Inside Trees: Summer Camp and Remote Learning for Increasing Awareness and Enrollment in Bio-Based Materials Degree Programs

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Abstract

The bio-based materials industry, which includes bio-based fuels, materials, and chemicals, is expanding and providing new career opportunities that are not well known by today's entering college students. In addition, the related undergraduate degree programs are neither gender nor ethnically representative of current U.S. demographics. A program model framework called Inside Trees was developed and tested in this project for an in-person summer camp and remote learning modules to help raise awareness and form a pipeline between high school students and future enrollment in higher-educational degree programs. To gain a better understanding of logistics, a prototype summer camp was delivered to 12 students, 10 of whom were women, 3 were first-generation college students, 1 was African American, and 1 was Hispanic/Latino. Three students who attended the Inside Trees summer camp enrolled at Virginia Tech University the following year. Content and activities from the summer camp were later converted into digital learning modules that could be used with a summer camp or as separate teaching/learning units. Review of supporting literature and informal student feedback indicates that a summer camp program that includes experiential learning, a positive experience in nature, support through the higher-educational academic program, multiple disciplines, and career opportunities shows good potential to be an effective pipeline to increase diversity in the bio-based industry. It is suggested that the Inside Trees model curriculum and framework could be adapted by other universities or organizations for achievement of institution-specific goals toward improved awareness and enrollment of underrepresented students.

The bio-based materials industry is an important sector of the bio-economy. This industry includes the processing and manufacturing of goods from biological products, renewable resources, and agricultural and forest materials. Bio-based materials science includes the fields of agriculture and forestry, bio-refining, bio-based chemicals, enzymes, bio-plastics and packaging, forest products, and textiles. Although the bio-based materials industry is expanding and providing new career opportunities, student enrollment in related undergraduate degree programs is not reflective of the growth experienced by the industry. Moreover, related undergraduate degree programs are neither gender nor ethnically representative of current U.S. demographics. The disparity of diverse educational attainment in related undergraduate degree programs can directly result in an underrepresented workforce, and economic development is negatively impacted due to the potential lack of innovation from homogeneous demographics. To increase gender, racial, and ethnic diversity in the biomaterials products industry, a deeper understanding of the factors inhibiting diversity in related degree programs needs to be gained so that applications of strategies to overcome these barriers can be effectively implemented.

In 2004 and 2007, Sharik and Frisk (2011) administered surveys to determine factors that significantly affected students' decisions to enroll in forestry and natural resource (FRNR) degree programs. The survey was administered to 78 (2004) and 127 (2007) students at the annual Society of American Foresters (SAF) national conventions. The students were asked open-ended questions and were

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analyzed using a content analysis method. The study found that students were attracted to FRNR degree programs due to an enjoyment of nature or the outdoors but were hesitant to pursue FRNR degree programs due to economic, personal, and academic concerns. Economic concerns included a perceived lack of jobs and competitive salaries, personal concerns included a negative public perception of natural resource fields, and academic concerns included ''narrowness and rigidity'' of the FRNR degree curriculum and the amount of time required to earn a degree. Regarding gender and race, the analysis indicated that students were concerned about the lack of diversity and potential discrimination in the field, but this was not considered a conclusive negative impact on students' enrollment.

In 2014, Rouleau et al. (2017) administered an online survey to retest Sharik and Frisk's (2011) findings by using closed-ended questions instead of open-ended questions. The survey was administered to 130 students attending the 2014 national convention of the Society of American Foresters in Salt Lake City, Utah. The participants ranked factors of four categories (career, academic, personal, and affective), using a 5-point Likert scale, by their significance in their decision to enroll in an FRNR program. The results of the study were comparable to Sharik and Frisk's findings in that students are attracted to FRNR degree programs due to their personal enjoyment of nature and that students are hesitant to enroll in FRNR programs due to concerns about earning potential and political issues. The study also found that women were hesitant to enroll in FRNR programs due to concerns about their gender, work locations, and work conditions.

A study that highlights the minority perspective of natural resource disciplines was conducted by Haynes and Jacobson (2015). They explored career motivations, barriers, and perceptions of natural resource careers for minority students. They used the social cognitive career theory as a framework for developing research methods. The theory proposes that sociodemographic variables and contextual factors affect student's self-efficacy and outcome expectations, which in turn encourage or discourage the student to pursue natural resource careers. The study found that lack of family support, family pressure to pursue traditional career paths, and discrimination based on gender or race/ethnicity were the most important career barriers for first-generation and minority students for enrolling in natural resource undergraduate programs. Other research indicates that perceptions of career barriers, such as ethnic or racial discrimination, lack of knowledge of particular fields, lower salaries, and lack of support through the academic pipeline, are possible hindrances to increasing diversity in science, technology, engineering, and mathematical (STEM) and natural resource programs (Allen-Ramdial and Campbell 2014, Balcarczyk et al. 2015).

Compounding possible hindrances and barriers is the growing disconnect between people and nature noted in several studies over the past 20 years (Krebs et al. 2021) that could also be leading to reduced interest in and appreciation of forest and wood-based materials science. Historically, natural resource degree programs have appealed to students from rural regions (Sharik and Frisk 2011). Currently, most Americans live in either suburban or urban environments. It is reported that only 14 percent of the population lives in rural areas (U.S. Department of Agriculture 2020). The growing disconnect and societal shifts from rural to urban environments and from nature to technology are suggested as leading to a fundamental lack of appreciation and understanding of the world's natural systems (Krebs et al. 2021). Natural resource and global environmental challenges have occurred worldwide that require a well-prepared and diverse educational system that leads to an informed and innovative natural resource workforce.

Summer camp programs are thought to be an effective strategy to increase interest and engagement of underrepresented minority (URM) students for STEM fields (Yilmaz et al. 2010, Martinez et al. 2012, National Research Council 2015, Carrick et al. 2016, Whitaker et al. 2017). It has also been determined that students who participate in a summer camp are more likely to attend the university that hosted the camp and pursue the camp's field of study (Sibthorp et al. 2020, Trivedi et al. 2021). But the pedagogy included in the summer program is an inherently important factor that impacts the outcome of the program by affecting the participants' interests and therefore educational achievement. One pedagogy that has proven to be successful in increasing interest and enthusiasm in agriculture and natural resource disciplines is experiential learning (Millenbah and Millspaugh 2003, Mazurkewicz et al. 2012, Jachowski et al. 2022). Experiential learning was defined by Kolb (1984) as ''the process whereby knowledge is created through the transformation of experience.'' Experiential learning is a continuous cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation, as illustrated in Figure 1. In experiential learning theory, the reflection of an experience results in the formation of concepts and generalizations about that experience. which can then be applied and tested through experimentation. The experimentation results in a new experience and creates a continuous learning cycle (Kolb and Kolb 2017).

Active learning has been shown to increase women and URM student interest and enthusiasm for STEM disciplines (Armbruster et al. 2009, Martinez et al. 2012, Carrick et al. 2016). Experiential learning is active learning through the integration of action and reflection and experience and concept (Kolb and Kolb 2017). Fundamentally ,students expand their knowledge of a discipline through reflection, conceptualization, and experimentation of knowledge assimilated through an experience. Therefore, in experiential learning, students are continuously engaged in active learning that expands their knowledge of a discipline through practical application. This allows students to connect the disciplinary content learned through experience and reflection to a practical application through conceptualization and experimentation. The practical application can then be connected to a societal context through an additional experience. Therefore, experiential learning allows for a more meaningful understanding and practical applicability of the disciplinary content in society that is not always apparent in active learning. The meaningful connection encourages women and URM students to pursue STEM disciplines in higher education and can be used as a tool to challenge preexisting attitudes and perceptions of women and URM students on the practical applicability of STEM disciplines (Rouleau et al. 2017). Based on this premise, a nonformal educational program called Inside Trees was developed in the Department of Sustainable Biomaterials (SBIO) at Virginia Tech University and tested as a model for a recruitment method to encourage women and URM

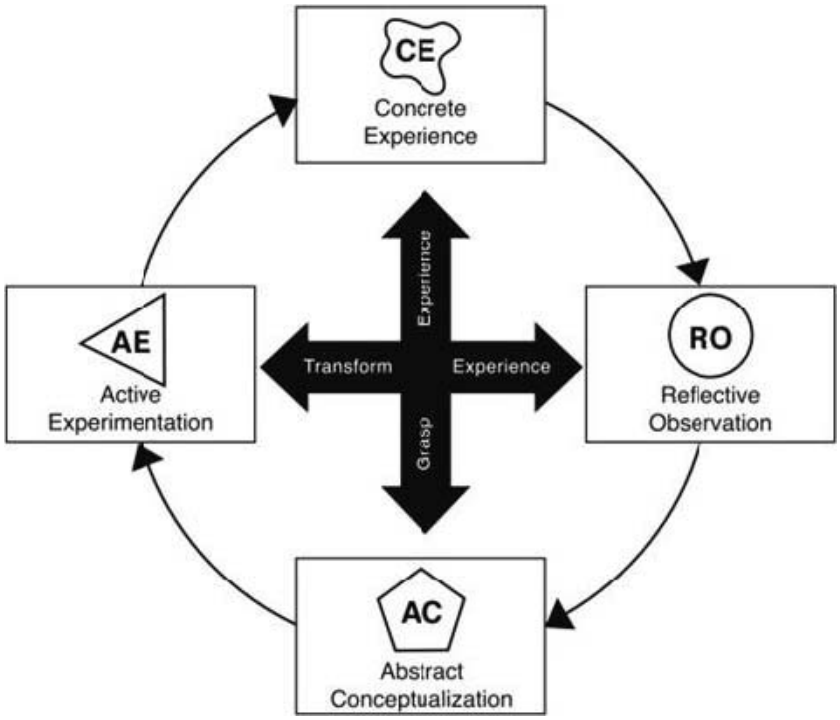

Figure 1.—The experiential learning cycle (Kolb 1984).

students to pursue bio-based materials science undergraduate education programs (College of Natural Resources and Environment 2022). Inside Trees at Virginia Tech had two components: the on-campus summer camp program for high school students and the remote modules and activity sheets. The in-person summer camp program was designed to introduce underrepresented students (women, minorities, and first-generation college students) to the field of forest- and wood-based materials. Remote learning modules and activity/information sheets were created to provide information about bio-based materials, trees, products from wood raw materials, and bio-based materials careers.

Methods

In-person summer camp

Application process.—The application process for Inside Trees was developed using certain techniques found in other summer programs at Virginia Tech, such as the Pathways for Future Engineers precollege program (https://eng.vt.edu/ceed/ceed-pre-college-programs/Pathways.html). The application process included three components: the application form, the student's high school transcript, and the legal guardian form. The application form was provided online and filled out by the student interested in the program. It included four sections: personal information, high school information, achievements and extracurricular activities, and essay questions. The purpose of the personal information section was to provide information about the student's demographic and how the student learned about Inside Trees. The high school information was to provide information about the students' grade level and to determine if the student was a first-generation college student. The achievements and extracurricular section was to provide additional background information regarding the students' accomplishments. The essay section was to provide specific interests of the student and was used to further develop program content included in Inside Trees. The purpose of including the student's high school transcript was to provide credibility regarding the student's academic performance. The legal guardian or parent form was provided online and filled out by the student's legal guardian. This form included three sections: personal information, residential adviser, and consent. The purpose of the legal guardian section was to provide personal contact information for the student's legal guardian in case of emergency and consent from the legal guardian for the student to attend the program and to determine if the guardian/parent was interested in volunteering as a residential adviser.

Program recruitment.—Inside Trees was announced through several avenues, including social media accounts, Virginia Cooperative Extension networks, Virginia high school counselor networks, Virginia Tech daily e-mails and news announcements, and an article featured on Virginia Tech's website daily news. Approximately 3 weeks after announcement, the summer camp application process concluded with 67 opened applications and 18 completed applications. From the 18 completed applications, 12 students who applied and successfully completed all application requirements were accepted into the summer camp program. The number of participants was intentionally kept small due to restricted project funding, limited project personnel availability, and the desire to have small-group dynamics and interactions during the initial prototype year. Program participants included seven rising seniors, one rising junior, three rising sophomores, and one rising freshman. Program participant demographics included 10 females and two males. Additionally, 10 participants were Caucasian, two participants were from an URM group (one African American and one Hispanic), and three participants were first-generation students.

Program content and delivery.—Inside Trees program content focused on delivery of and engagement with information about bio-based products and careers and included field-based and hands-on activities. The program content covered material ranging from tree species to growth to anatomy and how this affects structural and chemical applications of forest products. The program also included college preparation and career discussions. A schedule for the Inside Trees summer camp is shown in Figure 2. The program was held over 5 consecutive days and began with a Walk through the Woods activity on the Virginia Tech campus that included both student participants and their parents or guardians along with faculty and students from Virginia Tech. The purpose of the activity was to introduce the students to each other and to faculty members and to gain an understanding of tree species and products that are derived from specific species. This provided baseline knowledge to the participants that was further developed throughout the program.

The second day included two learning units and an introduction to SBIO and concluded with an SBIO student panel discussion. The first learning unit was appropriately named ''What's Inside a Tree?'' and included taking a tree core to determine characteristics of the tree, mainly age and seasonal growth, and analyzing the tree rings and microscopic slides of varying tree species. The second learning unit continued the discussion of wood materials but focused on the chemical content of wood and included a papermaking and recycling activity. In the evening, a student panel discussion on sustainable biomaterials was held named ''A Day in the Life of an SBIO student'' and presented by four current students enrolled in the Sustainable Biomaterials program. The panel discussion presented an opportunity for camp participants to interact with current students and ask specific questions related to the academic program at Virginia Tech.

The third day included two learning units and a college preparation and career discussion. The third learning unit discussed structural applications of wood and the influence

InsideTREES Schedule			
Sunday – Residence Hall (West A-J) and Campus			
1:00 – 3:00 pm	Arrival, check-in with residence hall	Conference Services staff	West Ambler-Johnston (A J)
4:00 – 5:30 pm	Opening meeting and orientation (camp participants AND parents if available)	Faculty and students	West A-J
5:30 – 6:30 pm	Dinner on campus		D 2 (Dietrick Dining Hall)
6:30 – 8:30 pm	*A Walk through the Woods (parents invited);* Stadium Woods	Faculty and students	Stadium Woods
10:00 pm	Dorm curfew	Graduate Student chaperone	West A-J
Monday – Julian Cheatham Hall (JCH)			
8:00 – 9:00 am	Breakfast on campus		D 2
9:00 – 12:00	***Learning Unit 1**: What's Inside a Tree?*	Faculty and students	213 JCH
	Activities: Daily Wood Charting; Reading the Rings; Looking Really Close	Faculty and students	213 JCH
12:00 – 1:00 pm	Lunch on campus		D 2
1:00 – 1:30 pm	*Introduction to SBIO Department*	Department Head	213 JCH
1:30 – 4:30 pm	***Learning Unit 2**: Green Chem is TREE*	Faculty and students	213 JCH
	Activities: Writing with Wood; Making a Chia Pet Paper Plant	Faculty and students	213 JCH
4:30 – 5:00 pm	Review and day one discussion	Faculty and students	213 JCH
5:30 – 6:30 pm	Dinner on campus		D 2
7:00 – 9:00 pm	***SBIO student panel discussion** – A Day in the Life of an SBIO student*	SBIO students	West A-J
10:00 pm	Dorm curfew	Graduate Student chaperone	
Tuesday – Cheatham Hall and Brooks Forest Products Center			
8:00 – 9:00 am	Breakfast on campus		D 2
9:00 – 12:00	***Learning Unit 3**: Engineering with Wood*	Faculty and students	213 JCH
	Activities: Nothing, Nails, & Glue; Going with the Grain (or not)?; Solid or Composite?	Faculty, students, & staff	213 & 235 JCH & Brooks
12:00 – 1:00 pm	Lunch on campus		D 2
1:00 – 4:30 pm	***Learning Unit 4**: Circular Economy*	Faculty and students	Brooks
	Activities: Learn and Apply LCA	Faculty and students	Brooks
4:30 – 5:00 pm	Review and day two discussion	Faculty and students	
5:30 – 6:30 pm	Dinner on campus		D 2
7:00 – 9:00 pm	***College Prep. and Career Discussion** with CNRE Advising Center*	Staff	315 JCH
10:00 pm	Dorm curfew	Graduate Student chaperone	

Figure 2.—Inside Trees summer camp schedule.

Wednesday – Cheatham Hall & Radford, VA			
8:00 – 9:00 am	Breakfast on campus		D 2
9:00 – 12:00	***Local field trip*** *to CLT railroad viewing platform, Radford, Virginia and timber frame at Farmers' Market downtown Blacksburg*	Faculty and students	Radford and Blacksburg, Virginia
12:00 – 1:00 pm	Lunch on campus or downtown Blacksburg		D 2
1:00 – 3:00 pm	***Comprehensive project*** *completed by InsideTREES participants*	Faculty and students	213 JCH
	Examples: Microscope collage; LCA of a product; Interview a professor; What wood is that ? Make a wood sandwich or two	Faculty and students	213 JCH
3:00 – 4:30 pm	**Project presentations by InsideTREES participants (parents are invited to attend)**	Camp participants	213 JCH
4:30 – 5:30 pm	Day three discussion and evaluation. Option to check out of residence hall	Faculty and students	
5:30 – 6:30 pm	Dinner for those remaining on campus		D 2
7:00 – 9:00 pm	***Breakzone*** *(recreational facility for billiards, bowling, table tennis, darts, foosball)*	Faculty and students	117 Squires Student Center
10:00 pm	Dorm curfew	Graduate Student chaperone	
Thursday – Residence Hall			
9:00 – 12:00	Check out of residence hall, depart	Conference Services staff	

Figure 2.—Continued.

of wood cell structure. The unit started with an informational session held on campus discussing wood anatomy and the effects on load-bearing beams. Then the program participants applied that knowledge to test the strength of different types of beams at the research center for SBIO. The fourth learning unit discussed the circular economy aspects of wood products and pallets. Camp participants completed a life cycle analysis of various products that allowed the students to gain an understanding of sustainability through energy consumption of varying products and how wood products are a more sustainable alternative. The third day concluded with a college preparation and career discussion conducted by the college's Advising Center.

The fourth day included two local field trips, a project and presentation, and a final social activity. The first field trip consisted of viewing a cross-laminated timber railroad platform in Radford, Virginia. The second field trip consisted of viewing a timber frame structure in downtown Blacksburg, Virginia. The afternoon consisted of a project and presentation wherein the students divided into groups and chose project topics covered throughout the week. The students conducted further research with assistance from faculty and staff and presented the project that afternoon to program participants. Family members of the program participants were invited to attend the presentation. The evening consisted of a social activity to celebrate the end of the program. The program participants played various games, including pool, bowling, and card games. The program participants had the option to leave after the social activity or stay one additional night.

Remote learning modules and activities

Initially, the Inside Trees summer camp was designed to be held for 2 consecutive years. The first summer program was to be used to gain an understanding of logistics concerning the program content and design, recruitment, application, and evaluation process. The second summer program was planned to be the finalized version that would focus on the pedagogy included in the program and evaluation of that pedagogy. Unfortunately, the second summer program was canceled by our university due to COVID-19, and time limitations prevented development and delivery of a virtual summer camp. However, the cancellation provided an opportunity to refocus on the creation of remote learning techniques for providing the content and experiences that might have been gained through in-person delivery. Several learning modules, activities, and information sheets were created for remote, online access using the 5E teaching and learning model, which includes five phases—engage, explore, explain, elaborate, and evaluate—based on Kolb's experiential learning pedagogy (Kolb 1984). Modules include engagement through discussion questions, exploration of the content through a quick activity, explanation of the disciplinary content, elaboration through a more in-depth activity, and evaluation through discussion of that activity. The modules were designed so they could be leader-directed group activities or self-paced and self-directed. Discussion questions were open ended, resulting in various answers that would stimulate interest, challenge viewpoints, and encourage problem solving. The experiential, ''learning by doing'' method is well supported by completion of the activities that accompany each learning module. The design of the remote modules was to create a logical, organized structure and to reinforce key concepts and provide activities well positioned to help participants engage and evaluate their own learning. In so doing, the 5E teaching design reflects the Inside Trees summer in-person program and helps address hindrances of enrollment in higher-education programs, such as lack of knowledge of diverse fields, prior misperceptions, and limited career opportunities. Inside Trees modules and activities can be accessed at this address: https://sbio.vt.edu/SummerCamp/learning.html.

Evaluation

Evaluation and data analysis of the in-person summer camp model was slated for the second project year but was not possible due to cancellation of this phase of the project by our university. However, a process shown in Table 1, combined with the exit survey questions listed below, could be used to evaluate institution-specific goals and measure performance indicators. In addition, extensive documentation of results, feedback, successes, failures, and other noteworthy items throughout each camp week should be completed so that a rich database will be available for evaluation and program revision. Expected outcomes in Table 1 were based on specific goals for Inside Trees at Virginia Tech and literature that reported hindrances, perceptions, and lack of information related to STEM and natural resource programs (Allen-Ramdial and Campbell 2014, Balcarczyk et al. 2015). Performance indicators are desired levels of success and should be customized by each institution according to their own strategic plans and program goals. Data collection can be accomplished through a variety of methods; however, a straightforward, easily administered method is an exit survey to assess responses to specific aspects of the program (Vernaza et al. 2007, Cappelli et al. 2019). Both qualitative and quantitative questions should be included to rate activities and experiences. Institutional review board approval may be required, depending on the specifics of data collection and intended use of the data. Questions for a summer camp participant exit survey might include the following:

1. What was your goal(s) for participating in Inside Trees?
2. Were your goals met by Inside Trees? If no, please explain.
3. What was the most enjoyable activity? Why?
4. What was the least enjoyable activity? Why?
5. What topics would you like to see addressed in future programs and career development sessions?
6. What did you learn about sustainable biomaterials by participating in Inside Trees?
7. What did you learn about our college by participating in Inside Trees?
8. Did your academic interest change by participating in Inside Trees? If so, why?
9. What needs to be improved the next time Inside Trees is offered?

Informal conversations with camp participants during our prototype summer camp indicated that the student project on the third day was quite popular because it was active and participants could take the knowledge they learned over the week and apply it to a topic of their own interests; however, it was also said that the projects could have used more time and planning. Mechanical testing at the research facility and the field trip to the Cross Laminated Timber railroad viewing platform were said to be useful because these activities provided real-life applications of the knowledge being gained during the camp. Making paper, the walk in the woods, and extracting tree cores were also mentioned as fun activities. Suggestions for improvement included building in more social or free time for camp participants, having more hands-on experiences and less lecture time, having a longer program with shorter days, and providing more activities outside with trees.

Discussion

Inside Trees was developed as a potential program model for increasing interest of URM students in pursuing higher education in the field of bio-based materials. Strategies and tactics included implementation of experiential learning and a positive experience in nature to significantly increase participants' interest. Hindrances identified by previous research were addressed by (1) introducing the participants to the multiple disciplines in bio-based materials; (2) providing support from the hosting university department through inclusion of current faculty, staff, and students in the summer program; and (3) introducing the participants to career opportunities in the field.

Slavich and Zimbardo (2012) described how experiential learning is a proponent of transformational teaching that is critically important for enhancing learning-related attitudes, values, beliefs, and skills. Authors state that experiential learning ''enables students to reshape their understanding of a concept through experience, develop self-confidence and self-efficacy by applying their capabilities to achieve success, challenge prevailing thoughts and attitudes through problem-solving and debate, and enhance attitudes and beliefs about learning by experiencing ideas as relevant and meaningful'' (Salvich and Zimbardo 2012). Therefore, experiential learning as implemented in Inside Trees could be used as a tool to challenge preexisting attitudes and perceptions of women and URM students on the practical applicability of STEM disciplines.

Active and experiential learning were applied in Inside Trees by including learning units that began with an experience and discussion of the experience, conceptuali-

Table 1.—Process for evaluation of participant perceptions, measurable performance indicators, and suggested time frame.

Expected outcome or decision	Performance indicators	Data collection technique
Improved career awareness and perception of opportunities in bio-based materials science	More than 80% indicate improvement in awareness	Exit survey
Academic interest change as a result of Inside Trees camp	More than 40% indicate potential for change in academic interest area	Exit survey
Better preparedness to enter a university program	More than 50% indicate improvement in preparedness	Exit survey
Reduction in perception of potential for discrimination based on race/ethnicity/gender	More than 80% indicate potential for change in perception of discrimination potential	Exit survey
Were you considering Virginia Tech (VT) before the camp? After the camp?	Increase of at least 40% in number that consider VT after camp week	Query at start and end of camp week
What university did you choose?	Of the students who went on to a university, at least 25% selected VT	Follow-up e-mail
Would you attend Inside Trees again?	At least 50% would attend again	Exit survey

zation about the disciplinary content, and then active experimentation. Each learning unit built on each other through active experimentation. For example, the first learning unit began with a concrete experience and reflective observation through the Walk through the Woods activity. Additionally, this activity provided the participants with a positive experience in nature. The conceptualization was gained through discussing wood anatomy and how the anatomy would differ between the tree species observed in the Walk through the Woods activity. Then active experimentation was implemented by taking a tree core and looking at the tree rings and the cell and chemical structure of the wood. This provided an introduction to the third learning unit, which discussed structural applications of wood that are derived from the wood characteristics.

Inside Trees addressed some of the hesitancies of underrepresented students to enroll in higher-educational programs through inclusion of multiple disciplines of bio-based materials, including wood anatomy, structural applications, and life cycle analysis/sustainability. Support and positive interactions from the hosting department were provided by introducing the participants to multiple faculty and staff members and current graduate and undergraduate students. Parents, guardians, or other accompanying persons were invited to attend the Walk through the Woods activity and the final project presentation to provide family support. Participants were introduced to career opportunities through the college preparation and career discussion with the college's Advising Center. Specific careers were discussed throughout the learning units that were related to the disciplinary content learned in the unit.

Three major elements have been reported as essential for creating a successful camp (Sibthorp et al. 2020): ''(1) fostering safe and supportive relationships between camp leadership and participants, (2) creating programming that is focused on hands-on learning, and (3) providing novel experiences that offer opportunities for skill growth and development.'' It was also stated that camps that create meaningful relationships are held in a safe environment in which participants feel comfortable attempting new experiences. One method employed by Inside Trees to create safe and supportive relationships was to provide a thorough informational camp manual to participants and their families prior to start of the program. The manual included Virginia Tech and Inside Trees policies regarding standards of conduct, residence hall accommodations, checking in and out, living on campus, clothing and personal items, the daily schedule and curfew, the buddy system, room keys, meal cards, cell phones, and medical facilities on campus. Contact information for faculty and student staff was provided along with the camp schedule, a campus map, and an emergency contact form for each camp participant. Another way Inside Trees fostered safety and reduction of anxiety was to include parents and guardians in the introductory activity, A Walk in the Woods, which set the foundation for additional camp activities and program atmosphere.

While the learning outcomes specifically included in Inside Trees are best implemented in person through active learning, remote learning provides unique opportunities not provided by the summer in-person program. For example, the summer program could reach only a specific number of students, and the students were responsible for transportation to and from the camp and any additional personal costs for attending. The remote learning modules and activities have potential to reach a larger audience by not limiting the number of students who can attend and have no additional cost for attendance. They can be self-directed and accessed at any convenient time. Additionally, widespread distribution to other universities might be implemented more effectively and consistently through remote learning modules. For future implementation, the learning modules could be used as an introduction or recruitment effort for a summer program conducted in surrounding high schools or community colleges.

Recommendations

Three students who attended the Inside Trees summer camp enrolled at Virginia Tech the following year, resulting in a 25 percent rate of enrollment from the summer program. If the same or a similar summer program was implemented each year by multiple universities, this could result in significant changes in demographic diversity in related bio-based materials degree programs. Assuming that the students who attain related degrees in bio-based materials pursue a career in the industry, this could result in changes in demographic diversity in the bio-based products industry. Initial review of the program content and outcomes from the summer camp indicates that a summer program that includes experiential learning, a positive experience in nature, support through the higher-educational academic program, multiple disciplines, and career opportunities shows good potential to be an effective pipeline to increase diversity in the bio-based industry. It is therefore suggested that the Inside Trees model curriculum and structure could be adapted by other universities or organizations for achievement of program-specific goals toward improved awareness and enrollment.

To further increase representation of underrepresented groups in bio-based materials undergraduate degree programs, recruitment efforts need to reach a larger, more diverse audience to create significant change in demographic enrollment. Providing a summer program to students who attend community colleges would present a unique opportunity to reach a larger, more diverse audience who are already inserted in higher education. Community colleges are institutions that offer postsecondary education. These institutions were created to increase public access to higher education in mostly rural communities (Drury 2003). Students enrolled in these institutions are sometimes overlooked when considering recruitment efforts to increase and diversify undergraduate programs (Hoffman et al. 2010). However, community colleges enroll an extremely diverse set of people and educate almost half of the nation's undergraduate students (Crisp et al. 2016). Of all the students who received a bachelor's degree in science and engineering from 2010 to 2017, 47 percent had been previously enrolled in a 2-year public institution, and 18 percent had previously earned an associate's degree (National Science Board 2020, Retallick et al. 2021). Recruitment efforts focused on community colleges would provide an additional opportunity to reach a larger, more diverse audience who are already involved in higher-educational programs.

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Literature Cited

Allen-Ramdial, S-A. A. and A. G. Campbell. 2014. Reimagining the pipeline: Advancing STEM diversity, persistence, and success. *BioScience* 64(7):612–618.

Armbruster, P., M. Patel, E. Johnson, and M. Weiss. 2009. Active learning and student-centered pedagogy improve student attitudes and performance in introductory biology. *CBE Life Sci. Educ*. 8:203–213.

Balcarczyk, K. L., D. Smaldone, S. W. Selin, C. D. Pierskalla, and K. Maumbe. 2015. Barriers and supports to entering a natural resource career: Perspectives of culturally diverse recent hires. *J. Forestry* 113:231–239.

Cappelli, C. J., K. L. Boice, and M. Alemdar. 2019. Evaluating university-based summer STEM programs: Challenges, successes, and lessons learned. *J. STEM Outreach* 2(2019):1–12. https://doi.org/10.15695/jstem/v2i1.13

Carrick, T. L., K. C. Miller, E. A. Hagedorn, B. R. Smith-Konter, and A. A. Velasco. 2016. Pathways to the geosciences summer high school program: A ten-year evaluation. *J. Geosci. Educ*. 64(1):87–97. https://doi.org/10.5408/15-088.1

College of Natural Resources and Environment. 2022. Sustainable Biomaterials. https://sbio.vt.edu/SummerCamp/learning.html. Accessed July 14, 2022.

Crisp, G., V. D. Carales, and A. M. Núñez. 2016. Where is the research on community college students? *Community Coll. J. Res. Pract*. 40(9):767–778. https://doi.org/10.1080/10668926.2015.1102104

Drury, R. L. 2003. Community colleges in America: A historical perspective. *Inquiry* 8(1):1–6. http://www.vccaedu.org/inquiry/inquiry-spring2003/i-81-drury.html

Haynes, N. A. and S. Jacobson. 2015. Barriers and perceptions of natural resource careers by minority students. *J. Environ. Educ*. 46(3):166–182. https://doi.org/10.1080/00958964.2015.1011595

Hoffman, E., S. S. Starobin, F. S. Laanan, and M. Rivera. 2010. Role of community colleges in stem education: Thoughts on implications for policy, practice, and future research. *J. Women Minorities Sci. Eng*. 16(1):85–96. https://doi.org/10.1615/JWomenMinorScienEng.v16.i1.60

Jachowski, D. S., M. J. Aguerre, G. Lascano, K. Titus, and T. Scott. 2022. Using multidisciplinary, conflict-based experiential learning to train students on how to address controversy at the public-private land interface. *NACTA J*. 66(2022):37–45.

Kolb, A. Y. and D. A. Kolb. 2017. Experiential learning theory as a guide for experiential educators in higher education. *ELTHE* 1(1):7–45. https://nsuworks.nova.edu/elthe/vol1/iss1/7

Kolb, D. A. 1984. Experiential Learning: Experience as the Source of Learning and Development. Prentice Hall, Englewood Cliffs, New Jersey.

Krebs, C. L., J. L. Loizzo, R. M. Crandall, J. C. Bunch, and L. Lundy. 2021. Project-based learning impacts on collegiate students' climate change attitudes, nature relatedness, and science communication skills. *NACTA J*. 65(2020–2021):506–516.

Martinez, E., J. Lindline, M. S. Petronis, and M. Pilotti. 2012. Effectiveness of a science agricultural summer experience (SASE) in recruiting students to natural resources management. *J. Sci. Educ. Technol*. 21(6):713–721. https://doi.org/10.1007/s10956-011-9359-3

Mazurkewicz, M., A. Harder, and T. G. Roberts. 2012. Evidence for experiential learning in undergraduate teaching farm courses. *J. Agric. Educ*. 53(1):176–189. http://dx.doi.org/10.5032/jae.2012.01176

Millenbah, K .F. and J. J. Millspaugh. 2003. Using experiential learning in wildlife courses to improve retention, problem solving, and decision-making. *Wildl. Soc. Bull*. 31(1):127–137. http://www.jstor.org/stable/3784366

National Research Council. 2015. Identifying and Supporting Productive STEM Programs in Out-of-School Settings. Committee on Successful Out-of-School STEM Learning. Board on Science Education, Division of Behavioral and Social Sciences and Education. National Academies Press, Washington, D.C.

National Science Board, National Science Foundation. 2020. Science and Engineering Indicators 2020: The State of U.S. Science and Engineering. NSB-2020-1. National Science Foundation. Alexandria, Virginia. https://ncses.nsf.gov/pubs/nsb20201

Retallick, M. S., E. A. Foreman, J. M. Bundy, K. Powell, and M. M. Morris. 2021. Characteristics and experiences of students who transfer to Iowa State University's College of Agriculture and Life Sciences. *NACTA J*. 65(2020–2021):518–524.

Rouleau, M., T. L. Sharik, S. Whitens, and A. Wellstead. 2017. Enrollment decision-making in U.S. forestry and related natural resource degree programs. *Nat. Sci. Educ*. 46(1). https://doi.org/10.4195/nse2017.05.0007

Sharik, T. L. and S. L. Frisk, 2011. Student perspectives on enrolling in undergraduate forestry degree programs in the United States. *J. Nat. Resour. Life Sci. Educ*. 40(1):160–166. https://doi.org/10.4195/jnrlse.2010.0018u

Sibthorp, J., C. Wilson, V. Povilaitis, and L. Browne. 2020. Active ingredients of learning at summer camp. *J. Outdoor Environ. Educ*. 23(1):21–37. https://doi.org/10.1007/s42322-019-00050-6

Slavich, G. M. and P. G. Zimbardo. 2012. Transformational teaching: theoretical underpinnings, basic principles, and core methods. *Educ. Psychol. Rev*. 24(4):569–608. https://doi.org/10.1007/s10648-012-9199-6

Trivedi, S., J. C. Clark, C. L. Pickworth, M. H. Fosnaught, and E. A. Discoll. 2021. Reflections on adapting agriculture summer camps to fit a virtual format. *NACTA J*. 65(2020–2021):390–396.

U.S. Department of Agriculture, 2020. Nonmetro population change has remained zero in recent years. https://www.ers.usda.gov/data-products/chart-gallery/ gallery/chart-detail/?chartId=99693. Accessed July 14, 2022.

Vernaza, K. M., T. Vitolo, S. Steinbrink, and B. J. Brinkman. 2007. Assessment of high school student's exposure to engineering via a summer camp. *In:* International Conference on Engineering Education—ICEE 2007, September 3–7, 2007, Coimbra, Portugal; European Journal of Engineering Education, Taylor & Francis, Milton Park, UK.

Whitaker, B., L. Worley-Davis, S. Brierton, J. Osborne, K. Anderson, and K. Livingston. 2017. Evaluating the poultry science summer institute (PSSI) as a recruitment tool for high school students from North Carolina counties to enter the Prestage Department of Poultry Science. *NACTA J*. 61(4):279–283.

Yilmaz, M., J. Ren, S. Custer, and J. Coleman. 2010. Hands-on summer camp to attract K–12 students to engineering fields. *IEEE Trans. Educ*. 53(1):144–151.