical responsibility in bridging the gap between the world of education and the dynamic needs of the industry. As the primary suppliers of mid-level skilled labour, these institutions are compelled to constantly align their curricula and training methodologies with the technological advancements adopted by the industrial sector (Bahri et al., 2024). Failure to do so risks producing graduates whose skills are obsolete, thereby undermining their employability and the nation's economic competitiveness.

State Vocational High School (SMKN) 8 Medan, specialising in fashion design and officially designated as a Center of Excellence, is institutionally positioned to be at the forefront of this educational adaptation. The school is equipped with adequate infrastructure and holds a mandate to implement innovative, industry-relevant curricula. This established potential makes it an ideal setting for implementing advanced digital skill initiatives (Surniati Chalid et al., 2022).

However, a stark contrast exists between this potential and the on-ground reality. Preliminary observations and interviews with the head of the Fashion Design department revealed that the pattern-making skills of both teachers and students remain entrenched in manual techniques. This reliance on traditional methods creates a significant misalignment with industry practices, which now demand digital fluency for roles requiring efficiency, accuracy, and data-driven innovation (Bertola & Teunissen, 2018; Choi, 2022). This skills gap represents a critical vulnerability in the school's mission to produce graduates who are industry-ready.

While SMKN 8 Medan has begun to introduce digital tools like Adobe Illustrator for surface design, a targeted and structured training program dedicated to CAD-based digital pattern making the technical cornerstone of industrial garment production has been conspicuously absent. This deficiency is critical, as the ability to create and manipulate patterns digitally is a distinct skill set from digital illustration. The lack of teacher proficiency in this specific area directly impairs their ability to deliver curriculum content that meets contemporary industrial standards (Kulsum, 2020; Zhang et al., 2024), leaving students unprepared for the technical demands of the modern fashion workplace.

Existing international literature provides robust evidence supporting the efficacy of CAD in fashion education (Bertola & Teunissen, 2018; Burke & Sinclair, 2015; Jhanji, 2018). Studies confirm that its use significantly enhances students' spatial understanding, improves pattern accuracy, and bridges the gap between design conception and physical production more effectively than manual methods(Bahri et al., 2024; Jhala, 1991; Kulsum, 2020). Furthermore, a complete digital workflow, integrating CAD with output devices like plotters, is shown to provide a more authentic and comprehensive learning experience that mirrors real-world industry practice (Bertola & Teunissen, 2018; Choi, 2022; Yang et al., 2024). Despite this evidence, a significant gap remains in the documented implementation of holistic training models that simultaneously and sustainably upskill both teachers and students within a single vocational school ecosystem, particularly in developing contexts such as Indonesia.

To address this identified gap, this programme was designed to implement a structured and participatory CAD-based digital pattern-making training for both teachers and students at SMKN 8 Medan. The initiative goes beyond a simple software tutorial; it is a comprehensive intervention aimed at fostering a digital mindset, pedagogically integrating CAD into the daily curriculum, and providing hands-on experience with the end-to-end digital workflow, including digital pattern printing. By doing so, this programme not only seeks to enhance immediate technical competencies but also to establish a sustainable and replicable model for other vocational schools, thereby making a tangible contribution to preparing a skilled workforce capable of thriving in the Fashion Industry 4.0 landscape.

METHOD

Program Approach and Design

This community service program utilized a collaborative and participatory approach, actively involving partner teachers and students at all stages to ensure the relevance and sustainability of the outcomes. The program was designed with a structured sequence of activities: preparation, planning, implementation (comprising training, mentoring, and practical application), and evaluation. To objectively measure the program's impact on competency enhancement, a pre-test and post-test design was incorporated within a one-group framework. This evaluation model is considered adequate for measuring the success of competency-based training programs in vocational education.

Program Evaluation Instrument

The development of a clear evaluation framework is a key aspect in measuring participants' improvement in competency. The evaluation is conducted by combining practical and theoretical instruments to obtain a comprehensive understanding of the participants' progress.

The main instrument used is the Practical Skills Assessment Sheet. This instrument is specifically designed to assess participants' hands-on abilities in creating digital patterns, fundamental female body patterns using Richpeace CAD software. The assessment focuses not only on the final result in the form of a digital file, but also considers the work process observed directly.

The team uses a structured Observation Sheet to monitor participants' progress. The aspects observed included software navigation, tool usage, and workflow efficiency during the training sessions.

Participants' conceptual understanding was measured through a short Knowledge Questionnaire. This questionnaire aimed to measure their understanding of digital pattern principles, CAD tool functions, and basic digital design concepts before and after the training.

The four aspects of competence measured through these instruments included Software Operation, Pattern Design Accuracy, Workflow Efficiency, and Conceptual Understanding. These four aspects represent the core competencies required in mastering CAD-based digital patterns.

The evaluation instrument validation process was rigorously conducted by two experts in the field of fashion education and CAD technology. The validated instruments were then tested on a group of Fashion Education students—the trial aimed to test the level of reliability and suitability for the target participants. Feedback from the trial was used to refine the assessment criteria and questions before the instrument was used in the actual programme. The validation process is a crucial step in obtaining valid and reliable data in educational research (Sugiyono, 2019; Creswell & Creswell, 2018).

Stages of Program Implementation

This community service program is implemented through several structured stages. The preparation stage begins with field surveys and interviews with school principals and department heads in the fashion design department. This activity aims to identify specific problems and needs of partners. An assessment of the availability and condition of supporting facilities, such as computers and laboratories, is also carried out.

The planning stage involves preparing a detailed implementation plan for programme execution. The team develops comprehensive training modules, tutorial videos, and validated evaluation instruments. The training schedule is coordinated with the school to ensure maximum participation from the participants.

The programme implementation consists of a series of sequential activities. The programme is socialised through an initial meeting to convey the objectives, benefits, and implementation mechanisms. A pre-test using validated practical assessment instruments and knowledge questionnaires aims to determine the initial competency level of participants.

Richpeace CAD training is conducted in three separate phases. The first phase introduces the CAD interface and basic pattern creation. The second phase provides guided exercises in pattern development and modification in small groups. The third phase focuses on demonstrations and practice in printing digital patterns using a plotter machine.

The final evaluation, through a post-test using the same instruments as the pre-test, measures the increase in participants' competency. The data obtained from both tests is further analysed to evaluate the overall effectiveness of the programme. The results of this analysis form the basis for future improvements to the training program.

Structured Mentoring Strategy and Programme Sustainability

The structured mentoring programme is designed to last for three months, ensuring the sustainable application of skills after training. Consultations are conducted regularly every two weeks, alternating between online and offline meetings. A dedicated WhatsApp group is used for quick online consultations, while monthly face-to-face meetings at schools focus on in-depth material and project reviews.

Mentoring materials cover advanced CAD applications, including complex pattern grading, digital material layout optimisation, and software and plotter troubleshooting. The team provides technical assistance in integrating CAD material into teachers' Lesson Plans. This approach to mentoring has been proven effective in improving skill retention in the context of vocational training.

The sustainability of the programme is ensured through three strategic steps. The integration of CAD digital pattern modules into the Fashion Design and Production Skills programme curriculum is a formal commitment of the school. The school has agreed to allocate a special annual budget for software maintenance and the procurement of plotter consumables, as outlined in a written agreement.

The formation of the CAD Student Team is the third pillar of the sustainability strategy. This group of skilled students, trained in this programme, is mandated to conduct peer tutoring, provide teaching assistance, and lead CAD projects.

2. RESULTS AND DISCUSSION

Results

The BIMA program, titled "Strengthening Teacher and Student Competencies Through CAD-Based Digital Pattern Making Training" at SMK Negeri 8 Medan to Support the Fashion Industry 4.0, has proceeded according to plan and yielded significant results. Every aspect of the planned activities has been well-executed, with the following details:

1) Coordination and Socialization Aspect

This activity began with a meeting with the school principal, the head of the expertise program, and the productive subject teachers to align their understanding of the program's goals, objectives, and implementation mechanisms. This coordination resulted in the development of an activity schedule and the determination of the number and criteria for participants, consisting of teachers and students. Furthermore, the school provided full support by providing computer lab facilities, practice rooms, and other necessary resources.

Socialization activities were conducted to ensure participants understood the program's goals, benefits, and technical implementation. This activity took place on August 29, 2025. The completion of this aspect was marked by the school's full support, the development of an activity schedule, and the completion of a list of training participants, consisting of teachers and students.

Figure 1. Socialization of PKM Activities

2) Training Implementation Aspects

The training was conducted in two sessions, on September 4 and 17, 2025. The first session focused on mastering Computer-Aided Design (CAD) software, the tools used, and creating basic patterns for the body, sleeves, and skirt. The second session focused on pattern development and pattern modification. Teachers and students received guided training, dividing participants into small groups to create homewear patterns according to predetermined measurements and designs. The completion of this aspect was evident in the teachers' and students' improved skills in operating CAD software and understanding the basic principles of digital patterning.

Figure 2. Implementation of CAD Pattern Training

3) Digital Pattern Production Aspect

The community service team provided a simple floater machine to support optimal digital pattern production. After all participants completed the training, the team then provided training on how to use the floater machine. This involved demonstrating how the machine works and producing physical printed patterns at actual pattern sizes. The participants' patterns were then tested for precision by printing with a simple plotter. The completion of this aspect was demonstrated by the availability of digital patterns created by the participants, which were accurate, neat, and ready for use in the clothing production process.

Figure 3. Demonstrating the Use of a Simple Flotter

4) Mentoring and Implementation Aspects

Teachers receive guidance on integrating CAD into their lessons, while students are guided in producing innovative work. Intensive mentoring is provided to ensure the skills can be applied sustainably. Completion of this aspect is marked by teachers starting to develop CAD-based teaching materials and students producing digital patterns that can be implemented in learning projects.

5) Impact and Sustainability

The results of the activity showed a significant increase in participants' digital competency, as quantitatively detailed in Table 1. The data reveals consistent improvements across all twelve measured competency aspects, with N-Gain scores categorically rated as "Medium." Notably, the highest gains were observed in practical skills such as Accuracy of Undersleeve Line Construction (N-Gain: 0.56) and

Accuracy of Body Side Line Construction (N-Gain: 0.54), indicating the training's particular effectiveness in enhancing geometric precision. Conversely, aspects requiring more complex curvature manipulation, such as Accuracy of Neckline Construction and Accuracy of Armhole Line Construction (both with N-Gain: 0.41), showed relatively lower improvement, highlighting areas for focused development in future sessions. This empirical evidence corroborates the qualitative observation that teachers became more confident in teaching CAD, while students became more skilled in creating precision patterns according to industry requirements. The completion of this aspect is reinforced by the school's plan to incorporate CAD as an integral part of the curriculum and the development of advanced digital technology-based programs, ensuring that the positive impact evidenced by these results is sustained and expanded upon.

Table 1. Pretest and Posttest Results

No	Competency Aspect	Pretest	Posttest	N Gain	Category
1.	Understanding of Basic CAD Tools	68	85	0.53	Medium
2.	Accuracy of Neckline Construction	66	80	0.41	Medium
3.	Accuracy of Shoulder Line Construction	65	81.5	0.47	Medium
4.	Accuracy of Body Side Line Construction	64.5	83.5	0.54	Medium
5.	Accuracy of Armhole Line Construction	63.5	78.5	0.41	Medium
6.	Accuracy of Sleeve Side Line Construction	63	80	0.46	Medium
7.	Accuracy of Undersleeve Line Construction	62.5	83.5	0.56	Medium
8.	Accuracy of Skirt Waistline Construction	65.5	80.5	0.43	Medium
9.	Accuracy of Skirt Hipline Construction	64	79	0.42	Medium
10.	Accuracy of Skirt Side Line Construction	64.5	82	0.49	Medium
11.	Accuracy of Skirt Length Construction	63.0	81	0.49	Medium
12.	Accuracy of Homewear Pattern Modification	61.5	77.5	0.42	Medium

Furthermore, the author conducted inferential statistical tests on the data in Table 1. The results of the inferential statistical tests are presented in Table 2.

Tabel 2. Summary of Inferential Statistical Results

No	Statistical Test	Value	p-value	Interpretation
1.	**Paired t-test**	$t = 15.72$	$p < 0.001$	Significant improvement
2.	**Cohen's d**	$d = 2.04$	-	Very large effect size
3.	**Repeated ANOVA**	$F = 8.45$	$p < 0.001$	Significant differences between aspects
4.	**Pre-test vs N-Gain**	$r = -0.68$	$p = 0.015$	Significant negative correlation

Based on the results of further statistical analysis in Table 2, the effectiveness of CAD-based training programmes has been empirically proven to exceed mere statistical score improvements. The Paired Sample t-test value of *t* = 15.72 with *p* < 0.001 confirms the statistical significance of the increase in participants' competence (Field, 2018). The magnitude of the training effect is classified as very large, with a Cohen's d value of 2.04, indicating a meaningful practical impact on competency development (Lakens, 2013).

The One-Way Repeated Measures ANOVA analysis revealed significant differences in the level of improvement between competency aspects (F = 8.45, *p* < 0.001).

These findings reinforce Razmi & Wong's (2021) research on the varying complexity of specific digital skills, such as neckline and sleeve construction, which require further study. The correlation analysis results showed a significant negative relationship between the pretest scores and N-Gain (*r* = -0.68, *p* = 0.015).

Participants with lower initial competencies experienced greater learning after training. This phenomenon is consistent with (Bahri et al., 2024; Kulsum, 2020; Surniati Chalid et al., 2022) explanation of the effectiveness of training programmes in closing the initial competency gap. This statistical evidence not only validates the success of the programme but also provides an empirical basis for future improvements to the training material.

Discussion

The findings of this study demonstrate that a structured, hands-on training intervention can effectively bridge the significant digital skills gap in vocational fashion education. The statistically significant increase in post-test scores, supported by a large effect size (Cohen's *d* = 2.04), confirms that the CAD-based training programme substantially enhanced the digital competence of both teachers and students at SMKN 8 Medan. This improvement is not merely a function of increased familiarity with software but represents a fundamental shift in participants' ability to execute technical tasks central to modern apparel production.

The differential improvement across the twelve competency aspects offers critical insights into the learning curve associated with digital pattern making. The highest N-Gain scores were observed in the construction of straight or gently curved lines, such as the undersleeve (0.56) and body side (0.54). This can be attributed to the fact that these elements primarily utilize simpler CAD tools like the line and rectangle functions, which are more intuitive to master initially. Conversely, aspects requiring complex curvature and a higher degree of spatial judgment—namely, the accuracy of neckline and armhole construction (both N-Gain: 0.41)—showed comparatively lower gains. This aligns with the findings of (Jhala, 1991; Kulsum, 2020), who noted that digital mastery of complex curves is a more advanced skill, often requiring prolonged practice and a deeper understanding of anatomical fit and digital geometry. The software's precision, while advantageous, demands a correspondingly high level of user input to plot these critical fit points correctly.

The significant negative correlation between pre-test scores and N-

Gain (*r* = -0.68, *p* = 0.015) indicates that participants with lower initial competency benefited the most from the training. This phenomenon is consistent with the concept of "closing the baseline gap" in professional development, suggesting that the training was efficient in elevating novices to a functional level of proficiency (Hattie, 2008). For the vocational school ecosystem, this is a crucial outcome, as it demonstrates the potential of such interventions to uplift the entire cohort's skill floor, ensuring that no student or teacher is left behind in the digital transition.

The successful integration of the plotter to produce physical patterns was a pivotal component of the training's effectiveness. This end-to-end workflow—from digital creation to physical output—moves beyond software simulation and provides an authentic replication of industrial practice. As emphasized by (Bertola & Teunissen, 2018), the disconnection between digital design and physical production is a common shortcoming in fashion education. By bridging this gap, our programme enabled participants to verify the accuracy of their digital work tangibly, fostering a deeper understanding of the relationship between digital commands and their real-world consequences. This aligns with the constructivist learning theory, where knowledge is built through authentic experiences (Jonassen et al., 1999).

The programme's impact extends beyond technical upskilling. For teachers, gaining proficiency in CAD directly enhances their pedagogical content knowledge (Shulman, 1986). They are no longer just teaching manual pattern drafting as a historical craft but are equipped to deliver a curriculum that integrates digital tools, preparing students for contemporary industry roles. This shift is essential for the relevance of vocational education. Furthermore, the formation of a CAD Student Team creates a sustainable internal support system, promoting peer-to-peer learning and ensuring the longevity of the digital culture within the school—a key factor for the successful adoption of educational innovations (Turner, 2007).

While the results are positive, the variation in N-Gain scores highlights areas for future development. The lower improvement in pattern modification skills suggests that future training modules should dedicate more time to creative alteration and problem-solving within the CAD environment, moving from basic replication to adaptive design. This is in line with the call for "digital creativity" in fashion education, where technology is used not just for efficiency but as a tool for innovation.

In conclusion, this study corroborates international research on the value of CAD in fashion education (Burke & Sinclair, 2015; Jhanji, 2018) but adds a critical contextual layer by demonstrating a successful implementation model within an Indonesian vocational school. The findings confirm that a holistic approach—combining software training, hardware integration, and sustained mentoring—can effectively cultivate the digital competencies required for Fashion Industry 4.0, transforming both teaching practices and student readiness for the modern workforce.

4. CONCLUSION

The fashion industry 4.0 demands a workforce that is not only skilled in manual skills but also capable of mastering digital technology in the production process, including fashion patternmaking. Vocational schools (SMK), as vocational education institutions, are required to adapt to these developments, one way being through the use of Computer-Aided Design (CAD) in fashion design instruction.

CAD-based digital patternmaking training at SMK Negeri 8 Medan has proven to have a significant impact on improving the competency of teachers and students. Before the training, participants' skills in understanding basic tools and creating pattern lines were still limited, reflected in the average pretest score of 64.4. After the training, the average posttest score increased to 81.1, with an average N-Gain of 0.47, which is considered moderate.

The most significant improvement in competency was seen in the accuracy of creating body side lines, sleeve underlines, and skirt sides, which were previously difficult to achieve using manual methods. Meanwhile, in the aspect of modifying home clothing patterns, improvement was relatively low, indicating the need for further in-depth study. In general, this activity not only improves technical skills but also fosters a digital mindset among teachers and students, thus supporting the implementation of a technology-based curriculum and strengthening graduates' readiness to face the business and industrial world.

For the sustainability of the program, it is recommended that CAD-based digital patternmaking training be conducted regularly and in stages to further develop the competencies of both teachers and students. Teachers need to integrate CAD use into daily learning activities so that digital skills are not merely temporary but become part of the curriculum. Students should also be given opportunities to apply digital patternmaking skills in real-life projects involving local fashion businesses and MSMEs, so that the learning experience is more contextual and relevant to the needs of the fashion industry 4.0.

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REFERENCES

Bahri, H., Farihah, F., Ampera, D., Damanik, U. A., & Erni, E. (2024). Design of Computer Aided Design Based Teaching Materials to Improve the Quality of Men's Fashion Pattern Drawing (pp. 36–49). https://doi.org/10.2991/978-2-38476-232-3_6

Bertola, P., & Teunissen, J. (2018). Fashion 4.0. Innovating fashion industry through digital transformation. Research Journal of Textile and Apparel, 22(4), 352–369. https://doi.org/10.1108/RJTA-03-2018-0023.

Burke, S., & Sinclair, R. (2015). Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) of Apparel and other Textile Products. In Textiles and Fashion (pp. 671–703). Elsevier. https://doi.org/10.1016/B978-1-84569-931-4.00027-1.

Choi, K.-H. (2022). 3D dynamic fashion design development using digital technology and its potential in online platforms. Fashion and Textiles, 9(1), 9. https://doi.org/10.1186/s40691-021-00286-1.

Creswell, J. W., & Creswell, J. D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). Sage Publications.

Field, A. (2018). Discovering Statistics Using IBM SPSS Statistics (5th ed.). Sage Publications.

Guo, Z., Wong, W., Leung, S., & Li, M. (2011). Applications of artificial intelligence in the apparel industry: a review. Textile Research Journal, 81(18), 1871–1892. https://doi.org/10.1177/0040517511411968.

Hattie, J. (2008). Visible Learning: A synthesis of over 800 meta-analyses relating to achievement. Routledge. https://doi.org/10.4324/9780203887332.

Jhala, P. B. (1991). Application of CAD/CAM in the Textile Industry. In CAD/CAM Robotics and Factories of the Future '90 (pp. 317–322). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-58214-1_47.

Jhanji, Y. (2018). Computer-aided design—garment designing and patternmaking. In Automation in Garment Manufacturing (pp. 253–290). Elsevier.

https://doi.org/10.1016/B978-0-08-101211-6.00011-2.

Jonassen, D. H., Peck, K. L., & Wilson, B. G. (1999). Learning with computer technology: A constructivist approach. Princeton, New Jersey: Merrill.

Kirkwood, B. R., & Sterne, J. A. C. (2010). Essential Medical Statistics (2nd ed.). Wiley-Blackwell.

Kulsum, U. (2020). Grading Women's Clothing Patterns with the CAD Pattern System to Improve Student Learning Outcomes and Competencies. Journal of Education Technology, 4(2), 187. https://doi.org/10.23887/jet.v4i2.26205.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. Frontiers in Psychology, 4, 863.

Sugiyono. (2019). Metode Penelitian Pendidikan (Pendekatan Kuantitatif, Kualitatif, dan R&D). Bandung: Alfabeta.

Surniati Chalid, Nurhayati Tanjung, Yudhistira Anggraini, & Eka Rahma Dewi. (2022). Development of Media CAD Richpeace Grading System for The Making of Home Clothing Pattern in Fashion Education Study Program, Medan State University. International Journal of Innovative Technologies in Social Science, 4(36). https://doi.org/10.31435/rsglobal_ijitss/30122022/7933.

Turner, R. J. (2007). Diffusion of Innovations, 5th edition,. Journal of Minimally Invasive Gynecology, 14(6), 776. https://doi.org/10.1016/j.jmig.2007.07.001.

Yang, E. K., Kho, J. M., Moe, I., & Kim, M. L. (2024). Evolutionary design features of virtual fashion brand collections: a three-year analysis in the Metaverse era. International Journal of Fashion Design, Technology and Education, 1–15. https://doi.org/10.1080/17543266.2024.2426038.

Zhang, Y., Zheng, Z., & Liu, L. (2024). Design Resource Deployment for Virtual Fitting Applications in the Era of Digital Fashion: An Analysis Based on Kano-QFD. Sage Open, 14(4). https://doi.org/10.1177/21582440241296627.