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3D Garment Simulation as A Tool to Actualize The Design Ideas of Fashion Students

Moda Öğrencilerinin Tasarım Fikirlerini Gerçekleştirmeye Yönelik Bir Araç Olarak 3D Giysi Simülasyonu

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ABSTRACT

This study explores how fashion design students perceive using 3D garment simulation to create their design ideas. As a part of an elective course taught in Fall 2022, twelve students were given a project to prepare virtual and physical garments of their design. The study had two parts: First was understanding students' expectations about 3D garment simulation before starting the project, and second was understanding students' experience after completing the project and comparing their before and after project experiences. Accordingly, a structured questionnaire measured on a seven-point Likert scale was applied to the students before starting their project to see their self-confidence in using 3D garment simulation, and after the project to understand their self-evaluations of their performance and difficulties they encountered during the project. The first part of the study presented here shows that students had a high self-confidence (M=5.16) that they will successfully apply their project digitally, which will be similar to their physical garment (M=5.50). Still, they were not confident that the digital garment would be visually satisfying (M=4.92). Students were highly convinced that using 3D garment simulation is very useful (M=6.42) to visualize their projects before starting to work on it. They had high intention (M= 6.00) to use it. After-project results showed that students self-evaluated their performance higher than before project expectations. Students' evaluations for the perceived usefulness of 3D garment simulation to visualize their project and intention to use it in the future dropped after the project (M=6.17 and M=5.75, respectively). Finally, students had the most difficulty creating the patterns and achieving the correct digital fit.

ÖZ

Çalışmada, moda tasarımı öğrencilerinin tasarım fikirlerini oluşturmak için 3 boyutlu giysi simülasyonunu kullanarak nasıl algıladıkları araştırılmıştır. 2022 Sonbahar döneminde verilen seçmeli ders kapsamında on iki öğrenciye, tasarlayacakları sanal ve fiziksel kıyafetleri hazırlamaları için bir proje verilmiştir. Çalışma iki bölümden oluşmuştur: Birincisi, projeye başlamadan önce öğrencilerin 3 boyutlu giysi simülasyonuna ilişkin beklentilerini, ikincisi ise öğrencilerin projeyi tamamladıktan sonraki deneyimlerini anlayarak proje öncesi ve sonrası deneyimlerini karşılaştırmaktır. Buna göre, öğrencilere projeye başlamadan önce 3 boyutlu giysi simülasyonu kullanma konusundaki özgüvenlerini görmek için, proje sonrasında ise performanslarına ve karşılaştıkları zorluklara ilişkin öz değerlendirmelerini anlamak için yedili Likert ölçeğinde ölçülen yapılandırılmış bir anket uygulanmıştır. Burada çalışmanın ilk kısmı sunulmuştur. Çalışma, öğrencilerin fiziksel kıyafetlerine benzer (M=5.50) projelerini dijital ortamda başarıyla uygulayacaklarına dair özgüvenlerinin yüksek olduğunu (M=5.16), ama dijital giysinin görsel olarak tatmin edici olacağından emin olmadıklarını göstermektedir (M=4.92). Öğrenciler, üzerinde çalışmaya başlamadan önce projelerini görselleştirmek için 3 boyutlu giysi simülasyonu kullanmanın çok faydalı olduğuna (M=6.42) oldukça ikna olmuşlardır. Kullanma niyetleri yüksektir (M= 6.00). Proje sonrası sonuçlar, öğrencilerin performanslarını proje öncesine göre daha yüksek düzeyde değerlendirdiklerini göstermiştir. Öğrencilerin, projelerini görselleştirmek için 3 boyutlu giysi simülasyonunun algılanan kullanışlılığı ve bunu gelecekte kullanma niyetleri konusundaki değerlendirmeleri projeden sonra düşmüştür (sırasıyla M=6,17 ve M=5.75). Öğrenciler en çok kalıpları oluşturmada ve doğru dijital uyumu yakalamada zorluk yaşamışlardır.

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1. Introduction

Even though 3D garment simulation has existed commercially for over a decade, its use in the fashion industry widened in the last two to three years. Parallel to it, fashion design educators had to adopt using digital tools to retain teaching the normally studio-based courses. Some universities were already using 3D garment simulation, but the need has drastically increased after the COVID-19 pandemic.

Nowadays, students and instructors are adapting to 3D garment simulation as a tool for designing clothes instead of or together with flat pattern making, draping, and tailoring. Traditionally, in fashion design education, students start with a design idea, followed by technical and artistic sketches and prototyping. However, due to the pandemic, many restrictions of this process outstood for the students to actualize these traditional design steps. For instance, many students didn't have patternmaking tools, a dress form, or a sewing machine in their homes. Moreover, they couldn't go out to buy fabrics. However, 3D garment simulation allowed students to create patterns using a keyboard, sew them digitally, and use digital fabrics from a digital library. Many fashion design departments are now transforming to fully or partially digital fashion design education. However, research (Baytar, 2018; Gu&Liu, 2019) is ongoing to understand students' expectations of this transformation.

The primary research purpose of this study was to measure students' attitudes toward using 3D garment design software to actualize their design ideas. To do so, twelve fashion design students who took the class 3D garment design during the 2022 Fall semester were asked to participate in the experiment. The 3D garment design course was conducted remotely; however, the midterm project and final project presentations were done face to face.

The students' project consisted of two parts. In the first part, students were asked to design a women's garment to achieve a casual look. After getting confirmation from the instructor about their sketches, they started to study the creation of the digitals of the garments.

In the second part, students were asked to prepare the actual clothes. The comparison between a real and virtual prototyping process from the students' perspective was evaluated as an experimental study. On the other hand, the technical difficulties during the digital prototyping process and how the students and the instructor handled it were addressed.

2. Experimental Study

The students used Browzwear VStitcher 3D Garment Simulation Software 2021.2 version for their digital projects. In the first ten weeks of the semester, students joined the online classes to learn how to use the program and how to improve their 3D design skills. In addition to this teaching process, students were granted full access to Browzwear University, which has all the necessary information to create a digital garment from basic to advanced. Besides, a three-hour workshop with a VStitcher expert was organized to advance students' 3D skills. At the end of this training period, students reached a certain level of knowledge about the program and were ready to create their digital projects.

At the beginning of the project, students created technical and artistic sketches of their project and brought the trims and fabrics they planned to use to get the instructor's approval. The instructor guided the students about achieving the desired look in 3D as a starting point. Later, students were asked to bring fabric samples for physical testing in FAB (Fabric analyzer instrument developed by Browzwear to test bend, shear, and stretch of the fabrics) and visual testing in Vizoo (a texture creator instrument that works with scanning principle) to achieve the best images for the digital garment. The test results obtained from FAB and Vizoo were shared with students for use in their projects.

In addition to the digital design process, students produced their real garments by preparing the patterns (either directly on VStitcher or manually by using flat pattern making or draping technique and digital table). Students were not limited to designing the digital first and the real garment after or vice versa. However, the deadline for creating the digital garments was earlier than the submission of physical garments, which encouraged students to develop the digitals first, like industrial applications. The project started in November 2022 and took approximately two months to finish.

To achieve the research goal of this study, descriptive research as the quantitative method was followed. The data were collected via structured questionnaires that consisted of multiple-choice questions (seven-point Likert Scale) and open-ended questions that were designed to measure constructs of students' satisfaction with using 3D garment simulation for fashion design education and practices, challenges of using 3D garment simulation as a design tool, the comparison of actual and digital prototyping process in terms of production time, visual quality of the end product, costs of the prototyping process.

Besides, comparing students' self-confidence in the project tasks before starting the project and their outcomes after the project was compared, to do so, two questionnaires (before-project and after- project) were applied online using Google Forms.

3. Results

All registered students agreed to participate in the research study; therefore, the sample number in the study was twelve. The first questionnaire was applied to the students before they started their project but after they had completed their training. According to the results of this first questionnaire, the majority of the students (n=5) more or less agreed that they could create the digital garments successfully; however, four of them doubted if it would be visually satisfactory, but still, more than half (n=7) of the students thought, at different extends that they would achieve a good visual standard. Most students (n=10) expected, to different extents, that their physical and virtual garments would be similar. Students' confidence that they could produce digital garments successfully was lower (M=5.17) than their confidence in making their physical garments successfully (M=5.50).

The results showed that most of the students were committed to the project. Only one student hasn't done research before starting the project by looking at the trims and fabrics offered by the software or browsing the internet to see what the program provides for designers. The other students had done research to different extents before starting the project. While choosing their project ideas, most students (n=10) considered the difficulty/easiness of creating the patterns, and almost all of them (n=11) chose fabrics and trims like the ones in the software library.

The second questionnaire was applied after students finished their projects. According to the results of this second questionnaire, most students (n=9) think they created digital garments successfully. However, four students were neutral about whether they were satisfied with their project's visual quality, while eight were satisfied to different extents. Most students (n=10) thought, to different extents, that their physical and virtual garments were similar at the end of the project.

On the other hand, this study questioned if students would use the 3D garment creation software in the future. Before the project and after the project results were different. Agreement to use 3D garment creation software in the future was lower for after-project results than before-project results (M= 5.75 and M=6.00, respectively). Similarly, agreement for the usefulness of creating digital garments to visualize the imagined garments before their production was lower for after-project results than before-project results (M=6.17, M=6.42, respectively).

Table 1. Before and after project evaluations of the students
Tablo 1. *Öğrencilerin proje öncesi ve sonrası değerlendirmeleri*

	Item	Mean (standard deviation) (1: completely disagree, 7: completely agree)
Performance	(Before project) I can apply my project digitally vstitcher successfully	5.17 (0.94)
	(after project) I applied my project digitally vstitcher successfully	5.42 (1.24)
	(Before project) I can produce the garments that i have designed for my project successfully	5.50 (1.31)
	(After project) I produced the garments that i designed for my project successfully	5.83 (1.11)
	(Before project) The digital project i will design in vstitcher will be visually satisfying	4.92 (1.16)
	(After project) The digital project i designed in vstitcher is visually satisfying	5.50 (1.17)
	(Before project) The digital garment that i will create will be similar to the real garment that i will produce	5.50 (1.00)
	(After project) The digital garment that i created is similar to the real garment that i produced	5.75 (1.22)
Perceived usefulness	(Before project) I think that creating digital garments is very useful to visualize the products we have imagined in our mind even before its production	6.42 (0.67)
	(After project) I think that creating digital garments is very useful to visualize the products we have imagined in our minds even before their production	6.17 (1.03)
Intention to use digital garment creation	(Before project) I think that i will use digital garment creation in the future as well	6.00 (0.95)
	(After project) I think that i will use digital garment creation in the future as well	5.75 (1.54)

Moreover, to understand the difficulties that students had while creating their digital garments, additional questions were asked. According to the answers given in Table 2, students struggled most with creating the digital patterns (M=4.58) and least with creating the fabric texture (M=3.00).

According to the answers to the open-ended question of the same query, "fitting" was the most used word by students to point out the most significant problem they had during digital garment creation, followed by the phrase "digital stitching."

Table 2. Difficulties encountered by students during the creation of the digital garments by using VStitcher as the 3D garment simulation software and the mean scores measured
Tablo 2. *3 boyutlu giysi simülasyon yazılımı VStitcher kullanılarak dijital giysilerin oluşturulması sırasında öğrencilerin karşılaştıkları zorluklar ve ölçülen ortalama puanlar*

	Item	Mean (standard deviation) (1: completely disagree, 7: completely agree)
1	Creating digital patterns was difficult	4.58 (1.88)
2	Fitting the digital garment was difficult	4.25 (1.06)
3	Creating the simulation was difficult	4.25 (2.01)
4	Creating the styling was difficult	3.58 (1.08)
5	Creating the visual details (light, pose, shadows, etc.) was difficult	3.67 (2.02)
6	Creating the fabric texture was difficult	3.00 (1.04)
7	Creating the trims; zippers, buttons, accessories, etc. was difficult	4.33 (1.97)
8	Digitally stitching the garment was difficult	3.83 (2.17)

The money spent to produce the physical garments was asked in the after project survey. Students spent 25 USD on average to prepare their physical garments (Min: 7.5 USD, Max: 100 USD). Also, the time spent on the digital and physical projects was asked. However, the answers to this open-ended question didn't give any reliable and measurable results (i.e., approximately two weeks, more than a month, etc.) since students spread finishing the project over two months. However, a subject-by-subject comparison of the time spent on digital and physical garments showed that students spent more time on physical projects than digital ones (except three students). For example, the student who spent three days on his digital project said he prepared the physical garment in two weeks.

a. b. c.

Figure 1. Physical and digital clothes examples from three different students' projects
Görsel 1. *Üç farklı öğrencinin projesinden fiziksel ve dijital kıyafet örnekleri*

Besides the matters that students self-acknowledged, the instructor observed some additional points. The first observation was about the fabric's physics and texture. Even if the fabrics had been tested via FAB and Vizoo, some students were not satisfied with the drape and/or the fabric texture obtained from the test instruments. They preferred to use the available fabrics in the program library and modify them according to their own fabric.

The second observation was about the accessories not in the program's library (i.e., safety pins, special design buttons, etc.) or any complicated details such as laced back. Students would have found/created these accessories through additional sources (i.e., other 3D object creation programs, the internet offering already created 3D objects). However, instead of this option, students preferred to change their designs even if they would get a lower grade upon any changes made to the initial design (See Figure 1. c

where the lacing at the back and the bones at the front of the corset have been canceled on the digital look). The final observation was about the fabric folds and drapes. Figures 1a, 1b, and 1c show that the real garments' folds and wrinkles were more visible than the digitals. The digitals had a flat and smooth look, flawless even, and one student addressed this issue.

Finally, Table 3. shows students' answers to the fashion design curriculum-related questions.

Even though students almost completely agreed (M=6.42) that 3D garment simulation is a useful tool to visualize their design ideas, they disagreed that this tool could neither replace the real garment-making process nor replace the flat patternmaking class that is traditionally taught in fashion design education (Table 1.). On the other hand, students were more positive towards replacing 2D digital patternmaking teaching with 3D garment design teaching (M=3.75).

Table 3. Descriptive statistics results of after-project surveys
Tablo 3. *Proje sonrası anketlerin tanımlayıcı istatistik sonuçları*

	Item	Mean (standard deviation) (1: completely disagree, 7: completely agree)
1	Creating digital garments instead of real garments is enough for fashion design education	2.50 (1.24)
2	3D Virtual garment design class can replace the flat patternmaking class)	2.58 (1.16)
3	3D Virtual garment design class can replace the 2d digital patternmaking class (i.e., lectra, gerber, etc.)	(2.01)

3. Conclusion

According to the analysis of the results, some points stood out to be discussed further. As given in Table 1., before and after project answers of the students differed. Before starting the project, students had lower confidence in whether they could successfully create the digital look, if the digital clothes would be visually pleasing and similar to the physical one. However, upon completing the project, their answers to the same questions showed that their satisfaction levels exceeded their expectations. Bandura (1977) described self-confidence as a person's confidence in his/her capabilities to accomplish a task (Bandura, 1977).

People's self-confidence depends on many variables, including expertise on the topic, previous experiences of success and failure, and task difficulty (Bandura, 1986). In this study, students' self-confidence for items listed in Table 1. was higher (M>5.00) than

the average (M=4.00). This might be related to students' gained experience due to the ten weeks of the training session they have received.

As documented well by Druckman et al., 1994, self-confidence is an essential mediator in performing towards achieving a goal (Druckman&Bjork, 1994) which simply can be translated as self-confidence helps people reach their goals (Woodman&Hardy, 2003). When this relationship is assessed for this study, the students' high (M>5.00) self-confidences in that they could apply the digital project and produce the garment successfully might have reflected on their performance. However, it should be noted that the performance measured in this study was students' self-evaluation of their own performance. On the other hand, subject by subject comparison of students' project grades (instructor's evaluation) and their self-confidence on the measured constructs (success of the digital clothes, physical clothes, their visual quality and their similarity to each other) showed that students with higher self-confidence performed better which supports the earlier findings (Woodman&Hardy, 2003).

On the other hand, interestingly, students' belief in the usefulness of 3D garment simulation to visualize their project ideas and their intention to use it in the future had dropped. The relationship between new technology and its acceptance is well documented by the Technology Acceptance Model (TAM) which shows the perceived usefulness and perceived ease of use of technology, translating to a behavioural intention to use it (Davis&Davis, 1989).

The study results reported in Table 2. and answers to open-ended questions showed that students had some difficulties (perceived ease of use) while preparing their digital projects. This issue might have lowered their evaluations of the usefulness of the technology and their intention to use it in the future.

As given in Table 2, preparing the digital patterns and fitting them on the avatar was the most challenging aspect of the program, according to students. Even if the software shows the fit changes instantly when a pattern is altered, students have difficulty achieving the correct fit.

According to the instructor's observation, this was related to the lack of students' patternmaking knowledge and expertise to analyze fit problems and offer solutions to solve them rather than the technical insufficiency of the program. On the other hand, most of the students had different design details or accessories they initially wanted to use. Still, they later decided not to use them as they struggled to create them digitally. However, more committed students (measured according to the self-reported time spent on the project and research done by the student before starting the project) achieved the desired details (trims or patterns) even if it required searching for community help to solve the problems. Although the program, VStitcher 2021.V2, offers a limited set of trims and accessories in the library and every new version of the software

library being upgraded, many alternative ways exist to find/create/modify the desired look in case enough time is spent on it.

One of the advantages of 3D garment simulation software is the shortening of the prototyping process. However, this advantage becomes vague if the garments have some design details, such as complicated patterns or some unusual accessories. On the other side, in this study, the advantage of 3D garment simulation programs to reduce the costs of garment making was confirmed since 25 USD average production cost which is high for a student (5% of the minimum wage as of Feb 2023) for doing the project has been omitted for its digital twin.

This study was an exploratory study to understand students' attitudes towards using 3D garment simulation software to actualize their design ideas during their university education.

This study can benefit educational institutions that are inevitably incorporating 3D garment design education into their curriculum after the pandemic to understand students' expectations, self-evaluations, and difficulties they encountered while working with 3D garment simulation software. One of the conclusions of this study was that even if students were convinced of the usefulness of the 3D garment simulation technology and had a high intention to use it in the future, they opposed it could replace traditional pattern-making education.

During the COVID-19 pandemic, 3D garment simulation was offered as an alternative to studio-based courses in fashion design education and after the pandemic, many digital fashion design bachelor's courses have been established (Barrera, 2022). Even if 3D garment simulation was a temporary solution for education to continue in extraordinary conditions, this study showed that it is not a replacement for studio-based pattern making and garment-making courses according to the students, and the results of this study showed that merely a digital fashion education would not be favorable for students.

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