Teaching Virtual Technology through Industry Collaboration: An Assessment of Pedagogical Process and Outcomes

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Graduates are entering a workforce that requires they not only be knowledgeable in the use of applied technologies, or those specific technologies that are directly relevant to performing job requirements, but that they are capable of learning and implementing new technologies on a regular basis (Wilen-Daugenti, 2009). Moreover, firms expect that their employees will have some degree of industry-relevant technology knowledge and skills, and value experience with such technology when making hiring and promotion decisions (Noguera & Watson, 2004). Within the apparel industry, computer applications and software, such as AutoCAD, Illustrator, and MS Excel, are frequently used for product development and then filtered through the supply chain by way of a data management system (Suleski & Draper, 2011). However, it is the 3D or "virtual" technologies that are fast becoming the requisite technology among apparel companies, especially the use of 3D printing and virtual prototyping (DeSilva, Rupasinghe, & Apeagyei, 2019). As new hires, graduates are expected to know how to use virtual technologies to help maximize efficiency while minimizing costs (Zhang & Huang, 2014).

At the same time that virtual technologies are becoming important to the industry, they are also becoming important in higher education, as programs seek ways to incorporate them into the teaching and learning environment. Thus, the two-fold purpose of this study was to develop an approach to teaching virtual technology that is apparel industry-specific, and to conduct a preliminary evaluation of the resulting outcomes to better understand the needs of apparel students as virtual technology learners. As it is still early in the adoption process, best pedagogical practices relative to virtual technology have yet to be identified and fully articulated in the literature (Baytar, 2018; Kwon & Kim, 2002). The present study seeks to address this void.

With IRB approval, a three phased, mixed-methods research design was used to address the purpose of the study. In Phase I, an on-site presentation of a virtual prototyping software called v-Stitcher, increasingly being used by apparel companies (Arribas & Alfaro, 2018) was provided to students by a local apparel company that served as the project partner. Students had not been exposed to the software prior to the presentation. Phase II consisted of two weeks of training, during which time students were taught to use the software. Prior to the introduction of the software, students were asked to complete a pre-test measuring their attitudes toward virtual technology (7 items adapted from Park, Kim, & Sohn, 2011 and Limayem & Cheung, 2008), skill development (8 items adapted from Gu, Zhu, & Guo, 2013 and Liaw, Huang, & Chen 2007) and assessing their spatial visualization skills (27 items adapted from Park et al., 2011 and

Workman, Caldwell, & Kallal, 1999). After the two-week training period, students were asked to complete a post-test which included the same items as the pre-test with the addition of open-ended questions, including, *What did you like most/least about the experience and why?* and *What did the experience help you to learn about technology in the apparel industry?* All measures displayed acceptable levels of reliability (attitudes: pre-test = 0.75 vs. post-test = 0.87; skill development: pre-test = 0.94 vs. post-test = 0.93; and spatial visualization skills: pre-test = 0.83 vs. post-test = 0.81).

Phase III was comprised of in-depth interviews where students were asked to reflect more broadly on the learning experience. Questions included, *How might learning a new technology benefit you? Why?* and *What do you think is important about learning a new technology?* A total of 15 students participated in the interviews lasting from 30 to 60 minutes, and each received a small incentive in the form of a $5 gift card. Kirkpatrick's (1994) four-phase model for evaluating workplace training was augmented by concepts important to learner-centered pedagogical practice (Cullen, Harris & Hill, 2012) to form the conceptual framework for interpretation of the data. *Reaction* and *learning*, two of the phases outlined by Kirkpatrick (1994), were assessed through a comparison of students' scores on the pre- and post-tests. However, because a student's unique experiences and expectations will often drive the learning process (Cullen, et al., 2012), the other two phases, consisting of *behavior* and *results*, were evaluated through the qualitative data.

A total of 40 complete and matched pre- and post-tests were analyzed using a paired sample *t*-test. Results indicated that the means of the three variables were significantly different between the pre- and post-tests: Attitude ($M_{Pre\text{-}test} = 5.60$ vs. $M_{Post\text{-}test} = 5.89$, $t = -2.713$; $p = .010$), skill development ($M_{Pre\text{-}test} = 5.32$ vs. $M_{Post\text{-}test} = 5.71$, $t = -3.339$; $p = .002$), and spatial visualization ($M_{Pre\text{-}test} = 3.95$ vs. $M_{Post\text{-}test} = 4.75$, $t = -3.361$; $p = .002$). Scores suggest that Phase II activities were effective in improving students' attitudes toward and skills with virtual technology, indicating both a positive reaction to the technology and interest in learning to use it (Kirkpatrick, 1994). To investigate students' experiences in terms of behavior and potential for meaningful results (Kirkpatrick, 1994), the open-ended questions and interviews were transcribed and thematically interpreted by two members of the research team. Three primary emergent themes elucidate students' perceptions of the software in terms of: (1) achieving personal learning goals (e.g., *I loved getting to learn about this technology and being able to practice with it; P7*), (2) understanding professional expectations (e.g., *It proved that I was able to easily adapt to a new program; P2*), and (3) relating to future career goals (e.g., *I was able to learn a little about how professionals work; P11*).

Results of this study revealed some of the benefits and challenges of learning virtual technology. Challenges included the time required to fully understand its capabilities. Indeed, one of the most frequent responses to the question of what students liked least was that there was not enough time to fully explore the software. Although the presentation of the material by the industry partner was important, it appeared to be more important to practice using the technology, that is, to engage in behaviors that will develop further skill in the use of the technology. However, understanding the potential for applying the learning more broadly emerged as a meaningful result of the overall learning experience. That is, the students seemed to appreciate the collaborative approach and presence of the industry partner, to the extent that the context they provided allowed students to better understand how gaining experience with virtual technology applies to their future careers.

Although findings of this study contribute to what is known about how students learn, specifically how they learn 3D technology applications, further testing and development of pedagogical approaches are needed, particularly research with larger samples and using more diverse methodologies. Indeed, although a comparison of pre- and post-test means revealed a positive difference across the three variables, it is difficult to establish that exposure to the technology was the only reason for this difference. The qualitative data help to fill in some of the gaps, but the small sample size makes it difficult to generalize based on findings. Incorporating emerging virtual technologies that are used in the apparel industry is important because it ensures currency and relevancy of the curriculum, and at the same time, addresses students' professional development needs. While there is still much to be discovered about how apparel students learn to use virtual technology, this study contributes to a foundation for developing best pedagogical practices.

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