



Title:

The Role of 3D CAD in Shaping Career Orientation in Fashion Education: Insights from the 3D4U Project

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Introduction:

Technological advances associated with Industry 4.0 have reshaped the fashion industry by integrating digital and physical media, enhancing human-machine collaboration, and enabling real-time data exchange [28]. These technologies now permeate design, production, and distribution, influencing product quality, personalization, and innovation while supporting designers' creativity and expanding production variety [26]. Developments such as smart factories [11] and the EU's proposed Digital Product Passport [19] further highlight the sector's technological shift and its contribution to sustainability, while the emergence of Artificial Intelligence and its varied interactions with fashion professionals underscores the need for continuous adaptation [24]. As a result, the digital transformation of the fashion industry increasingly demands a workforce with advanced technological competencies, making digital training essential [11]. As industries evolve, digital literacy becomes fundamental, reshaping roles and requiring professionals who combine creative and technological expertise [1, 27]. Evidence from the Greek clothing sector illustrates a shortage of digitally skilled personnel, particularly 3D designers, and emphasizes the need for updated curricula and continuous training [12]. In response to these challenges, this study examines the integration of virtual prototyping and 3D CAD systems into fashion and clothing curricula, focusing on their influence on students' attitudes toward professional orientation.

Research Development:

Literature Review

In this changing environment, several universities are adopting new practices to modernize their curricula and offer their students a stronger cognitive foundation. At this point, previous research on the integration of 3D CAD systems into higher education in fashion was examined. These studies have primarily focused on the impact of these technologies on students' skills. 3D CAD was used either as supplementary teaching material [23] or as the main subject of study [2-3, 8-9, 13, 21, 25]. In all cases, the sample consisted of fashion students, while [4] investigated the impact of using 3D CAD on students specializing in the apparel business sector. Overall, the attitudes towards the integration of 3D CAD curricula were positive. However, since 3D design technology is not yet widely used in higher education institutions, the studies that have been conducted use qualitative methods or a combination of qualitative and quantitative methodology to determine how the virtual prototype was taught and the results of the students' experience, without focusing on students' attitudes toward their professional future.

3D Concepts for Fashion Education in Ukraine

The Department of Creative Design and Clothing of the International Hellenic University has included Virtual Prototyping in its curriculum in 2019 following a curriculum revision that accompanied the department's transition from a technological education institute (TEI) to a university-level institution (AEI). The course is part of the 3rd year in the 4-year program and requires knowledge of 2D CAD and other digital tools. The integration of the Virtual Prototype into the curriculum, as well as the way the course and the final assessment are structured, significantly enhances the educational experience and academic level of the students. In particular, in terms of general skills, it functioned as a catalyst for the cultivation of critical thinking, helping students develop problem-solving skills. In addition, extensive contact with three-dimensional digital environments helped develop spatial visualization and perception skills to varying degrees, while the experiential nature of the work contributed to the acquisition of both theoretical knowledge and practical experience in the creation of virtual prototypes, thus increasing the students' competence in areas related to their studies [22].

Moreover, it is worth noting that the long-term goal of the course is to establish cooperation with foreign university departments with the same or similar experience in three-dimensional clothing prototyping, in order to carry out joint projects. Through this contact, students from various academic institutions will come closer together in a broader and more diverse environment of cooperation and exchange of knowledge and experience.

The Department of Creative Design and Clothing (Kilkis) of the International Hellenic University (IHU) leads the 3D Concepts for Fashion Education in Ukraine (3D4U) from November 2023, to October 2026. Co-funded by Erasmus+, the project aims to increase the adoption of 3D technologies, as 3D design, virtual prototyping, and additive manufacturing in higher education, strengthening related skills in fashion and supporting Ukraine's competitive capacity. The consortium includes eight partners: IHU (Greece), Technische Universitaet Dresden (Germany), Universitatea Tehnică "Gheorghe Asachi" din Iași (Romania), and three Ukrainian universities: Kyiv National University of Technologies and Design, Khmelnytsky National University, and Lutsk National Technical University, collectively covering a broad geographical area within Europe, alongside two non-academic partners, Creative Thinking Development (CreThiDev) and the National Sectoral Partnership Fashion Globus Ukraine (FGU) [10].

Methodology

The research aimed to examine students' attitudes toward 3D CAD tools in relation to their future professional orientation. Educational experience and perceived quality strongly shape students' attitudes toward their field of study [5], with active participation and enjoyment of the learning process increasing engagement, satisfaction, and motivation [29]. Such positive experiences can influence students' career decisions and encourage them to pursue related professional paths [6]. In the context of fashion education, students' positive attitudes toward and understanding of 3D technologies further enhance their interest in and willingness to learn these tools [7]. As students are tomorrow's professionals and as they come into contact with new technologies through their curriculum, we can make the following hypothesis:

H: Research participants who have a positive attitude towards 3D design tools are more likely to pursue careers that are oriented towards or specialise in digital environments.

For the hypothesis investigation and data collection, a quantitative research method using a structured questionnaire was employed. The aim was to examine the attitudes of students in fashion study programs toward the ability to create virtual prototypes in 3D CAD environments, specifically in relation to creativity, digital skills, and their intention to pursue a career in digital fashion.

The participants were students from the six universities involved in the 3D4U project, all of which offer one or more courses in 3D design within their curricula. To facilitate distribution, the questionnaire was created digitally using Google Forms and made available in Greek, English, and Ukrainian to ensure convenience and better comprehension for participants. Students responded voluntarily to the self-administered instrument, completing it anonymously in their own time. To reach participants, professors of the respective courses were asked to share the questionnaire link with their student cohorts and request voluntary participation. Because non-probability sampling was

used, the results cannot be generalised to fashion students at other institutions or in other specialisations [17]. Finally, a 5-point Likert scale [14,-16, 18, 30] was used to measure students' attitudes more accurately and ensure a higher degree of reliability for the tool.

Results

The questionnaire was available for one month and collected 138 responses. Data were analysed using descriptive and inductive statistics (Pearson's r, Multiple Regression Analysis) in Microsoft Excel and SPSS. Internal reliability was assessed with Cronbach's alpha, which reached $\alpha = 0.78$, an acceptable level according to [20]. The questionnaire included three sections examining creativity, skills, and career orientation, along with demographic questions. The final section focused specifically on students' attitudes toward their professional future in relation to virtual prototypes and digital fashion.

The results showed that for most students, the course provided their first meaningful contact with virtual prototyping, introducing not only a new digital tool but also a different way of thinking within the design process. Engagement with 3D design was positively associated with a broader understanding of its relevance in the contemporary fashion industry, alongside an awareness of both its possibilities and limitations. Exposure to 3D CAD fostered creative thinking, imagination, and cognitive flexibility, while also contributing, though to a lesser extent than expected, to the development of digital skills. Students demonstrated an emerging ability to adapt to new digital environments, select appropriate tools for project requirements, and critically evaluate the quality of their digital outputs.

Students' perceptions of their digital skills emerged as the strongest factor influencing their interest in pursuing careers in digital fashion. Those who felt more confident and experienced greater improvement in using 3D tools were more inclined to consider professional pathways in this field, suggesting that stronger digital intelligence may help address the industry's shortage of skilled professionals. Creativity also played a significant role: students who recognised the creative benefits of 3D design expressed greater interest in working within digital fashion environments. The course provided a new platform for experimentation and expression, expanding students' understanding of fashion's digital possibilities and inspiring some to explore new career options. However, concerns remained regarding their readiness for the demands of the modern workplace and the limited access to 3D tools after graduation, indicating that increased institutional and industry support, such as free learning resources and accessible software, could further enhance engagement and professional confidence.

Conclusions:

The study confirms that exposure to 3D design and virtual prototyping positively shapes students' perceptions of creativity, digital skills, and future career possibilities in digital fashion. Students who felt more confident in their digital abilities and creativity were also more inclined to consider professional pathways involving 3D technologies. At the same time, limited access to software and equipment, particularly after graduation, remains a barrier to sustained engagement and professional development. These findings highlight the need for academic institutions to strengthen the integration of modern digital tools, invest in appropriate infrastructure and staff training, and collaborate more closely with industry to support students' transition into emerging digital roles. As the fashion sector continues to evolve, universities play a critical role in equipping future professionals with the skills, resources, and opportunities required to thrive in an increasingly technology-driven environment.

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