



Applying Problem-Based Learning (PBL) Strategy to Strengthen Sustainability Education in Textile and Apparel Curriculum

Huantian Cao, Martha Carper, Kelly Cobb, Jillian Silverman, Shameeka Jelenewicz
University of Delaware, USA

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Over 19.5 billion garments are sold in the U.S. each year, with significant environmental and human health problems generated during the product lifecycle. The textile and apparel industry is conscious of these problems and has developed sustainability tools and programs such as the Sustainable Apparel Coalition (SAC)'s Higg Index (www.apparelcoalition.org) and the Joint Roadmap to ZDHC: Zero Discharge of Hazardous Chemicals (www.roadmaptozero.com). Learning these industry strategies and tools will enhance students' sustainability knowledge and problem-solving skills, which will be useful in their future careers.

Various educators have recommended problem-based learning (PBL) to provide students with guided experience in learning through solving complex, real-world problems (Hmelo-Silver, 2004). Becoming a professional is not just about acquiring professional knowledge, but is also about being able to define the kernel of a problem and stand over professional judgment (Barnett, 2013). In this paper, we applied PBL in four required courses in apparel design and merchandising programs and reported the PBL projects and student learning assessment.

In the Fall 2016 semester, four courses were revised and taught to include PBL projects. The student learning outcomes were evaluated using pre- and post-quizzes and PBL project evaluation rubrics. The course titles, number of students, and PBL projects are described below. Seminar on Fashion Sustainability (a 200-level course, two sections with 43 and 21 students, respectively) In a two-unit workbook format, students were given the challenge to "Design Sustainability into a Pair of Jeans". Unit 1 involved defining the Triple Bottom Line of sustainability and to evaluate and better understand SAC's mission and the Higg Index. In Unit 2, students were given information regarding the lifecycle of a pair of jeans and worked with peers to comprehend social and environmental impacts at every stage of the lifecycle. After laying a contextual framework, students were asked to design out waste in the manufacture of jeans by determining the impacts from fiber through manufacture to the finishing of denim. Fundamentals of Textiles I (a 200-level course, 49 students) Each student was given a used textile product from Goodwill that could not be sold in its thrift shores and was asked to provide solutions to divert the textile waste from landfills. The students were asked to complete 4 tasks: (1) analyze the product and describe the serviceability requirements for this product; (2) state the fiber content, calculate the Material Sustainability Index (MSI) score (MSI is part of the Higg Index) of the product, and answer why the fiber content was used in this product; (3) propose end of use (EOU) solutions for the textile fibers, explain the EOU solutions and describe the obstacles that may make the EOU solutions difficult; and (4) without compromising the serviceability of the product, make recommendations on choosing textile fiber content for the product that will make the EOU solutions easier.

Fundamentals of Textiles II (a 200-level course, 44 students) Leading apparel companies including Nike, Gap, and Levi Strauss established the Zero Discharge of Hazardous Chemicals (ZDHC) programme. They identified classes of hazardous chemicals that must be eliminated for use in their supply chain by 2020. Students were asked to analyze four hazardous chemicals in the ZDHC programme: chlorobenzenes, CI Disperse Blue 1, phthalates, and perfluorinated chemicals. The tasks included: (1) to explain why these chemicals are used in the manufacturing processes, and why these chemicals should be eliminated from the manufacturing process; and (2) to identify alternative methods that can replace these hazardous chemicals.

Advanced Apparel Product Development (a 300-level course, 51 students) The objectives were to (1) become familiar with sustainability issues (both environmental and social) involved in developing and sourcing the components for an outerwear jacket or parka; and (2) to apply the knowledge to develop a plan to improve the sustainability of a parka. Students worked in teams to dissect a parka found at a thrift store, and were given a hypothetical case study where they were required to make recommendations for designing a more sustainable parka. Key deliverables included researching the sustainability issues related to the component parts of the parka and developing alternatives in product development and sourcing that result in a parka that is more sustainable. Finally, students were asked to develop a set of guidelines to follow when developing and sourcing production of a parka.

Whether students gained sustainability content knowledge was evaluated by 10-question pre- and post-quizzes in each course. Students averaged a score of 5 on the pre-quiz (50%) and increased to an average score of 8 (80%) on the post-quiz. When examining individual courses, students in Advanced Apparel Product Development and Seminar on Fashion Sustainability experienced the greatest gains in knowledge. Whether students demonstrate analytical, problem-solving, and decision-making skills was evaluated by PBL project grading rubrics. The average PBL project scores and score ranges were 99% and 90-100% (Seminar on Fashion Sustainability, section 1), 93% and 78-100% (Seminar on Fashion Sustainability, section 2), 92% and 49-100% (Fundamentals of Textiles I), 93% and 72-100% (Fundamentals of Textiles II), and 89% and 83-97% (Advanced Apparel Product Development).

In summary, PBL was applied in four textile and apparel courses. Students demonstrated short-term gains in their sustainability content knowledge and overwhelmingly demonstrated their analytical, problem solving, and decision-making skills in their completed PBL projects. In the future, PBL will be continuously applied in the courses to strengthen sustainability education.

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