A conceptual approach for using VR and digital simulations to train students in fit assessment and correction skills

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Introduction: When fitting garments, the existing knowledge of body shape is transferred to the 2D pattern. This knowledge cannot be captured, recorded, or shared because of its complexity (McKinney et al., 2012). Transferring the intuitive knowledge of expert pattern makers to new designers is a much-required approach in apparel design education Due to the lack of problem-based learning (PBL) modules that are representative of real-world garment fit issues, fashion designers must acquire fit correction skills through experience. Multi-media tools such as 3D simulations are known to escalate the learning curve (Park et al., 2011), improve 3D visualization and problem-solving skills (Baytar, 2017), reduce the time required to train users (Liu et al., 2018), and help develop a positive attitude towards the technology. Digital prototyping software enables 2D pattern pieces to be sewn together and draped on a virtual avatar as a 3D garment. The reactive 2D/3D design process provides instantaneous feedback that enables designers to view the impact of modifications made to 2D patterns on the garment simulation in real time, thereby, eliminating the need to develop numerous physical prototypes to improve the fit and style (Zhang & Pei, 2021).

Additionally, without a learning platform to measure the fit assessment and correction skills, it would be difficult to evaluate the benefit of training sessions. Therefore, virtual reality (VR) can be used as a medium to provide learners with digital tools to acquire new skills and test their learning. Drawing on the constructivist learning theory, it can be argued that in VR learners absorb information and connect it with existing knowledge to create new knowledge (Huang et al., 2010). With a high resemblance to physical reality and providing an opportunity to "learn by doing", VR has been shown to positively affect the learning experience (Özgen et al., 2021). Since apparel technical designers learn to manipulate patterns by going back and forth between 2D and 3D, interactive PBL activities replicating real-world fit sessions would be appropriate to train students in fit assessment and correction skills. In the present study, we propose a conceptual approach to fill the gap between knowledge provided through pattern-making textbooks and the knowledge required in the fashion industry by using problem-based learning (PBL) modules developed by using digital garments in VR.

Conceptual Approach: PBL is similar to the concept of constructivism in the way that learners address real-life problems and gain from their experiences, thereby, promoting problem-solving

skills and enhancing the output (Huang & Liaw, 2018). Experiential learning embraces the notion that to understand the world, learners need to interact directly with it (Schott & Marshall, 2018). Through enhanced interactivity, VR can provide an ideal environment to learn through concrete virtual experiences, observation, and conceptualization. Real-time interaction and immediate feedback with each interaction can enable the learners to create, apply and gain knowledge, thereby, making it apt for experiential learning (Kwon, 2019).

VR provides the necessary technological support to connect textual knowledge with real-life applications by giving learners the ability to navigate, manipulate and observe the effects of their actions in simulated environments (Huang & Liaw, 2018). VR also enables learning environments to be digitized and allows learners to manipulate objects in the three dimensions environment through gestures (Johnson-Glenberg, 2018). Users make a larger arm movement as compared to swiping a finger on the screen which in turn leads to higher sensory-motor engagement (Johnson-Glenberg, 2018). Hand gestures require the use motor system and reduce the cognitive load by freeing up cognitive space for other activities. Consequently, VR improves the retention of information. 3D visualization of garments provides clear information about garment fit and aesthetics, thereby, improving understanding of the subject matter and learning (Hwang & Hahn, 2017). VR is an appropriate environment to use for learning about 3D representations.

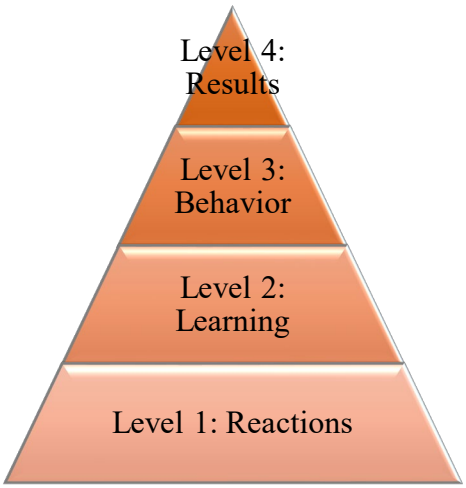

Figure 1. A VR-supported PBL platform assessment by using Kirkpatrick's Training Evaluation model

Our conceptual approach merges the VR-supported PBL with Kirkpatrick's Training Evaluation model as the theoretical framework which defines four levels of training assessment to ensure effective learning: (1) Reaction, which determines the perception of learners towards the VR PBL modules, (2) Learning, which measures the knowledge and skill gained by the participants (3) Behavior, which measures how the knowledge is put to use in a real-life situation through formal testing or observation, and (4) Results, which is related to measuring the impact of training on performance goals of an educational institution (Kirkpatrick, 1959) (Figure 1).

Discussion and Implications: Applications of immersive VR in training apparel designers to correct the fit of digital prototypes have not been explored before. Therefore, the primary aim of this study was to introduce the potential of using interactive VR technology for apparel pattern making and digital prototyping education. Designing PBL activities in VR would be very beneficial in providing an intuition about the 2D pattern modification that corrects the 3D garment fit. When designing training modules by using digital simulations, there would be likely

some limitations related to the technical limitations of 3D CAD software programs creating an inability to view seams and limited expression of pulling and wrinkles (Kim & LaBat, 2012). Additionally, learning in VR is complex. Headsets' lower resolution and cybersickness might limit students' ability to view the training content for prolonged periods. Nonetheless, PBL through a VR platform that uses digital garment simulations can enable users to address real-life problems and improve their technical skills.

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References

Baytar, F. (2017). Apparel CAD patternmaking with 3D simulations: impact of recurrent use of virtual prototypes on Students' skill development. *International Journal of Fashion Design, Technology and Education*, *11*(2), 187–195. https://doi.org/10.1080/17543266.2017.1378731

Huang, H. M., Rauch, U., & Liaw, S. S. (2010). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers & Education*, *55*(3), 1171–1182. https://doi.org/10.1016/J.COMPEDU.2010.05.014

Huang, H.M. & Liaw, S.S. (2018). An analysis of learners' intentions toward virtual reality learning based on constructivist and technology acceptance approaches. *International Review of Research in Open and Distance Learning* 19, 1, 91–115. DOI:https://doi.org/10.19173/IRRODL.V19I1.2503

Hwang, J. & Hahn, K.HY. (2017). A case study of 2D/3D CAD virtual prototype simulation programs to enhance student performance in student-centered fashion design education. *Journal of Textile Engineering & Fashion Technology*, 3, 1. DOI:https://doi.org/10.15406/JTEFT.2017.03.00088

Johnson-Glenberg, M.C. (2018). Immersive VR and Education: Embodied Design Principles That Include Gesture and Hand Controls. *Frontiers in Robotics and AI*, 5. https://doi-org.proxy.library.cornell.edu/10.3389/frobt.2018.00081

Kim, D. E., & LaBat, K. (2012). An exploratory study of users' evaluations of the accuracy and fidelity of a three-dimensional garment simulation: *Textile Research Journal*, *83*(2), 171–184. https://doi.org/10.1177/0040517512458339

Kirkpatrick, D. (1959). Techniques for evaluation training programs. *Journal of the American Society of Training Directors* 13, 21–26.

Kwon, C (2019). Verification of the possibility and effectiveness of experiential learning using HMD-based immersive VR technologies. *Virtual Reality* 23, 1. 101–118. DOI:https://doi.org/10.1007/S10055-018-0364-1/FIGURES/8

Lee, E. A.-L., Wong, K. W., & Fung, C. C. (2010). How does desktop virtual reality enhance learning outcomes? A structural equation modeling approach. *Computers and Education*, *55*(4), 1424–1442. https://doi.org/10.1016/J.COMPEDU.2010.06.006

Liu, K., Zeng, X., Bruniaux, P., Tao, X., Yao, X., Li, V., & Wang, J. (2018). 3D interactive garment pattern-making technology. *Computer-Aided Design*, *104*, 113–124. https://doi.org/10.1016/J.CAD.2018.07.003

McKinney, E. C., Bye, E., & Labat, K. (2012). Building patternmaking theory: a case study of published patternmaking practices for pants. *International Journal of Fashion Design, Technology and Education*, *5*(3), 153–167. https://doi.org/10.1080/17543266.2012.666269

Özgen, D. S., Afacan, Y., & Sürer, E. (2021). Usability of virtual reality for basic design education: a comparative study with paper-based design. *International Journal of Technology and Design Education*, *31*(2), 357–377. https://doi.org/10.1007/S10798-019-09554-0

Park, J., Kim, D. E., & Sohn, M. H. (2011). 3d simulation technology as an effective instructional tool for enhancing spatial visualization skills in apparel design. *International Journal of Technology and Design Education*, *21*(4), 505–517. https://doi.org/10.1007/S10798-010-9127-3

Schott, C. & Marshall,S. (2018). Virtual reality and situated experiential education: A conceptualization and exploratory trial. *Journal of Computer Assisted Learning 34,* 843–852. DOI:https://doi.org/10.1111/JCAL.12293

Workman, J. E., Caldwell, L. F., & Kallal, M. J. (1999). Development of a test to measure spatial abilities associated with apparel design and product development. *Clothing and Textiles Research Journal*, *17*(3), 128–133. https://doi.org/10.1177/0887302X9901700303

Workman, J. E., Caldwell, L. F., & Kallal, M. J. (2016). Development of a Test to Measure Spatial Abilities Associated with Apparel Design and Product Development: *Http://Dx.Doi.Org/10.1177/0887302X9901700303*, *17*(3), 128–133. https://doi.org/10.1177/0887302X9901700303

Zhang, X., & Pei, C. (2021). Analysis on the Application of 3D Virtual Digital Technology in the Teaching of Clothing Specialty. *2021 2nd International Conference on Big Data and Informatization Education (ICBDIE)*, 265–269. https://doi.org/10.1109/ICBDIE52740.2021.00066