The Effectiveness of Using 2D and 3D Software on Apparel Design Students' Learning Experience

Han Ah Yoo, Yu Li, and Young-A Lee, Auburn University, USA

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Introduction and background. Despite the rising use of virtual design technology in the apparel industry (Lee, 2022; Joy et al., 2022; Papahristou & Bilalis, 2017), limited studies exist examining the application of different types of 2D/3D apparel design software in the apparel design curriculum, as well as the effectiveness of using this technology on students' learning experience and outcome. Fontana et al. (2005) and Papachristou et al. (2019) explored the interface differences among various 2D/3D programs used in apparel design without considering students' learning experience with the use of different 2D/3D programs. Baytar (2018) and Park et al. (2011) investigated students' experience in an apparel design course using a single 2D/3D apparel design software. Waving through the pandemic, the increased number of apparel programs have adopted and used various types of 2D/3D design software such as Browzwear, CLO, and Optitex simultaneously; thus, it is crucial to explore the effectiveness of using different types of 2D/3D design programs on students' learning experience and outcome, which is critical nowadays for the apparel design education to be aligned with the industry needs and demands. Thus, this study aimed to explore the effectiveness of using two different 2D/3D programs on apparel design students' learning experience, which would lead apparel educators to choose the right 2D/3D software aligning with students' learning outcomes and pedagogical goals. The specific objectives were to: (a) assess students' learning outcome by reviewing their 2D/3D design projects completed by using two different 2D/3D programs (hereafter software A and software B) and (b) examine their learning experience by comparing their thoughts and knowledge about software A and software B, intent of their use, and perceived characteristics of using the software.

Method. This exploratory case study consisted of two parts: (a) the expert reviews of their 2D/3D design projects completed by using software A and software B (objective assessment) and (b) the online survey examining students' learning experience of using two different 2D/3D programs (subjective assessment). The 2D/3D project using software A in spring term and software B in fall term (N_A=11 and N_B=11, respectively) were assessed. Students from the same cohort were given four weeks per semester to complete their 2D/3D design project. The objectives of 2D/3D design project were identical for both courses, including an overview of the software, 2D/3D pattern digitizing, virtual material fabrication, digital sewing, avatar editing, fit evaluation, assigning and adjusting colorways, logos, and engineered print mapping. The only difference was the software type they used. For the objective assessment of students' effective learning, two design experts who taught the courses visually assessed both digital and printed outcomes, using the following review criteria: 2D/3D simulation, pattern digitizing, digital sewing, fit adjustment, and textile and engineered print application.

The online survey questionnaire consisted of two different steps. Students first were asked about their overall thoughts and learning experiences of software A in open-ended questions. After completing the second 2D/3D design project, another survey was performed to

examine: (1) students' subjective knowledge about software A and software B (adopted Flynn and Goldsmith's (1999) subjective knowledge scale), (2) their intent to use software A and software B (adopted two items from Venkatesh and Davis's (2000) intention to use technology scales and one item from Tsai et al.'s (2019) intention to use or adopt scales), (3) their perceived characteristics (e.g., relative advantage, compatibility, complexity, trialability, observability) of using software A and software B (adopted Rogers' (1983) perceived characteristics of the innovation scale), and (4) open-ended questions to gather students' learning experiences of software B. Data analysis involved independent *t*-tests for the quantitative data and content analysis for the qualitative data obtained from the open-ended questions.

Results and discussion. In terms of the objective assessment of students' learning, the expert review demonstrated that students in both courses presented the positive effectiveness of using 2D/3D simulation tools such as digital sewing and adjusting fitting with a 360-degree view. Moreover, students effectively utilized (1) the fabrication feature to select appropriate materials with texture adjustment for their 2D/3D design and (2) fit mapping tool to adjust 3D simulation of their design while using both software A and software B. However, students in both courses revealed the weakness in terms of developing and adjusting precise 2D patterns.

The online survey results also supported the above objective assessment results, presenting no significant difference of students' subjective knowledge (t (20) = -1.43, p = .17) between software A (M = 2.90, SD = 0.83) and software B (M = 3.33, SD = 0.57). In addition, there was no statistically significant difference of the intent to use (t (20) = -1.95, p = .07) between software A (M = 2.55, SD = .87) and software B (M = 3.27, SD = .88). However, perceived characteristics was significantly different (t (20) = -2.63, p = .02) between software A (M = 2.90, SD = 0.52) and software B (M = 3.40, SD = .45). The differences in their perceived characteristics using software A and software B were also revealed through the responses of open-ended questions. About the question asking their experience using software A, lack of user-friendly interface (47.2%, f = 17) was the most frequent theme, followed by effective function related to 2D pattern making (30.6%, f = 11). Regarding the experience with software B, the most frequent theme was towards its user-friendliness and enjoyment (37.5%, f = 12). After learning software B, the new themes, 3D textile design (11/43%, f = 4) and virtual 360-degree view design (8.6%, f = 3), emerged. The findings showcase that the students perceived software A preferable for 2D pattern development, while software B was favored for user-friendliness of interfaces, realistic textile fabrication, and 360-degree simulation.

Despite the weakness of their 2D pattern development skillset based on the expert review, the students in both courses expressed that creating 2D patterns (23.3%, f = 17) is an important component of learning 2D/3D apparel design technology. Furthermore, 10 out of 11 expressed positive learning experiences of software B and their preference to use software B, citing reasons such as easy to learn (72.7%, f = 8) and better interface (63.6%, f = 7). The findings clearly demonstrate that the user-friendliness of 2D/3D software plays an important role for students' learning experience.

Conclusion. This study explored the effectiveness of using two different 2D/3D programs on apparel design students' learning experience. Despite differences in students' perceived characteristics of using software A and software B, this study revealed (1) the equivalent effectiveness of using both software on apparel design students' 2D/3D learning and (2) the importance of the software's user-friendliness in their learning effectiveness. This study

only compared students' effective learning of 2D/3D software based on one 2D/3D apparel design project within a short period in each semester, challenging to assess their learning progress with both software that were new to them. Future studies are suggested to examine students' learning effectiveness of 2D/3D programs throughout the entire semester by incorporating various projects, allowing instructors to gain more comprehensive understandings of students' learning progress. Despite the limitations, the findings provide valuable insights for apparel design educators, enabling them to make informed decisions when choosing 2D/3D software that better aligns with their pedagogical goals and the current industry demands.

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