# Engineering Connections in a Native American Community and Culture

**Ieshya Anderson, Arizona State University**

Ieshya Anderson is Naakétł'áhí (Tohono O'odham), born for Tł'ááshchí'í. Her cheii is Naakétł'áhí and her nálí is Tódích'íí'nii. Ieshya graduated from Arizona State University, Ira A. Fulton Schools of Engineering with a Bachelor of Science in Engineering, emphasis in electrical systems. She is pursuing her PhD in Engineering Education Systems and Design at Arizona State University. Ieshya also continues to work with Dr. Shawn Jordan to develop engineering design curricula for middle school students on the Navajo reservation and facilitates Dr. Jordan's STEAM Machines™ outreach camps across the Navajo Nation with the ambition to expand to Tohono O'odham Nation.

**Dr. Shawn S. Jordan, Arizona State University**

SHAWN JORDAN, Ph.D. is an Associate Professor of engineering in the Ira A. Fulton Schools of Engineering at Arizona State University. He teaches context-centered electrical engineering and embedded systems design courses, and studies the use of context in both K-12 and undergraduate engineering design education. He received his Ph.D. in Engineering Education (2010) and M.S./B.S. in Electrical and Computer Engineering from Purdue University. Dr. Jordan is PI on several NSF-funded projects related to design, including an NSF Early CAREER Award entitled "CAREER: Engineering Design Across Navajo Culture, Community, and Society" and "Might Young Makers be the Engineers of the Future?," and is a Co-PI on the NSF Revolutionizing Engineering Departments grant "Additive Innovation: An Educational Ecosystem of Making and Risk Taking." He was named one of ASEE PRISM's "20 Faculty Under 40" in 2014, and received a Presidential Early Career Award for Scientists and Engineers from President Obama in 2017.

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Abstract

This Research Work in Progress investigates Native American perspectives regarding community and cultural connections to engineering.

Effective problem-solving for issues the world is facing involves generating diverse solutions. These diverse solutions need to include Native American perspectives. Native Americans are among the most underrepresented minority (URM) population in STEM fields in the United States, and yet little is known about why so few Native Americans choose to pursue higher education and careers in STEM fields. Recognizing that community and culture help shape students' academic and personal development, it is important to consider how community and culture regard and experience the field of engineering and the role(s) that engineering could play within the community.

This study is a work in progress which will seek to answer the research question, how do Tohono O'odham community members perceive engineering in the context of their culture and community? In this article, I will present the framework, methods, procedures, data collection, and preliminary findings.

Through the lens of social constructivism, this qualitative study will explore how Tohono O'odham community members experience the intersection of engineering and Tohono O'odham culture and community. Data for this research study will be based on the perspectives provided by three Tohono O'odham adults using semi-structured interviews. An iterative process of peer reviews, memoing, and coding will be used for interview transcript analysis. Utilizing In Vivo and Concept mixed methods coding, the data will be analyzed for any emergent themes and/or categories. Results from this research study could be used to inform culturally-relevant engineering lessons for schools that serve Tohono O'odham students and point to directions for further research.

Introduction

It has been recognized the U. S. must find ways to diversify and connect the next generation to STEM fields (U.S. Government Accountability Office, 2005, National Science Foundation, 2014). Part of the next generation includes Native Americans whom have been among the most underrepresented population in the fields of STEM (Stevens, Andrade, & Page, 2016). Although there are programs to support NA/AN inclusion in STEM, it is imperative to first understand how Native cultures relate to STEM. This insight could provide strategies for relevant and effective lessons fostering a positive engagement to STEM among Native students.

This Work in Progress research builds upon an approach for "culturally sustaining pedagogy" through "community-based educational accountability that is rooted in Indigenous education sovereignty" (McCarty & Lee, 2014, p. 101). This approach considers the unique position Native Nations hold in terms of sovereignty, language, social class, and self-determination. Since community is a strong factor in Native culture, the community (elders, parents, community members) is an integral part of student identity. McCarty and Lee point out that Native communities encourage their youth to attain education as a pathway to become leaders with traditional knowledge and formal education for the benefit of the community. In support of this,

culture specific understanding must be considered as the engineering education community seeks to broaden participation among Indigenous people.

## Purpose Statement

The purpose of this work in progress research project is to understand how Tohono O'odham community members perceive engineering. Because community shapes the education of students on both an academic and personal level, it is important to understand how the community views engineering. This work in progress study also serves as groundwork for understanding how the Tohono O'odham community's perception of engineering can influence the development of culturally contextualized lessons in engineering. Given this, findings have the purpose of helping provide insight for further research direction of culturally contextualized STEM curricula for Tohono O'odham students. The research questions guiding this work are:

RQ1: How do Tohono O'odham community members perceive engineering in the context of their culture and community?
RQ2: How do Tohono O'odham community members connect to engineering in their daily lives?

## Conceptual Framework

This study will be conducted using a social constructivist epistemology. This theory of knowledge supports the idea that knowledge is constructed by a community in a social and cultural context (Prawat & Floden, 1994). Individuals of that community are influenced by one another and their environment to form knowledge and understanding. Therefore, meaningful learning happens when individuals of a particular community interact in social activities (McMahon, 1997).

Currently, there is little to no literature on Tohono O'odham perspectives connecting community and culture to engineering. Even zooming out to consider other Native American cultures' perspectives connecting with engineering still yields little investigation in this area. Powers (2006) reports on cultural programming's larger direct and indirect effect on those students more strongly affiliated with their native culture. While Powers' study captured a snapshot of participant perspective through surveys, there is still a need to develop a deeper understanding of cultural connections. It must also be noted this finding is in the context of urban American Indian students, not students living in Native Nations.

Bradly (1987) conducted work in the same realm of culture-based education for Native American students by investigating the use of culture in teaching mathematics. This work introduced the idea of "identity accomplishment confusion," where culture compromises the learning of fundamental skills. Although this report provides examples of how teaching methods (e.g., peer learning) have had positive results in teaching fundamental mathematics among Native American students, it concedes that culturally infused methods have not been evaluated. This study also acknowledges Native Americans cannot and should not be homogenized due to various environments, and differing cultures. My work will not only illustrate the differences between cultures but it will also contribute the literature of STEM and Tohono O'odham connections.

Researcher Role

My life experiences and beliefs shape my research role. I am a Tohono O'odham woman, born for the Diné. I grew up on the Navajo Nation and was always encouraged to seek higher education. I am a first-generation college graduate, an engineer, an engineering education PhD student, and a mother.

My family and Native community had been my biggest supporters in seeking higher education. I have experienced tribal leaders and elders encouraging Native students to pursue education for the purpose of helping Native people, community, and culture. This sentiment is one that has resonated with me. It drives me to find ways to connect the next generation to STEM and higher education. Therefore, the prospect of supporting and strengthening tribal schools is a big motivator for me.

My involvement in an ongoing study titled, CAREER: Engineering Design Across Navajo Culture, Community, and Society (Jordan, 2015) inspired me to explore Tohono O'odham cultural connections to engineering. Although I will draw from my experience, I must allow any Tohono O'odham connections to emerge without imposing results from my involvement in Dr. Jordan's study.

The relationship I would like to foster with my research is one of mutual respect and collaboration among Native community and researcher. This partnership position encourages open dialogue and allows alternative perspectives to be heard.  The partner relationship is important because it allows the culture and community to have a voice in the research on different levels.

I must be conscious of my views on science. It has been my experience that science provided answers and explanations where traditional teaching did not. I must be cognizant of my perspective. Especially in situations where traditional knowledge conflicts with aspects I want to investigate or in the framing of my research questions and data analysis. In these situations, I must always concede to traditional knowledge.

As a member of the Tohono O'odham Nation, I have a unique relationship to the participants and community. Although I am a tribal member and have roots in the Tohono O'odham community, I did not grow up in the Tohono O'odham culture. I must be perceptive to my limited understanding and knowledge of local and cultural nuances. Follow-up questions and/or participant review iterations with Tohono O'odham community advisors may help clarify or enhance understanding.

Methods

This work in progress research is grounded in the theoretical framework of social constructivism (Vygotsky, 1978). The interpretive perspective this work aligns with asserts knowledge and meaning are based on an individual's interpretations (Gephart, 1999). Structured using a phenomenological approach this research explores how individuals experience a specific phenomenon (Van Manen, 1990; Creswell, 2016). Using this approach, it is important to

acknowledge context is a major factor in how the phenomenon is experienced. This research also acknowledges individual's experiences shape how they perceive, assume and understand the phenomenon.

Data Collection

The Tohono O'odham Nation is comprised of 11 districts: Baboquivari District, San Lucy District, Chukut Kuk District, San Xavier District, Gu Achi District, Schuk Toak District, Gu Vo District, Sells District, Hickiwan District, Sif Oidak District, and Pisinemo District. As of 2016, the Tohono O'odham have a total of approximately 34,000 enrolled members.

Three participants (1 male, 2 female) were recruited from personal and professional contacts. There were no incentives offered to participate in study. These participants are members of the Tohono O'odham tribe who grew-up on the Tohono O'odham Nation. All three individuals currently work and reside outside the Tohono O'odham Nation. The participants are adults over 18 years old from various age groups and professions.

One-on-one semi-structured interviews were conducted off the Tohono O'odham Nation. These interviews were transcribed and all participants were assigned pseudonyms.

Interview Questions

As stated above, the one-on-one interviews were comprised of semi-structured interview questions to encourage discussion and capture ideas in the participant's own words. Interviews were allotted for approximately 60 minutes per participant. Below is the list of interview questions:
1. Can you tell a little bit of the history of the Tohono O'odham?
2. How would you describe your community?
3. When you hear the term "engineering", what are your thoughts?
4. When you say (*insert participant thought about the term "engineering" here*), why do you suppose that is?
5. What are some examples of engineering in your Tohono O'odham culture?
6. How do you see engineering influencing your community?
7. In your youth, what were your interests in school?
8. In school, what values were taught?
   In the community, what was important?

Analytical Procedures

Dedoose software was utilized for general analysis which involved various coding techniques (In Vivo, Concept) that seek to draw out varied meaning from participants as well as reduce or "lump" this meaning into more refined categories and themes (Saldaña, 2013). The general analysis of the data includes three stages of data analysis (preliminary, secondary, and final). I am currently in the final stage of data analysis.

Preliminary Data Analysis: This phase included transcribing data and first cycle coding, where initial codes were generated. Guided by the motivation to stay close to participants' own words, the chosen approach for first cycle coding was In Vivo coding. In Vivo coding captures

participant words and phrases specific to their culture which may provide insight to their worldviews (Saldaña, 2013). Each code was used to help to define categories. These categories will be based the participants' rituals, rules, roles, and relationships as suggested by Saldana's "five Rs" (Saldaña, 2013).

Secondary Data Analysis: In this phase, the transcripts are reread and concept coding will be implemented as second cycle coding. Concept coding looks beyond tangible or observable aspects to ideas and meaning. Building on In Vivo coding which allowed the data to stay close to participant's own words, concept coding will capture the "read between the lines" data. This will add another dimension to my understanding of the data. Analytical memos will play in important role to organize and condense codes. At this stage, themes may start to develop.

Final Data Analysis: At this stage of data analysis, codes are refined and themes are defined. Strategies will include FRAMES (Focal sentence, Rich thick description, Analysis, Meaning, Expansion, and So what?) and Codeweaving (Saldaña, 2013). FRAMES is a technique which forms an aggregate statement to develop toward theory to explain a phenomenon. Codeweaving a technique which seeks to connect key codes in a narrative or process which may illuminate themes.

Validity

It is impossible to separate the researcher's bias during the data collection and analyzation process. Instead, I strive to be self-aware and conscious of my bias thereby affording me an opportunity to monitor my subjectivity (Peshkin, 1988). To minimize researcher bias, I am employing iterative peer reviews as well as member checking to address researcher bias and protect the trustworthiness of the study (Creswell, 2016). Peer debriefing will include fellow student researchers, faculty advisors, and peer-faculty group meetings. Peer debriefing works to relate one's research conclusion to a peer more distant from the data to explore alternative conclusions that may have been overlooked. Built-in probing interview questions and/or respondent validation, in which the participant is asked to elaborate or confirm their position, is another way to mitigate misconnections (Maxwell, 2013). In unforeseen situations where traditional knowledge may conflict with the research, community, traditional, and cultural sensitivities will be respected and supported.

Memo writing is serving to track the analysis process which would support repeatability and provide additional context to the data. The memos will also capture researcher reflections and decision-making processes during analysis. The memos may also provide details about the community and participants.

Preliminary Results

This work in progress is transitioning from secondary to final data analysis. At this point, there are five categories which will help develop themes for this research. One category links engineering as a cultural strategy to survive. Another category points to engineering as a process for community development. A third category maps Tohono O'odham values to engineering

design traits. Two other categories are not directly associated to engineering but rather to community self-perceptions as a result of engineering impacts.

Significance

Qualitative research provides rich descriptive data on a fraction of a population and is not generalizable to the population. The value is gaining understanding through the perspective of individuals in the population. The outcomes gained from the 3 Tohono O'odham community members is not only significant for providing insight to Tohono O'odham community views on engineering but it also helps build a background for future work in connecting Tohono O'odham students to engineering. Given there is a void in research and literature on how Tohono O'odham students culturally connect with STEM, this research will not only fill gaps in the literature but it may inspire more culturally sustaining pedagogy.

References

Creswell, J. (2016). *30 essential skills for the qualitative researcher*. Sage.

Gephart, R. (1999). Paradigms and research methods. *Research Methods Forum*, Retrieved from http://www.aom.pace.edu/rmd/1999_RMD_Forum_Paradigms_and_Research_Methods.htm

Jordan, S. (2015). CAREER: Engineering design across Navajo culture, community, and society. In Proceedings of the American Society for Engineering Education (ASEE) Annual Conference and Exposition (p. 26.329.1-26.329.19). Seattle, WA: ASEE Conferences. https://doi.org/10.18260/p.23668

Maxwell, J. (2013). *Qualitative research design: An interactive approach 3rd edition*. Sage.

McCarty, T., & Lee, T. (2014). Critical culturally sustaining/revitalizing pedagogy and indigenous education sovereignty. *Harvard Educational Review*, 84(1), 101-124.

McMahon, M. (1997, December). Social constructivism and the world wide web - A paradigm for learning. Paper presented at the ASCILITE conference. Perth, Australia.

National Science Foundation. (2014). Pathways to broadening underrepresented minorities. Retrieved from: https://www.nsf.gov/od/broadeningparticipation/PathwaysToBroadeningParticipationInResponseToCEOSE2011-2012Recommendation_Nov2014.pdf

Peshkin, A., (1988), In search of subjectivity-one's own. *Educational Researcher*, 17(7), 17-21.

Prawat, R., & Floden, R. (1994). Philosophical perspectives on constructivist views of learning. *Educational Psychologist*, 29(1), 37-48.

Powers, K. (2006). An exploratory study of cultural identity and culture-based educational programs for urban american indians. *Urban Education*, 41(1), 20-29.

Saldaña, J. (2013). *The coding manual for qualitative researchers*. Sage.

Stevens, S., Andrade, R., & Page, M. (2016). Motivating Young Native American Students to Pursue STEM Learning through a Culturally Relevant Science Program. *Journal of Science Education and Technology, 25*(6), 947-960.

Tohono O'odham Nation. (2016). The distribution of our population by district. [Data File]. Retrieved from http://www.tonation-nsn.gov/districts/.

Van Manen M. (1990) *Researching Lived Experience: Human science for an action sensitive pedagogy*. London, Ontario: Althouse