Piloting an Innovative Bridge Camp at a Tribal College to Improve the Transition from High School to College

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Abstract

This complete evidence-based practice paper presents an innovative approach to a traditional summer bridge camp. This approach, developed by North Dakota Established Program to Stimulate Competitive Research (ND EPSCoR) and implemented at Turtle Mountain Community College (TMCC; a tribal college/university [TCU] in North Dakota), was aimed at enhancing the college-readiness and interest in STEM degree programs of recent high school graduates. Research has shown that short and intensive bridge camps have positive impacts early in a participant's collegiate career, but the results diminish over time. The pilot bridge experience presented in this paper was designed to have a more lasting impact on participant attitudes and preparation. A significant characteristic of the instructional strategy was the inclusion of independent projects. Participants engaged in face-to-face lessons that ranged from improving study habits to learning technical skills that would not only help them successfully complete the pilot bridge camp, but also provide academic skills that would potentially help them to be more successful in an undergraduate program. Participants also learned life skills to prepare them for professional careers. The learning experiences integrated math and technology into hands-on engineering and science projects over three months in 2-3 week intervals. After the completion of each face-to-face session, participants had the needed tools, skills, and information to accomplish each related independent project. The independent projects engaged the participants throughout the summer, built skills and self-confidence in each successive step, and provided an experience that mimicked many of the challenges encountered in a college setting.

Introduction

North Dakota (ND) is a sparsely-populated state with roughly 755,400 residents in approximately 70,700 square miles [**1**]. American Indians (AI) comprise 5.5% of ND's population, which ranks as the 6th highest percentage in the United States [**2**]. In ND, there are four reservation-based tribal colleges/universities (TCUs) and one TCU not on a reservation. Since most AI college students in ND are enrolled at one of the five TCUs in the state, these institutions are vital for recruiting AI students into STEM fields to enhance and diversify ND's workforce and improve tribal communities.

For more than twenty years, the five TCUs have collaborated with the state's two research universities [RUs; North Dakota State University (NDSU) and the University of North Dakota (UND)] to get more AI youth interested in STEM degrees and careers. This collaboration is known as Nurturing American Tribal Undergraduate Research and Education (NATURE). Since 2006, the North Dakota Established Program to Stimulate Competitive Research (ND EPSCoR) has funded (state and federal dollars) and administered NATURE. All NATURE activities are designed to form a connection between indigenous culture and the STEM theme being explored. This method of relating the participants' culture to the NATURE activities helps the participants understand an activity's relevance and thereby enhances their engagement **[3]**. With the 2019 addition of this pilot bridge camp, annual NATURE programming now consists of four

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components: 1) university summer camp, 2) TCU summer camp, 3) Sunday academy, and 4) bridge camp (the subject of this paper).

Nationwide data show that American Indians have consistently lower college matriculation and graduation rates than other groups. In 2017, only 20% of AI youth ages 18 to 24 were enrolled in college **[5]**. In its 2019 report, the National Center for Education Statistics identified AIs as lowest among the ethnic groups to attend college, with the next closest group being 13 percentage points higher **[5]**. Of the AIs who enroll in college, many have not earned a degree within the normal time for completion; indeed, research shows that 41% of AI students in the fall 2007 cohort graduated with a bachelor's degree within 6 years of enrolling, compared to 59% of all students in the same cohort **[6]**. Similarly, 15% of AI students in the fall 2010 cohort graduated with an associate's degree within three years of enrolling compared to 20% of all students in public institutions **[6]**. Thus, there is a demonstrated need for programs that encourage AI students to enroll in college and enable them to persist in completing their college degrees.

A 2016 "Partnerships To Build STEM Capacity" document compiled by ND EPSCoR identified the need for ND programs directed at recent high school graduates that would help transition these students to college. At that point, three of the five TCUs identified this as a high need. By December 2017, all five TCUs had identified this as a need **[4]**, which aligns with the national inequity described above. Turtle Mountain Community College (TMCC) was the first ND TCU to express an interest in implementing a bridge camp to better enable/facilitate a recent high school graduate's transition to college. As a result, a pilot bridge camp was developed by ND EPSCoR and implemented at TMCC during the summer of 2019.

Literature has shown that traditional bridge camps render short-term benefits for participants with little to no long-term effects **[7]**. Therefore, the authors designed the activities of ND EPSCoR's NATURE bridge camp to extend beyond basic academic skills work, student professional development, and campus tours. The goal of the bridge camp was to give students the motivation, mindset, and skills needed to persist in obtaining STEM degrees by supplementing traditional face-to-face sessions with innovative independent projects. For motivation, the participants were led through exercises that focused on the all the various rewards that could come from succeeding in college and career. For mindset, the participant's upcoming college experience was simulated by independent and group projects, each lasting at least 20 hours, outside of each of the face-to-face session. For skills, the authors gave participants specific skills to help prepare them for the academic challenges of college (or for everyday life). The theme of the camp was sustainability, since it is an issue important to indigenous communities, and it leads to a wide variety of activities.

Methods

Guided by IRB protocols #19235 at NDSU, #81 at Tribal Nations Research Group, and # IRB-NDSU-Navarro-NATURE at UND, the authors piloted the bridge camp at TMCC. The bridge camp took place during portions of three summer months (Table 1) in 2019 and consisted of three traditional face-to-face sessions, three independent projects, and a final presentation. Throughout the entire camp, participants had open communication with, and support from, their

instructors. The three face-to-face sessions covered the following topics: 1) math integration, culture, communication, careers, and financial aid; 2) engineering investigation; and, 3) scientific research. Following each face-to-face session, instructors assigned a corresponding independent, self-directed project: 1) website portfolio, 2) engineering application, and 3) scientific research. The independent project approach gave participants an experience that mirrored what they would encounter in college since they spent more time doing the individual projects than participating in a formal classroom setting.

TABLE 1. Timeline of bridge camp.

Month 1 (May/June)		**Month 2 (June/July)**		**Month 3 (July)**		
Face-to-face Session 1	Independent Project 1	Face-to-face Session 2	Independent Project 2	Face-to-face Session 3	Independent Project 3	Face-to-face Final Presentations
4 days	3 weeks	2 days	3 weeks	2 days	2 weeks	1 day

The instructors designed each successive independent project to afford participants more autonomy. The authors viewed this trajectory as a necessary experience to prepare participants for a successful transition from high school to college.

- The first independent project was very structured and did not leave much latitude for individual variation. During the first project, the participants were required to give the instructor a progress update twice, and they were able to ask for guidance at any time.
- For the second independent project, participants were able to choose to build one of two possible models. They also had to propose some enhancement to the original design and then implement and test their modifications. This project allowed the participants to apply more independence and creativity. During the second project, the participants were required to give the instructor a progress update once, and they were able to ask for guidance at any time. However, when soldering or operating the 3D printer, they were in the lab with an engineering instructor present at all times to ensure safety and prevent damage to the equipment.
- In the third independent project, participants designed an entire research project. Each participant developed their own research question and, with guidance, came up with an experimental design to test that hypothesis. For this project, participants performed a literature review, collected and analyzed data, and discussed the results. This project afforded participants more latitude and autonomy than the preceding projects. During the third project, the participants were required to give the instructor a progress update once, and they were able to ask for guidance at any time.

Session 1: Math Integration, Culture, Communication, Careers, and Financial Aid

Math was the primary focus of the first session and instructors intentionally integrated it into each of the three independent projects to help participants understand and reflect upon its value to each component of STEM. A significant emphasis was placed on the teaching methods and approaches used in math to prepare participants for sessions 2 and 3. Math was implemented, not

as rote memory and use/re-use of given formulas, but as a form of project-based learning; as the language of science, technology, and engineering; and, as a place of critical thinking and discovery **[8]**.

Because the theme of the camp was sustainability, the authors titled the first math activity "Trash Math." To begin the activity, seven participants and six instructors formed three groups of four to five individuals and collected roadside trash at three sites near the TMCC campus. The goal of this activity was to have participants mathematically analyze the roadside trash they had gathered in an effort to gauge its effect on their community and the earth. Participants then evaluated the viability of creating a sustainable trash/solid waste collection business in their community. Participant voice and choice were incorporated into the process by allowing them to choose how best to analyze the trash: by weight, by volume, by number of items, etc. To expand their learning process, instructors asked participants a number of questions, such as, '*How much trash is on the roadside of our entire reservation?*' and '*How many years of decomposition did we save today?*'

The instructor divided these "Trash Math" activities into multiple sessions over the course of the four days of session #1. Participants employed multiple self-generated hands-on methods to estimate the volume of trash collected by molding the bags of trash into cylindrical, rectangular, and ellipsoid shapes to simplify the estimation of their volume. They then combined their understanding of geometry and algebra with critical thinking to design their own methods for estimating the volume of the various types of trash collected.

Participants also explored how to develop a business/financial plan for the operation of a recycling business in their community for the fictional purpose of submitting a proposal to the tribal government. The plan used profit and cost equations to analyze the trash data. Lesson content emphasized algebra and ratios, while instructional methods emphasized Socratic questioning (asking questions rather than "spoon-feeding" answers). This exercise gave participants the opportunity to assess the viability of creating and owning a recycling business in their own community. This type of hands-on, practical approach breaks math out of rote memory and plug-in formulas and transforms it into a useful tool for critical thinking and discovery. Using math to analyze roadside trash connected the calculations to the participants' community, the earth, and concepts of sustainability. Not only did "Trash Math" build participants' interest in mathematics, it helped prepare them for critical thinking and discovery in future sessions and independent projects. Following the development of the business/financial plan, a statistics lesson gave participants additional quantitative reasoning skills. Participants learned descriptive statistics and the basics of regression lines by analyzing their own trash collection data in Microsoft Excel®.

The instructor then covered standard interest problems. Participants developed interest calculators using Excel®, which exposed them to elementary coding, a skill they built upon when doing the engineering project in session 2. The participants also explored mortgage interest, the productive power of saving and long-term investing, and the destructive power of credit card debt.

This first session also included sessions on culture, communication, careers, and financial aid. An elder discussed indigenous views of STEM and career preparation. These cultural connections allowed participants to see how STEM concepts are part of traditional Native culture, allowing them to experience a deeper sense of connectivity to the material. Participants also learned how to write a resume and prepar for job interviews. TMCC Admissions staff talked about how to apply for college and common matriculation issues. Staff also discussed financial aid options and ways to find scholarships and grants.

Finally, a reflective writing assignment pushed participants to see the connection and value of math to each field of STEM. The free-write reflection prompt was: *'Math is the language of science. How have your attitudes and thoughts towards this statement changed because of these math activities?'* With this activity, participants had the opportunity to process their experience and reflect on their use of math in various ways. Lastly, an instructor prepared them for the first independent project by covering PowerPoint® basics and discussing how to conduct a professional interview.

Independent Project 1: Website Portfolio

The first independent project required the participants to produce a website portfolio. The goals for the website portfolio were to: 1) enable participants to use online tools for collaborations and presentations and 2) provide participants with tools and skills to look for jobs in their chosen field in the future. The portfolio consisted of five sections: a resume, a life plan, a financial plan, an interview report, and a biographical presentation. The portfolio assignment required participants to describe, analyze, and convey information about their own goals and strengths. The assignment also prompted participants to think about their career choices and plan how to work toward their long-term career goals.

Participants wrote life and financial plans to help build self-awareness and encourage goal setting. Participants defined their dream job based upon their skills, interests, and values. This self-reflection required participants to start forming goals or, for those who already had clear goals, to articulate why they chose a certain career goal or to see how paths they had not previously considered might also fit into their life goals. The instructor also asked each participant to develop SMART (specific, measurable, actionable, relevant, and time-bound) goals to obtain their dream job and include them in their life plans [**9**]. The goal was to teach participants to break down big projects into achievable steps, a skill that is critical for time management. The financial plan covered both personal and academic finances and gave participants an understanding of budgeting and another opportunity to develop math skills relevant to their lives.

The interview assignment required participants to interview two individuals from their community currently employed in STEM and then write a reflection about what they learned from the interviews. The purpose of this assignment was to connect participants to STEM professionals and provide an opportunity to learn about each interviewee's path to becoming a STEM professional. The assignment also required participants to understand the difference between description and analysis/interpretation of facts.

For the final assignment pairs of participants prepared biographical presentations about AIs in STEM careers. The participants were free to choose any AI STEM researcher, but they were also given a list from which they could choose. Using online search engines to find biographical information required participants to use Boolean search strategies, strengthening their online search skills. This group project also strengthened participants' collaboration and presentation skills.

Session 2: Engineering Investigation

The goals of the second session were to introduce participants to engineering and technology careers, teach them the engineering design process, prepare them for their second independent project, and enhance their critical thinking skills by challenging them to apply the engineering design process during hands-on projects [**10**]. The session began with a discussion of study skills and balancing academic and personal calendars. Instructors then hosted a panel discussion featuring six AI engineering professionals from the Turtle Mountain community who talked about the challenges they each faced during college. The discussion also included advice to help the participants overcome or prepare for issues they may encounter in college.

The rest of session 2 was devoted to teaching participants the technical skills necessary to complete the second independent project. The participants learned how to solder, program Arduinos, and operate a 3D printer. They learned how to solder by assembling a miniature LED Christmas tree and a robotic car. The tree activity helped demonstrate the structure of LEDs and the importance of soldering the anode/cathode wires correctly. The car activity introduced participants to resistors, transistors, capacitors, and potentiometers and taught them how to solder on a smaller surface. To understand Arduino programming, the instructors provided participants with sample code and were instructed on ways to modify the code.

To learn how to operate 3D printers, instructors gave participants a file that was ready to print, demonstrated how to load the file into the correct software, and discussed the settings (such as layer thickness, print speed, and number of shells) and their importance to print quality. Instructors also covered best practices for the proper orientation and sizing of models to have an efficient final print and to minimize waste. To help participants become more comfortable with 3D printing software, the instructors discussed CAD® basics, Solidworks® basics, how to create new models and how to modify existing models.

Independent Project 2: Engineering Application

The second independent project required each participant to create a device (students could choose either a 4x4x4 LED cube or a desktop wind turbine). Participants investigated how each component of their device operates. Learning to improve or modify the design of a CAD® file was an important component of this project. If they successfully constructed their device, instructors asked them to propose changes to the original design and predict how the changes would affect their device.

Completion of this independent project required both critical thinking and application of the engineering design process to develop and test a hypothetical improvement to the technical

system. Finally, the participants presented their projects/progress to the group and discussed the design changes they made and challenges encountered in the process.

Session 3: Scientific Research

The goal of the third session was to introduce participants to the scientific inquiry process and to explore science career possibilities. The schedule of the third session was a scaffolded learning process to help participants understand the basics of the scientific method and successfully compose a college-level research report [**11**]. The instructor structured this session according to the backward design model to enhance understanding and to keep participants focused on their long-term goals. Backward design is an approach to curriculum where the learning goals are determined first and then assessments are built based on the goals. The assignments are then designed to align with the assessments, and lastly, evaluations are determined **[12, 13]**. Using this model, each participant first developed a research goal and then, using a guiding worksheet, the instructor introduced the basics of scientific literature searches, hypothesis creation, and research methods. The worksheet was instructor-led, but also served as a reference guide as the participants completed their research projects. The next activity introduced participants to peer review and feedback. The participants were able to present their proposed research topics to their peers and instructors and get "peer review" feedback, which they integrated into their project design.

The next activity was an introduction to writing college-level research reports and incorporating citations, beginning with how and why sources are used and how to cite sources properly. The session then covered data, information, and statistical analysis. The instructor pointed out the prevalence of failure in scientific inquiry, stressing that many scientific discoveries occurred because the scientists learned from their failures and were then successful because of that.

The instructor dedicated the final segment of the session to test-trials of the participants' planned research methodologies for their research projects, trouble-shooting issues that might arise, and giving guidance on how to ensure uniformity and replicability of results. The instructor then discussed how to write research reports.

Independent Project 3: Scientific Research

The third independent project provided participants an opportunity to conduct the research they had planned during session 3, which included gathering data, performing statistical analyses, and writing the research report. Participants asked instructors for guidance during this time and receive feedback. The instructors told the participants that they should present the results of their scientific projects during the final presentation.

Results and Discussion

We originally recruited 15 participants for the camp; however, only seven chose to attend the camp. When we contacted those who did not attend to ask why, only two responded, saying they chose other summer opportunities. Of the seven who attended the camp, five completed the first independent project, four completed the second independent project and two completed the third

independent project. All seven matriculated in college: four at TMCC (two in associate of science programs; two in associate of arts programs); one at Minot State, Minot, ND University in a bachelor of arts program; and, one at University of North Dakota in a bachelor of arts program.

When each participant presented his/her website portfolio [Independent project #1] at the beginning of the second session, it was apparent that many of the participants had not engaged strongly with the portfolio. In retrospect, there was a disconnect between the focus of the first face-to-face session and the first independent project. While participants were provided with instruction on their portfolio, the first session did not allow adequate time for participants to engage with class material in order to prepare and start working on the first independent project. A suggested revision to the independent project would be to focus more on asking participants to expand their "Trash Math" project and to omit one or more of the other portfolio components. The authors believe that shifting some of the focus back onto the "Trash Math" activity might prove beneficial in helping the participants to better scaffold their learning to subsequent independent projects and also allow for greater participant autonomy, which would in turn build participants' confidence and independence.

The discussion panel, composed of six AI engineering professionals from the Turtle Mountain community, offered participants a chance to interact with STEM professionals from their community. According to the panel members, cultivating and nurturing a support system of individuals with similar goals and broad experiences is one of the most critical factors to long-term success in an engineering (or any) STEM degree program. When discussing career success, panel members stressed the importance of internships, networking, goal flexibility, and organization.

During the engineering session, there was a nearly equal split between the number of participants who chose to construct the cube and those who chose to 3D print and assemble the wind turbine (three working on the cube and two on the wind turbine). During independent project #2,participants who worked on the 4x4x4 LED cube project were able to produce a fully functional device, but those who attempted the wind turbine were not as successful. This may have been caused by the participants' unfamiliarity with the 3D printing software/hardware, inadequate supplementary instruction material, and/or the complexity of the device (an intermediate level project). The purpose of the second face-to-face session was to prepare the participants adequately for their independent project, and in retrospect, more hands-on experience with the hardware/software is necessary for participant success. Future individual engineering projects should start with a simpler model that could be upgraded to a more advanced design for participants that are more skilled. The authors believe this shift in philosophy would boost participant success and self-efficacy, as they would be more likely to construct their initial device successfully.

Instructors asked the three who successfully constructed the 4x4x4 LED cube to propose modifications to the design that would improve the device. Participants integrated their design modifications either by creating an entirely new cube or by reworking their existing structure. All three participants were able to produce functional modified cubes.

Two participants gave a PowerPoint® presentation of his/her research project to demonstrate what he/she had learned during the entire bridge camp. Although just two of the participants did final presentations, it was a meaningful experience for each, especially since their parents attended the event as well, and the instructors had a chance to talk with the parents and get their feedback on the camp.

Bridge Camp Summary and Future Direction

The authors piloted a ND EPSCoR NATURE bridge camp at TMCC during the summer of 2019. The authors wanted to prepare participants for college in a manner that would also get them excited about and interested in pursuing a STEM degree and career. The structure of the camp consisted of face-to-face sessions and three independent projects aimed at developing a mindset that will ultimately help participants succeed in college. Each independent project built upon knowledge gained during that face-to-face sessions and previous independent project(s). The authors believe this systematic process of progressively giving the participants more responsibility and less instruction over the course of the camp helped to promote the self-reliance and critical thinking skills of the participants. The authors also believe that this enhancement of knowledge and skills will be a necessary component for all future bridge camps developed by ND EPSCoR. ND EPSCoR is planning to conduct four bridge camps during the summer of 2020 and will continue to refine the camp and track participants throughout their academic careers. In subsequent research, in an effort to determine the overall impact of these camps, ND EPSCoR will compare the college matriculation rates of the bridge camp participants to the college matriculation rates of all AI high school graduates in ND.

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