Exploring students' perceptions and applications of 3D virtual technology during the COVID-19 pandemic

Uikyung Jung and Chanmi Hwang, North Carolina State University

Background, Purpose, Significance. Fashion executives picked the Covid-19 Pandemic as the biggest challenge and digital as the biggest opportunity in 2021 (McKinsey & Company, 2021). The Covid-19 pandemic has accelerated the adoption of digital technology and electronic educational delivery systems as an alternative to face-to-face classroom instruction (Lee, 2021). The adoption of virtual reality and augmented reality technologies became a growing trend across multiple industries as consumer behavior shifted and businesses have turned to remote work (Vardomatski, 2021). In the apparel industry, leading brands and retailers have begun to adopt 3D virtual prototyping technology to streamline the product development process and deal with supply chain disruptions due to the pandemic (Papahristou & Bilalis, 2016; Roberts-Islam, 2020). With the rise of digital design practices, more courses have introduced 3D virtual prototyping technology for students in the apparel and textile discipline (Hodges et al., 2020; Starkey et al., 2021). For such a reason, integrating 3D virtual prototyping technology into the apparel and textile curriculum has gained more stature than ever. Therefore, the current study aimed to understand students' holistic views on the application of 3D virtual prototyping technology and develop an innovative teaching framework during the pandemic. Specific research objectives included 1) examining factors influencing students' adoption of 3D virtual prototyping technology based on an extended technology acceptance model (Davis et al., 1989) and 2) exploring how the Covid-19 pandemic influenced students' perceptions of using 3D virtual prototyping technology through a content analysis. The findings of this study would benefit educators in the apparel and textile discipline to understand students' expectations and foster their communication and spatial visualization skills while preparing them for successful professional practice in the apparel industry.

Method. Data were collected from a total of 144 undergraduate and graduate students via an online survey. The survey included open-ended questions and 7-point Likert scales with measurement items adapted from previous studies based on the TAM (Davis et al., 1989). A convenience sample was used, and the survey link was provided to students enrolled in twelve apparel and textile classes at a university in the Southeastern United States. Data were collected from participants regardless of their prior experience with using 3D virtual prototyping technology. The survey included an information page introducing an overview of 3D virtual prototyping technology with sample images and participants completed the survey based on their current understanding of the technology. Structural equation modeling from MPlus was used to test the proposed relationships (Figure 1). Moreover, categories and themes were identified for the qualitative data using the constant comparison analysis (Corbin & Strauss, 2008).

Results and Discussions. The sample consisted of 122 female (85.3%), 17 male (15.4%), and 4 non-binary (2.8%) students aged between 18 and 35. Descriptive statistics were used to analyze demographic and proficiency evaluation questions. Most participants reported they are majoring in the brand management and marketing (n=57, 39.9%), followed by fashion development and product management (n=42, 29.4%), fashion design (n=21, 14.7%), other (n=16, 11.2%), and textile design (n=7, 4.9%) program of senior (n=35, 24.5%), junior (n=34, 23.8%), sophomore (n=25, 17.5%), first-year (n=26, 18.2%) and graduate (n=23, 16.1%) class standing. The majority of the participants identified themselves as White/European American (n=102, 71.3%), followed by Asian (n=21, 14.7%), African American/Black (n=8, 5.6%), Other (n=8, 5.6%), and Hispanic/Latino (n=4, 2.8%). The proficiency evaluation results indicated that participants perceive they have the most significant degree of proficiency in using Illustrator (M=5.5, SD=1.6), followed by market research and fashion forecasting (M=4.4, SD=1.9), digitizing patterns (M=3.9, SD=1.9), Photoshop (M=3.9, SD=1.9), garment construction/sewing (M=3.5, SD=1.8), digital pattern making (M=2.9, SD=1.9), 3D virtual prototyping (M=2.8, SD=1.8), Kaledo (M=2.7, SD=1.6) and traditional pattern making (M=2.4, SD=1.6).

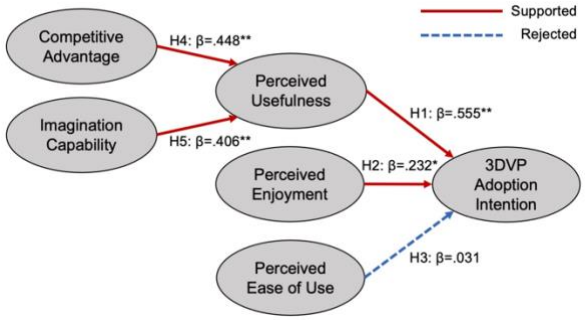

Figure 1. Research Framework

The structural model ($\chi 2$=417.544, df=232, p=.000, SRMR = 0.098, RMSEA=0.075, TLI=.914, CFI=.927) showed acceptable fit. The SEM results suggested that both competitive advantage (β=.448, p<.001) and imagination capability (β=.406, p<.001) have significant influences on perceived usefulness (H4, H5 supported). In addition, perceived usefulness (β=.555, p<.001) and perceived enjoyment (β=.232, p<.001) have significant influences on students' adoption intention toward virtual prototyping technology (H1, H2 supported), whereas perceived ease of use did not exert significant influences. Specifically, functional values had a greater influence on students' adoption intentions toward 3D virtual prototyping technology than experiential value.

The content analysis of the open-ended questions showed that the students perceive the adoption of 3D virtual technology during and the post pandemic to be useful and "*imperative to be successful*" in future careers: the applications would "*build industry relevant portfolios*" and make them "*more competitive*" and "*stand out*" in the job market. By applying 3D virtual technology, students also felt being part of the current "*digital transformation era*" and developed their visualization skills including body-garment relationship and garment construction. Students perceived the technologies to enhance "*communication and collaboration*" in the apparel industry and limit physical interactions during the pandemic. Based on the results of the study and the Technology Acceptance Model (Davis et al., 1989), a guiding instructional strategy was proposed emphasizing the competitive advantages of using 3D prototyping technology from personal and industry levels during the pandemic. The study also highlights how students could flexibly adopt the technologies to suit their professional goals,

whether they are majoring in apparel design and product development, textile design, and merchandising.

Conclusion. The Covid-19 pandemic caused students to perceive 3D virtual prototyping technology as an alternative to visualize and present garments while conforming to social distancing and remote working protocols. Moreover, they considered 3D virtual prototyping technology as a facilitator to make them suitable job applicants, the kind of talent the industry wants in the digital transformation era.

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