SMARTS – (STEM, Multiculturalism, and the Arts): A framework for the integration of cultural inclusivity in educational outreach utilizing the Renaissance Foundry Model

Payton Womack, Elementary Education, Mohera Narimelta, Chemical Engineering, Kellie Malone, Chemical Engineering
Advisors: A. Arce-Trigatti[1], P. E. Arce[2], S. Jorgensen[2], and J. R. Sanders[2]
In Collaboration between the College of Education[1] and College of Engineering[2]

Abstract

Research suggests integrating the arts into Science Technology Engineering and Math (STEM) curriculum is essential in the recruitment of an interdisciplinary workforce necessary to meet the challenges of the modern world (Segarra, Natalizio, Falkenberg, Pulford & Holmes, 2018). To enhance this initiative, attending to multiculturalism is the next step. Often the acknowledgment of cultural and historical narratives and considerations within academia, a field primarily dominated by interests of atypical western norms with only 22 percent of minority groups represented in the post-secondary setting, is overlooked. (National Science Foundation, 2017). Furthermore, to address this representation issue, the intentional integration of multiculturalism is essential.

The work presented offers insight through theoretical analysis into the preliminary stages of a service learning project born from the STEM Foundry Heritage Fellows (STEM FHF) program at Tennessee Technological University. By using the Renaissance Foundry Model (herein the Foundry) a team of student leaders worked iteratively in community projects and program planning to establish a new framework for including multiculturalism into STEM entitled SMARTS: STEM, Multiculturalism, and the Arts (Arce et al., 2015). This framework provided the basis for a community outreach project of the same name.

Introduction

Background and Connection to Literature

Discussing norms is important in assessing the current STEM climate and discussing the gap in cultural presence with STEM academia, outreach, and related considerations. The Foundry offers a framework to guide complex issues like the lack of representation in STEM. All these factors made the basis for SMARTS: STEM, Multiculturalism, and the Arts. The selected literature is relevant, creditable, accurate, and published within the last five years. The subscripts are indicative of those in the references.

Norms[2]
- Institutionalized cultural norms in STEM are historically characterized by male, white, western, and privileged emphases, which, in turn, discourages a large pool of participation from those who do not fall into these social groups.
- To disrupt these dominate STEM norms, the intentional integration of multiculturalism in STEM outreach is essential in changing how STEM engagement is communicated, understood, and encouraged.

Cultural Visibility
- Current pitfalls in cultural visibility efforts within STEM are typically centered around cosmetic diversity which communicates a narrow understanding of a cultures' role in STEM.[3]
- These efforts lack direct, meaningful connections between STEM and cultural communities.[7]
- Cultural visibility efforts in STEM which welcome inclusion recognizes the people involved and the range of purposes in which their innovative and creative contributions served their community creating a lasting, sustaining representation. [4]

Foundry[1]
- The Renaissance Foundry Model is a pedological framework that starts with a Student Learning Challenge with societal relevance and ends with a Protype of Innovative Technology. The six steps include: 1. Student Learning Challenge 2. Organizational Tools. 3. Learning Cycles and Documentation 4. Resources 5. Linear Engineering Sequence (Les) 6. Protype of Innovative Technology. See Analysis.
- The Foundry serves as a multifunctional tool to guide complex issues such as the lack of multiculturalism in STEM outreach.

Pathways
- Current federal strategies for STEM pathways encourage transdisciplinary learning to promote a fuller view of STEM by adhering to historical and cultural narratives.[5]
- National Research Council's latest data reflects the most success in engaging non-dominant communities in STEM is found in programs designed to have a strong culturally-responsive identity. [6]

SMARTS
Final Project from the STEM FHF
See Criteria 1
- SMARTS: STEM, Multiculturalism, and the Arts adds the additional dimension of diversity and inclusion, creating better representation, enthusiasm, and more cultural inclusive participation.
- In recognizing the lack of access to multicultural experiences within the community, the objective of the event was to create an experience that provides children and their families a pathway to engage in science, art, and cultural awareness by connecting and representing various cultures' contribution to STEM.

Methods

Research Question:
- In what ways does the Foundry enhance the integration of cultural inclusivity in community outreach projects?

Criteria 1: Context
- Findings were facilitated through a year long platform offered by the STEM Foundry Heritage Fellows (STEM FHF) Program at Tennessee Tech through the Tennessee Board of Regions grant focused on student engagement, retention, and success.
- Fellows were tasked with the creation of a service learning project using the Renaissance Foundry Model to guide their efforts to intentional integrate a multicultural identify in STEM outreach.

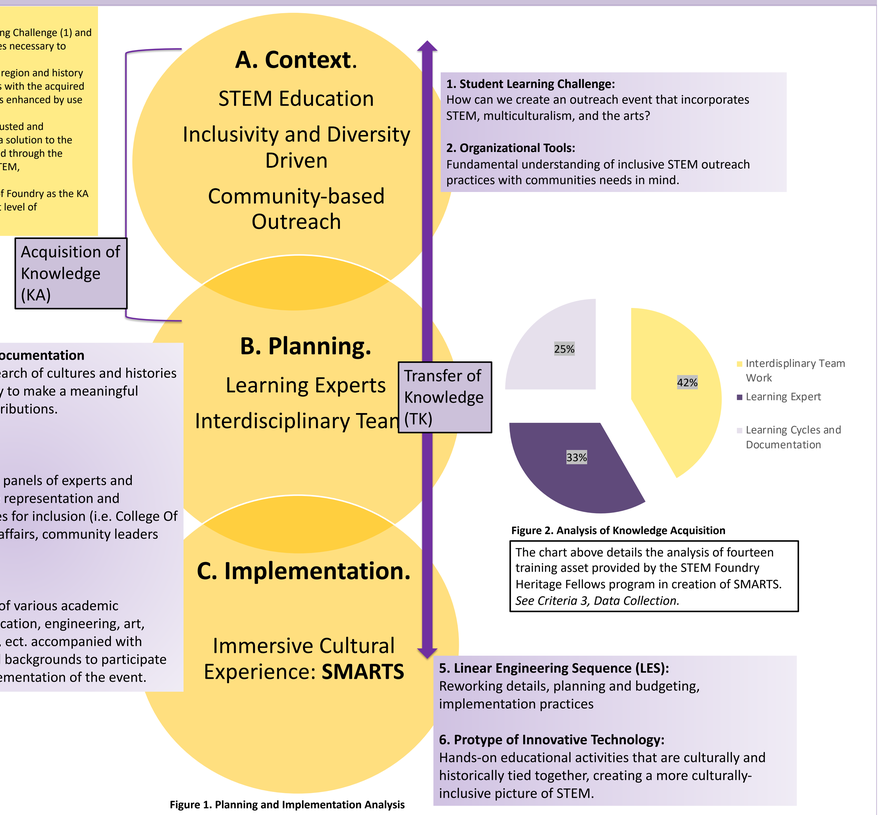
Criteria 2: Theorical Framework
- The Renaissance Foundry Model is utilized to answer the student learning challenge through a series of six steps with two key paradigms: the *Knowledge Acquisition Paradigm(KA)* and the *Knowledge Transfer Paradigm(KT*). *See Analysis section.*
- This framework is used to identify useful practices found during the planning and implementation experiences in the STEM Foundry Heritage Fellows Program. *See Figure 1.*

Criteria 3: Data Collection
- Collection includes training assets from the STEM Foundry Heritage Fellows Program.
- Assets included student coursework, reflections, observations, guest speakers, independent research, volunteering, and assigned readings over the course of a year.
- In total, fourteen documents were reviewed and offered the content for anaylsis.

Criteria 4: Analysis
- A theoretical research approach is used by analyzing the Foundry and identifying the ways the model influences the program planning process of multicultural STEM events.
- Reflects the findings of useful methods of multicultural program planning found from the preliminary stages of the outreach event: SMARTS.

Analysis

The Connection
- Part A provides the context for the Student Learning Challenge (1) and establishes the fundamental theories and purposes necessary to begin the Knowledge Acquisition Paradigm.
- Part B includes exploratory research of a culture's region and history to make a connection to STEM (3). Research aligns with the acquired knowledge from the Organizational Tools (2) and is enhanced by use of Resources (4).
- Part C begins the LES (5) process as details are adjusted and implementations practices begin. When finalized a solution to the original Student Learning Challenge (1) is answered through the Protype of Innovative Technology (6) - SMARTS: STEM, Multiculturalism, and the Arts.
- The KT paradigm occurs throughout the entirety of Foundry as the KA evolves throughout each step to reach the highest level of understanding.



1. Student Learning Challenge:
How can we create an outreach event that incorporates STEM, multiculturalism, and the arts?

2. Organizational Tools:
Fundamental understanding of inclusive STEM outreach practices with communities needs in mind.

3. Learning Cycles and Documentation
Conduct preliminary research of cultures and histories within each STEM activity to make a meaningful connection to STEM contributions.

4. Resources
Expert Collaboration
Reaching out to different panels of experts and resources to improve the representation and implementation strategies for inclusion (i.e. College Of Education, Multicultural affairs, community leaders and organizations).

Interdisciplinary Team
A student-led workforce of various academic backgrounds such as education, engineering, art, music, foreign languages, ect. accompanied with various socio-economical backgrounds to participate in the planning and implementation of the event.

5. Linear Engineering Sequence (LES):
Reworking details, planning and budgeting, implementation practices

6. Protype of Innovative Technology:
Hands-on educational activities that are culturally and historically tied together, creating a more culturally-inclusive picture of STEM.

Figure 1. Planning and Implementation Analysis

Figure 2. Analysis of Knowledge Acquisition

The chart above details the analysis of fourteen training asset provided by the STEM Foundry Heritage Fellows program in creation of SMARTS. *See Criteria 3, Data Collection.*

Findings

The Connection Between Learning Cycles and Documentation (3) and Resources (4)
- Preliminary research of cultures' contribution in STEM is deepened and authenticated by the resources found through expert collaboration and interdisciplinary teamwork. *See Figure 3.*
- Multiple perspectives within outreach planning creates a transdisciplinary learning climate in STEM representation efforts that are both high in Knowledge Acquisition and cultural inclusivity. *See Figure 4.*

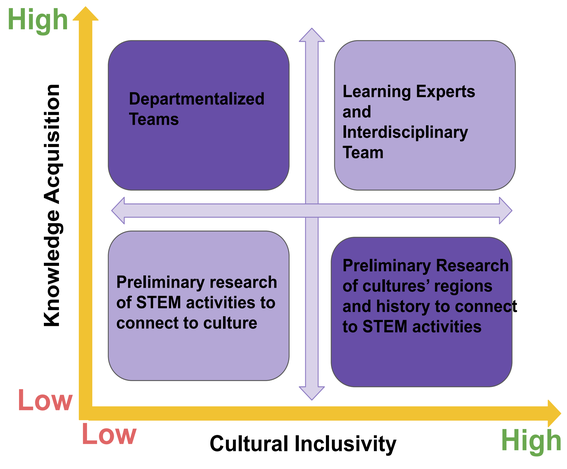


Figure 3. Knowledge Acquisition and Cultural Inclusivity Gauge

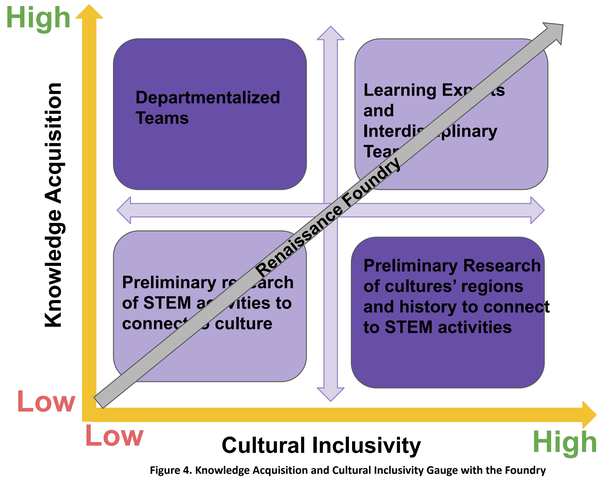
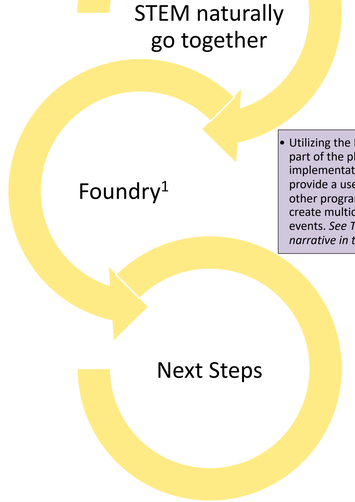


Figure 4. Knowledge Acquisition and Cultural Inclusivity Gauge with the Foundry

Implications

- The Foundry is utilized as a roadmap to guide the integration of multiculturalism into STEM outreach planning.
- Two major takeaways from the analysis include:
  - The Knowledge Acquisition paradigm increases the depth of cultural knowledge that relates to STEM. *See Figure 4.*
  - Learning Cycles and Documentation and Resources are leveraged to increase authenticity within representation through the use of expertise from a panel of perspectives with diverse academic and socioeconomic backgrounds. *See Figure 2 and 4.*

Conclusions



- All cultural communities engage in STEM initiatives that relate to their societal goals and values. Educational outreach should reflect the diversity of STEM efforts and purposes. *See Figure 1, Steps 2 and 3.*
- Utilizing the Foundry model as part of the planning and implementation process can provide a useful framework for other programs that want to create multicultural campus events. *See The Connection narrative in the Analysis section.*
- Next steps include participatory action research to gather insight on the experience of participants at the outreach event SMARTS: STEM, Multiculturalism, and the Arts.

References

1. Arce PE et al. 2015. The Renaissance Foundry. Critical Conversations. *1(2):176-202*

2. Barton, A., Menezes, S., Ambrogio, O., & Ballard, M. (2018). Informal Science. What are the cultural norms of stem and why do they matter? Retrieved from https://www.informalscience.org/sites/default/files/BP-4-Cultural-Norms.pdf

3. Bell, P., Rodriguez, A., Tzou, C., & Moorison, D. (2018). How to avoid possible pitfalls associated with culturally responsive instruction. Retrieved from http://stemteachingtools.org/brief/53

4. Bevan, B., Barton A., & Garibay. (2018). Broadening Perspectives on Broadening Participation in STEM. Washington, DC: Center for Advancement of Informal Science Education. 1-24.

5. Committee On STEM Education , & National Science and Technology Council. (2018). Charting a course For success: america's strategy for stem education. Retrieved from https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic- Plan-2018.pdf

6. National Science Foundation, National Center for Science and Engineering Statistics. 2017. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017*. Special Report NSF 17-310. Arlington, VA. Available at www.nsf.gov/statistics/wmpd/.

7.Rodriguez, A. J., & Bell, P. (2018). Why it is crucial to make cultural diversity visible in stem education. Retrieved 1n.d., from http://stemteachingtools.org/brief/55

8. Segarra, V. A., Natalizio, B., Falkenberg, C. V., Pulford, S., & Holmes, R. M. (2018). STEAM: Using the Arts to Train Well-Rounded and Creative Scientists. *Journal of microbiology & biology education*,*19*(1), 19.1.53. https://doi.org/10.1128/jmbe.v19i1.1360