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Integrating Context and Authenticity to Increase Pre-College Engagement through the STEM Academy for Renewable Energy Education

[1]Lisa B. Bosman & [2]Kelli A. Chelberg

[1]Purdue Polytechnic Institute, Purdue University, West Lafayette, IN, U.S.A.
[2]Department of Education, College of Menominee Nation, Keshena, WI, U.S.A.

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Abstract: American Indian engagement in STEM undergraduate degrees remains limited, at best. One approach to increase minority interest and enrollment in STEM degrees is through culturally relevant pedagogy, incorporated into pre-college, high school level educational experiences. Due to the natural connection between American Indians and the environment, the authors set out to design a renewable energy focused learning experience for American Indian High School and undergraduate students. This paper outlines the development and assessment of the first STEM Academy for Renewable Energy Education offered to 10 students (7 High School students and 3 college level student mentors). The academy engaged students in a series of learning activities related to renewable energy, often based on a Problem Based Learning approach that encompassed STEM as well as the social sciences. Most activities had a small group and/or hands-on component, and embedded assessments were prevalent. The mixed methods assessment included surveys, a focus group, and facilitator observation. The findings provide considerable evidence that the academy made substantial progress toward its learning goals, including the fact that participating students found the experience to be very engaging, enjoyable, motivating, and rich with learning on new topics. The findings provide much insight into ways for faculty to engage both American Indian K-16 students in STEM topics through the context of renewable energy and sustainability.

Keywords: summer, mentoring, solar energy, pre-college, K-12.

Introduction

Educational outreach programs offered to K-12 students has become an integral component of STEM education in the United States (Bosman, Chelberg, & Fernhaber, 2017; Bosman, Chelberg, & Winn, 2017; Dika, Alvarez, Santos, & Suárez, 2016). The intended purpose of many of these STEM-related outreach programs is to pique interest and generate interest through the provision of hands-on activities which are significant first steps in the development of STEM interest (Bosman, Winn, & Chelberg, 2016; Hidi & Renninger, 2006; Winn, Bosman, & Chelberg, 2017); specifically for underrepresented populations. Dabney et al. (2012) found positive relationships between students' participation in extracurricular STEM activities and interest in STEM careers in college. Furthermore, Noam, Robertson, Papazian, and Guhn (2014) identified that through higher amounts (e.g. more time) spent in STEM opportunities through afterschool programs was associated with higher test scores in science as well as a higher self-reported interest in STEM disciplines.

In an attempt to close the curriculum and achievement gap and increase STEM interest, there have been many federal directives such as Next Generation Science Standards, Common Core State Standards, and Every Student Succeeds Act (ESSA) (Porter, 2016) designed to set standards and universal expectations

E-mail: lbosman@purdue.edu, kchelberg@menominee.edu

for all students. Additionally, there have been numerous program initiatives such as STEM Pathways, Project Lead the Way, Engineering by Design, and Engineering is Elementary (Mativo & Jae, 2012) that were created as a means of supporting teachers through the provision of the required understanding and skills needed to teach engineering and STEM related concepts.

Additionally, beyond K-12 educational initiatives, a few predominately white institutions (PWI) offer pre-college summer bridge programs that focus on underrepresented students (e.g. Villanova (NovaEdge Diversity), UW-Madison (WiscAMP), Ohio State (PREFACE), etc.) with an intent to deepen students understanding of science and math as well as engage them in research in areas of individual interest. The focus of these summer bridge programs is to introduce students to the rigor of college coursework and for students to spend time on campus giving them an opportunity to experience the college social setting while participating in a supportive smaller group setting (Tomasko, Ridgway, Waller, & Olesik, 2016).

Although STEM outreach and educational opportunities in K-12 settings has increased over the past decade (Honey, Pearson, & Schweingruber, 2014); there are commonly reported challenges that K-12 schools encounter when implementing STEM programming. Zuger (2012) found program funding as one of the most common, however, insufficient teacher professional development, inadequate K-8 education, lack of qualified teachers, and unclear best practices contributed to poor STEM outreach and educational opportunities for students. Furthermore, teacher preparation programs have been slow to respond to the need for preparing K-12 teachers to teach the necessary STEM competencies and skills in future classrooms.

More specifically, there is limited literature on STEM educational opportunities for AI students'. Through a National Science Foundation (NSF) Pre-Engineering Collaborative (PEEC) grant, Kant, Burckhard, and Meyers (2018), designed a program called STEAM (science, technology, engineering, arts, mathematics) Girls to explore whether culturally relevant experiential learning activities partnered with STEM and traditional AI crafts would increase girls interest in STEM studies and careers. Kant et al. (2018) findings suggests that providing culturally responsive STEM enrichment activities paired with traditional AI arts and crafts, might pique AI high school students interest in STEM studies and careers and may be one approach to addressing underrepresentation of AI students entering STEM fields. To provide a strong foundation in STEM education, K-12 schools must continue to promote STEM education learning opportunities for both educators and students alike.

American Indian (AI) students are severely underrepresented in science, technology, engineering, and mathematics (STEM) fields (National Science Foundation, 2018). According to 2018 NSF S&E Indicators report, from 2000 through 2013, of those earning a Bachelor's Degree, 1.2% of the degrees were earned by American Indians and Alaska Natives. However, of those earning a Bachelor's Degree in Science and Engineering, only about 0.68% of the degrees were earned by American Indians and Alaska Natives. In general, AI students come across greater challenges in obtaining undergraduate degrees and take longer to graduate than their peers (Cahalan et al., 2016; Keith, Stastny, & Brunt, 2016). Beyond the numerous barriers that are presented to AI students pursuing STEM in postsecondary settings (Keith et al., 2016), there is an underlying issue of poor STEM education during student's early education (K-12) years. As a result, students are not as prepared to learn STEM concepts (Gleason et al., 2010) and lack exposure to STEM careers (Tomasko et al., 2016) which lessens their desire to pursue STEM degrees. Furthermore, an achievement gap in STEM subjects can be observed as early as elementary and middle school as indicated on the National Assessment of Educational Progress (NAEP) in both Mathematics and Science (National Science Foundation, 2018). In general, as a result of limited STEM focus in

K-12 settings and current student achievement levels there is evidence that more needs to be done to ensure that students leaving high school are prepared to enter the STEM pipeline (Hayes, 2017).

Although many of the STEM focused educational outreach programs provide for development of STEM interests and skills for K-12 student's the literature is limited on STEM programs specifically designed to serve underrepresented and low-income populations. Furthermore, the challenge still remains that many rural school districts lack funding, resources, and teacher expertise to sufficiently run extracurricular programs (Zuger, 2012). This study seeks to provide STEM enrichment to AI students' living in a rural setting who come to the academy with limited STEM knowledge and who may come with deficiencies in their understanding and knowledge of basic STEM concepts and skills.

Additionally, the literature lacks connection to STEM programs that have been designed to provide cultural relevance to AI students' cultures and communities. Although recent research suggests the importance of culturally responsive and culturally relevant instruction there is scant literature on incorporating AI culture through community values (e.g. renewable energy, sustainability) into the curriculum and teaching methods of extracurricular STEM programming. This study seeks to incorporate community values and demonstrate relevance to the participants' daily lives through the construction of knowledge around renewable energy and the importance to students' traditional ways of knowing and doing.

Furthermore, many of the summer bridge programs provide on campus opportunities for students to explore campus and experience a bit of college life, however, in this study AI high school students will meet for a week-long academy in their hometown. For many students leaving the comfort of their communities, traveling, and spending several nights away from their homes presents a challenge. The week-long academy is designed to provide daily engagement and on-campus experiences in STEM but also allows for students to go home on a nightly basis. This paper aims to add to the knowledge gap by responding to the following research question: How does engaging in renewable energy focused STEM learning experiences increase interest in STEM for American Indian pre-college students?

Theoretical Framework

This project is grounded in Kearsley and Shneiderman (1998) engagement theory. Engagement theory is based on the premise that in order for students to be engaged it must be through meaningful and authentic project based learning activities while collaborating with others. Kearsley and Shneiderman (1998) identified three components that defines engagement theory: (1) Relate, (2) Create, and (3) Donate which implies that learning activities must (1) occur in a collaborative group context, (2) are project based, and (3) have an authentic emphasis. Although, Kearsley and Shneiderman (1998) believed student engagement was enhanced through the use of technology; engagement theory is consistent with both constructivist and learning situated approaches because it focuses on experiential learning and does not require the use of technology.

The first component "relate" emphasizes the efforts a group makes to collaborate; which involves planning, communication, time management, and social skills (Kearsley & Shneiderman, 1998). The benefits of collaborative learning relationships are highlighted by Kuh, Kinzie, Buckley, Bridges, and Hayek (2006). Their findings suggest that peer relationships and active learning in groups are essential for engaging learners. Moran and Gonyea (2003) examined the extent student-teacher interactions, peer interactions, and the quality of student effort contributed to students' perception of engagement. Peer interaction was the strongest predictor of student engagement and improved learning outcomes (Moran & Gonyea, 2003). Ahlfeldt, Mehta, and Sellnow (2005) found that student's levels of cognitive challenge, cooperative learning and student growth in personal skills were highly correlated and statistically significant when engaged with others during learning.

The second component "create" provides an opportunity for learning to become a purposeful activity in which students are required to define the project and focus their energy on applying ideas to a specific situation (Kearsley & Shneiderman, 1998). Kuh et al. (2006) found that teachers who provided active learning experiences for their students promoted student engagement. Notably, Redmond et al. (2011) recognized that a project-based learning framework was found to provide students with authentic learning experiences that may allow for increased persistence in the STEM pipeline by increasing student awareness and interest. Allowing students an opportunity to construct their own knowledge and investigation of meaningful problems through project-based learning promotes a deeper understanding and increased competence (Hall & Miro, 2016).

The third component "donate" emphasizes the importance and value of students' making a useful contribution or authentic focus while learning (Kearsley & Shneiderman, 1998). The results of a study conducted by Zarske (2012) found that by providing service-learning contexts within project-based engineering courses there was a positive impact on targeted underrepresented populations of high school and undergraduates students attitudes toward community service. Based on Zarske (2012) results education and professional development opportunities should consider using project-based service-learning engineering design opportunities to improve students' understanding of engineering as well as demonstrate relevance of engineering to diverse student populations.

Specifically, Bouvier and Connors (2011) research indicates best practices that should be used to increase K-20 students' interest in STEM. These best practices align with Kearsley and Shneiderman (1998) engagement theory: (1) critical thinking, small group work, and collaboration, (2) content connected to real-world application involving hands-on learning, (3) participation of caring adults, and (4) opportunities to participate in STEM activities.

In keeping with engagement theory, one might maintain that collaborative engagement through authentic project-based learning activities is one way in which students develop an interest in STEM disciplines and career fields. As a result, student participation in a renewable energy STEM academy may increase pre-college American Indian student's interest and positive attitudes towards STEM fields and careers.

Methods

The Academy was offered for 1 week in August 2014, meeting for about 6.5 hours per day. Lunch was provided, and participants ate together, allowing for informal interaction between sessions. The academy was held at minority-serving college campus in the Midwest. Transportation was provided for approximately half of the High School students and 2 of the college students. The study deployed a multiple method design that included pre- and post-surveys, observation and a focus group. A Human Subjects protocol was approved by the College of Menominee Nation IRB. Students under 18 years of age participated only with parental informed consent and by their own informed assent.

A. Academy Design

The STEM Academy for Renewable Energy Education was designed with an emphasis on the three main components of Engagement Theory (Kearsley & Shneiderman, 1998). First, the week-long academy was design to ensure the majority of activities were completed in a group context with collaborative teams. Each of the small group activities were led by near peer mentors (undergraduate students) and included regular positive feedback from the session instructor. Second, all activities were grounded in project-based experiences, with an intentional focus on active learning, problem-based learning and experiential learning. Lastly, the activities promoted an outside and authentic focus through the use of culturally relevant topics, specifically through the context of renewable energy and social justice. The academy had 4 main objectives.

1. Engage High School students in learning about renewable energy from a STEM as well as social science or public policy perspective.
2. Introduce High School students to college faculty and college students involved in STEM coursework and engage students in college-level learning experiences in order to enable High School students to appreciate and gain comfort with the nature of college-level work.
3. Make students aware of and favorable toward participating in college level courses for which they would receive advance college credit at no direct cost while also counting toward High School graduation.
4. Promote student interest in and favorable attitudes toward attending college, especially to study STEM, including renewable resources and sustainability, at a local college.

The Academy was designed with a strong interdisciplinary element. One factor in this was the inclusion of facilitating instructors from various sub-disciplines (e.g., Physics, Biology, Engineering, Climatology, and Hydrology). Instructors were able to quite appropriately draw upon their respective sub-disciplines to approach renewable energy in somewhat distinct ways. In addition to visiting sub-disciplines within the physical sciences, mathematics, and technology, instructors regularly addressed renewable energy from a social scientific perspective. Frequent topics included economic considerations in renewable energy; social impacts of energy production, distribution, consumption, and by-products such as carbon emissions; and a multiple-stakeholder perspective on political processes related to renewable energy. Several instructors engaged students extensively in considering the implications of renewable energy specifically for indigenous peoples. Each day of the academy was divided into morning and afternoon sessions, as shown in Table 1.

B. Participants

Seven High School students participated in the academy, with only 1 student missing 1 day. Three of the students were male, and 4 were female. The group included 2 students from Grade 10, 1 from Grade 11, and 4 from Grade 12. All 7 participants were American Indian. The number of participants was less than had been anticipated. As of the week prior to the academy there were 15 students signed up. Possible implications of low turnout for recruitment strategies for future events of this kind are discussed elsewhere. Three college students served as near peer mentors, engaging with the High School students as co-learners. All 3 college students were American Indian; 1 male and 1 female student were enrolled in the engineering program, and 1 male from the sustainability program. The academy enrolled the assistance of 9 facilitating instructors. A different instructor lead each session (as shown in Table 1), except Thursday, when the same instructor led both sessions. Of the 9 facilitators, 7 were college-level faculty or staff, and 2 came from external organizations involved in renewable energy. Areas of expertise represented by facilitators included Engineering, Physics, Statistics, Sustainability, Geography, Solar Power, Bioenergy, Education, and Technical Writing. Three facilitators were female, and 6 were male; two facilitators were of American Indian.

TABLE 1. STEM Academy Overview

Day/Time	Session Topic
Monday A.M.	Geography and Renewable Energy
Monday P.M.	Energy Enigma
Tuesday A.M.	Science of Solar Energy
Tuesday P.M.	Biofuels and Biomass
Wednesday A.M.	Excel and Statistical Analysis of Solar Energy Systems
Wednesday P.M.	Wind Power
Thursday A.M.	Word and Writing Science Lab Reports
Thursday P.M.	PowerPoint and Poster Development
Friday A.M.	Physics of Energy
Friday P.M.	Sciences Activities and Trivia

C. Pre- and Post-Survey

The High School student participants completed a 13-item survey at the beginning and end of the academy to measure the effects of academy participation on student interests, values and attitudes toward STEM, renewable energy, and climate change. Of the 7 High School students who attended the Academy, 6 completed the Pre- survey, 6 completed the Post- survey, and 5 completed both. The survey, Student Attitudes towards STEM (Faber et al., 2013), had items which used a Likert scale response options. Note that the wording of items differed slightly between the Pre- and Post-treatment versions. The main changes were the substitution of the term “STEM” for “Science” in items a-h, and “Native American” for “tribal affiliation” in Items h-l, and the wording of the climate change items (m-n). It seems unlikely that these wording changes had a major impact on student responses, but there is no way to be certain.

D. Observations

The researchers opted for an unstructured approach to observations, as this was the first time an Academy of this kind was conducted. Initial efforts at innovative instruction are typically characterized by surprises and adjustments that tend to make it very difficult to anticipate appropriate features of a highly structured observation instrument. An overly structured observation protocol might well have interfered with the researcher’s attention to such considerations.

E. Focus Group

On the last day of the Academy, a focus group was conducted with six of the High School student participants and the three college students (near peer mentors). The interview was audio recorded and transcribed for analysis. In summary, the following general areas were addressed:

- Suitability of the learning spaces and equipment,
- Academy location,
- Major learning takeaways,
- College students and High School students working together,
- Comfort with instructors and college-level work, and
- Academy impacts on interest in college, college STEM coursework, and STEM careers.

Analysis and Results

Specific documents used in the analysis included quantitative data and qualitative data. The quantitative data resulted from the pre- and post-survey. The qualitative data included observations and a focus group.

A. Pre- and Post-Survey

In view of the small sample size, it is not surprising that no statistically significant changes were observed in student responses from Pre- to Post-academy surveys. Despite the absence of statistically significant changes, there were some items that trended in a positive direction and are therefore noted in presenting findings about various aspects of the academy.

B. Observations

Except for two students each of whom missed 1 day, all students attended all 5 days of the Academy. Students displayed on-task behavior the vast majority of the time during instructional activities. Students participated extensively in whole group discussions, frequently providing correct answers to instructors' questions about topics and ideas addressed earlier. Students participated actively by frequently contributing their own questions, comments, and observations. This resulted in a frequent two-way conversation instead of uniformly high levels of one-way teacher talk of the sort that is often an indicator of low student engagement. The overall tenor of sessions was relaxed but productive. Facilitators were consistently respectful of students and responsive to their individual needs and questions. Most session facilitators explicitly incorporated consideration of how renewable energy related to indigenous peoples, including Native Americans and the Menominee Tribe. Students were likewise respectful of instructors, asked good questions during activities, and expressed appreciation for instructors' efforts.

College students worked alongside High School students as co-learners and mentors through the entire academy. The rapport between the College students and High School students was excellent. College students provided the High School students with personalized support to succeed with challenging tasks during small group activities, role models for how to work in a college setting and mentoring to encourage their best effort in the task at hand, and to seriously consider attending college, possibly to study for a career in STEM. College students provided such support while explicitly embracing their tribal identity and articulating the importance of the issues addressed in the academy to the tribe's future well-being.

The academy implementation can be summarized through patterns of practice evidenced in Table 2. In the table, an "H" indicates and area that received relatively high emphasis during the relevant session. An "M" indicates moderate relative emphasis, and an "L" is used to denote low but significant emphasis. A blank cell indicates little or no emphasis on the dimension of practice during the session. Overall emphasis is calculated by assigning a value of 3 to High, a 2 to Moderate, and a 1 to Low emphasis, and summing for the row.

Renewable energy and related technology were the primary STEM topics addressed in the academy. A STEM perspective on renewable energy was consistently combined with a social scientific or public policy perspective to encourage students to view technical knowledge about renewable energy not as an end in itself, but as a resource for addressing important human needs and societal challenges.

Instructional time was split fairly evenly between whole group and small group activities. Whole group activities were dominated by discussions that actively involved students. Instructors did some "lecturing" (i.e., engaged in episodes of largely uninterrupted teacher talk lasting from one to several minutes) in order to lead into and inform subsequent group discussion. Small group work emphasized hands-on activities in which students used computers, manipulatives, and scientific instruments to explore and gain insight into a range of renewable energy phenomena and issues.

Activities were well balanced as to relative emphasis on cognitive demand categories—that is, the types of cognitive tasks students were asked and expected to do. Communicate understanding, and Make Connections received the greatest emphasis, with other types of cognitive tasks often done so as to support communicating understanding and making connections. When Making Connections came to the fore, the emphasis was almost exclusively on students making connections between science content knowledge (e.g., renewable energy production) and real-world situations (e.g., criteria for siting renewable energy technology for optimum efficiency or economic return; trade-offs between energy production and carbon footprint). Students were rarely asked to make connections of the kind that involved extensive synthesis and integration of scientific facts, procedures and concepts within or between sub-disciplines. This is also reflected by the emphasis on the Explore dimension in the Instructional Model domain. Having students get substantially into the Elaborate and Evaluate phases of learning would have involved, for example, the kind of synthetic thinking involved in making connections through high-level synthesis and integration of knowledge.

The emphasis of the academy on exploration and discovery was associated with no rigorous summative student assessment, but embedded assessments were used throughout. Students did not receive grades or scores on embedded assessment tasks, but often received feedback that enabled individual students to gauge the extent to which they understood a given question or task.

B. Focus Group

The group interview yielded much valuable information, most of it reflecting positively on the academy design and implementation. By the time of the interview students had been working together closely all week long and had interacted a good deal with the evaluator. This may have accounted for the great extent to which students seemed forthcoming, constructive and interpersonally supportive during the interview.

The inclusion of the College students and the way in which their role was structured appeared to have encouraged High School student engagement in several ways. Although the High School students may have been just as inclined to engage productively on their own, it is also possible that having a slightly older member of the community there to lead by example fostered deeper engagement.

High School students reported that the College students helped them work through tasks they did not initially understand. College students were observed commenting positively on High School students' efforts and even applauding when students presented the fruits of their labor at the end of some sessions.

College students also exemplified the attitudes and behaviors of college students who are deeply engaged in STEM studies and applying STEM knowledge and skills to their lives and that of their community. Examples included the following comments from College students:

"I read a book about embracing the 'end of oil'. We're going to have to foster creativity to find solutions."

"We had a proposal from an energy company to do an energy project for wind and water and they told us how little they would charge us. We said, "Why don't we just build it ourselves and then charge you?" That's one of the things I'm looking at. We have 2 hydro dams on the reservation. If we get power from them it might power the entire reservation."

"I just want to tell all of you, don't stop here when it comes to the STEM field. I never liked math and I've never been good at it. But I'm going to try it at College and hopefully I'll be good at it."

"People are always talking about STEM. I wish it was STEMS—Science, Technology, Engineering, Math, and Sustainability."

During the group interview students offered feedback on other aspects of the academy that fostered or impeded participation and engagement. Comments about helpful features included:

"I liked that we got snacks in the morning. I'm not a morning person at all. I like to have a snack to help wake up and be more creative."

"Driving back and forth from the home site to the Academy was a plus for the College students who already spend a lot of time at Keshena. High School students appreciated the chance to interact informally with the College students on the van ride."

"The classrooms were great, including the computer lab."

"The instructors were great and came with interesting and fun activities for the students."

In general, students found the hands-on activities especially engaging. Students had all the science equipment they needed to make activities interesting and informative.

The academy was "comfortable", "fun", "collaborative", and involved much enjoyable "teamwork".

Comments about things that might have been done differently or better included:

"For group discussions sit in a horseshoe so everyone can see everyone else. Don't sit so people are talking to your back."

Several students said they had trouble attending to the one instructor who engaged in a couple hours of teacher-centered talk at the beginning of one session. However, at least 2 students also said they found it very interesting. Two of the students who had been bored by the session segment that was heavy on teacher-talk said the session got interesting when the instructor turned to using various types of equipment and materials to demonstrate numerous principles of the physics of energy.

"I think the Energy Enigma activity (done Monday afternoon) should have moved to the end because I have trouble arguing with people I don't know well yet."

Students wished they had had ready access to a printer, so they could keep a hard copy of the computer documents they created.

"What frustrated me was when [instructor name] came and we didn't even get to use our paper. We didn't get to share it. I worked 3 hours on it and we didn't get to read it aloud or something." (Others shook their heads in affirmation).

The last point above is possibly the most important one that students made about things to do differently in the future. In each of the 4 sessions in which students were expected to produce a significant specific product (e.g., a report, an excel spreadsheet, a PowerPoint, a solution to a complex problem) the evaluator observed that students tended to need more time than they were allotted. One consequence of bumping into time constraints was that work activities cut into time that instructors had expected to have students for students to share out and get feedback on their work.

Discussion

A. Collaborative Teams and the Judge-Free Zone

While completing group work, the students appeared to interact in such a relaxed and mutually supportive way while staying focused on learning. Academy small group work was free of disruption from students who were not committed to the learning opportunity or approached it in an individualistic, competitive way that sometimes happens and undermines group learning. In the group interview, students indicated that one of the things they liked about the academy was its "judge-free" environment. The high level of inter-personal respectfulness that fostered their engagement was observed repeatedly in small group and whole class activities alike.

This notion of acceptance, collaboration, and team development is in alignment with student identity and belonging documented in the literature. Student beliefs and identity, in comparison to performance and competence, significantly influence student decision to enroll in STEM programs (Godwin, Potvin, Hazari, & Lock, 2016), and retention and persistence (Tonso, 2014). On the other hand, the "chilly climate," reported more often by women and minorities in STEM programs, can result in perceptions of isolation, self-doubt, and lack of student belonging (Lichtenstein, Chen, Smith, & Maldonado, 2014). In summary, when designing and implementing STEM recruitment and learning experiences, educational institutions should be intentional towards creating an inviting and welcoming environment for historically underrepresented students (Bosman, Chelberg, & Duval-Couetil, 2019; Chelberg & Bosman, 2019; Guillory & M. Wolverton, 2008; R. M. Guillory & M. Wolverton, 2008).

B. Project-Based Learning

Students responded very well to hands-on activities. Observation and student self-reports indicated that students were equally highly engaged in hands-on activities that involved physical manipulatives and scientific instruments as they were in activities involved student use of computers and tools such as Excel. Most hands-on activities were designed and experienced by students as opportunities for exploration rather than needing to strictly follow or reenact someone else's procedures. Students had many opportunities to engage in minds-on as well as hands-on exploration because they attended to instructors' substantive concerns instead of merely playing with stuff. Most hands-on activities were done in small groups that typically included one College student and 2 or 3 High School students. The small group work was characterized by exceptionally high levels of cooperation, mutual support, and the active exchange of ideas. Teamwork was evident throughout and students explicitly cited as an important aspect of their experience.

This notion of active learning, experiential learning and student engagement is in alignment to the literature. Specifically, research has shown the benefit to American Indian students towards STEM recruitment and persistence when engaging with the STEM children's book writing process (Bosman, Chelberg, & Fernhaber, 2017), game playing (Miller, Doering, Roehrig, & Shimek, 2012), technical instruction and hands-on learning (Schmidtke, 2009), STEM clubs and science fairs (Sahin, 2013), and service learning (Bosman, Chelberg, & Winn, 2017)

C. Authentic Focus

For decades research on teaching and learning has recognized that student engagement is often enhanced when it addresses culturally relevant topics. As noted previously, instructors recognized and encouraged students to explore how renewable energy issues played out in the local contexts of different indigenous communities. Instructors who did not put the implication of renewable energy for American Indians at the center of their session still frequently noted how certain points related specifically to indigenous peoples.

Developing authentic and culturally-relevant instructional materials is in alignment with the literature. Due to the natural connection between American Indian values and the environment, the context of renewable energy allows for an easy way to engage American Indian students into the STEM disciplines. Research related to STEM engagement through renewable energy is established within the literature (Bosman, Chelberg, & Strimel, 2018; Dalbotten et al., 2014; Lowan-Trudeau, 2017). Noteworthy additional contexts for STEM engagement are traditional ecological knowledge (Charnley, Fischer, & Jones, 2007; Ignas, 2004) and place based learning (Bang, Medin, Washinawatok, & Chapman, 2010; Riggs, Robbins, & Darner, 2007).

Conclusion

A. Summary

In conclusion, the academy provided students with opportunities to learn a broad range of knowledge and skills related to the topic of renewable energy from the perspective of STEM disciplines, the social sciences, and other areas such as English Language Arts and Reading. The multidisciplinary perspective of the sessions also gave students the opportunity to better understand the interplay of basic scientific phenomena such as climate change and human social behavior and needs. The sheer breadth of content addressed in the academy made it difficult to capture systematic measures of student learning, although ample evidence of student learning emerged as the sessions unfolded. However, students perceived that they learned a good deal. Students felt comfortable with CMN faculty and became comfortable with engaging in college-level STEM learning activities despite being apprehensive at the outset. Students emerged from the academy with favorable attitudes toward pursuing STEM college learning and STEM careers.

B. Future Learning Experiences

Future pre-college learning experiences will investigate methods to better capture systematic data on student learning. Furthermore, tasks that include embedded assessments will be designed so that students have time to complete them. A greater focus on backward course design will allow the assessments to drive the lesson plans. Future experiences will continue to provide students with opportunities to explore, discuss, and learn about the interplay of STEM and social scientific knowledge for understanding the real-world challenges and needs of humans and their biomes. Also, future experiences will continue to build student skills in literacy and knowledge of productivity tools such as Excel and PowerPoint during STEM activities. However, modifications will be made to build a clear conceptual flow into activities that span multiple lessons or sessions, then using the conceptual flow as the primary guide for backward planning.

C. Future Research

Future research will have an increased focus on reliable assessment methods for garnering student learning outcomes data. To this end, there should be more precision in matching student survey items with the specific intended impact of activities on student beliefs, interests and attitudes. Furthermore, there should be more discussion of instructional design on the front end to provide clear guidance to evaluation design and instrumentation. In addition, the results of this study need to be supported by more research on a bigger sample. Lastly, the researchers will continue to investigate the role of culturally responsive pedagogy for K-16 American Indian students with a particular focus on the development and adaptation of instruments to better assess the efficacy of culturally responsive instruction.

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