Teaching Virtual/3D Technology in the Apparel and Textiles Curriculum: A Conceptual Model for Developing Pedagogical Best Practices*

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Because virtual/3D technology is a rapidly developing area of apparel industry innovation (Arribas & Alfaro, 2018), academic programs that prepare graduates for this industry face the need to teach students how to use it. Consequently, such programs must seek out cost-effective ways of integrating opportunities for teaching this technology into the curriculum. At the same time, best practices for teaching virtual/3D technology have yet to be developed. Indeed, existing research focuses primarily on teaching virtually using technology (i.e., online teaching) rather than how to best teach virtual technologies. Thus, the purpose of this project was to develop a conceptual model for creating strategies for teaching virtual/3D technologies in the apparel and textiles curriculum. A three-step approach was followed to address this purpose, starting with an extensive review of the literature. Second, key concepts emerging from the literature were mapped. Third, the concepts were organized into a model grounded in technology learning theory and addressing the three focal points of the pedagogical process: the instructor, the technology, and the student.

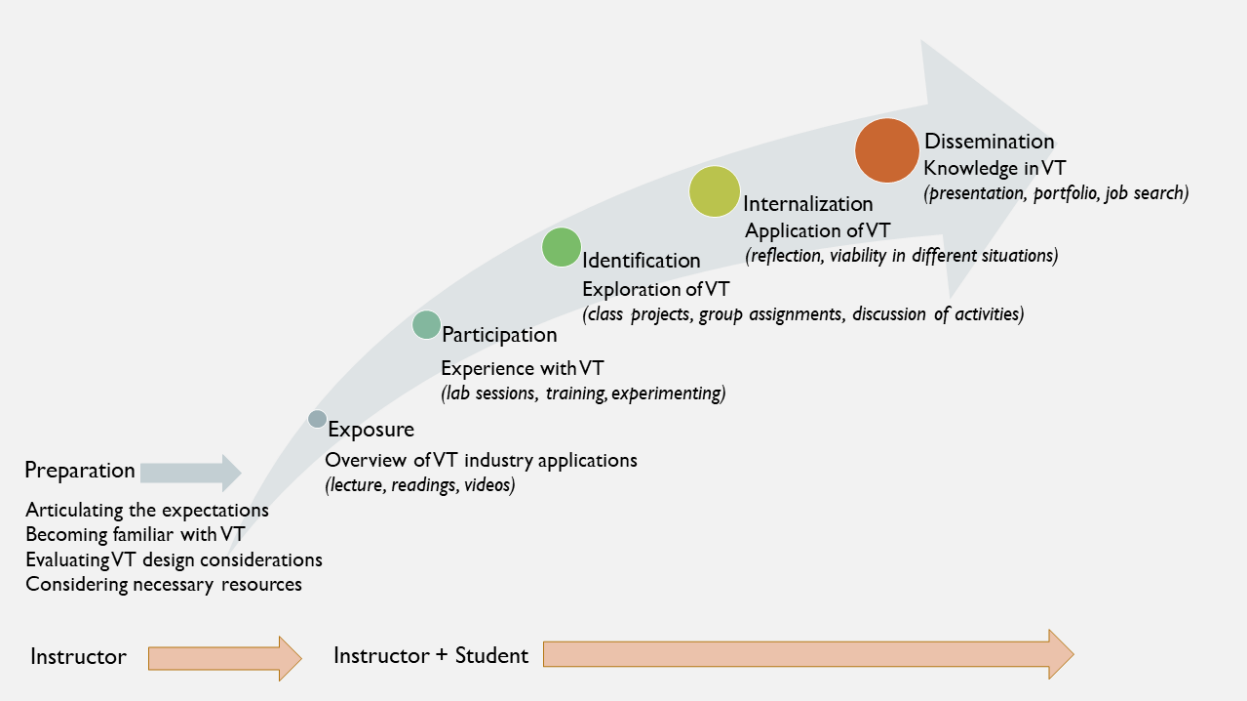
According to the literature, learning virtual/3D technologies is important to developing students' spatial visualization skills and abilities (Park, Kim, & Sohn, 2011), visual reasoning and cognitive skills (Lee et al., 2018; Lee et al., 2021a), interaction, imagination, and problem-solving skills (Baytar, 2018), and critical thinking skills (Yu, 2018). Prior studies indicate that students' understanding of the applicability of a virtual/3D technology is important to learning it (Starkey et al., 2020). That is, an instructor must foster understanding of the potential for applying the virtual technology learning more broadly, such as how it applies to students' future careers (Hodges et al., 2020). In a similar vein, Han et al. (2020) found that students' perceived usability and applicability of virtual technologies are important to facilitating their interest in learning it. In addition, to build students' skills in the use of virtual/3D technology, the literature emphasizes the importance of providing actual experiences with the technology. For example, Baytar (2018) incorporated the repeated use of virtual prototypes through three consecutive class projects. Teaching strategies that others have used include an explorative-oriented method (Han et al., 2020), industry collaboration (Hodges et al., 2020), teamwork (Yu, 2018), lecture and lab sessions (Lee et al., 2021b), class projects (Baytar, 2018), and assigning readings and videos on virtual/3D technologies (Starkey et al., 2021). Notably, a variety of learning theories/models have been employed in these existing studies (e.g., task- vs. explorative-oriented, experiential, four-stage

training, etc.). However, to our knowledge, a model developed specifically for use in teaching and learning virtual/3D technologies in the apparel and textile curriculum has yet to be created.

Hanson and Shelton (2008) identified four (not necessarily sequential) steps that are important to teaching virtual/3D technology that must occur before introducing a technology in a course. First, the instructor must determine how the technology will be used to enhance learning outcomes and the expectations around using the technology in class. Second, the instructor must become familiar with using the technology. Third, the instructor needs to evaluate the technology's characteristics (e.g., features, pros and cons, challenges) for achieving the learning outcomes and expectations identified in the first step. Last, the instructor must consider necessary resources to implement the technology in class, such as licenses, equipment, and IT support. Once the decision to introduce the technology has been made, the next major consideration is how to best foster student learning of it. To this end, Steinaker and Bell (1976) developed the Experiential Taxonomy for technology applied to education, which includes five phases: exposure, participation, identification, internalization, and dissemination.

Based on these five phases, findings from previous studies were used to develop a model for mapping and organizing the virtual/3D technology (VT) pedagogical process to be applied in apparel and textile courses (the TVTAT model, see Figure 1). First, students are *exposed* to the VT. In this stage, students do not interact with the VT. Instead, the instructor provides an overview introducing students to its purpose, functions, and value within the context of the course specifically and industry more broadly (e.g., a lecture presentation on how virtual prototyping is used in apparel product development). Second, students *participate* in experiences with the VT that are guided by the instructor. In this stage, students gain initial knowledge of how to use the VT without being evaluated on it (e.g., lab time devoted to experimentation with a virtual prototyping software). Next, students explore the VT through structured activities, such as class projects, group assignments, and discussion, and through repeated use of the VT, helps foster *identification* with it (e.g., class discussion of the kinds of problems addressed by virtual prototyping), which leads to the *internalization* of what they are learning. At this stage, students understand the applicability of the VT within different situations through reflection on their learning experiences (e.g., written analysis of how virtual prototyping can be used by product developers vs. merchandisers). Last, students *disseminate* what they have learned as they take their knowledge of the VT beyond the classroom for the purposes of professional development (e.g., use the VT to create a virtual portfolio). Overall, the model helps the instructor identify and map the VT teaching and learning process in order to develop effective pedagogical strategies for each stage.

Figure 1. Model for Teaching Virtual/3D Technology in Apparel and Textiles (TVTAT)



Integration of virtual/3D technologies is a rapidly growing industry trend and, as future industry professionals, students in apparel and textile programs are expected to be skilled in their use and knowledgeable of their applications. However, research on strategies for teaching virtual/3D technologies specifically in the apparel and textiles curriculum remains nascent. The TVTAT model developed in this study is based on key concepts emerging from the literature and can be used to shape pedagogical best practices for teaching virtual/3D technology that take the goals of the instructor, capabilities of the technology, and needs of the student into consideration. Further application and refinement of the TVTAT model is necessary through continued empirical study, particularly as new technologies are developed and industry practices evolve.

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