“Absolutely hands on!”: Analyzing student learning gains and perceptions from an experiential learning experiment in an Advanced Textile Science course

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Keywords: Experiential Learning, Bacterial Cellulose, Student Learning, Textile Science

Literature Review. According to the Association for Experiential Education (2019), experiential learning “…is a hands-on form of learning that begins with a concrete experience,” which also involves reflection on the process.” The use of classroom based experiential learning can be traced back to the 1980s. In the 1980s, traditional education began to experience a backlash for being too passive in transferring knowledge (Lewis & Williams, 1994). With classroom based experiential learning, active learning, where students learn by doing and thinking about what they are doing, is utilized (Lewis & Williams, 1994). Hands on learning by doing has improved student assessment performance with scientific concepts (Kontra et. al., 2015). Chemistry and the application of related concepts is often difficult for textiles students and, with that in mind, the following laboratory experience was constructed to enhance learning.

In the experience, students were responsible for creating new knowledge in the coloration of bacterial cellulose (BC) with fiber reactive and natural dyes using company instructions for cotton as a guide, in the colors of blue, red and yellow. They also performed selected colorfastness tests. Cochineal and weld samples were dual mordanted with tannic acid and alum acetate where indigo did not require a mordant.

Acetobacter xylinum is a Gram-negative, acetic-acid bacterium found it certain aerobic conditions (Iguchi et. al., 2000). This bacterium is typically cultivated with static fermentation using carbon sources such as glucose, fructose and sucrose (Bae & Shoda, 2004). The core component of cotton and BC is cellulose, a polysaccharide of glucose units making up the main component of cell walls of several plants (Merriam-Webster, 2019). Cellulosic fibers differ in the amount and types of impurities present. Unlike cotton, BC lacks hemicellulose and lignin (Iguchi et. al., 2000). This lack of impurities indicates that BC will need less intensive processing to be prepared for dyeing.

The purpose of this research was to investigate how students in a Western University’s Design, Merchandising and Textiles program’s Advanced Textiles Science course would gain knowledge from a dyeing experiment on bacterial cellulose and subsequent colorfastness tests in laboratory sessions. These experiential learning exercises were modeled on elements of the product development evaluation process in which concepts discussed in the Advanced Textiles Science course would be applied. To assess learning gains from the laboratory sessions, assessments were administered after discussion of dyeing and colorfastness tests in lecture and again after laboratory sessions and projects were complete. The following predictions were made:

Hypotheses. 1) Students will score higher on the post-test knowledge assessment.
2) Students will report a preference for experiential learning.

Material Preparation. The author prepared and treated the material for students to use.

Methodology. *Study Design.* Following IRB approval, a senior level Advanced Textiles Science course participated in this study, with a total of ten students. In the course, students completed a pre-test knowledge assessment covering dyeing and colorfastness topics after the lecture sessions on these topics. After the laboratory sessions and project presentations, students completed the assessment again, along with providing their assessment of the learning experience. *Course Design.* In the course, various types of dyes, their parameters and AATCC colorfastness tests for crocking, light exposure, perspiration and laundering were discussed in lecture. After the discussion, laboratory sessions where students conducted dyeing and colorfastness experiments with the prepared bacterial cellulose occurred. Each student group selected a color, either blue, red or yellow. Each color used a fiber reactive dye and the corresponding natural dye, either indigo, cochineal or weld. Then, students followed the instructor provided dyeing procedure based on the instructions from the dye source companies. Following the dyeing, AATCC colorfastness tests for crocking, light exposure, perspiration and laundering were performed. Students used these results in their final projects to compare the colorfastness performance of the fiber reactive and natural dye for their color.
Results. *Quantitative.* On the pre-test measure, scores ranged from 36% to 82% and from 73% to 91% on the post-test. Impressively, 9 out of the 10 students increased their scores on the post-test and one student achieved the same score. To test the significance of this result, a sign test was performed, as the data from the 10 students violated the symmetry in score difference assumption for the Wilcoxon Signed Rank test. The result indicated that median post-test scores were significantly higher than median pre-test scores ($Z = 9.00$, $p = .004$). This result confirmed hypothesis 1. As pre-test measures were not redistributed or discussed, this result also points to knowledge gains primarily resulting from lab sessions. *Qualitative.* When asked whether they preferred hands-on laboratory sessions or lecture, all 10 students reported they preferred the laboratory sessions. One student offered, "Absolutely hands on! I learned so much more doing the tests myself than just reading about them." Though strongly positive towards the lab sessions over lecture, two students did note that they felt the lab session time period was too short. Further, when asked whether they felt they had learned more from laboratory sessions or lecture, all 10 students reported they learned better in the laboratory sessions. One student elaborated "I felt I understood more through the labs because I am a visual learner and actually seeing it made it more understandable."
Conclusion. The results from this study demonstrated that student knowledge of dyeing and colorfastness concepts can be dramatically enhanced by performing a product development situated experiment informed by the experiential learning process. Though this experience proved quite beneficial for student learning gains, several logistical concerns were observed. First, the novel material had to be developed a full semester before this experiment occurred. Also, the assignment worked well with a small class size but would be more difficult in a larger course. Additionally, one hour of class preparation was necessary before each lab session and one to three hours after each lab session. Despite these constraints, students reported unanimously preferring learning the covered dyeing and colorfastness topics in the lab session.
Acknowledgement. This project was possible with a University of Wyoming AES; NIFA grant.

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