Engaging Students with a US Sheep and Wool Course-Based Undergraduate Research Experience at a Hispanic-Serving Institution

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Introduction

Undergraduate research experiences provide a unique opportunity for students to apply critical thinking, problem solving, and collaboration skills. Course-Based Undergraduate Research Experience's (CURE's) are traditionally lab-based courses where students engage in research connected to a real-world problem. This involves using scientific practices, discovery, focusing on a relevant issue, collaboration, and iteration (Auchincloss et al., 2014). Many CUREs have focused on STEM majors, but approaches are expanding to provide students from a variety of majors with undergraduate research experiences (Shuster et al., 2019; CSU Chancellor's Office, 2020). Based on changing US demographics, many universities with a student population of at least 25% are designated as Hispanic-Serving Institutions (HSI's) and aim to create equity and success for all students; they are intentional in meeting the needs of Hispanic students. According to the National Center for Education Statistics (2018), there are over 410 HSI universities with total enrollment of over 4 million students in the US and Puerto Rico.

Purpose

The purpose of this study was to develop an undergraduate research experience based on USDA priorities for Hispanic-Serving Institutions (HSI's) including curricula design, materials development, library resources, and experiential learning. Student's research aimed to support USDA Strategic Goal 4 to facilitate rural prosperity and economic development. The project involved conducting guided research about US sheep farms, wool, water re-use, economic development, and sustainability. Researchers present a) three student research projects, b) "Wool Wiki" discussions, and c) results from an end-of-semester survey. This study seeks to extend CURE's in sustainable apparel research.

Methods

A senior Apparel Research Lecture and Activity course was developed to create a CURE that meets USDA priorities at a southwestern university in the United States. The class was 100% virtual during the 15-week semester in Fall 2020 with weekly 1-hour class meetings. The research was student-led with facilitation by a faculty. To introduce students to the topic, sustainable fashion and US wool were discussed. A pre-survey was given to students to determine research paper major themes and regional interests (n=13). Responses led to the development of 6 groups. Students went through five main research phases including: developing a literature review, creating a sheep farm database, developing Qualtrics online surveys for sheep farmers, data visualization (QGIS, Excel), and wool sourcing based on a farms' location and regional socio-economic data. Students read key literature about sustainable fashion, wool, obtained IRB training, engaged in discussion forums, and critical reflections. The end-of-semester survey evaluated students' research self-efficacy, research identify, value for research community objectives, intention to persist (Shuster et al., 2019), and library skills (Freeman, 2004). Survey responses were on a Likert scale of 1 to 5 (strongly disagree to strongly agree).

Results and Discussion

Student Projects

The 3 projects focused on overlapping themes of wool, water, and economic development. Collectively these projects received 15 online survey responses from farmers in California, Colorado, New Mexico, and Texas with small to mid-sized farms. Survey respondents were primarily Caucasian women between the ages of 60 to 80.

Among this sample of sheep farmers, they expressed having 16 different types of sheep breeds. These include Merino sheep that are known for fine fibers in the global apparel industry, as well as heritage sheep that are threatened to be endangered (Livestock Conservancy, 2020). In 2019, farmers reported selling a variety of fiber products including raw wool, washed fleece, roving, yarn, clothing, textiles, and/or dryer balls. Farmers reported earning less than $1,000 for fiber products. Average prices for raw wool were between $1 to $25; washed fleeces were priced between $6 to $25 per pound. Prices for yarn ranged between $12.50 to $20, and prices for clothing ranged from $30 to $75. These prices are significantly higher than commercial raw wool prices between 2.10 to 2.60 in these states (USDA, 2020).

The amount of wool that was processed varied between less than 50 pounds to over 200 pounds depending on the sheep farm. Some farmers processed their wool on their farm; a farmer estimated using 8 gallons per pound to scour raw wool. Key limitations were that they were only able to wash 100 pounds per day, it was also time and water intensive. Many farmers sent their wool to US mills in the Mid-West or West. They expressed spending between $300 to $3000 on fiber processing and indicated that a mill's wastewater management was extremely important. Major challenges included limited local mills, long lead times, and high shipping costs, which aligns with previous research with US wool processing (Daniels, 2018; Wilkes, 2017).

Water for land management and sheep grazing was identified as an issue since many of these farms were in drought-risk areas. Some farmers used rainwater harvesting practices with a roof catchment system or barrels to catch run-off water from buildings. For sustainable land management practices, farmers tried to conserve water, used rotational pasture grazing, and/or native grasses. Students developed maps to visualize US county household median income data and sheep farm locations. Wool was sourced from farms to support economic development. Fine and medium wool was sourced from CA and WY farms in counties with county household incomes between $49,000 to $55,000. The wool was naturally colored white, grey, and brown. Merino wool had the most lanolin and would require the most wool scouring with water use for production into products for fiber artisans or broader consumers.

Wool Wiki's

The Wool Wiki's encouraged students to watch short videos developed by sheep farmers and Fibershed, a non-profit organization. It aimed to enhance students' understanding of raw wool fiber processing. In reflections, students expressed learning the basis of preparing wool including skirting and washing. They also proposed ways to scale up skirting and washing processes by expanding the size of workspaces, hiring more employees, and selling wool commercially. Students identified major challenges with US mill infrastructure, such as decline of fiber mills and raw fiber waste between 30 to 50%. Proposed solutions included using Fibershed's approach of reaching out to fiber mill owners for fiber processing, developing a universal platform for local mills to sell products to designers, implementing ways to reduce fiber waste, and greater educational outreach.

End-of-Semester Survey

The survey received a 92% response rate (n=12). All students were seniors between the ages of 20 to 25; 83% identified as Hispanic, 8% were Asian-American, and 8% African-American. Many

respondents were female, 83%, and less were male, 17%. Among survey items for Research Skills gained, students expressed agreement ($\bar{x}$=4.18, SD=0.8); for items associated with Sense of a Research Community, students were neutral ($\bar{x}$=3.28, SD=0.9); regarding Personal Development with Research, responses also revealed a neutral response ($\bar{x}$=3.5, SD=1.3); for Intent to Pursue a Research career related to agriculture or sustainability, students expressed less likelihood ($\bar{x}$=2.5, SD=1.1); for library resources, students felt confident in using the library ($\bar{x}$=4.15, SD=0.9). To remain on track, 75% of students found assignments to be helpful, and 58% also found meeting with the professor and readings to be helpful. With virtual learning and the pandemic, all students expressed difficulty remaining focused, 75% felt distracted, and 25% faced challenges with their Internet connections.

Conclusion

This study provides an overview of approaches taken to develop a CURE in an apparel research course focused on US wool to meet a USDA priority at an HSI. There were several limitations to this study including the virtual learning environment, the pandemic, and limited online survey responses from farmers during the course timeframe. Nonetheless, most students were able to go through the five main research phases. They expressed strongest agreement in research skills gained and use of library resources. Strategies to help students feel like they are part of a broader research community and personal development with research can be enhanced. This course will be repeated to improve overtime and validate results. This study also involves a Civil Engineering undergraduate senior project course that uses the data collected from the Apparel students to support interdisciplinary learning.

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