2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #52945

Toward a more Rightful Presence in Middle School Engineering: Exploring the affordances of community research-practice-partnerships

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Abstract

The chronic underrepresentation of students of color in engineering education and the profession is well documented. The percentage of Black graduates from engineering degrees remain hovering at 4% [34]. This persistent lack of representation of students of color is entangled with the norms and practices of canonical engineering, calling into question the nature of canonical engineering epistemology [10]. At the K-12 level with the Next Generation Science Standards, engineering is a core and distinct component of the K-12 curriculum [35]. However, few K-12 teachers have had formal exposure to the concepts and practices of engineering [2] and most do not feel equipped to teach engineering [26]. For students of color across K-16, cultural dissonance and a lack of community representation are important factors that alienate and marginalize student engagement in engineering education [10]. Emphasizing the personal relevance of engineering to students' everyday experiences has been found to be helpful in increasing student interest in engineering [18], [19],[48]. This can be done through a collaborative effort of engaging in engineering experiences with families, teachers, and students. Boberiene [14] showed that family engagement improves classroom dynamics and increases teacher expectations, student-teacher relationships, and cultural competence, regardless of student's age groups. In the K-12 context, while parental engagement in school is largely framed as positive [15], school-centric approaches to parental engagement obscure both the barriers minoritized parents face in gaining access to participating in these ways [41] and the rich community wealth that minoritized parents bring to their children's disciplinary learning [40]. In this study in a 7th grade classroom at a Title 1 school with a Black teacher, Ms. D, and 100% students of color, we engaged in a research-practice-partnership with five youth and families to co-design and enact a 4.5 week-long, engineering for sustainable communities' curriculum in middle school science. We ask: How are engineering knowledge and practices co-constructed during the co-design and enactment of a sustainable communities (EfSC) curriculum within the classroom and Research-Practice-Partnership meetings? What are the outcomes to students' engineering experiences? We held three, 90-minute family-teacher-researcher RPP sessions that bookended the curriculum implementation, with one RPP session in the middle of the enactment to facilitate dialogue with families and incorporate their feedback. Guided by the Rightful Presence framework for justice-oriented teaching and learning [8], data was collected and analyzed via a grounded theory approach [31]. Data Sources included fieldnotes, interviews, audio recordings, and student/family artifacts from both classroom and RPP meetings. Findings include: 1) Co-construction of authentic engineering knowledge is emergent and contingent on familial relationships and technical and social aspects relevant to engineering design: 2) Familial presence in engineering provides a platform for seeding a student's rightful presence in engineering education.

Introduction and Literature Review

The National Research Council (NRC) defines engineering as "a systematic and often iterative approach to designing objects, processes, and systems to meet human needs and wants" [38]. Engineering Education is the instruction of principles and knowledge that lead to the design and analysis of products, processes and systems. In our study with Astro Middle School, we consider four intersecting domains that backdrop our investigation. These are 1) the history of engineering, 2) considerations of authentic engineering, 3) family engagement in youths' education, and 4) K-12 STEM education.

Engineering has been birthed out of the needs of society. In the article, Defining Engineering Education, Cheville [11] does a comparison of four engineering reports at four different time points in history to illustrate how engineering education requirements changed based on the societal needs. Table 1 illustrates the comparison. This is important because this is

Table1: Comparison Trends across reports (Cheville, 2024).

	Mann (1918)	**Grinter (1955)**	**E.E.P.U.S. (1985)**	**2020 (2004)**
Purpose of Engineering	• Improve industrial production. • Elevate mechanical arts to a learned profession.	• Apply basic science for economic advance. • Discover and create through research.	• Serve necessary technical function in larger system.	• Creative element of social-technical system . • Increase prosperity. • Avert catastrophe.
Role of the Engineer	• Apply scientific principles to production. • Manager.	• Provide technical advances to larger economic system.	• Member of a team that includes management and technicians.	• Advance technical breakthroughs. • Leadership. • Tackle societal problems.
Preparation of the Engineer	• Learn science. • Apply science in mechanic arts. • Managerial skills. • Build character.	• Predominately technical. • De-emphasis of social. • Two tier system-undergraduate and graduate.	• Technical preparation in social context. • Able to function on a team.	• Function within social-technical system. • Leadership and management.
Social-Technical Duality	The apparent social-technical duality increases over time.			
Five Year Degree Program	Each report mentions extending the degree program to fit in necessary content.			

tied to who can participate in engineering. Sociohistorical narratives about what counts as engineering, what it means to be trained as an engineer, and who can be labeled an engineer can be traced back to the professionalization of engineering in the late 1800s and early 1900s [55]. In the mid-1800s, engineering training was primarily through field experiences, namely in the railyards or on the shopfloor, but by the turn of the century, higher education had become a central pathway for becoming an engineer [55]. This pathway became a set standard for an upcoming engineer. By situating engineering training in segregated colleges and universities, these policies restricted who could become an engineer along racial, gender, and class lines [49]. The history of the professionalization of engineering informs disciplinary narratives today—the profession continues to marginalize based on class, race, (dis)ability, and gender as reflected in the continued underrepresentation of Black and Hispanic graduates and women with engineering degrees [32], [45], [49], [37]. This narrative was developed to imbue engineering with white masculinity as professional engineers' preparation shifted from being "in the field" to in the classroom [39], [47].

Inevitably, the historical narrative of engineering shaped the contours of engineering education, raising the question of how engineering education might be authentic, how, and to whom. Authentic learning has been defined in various ways as a clear representation of truth. This definition poses a challenge: Whose truth? A main concept and usage of authentic learning is that of providing a realistic problem to solve. This idea of authenticity is apparent in engineering education. One of the goals of engineering education is to provide real life problems or workplace problems that could be examined. To address the concern for more realistic workplace problems in STEM education, the development of tools and frameworks such as simulations [58] and problem-based learning frameworks [46] were created to provide workplace-based authenticity. The three major aspects of workplace-based authenticity are (a) Context authenticity - context resembles real world context (e.g. patient data in medical school), (b) Task authenticity (including process/procedural) - activities of students resemble real-world activities (e.g. scientific inquiry or chemical analysis), and (c) Impact authenticity - products of students are utilized in out of school situations (e.g. collected data are utilized in NASA projects) [3]. However, this workplace-based authenticity has been based on corporate world norms [4] that represent the view of Canonical Science Perspective (CSP) [5]. This is important to illuminate because this study is based on the theory of sustainability with renewable energy which is an authentic problem. However, it is focused on and driven by the student's school community. In a review article conceptualizing authenticity in engineering education, Wang and colleagues [54] share that there are two other components of authenticity that should be recognized and could enhance engineering education: (a) Personal authenticity - projects that are close to students' own lives (i.e. life-stories of their neighborhood, biodiversity in the forest nearby) and (b) Value authenticity – personal questions get answered or projects satisfy personal or community needs. These two concepts resonate with the next component of our study, as described below.

Family engagement has been defined as parents' work with schools and with their children to benefit educational outcomes and future success [21] and a commitment of family resources to support academic development [43]. The National Association for Family, School, and Community Engagement (NAFSCE) [36] defined family engagement as a shared responsibility in which schools and other community agencies and organizations are committed to reaching out to engage families in meaningful ways and which families are committed to actively support their children's learning and development. However, the definition of commitment and support differs from person to person. Ethnic minority families often engage in strategies to support their children's achievement, communicate the importance of education, and advocate for better educational experiences that are not captured by current frameworks and are sometimes missed by school personnel [23], [28], [53], [9]. Hill et al. [24] share two examples of family engagement that may not be recognized by school personnel. First, ethnic minority and immigrant parents use stories about their own sacrifice help their youth understand the importance of education, along with exposing youth to manual labor, to demonstrate the utility and value of education [9], [22], [28]. Second, African American parents' dissatisfaction with school was associated with higher levels of parental involvement at home [42]. Families with language or cultural barriers often feel unwelcome, powerless, and marginalized within their child's school [27]. In the K-12 context, while parental engagement in school is largely framed as positive [15], school-centric approaches to parental engagement obscure both the barriers minoritized parents face in gaining access to participating in these ways [41] and the rich community wealth that minoritized parents bring to their children's disciplinary learning [1]. Boberiene [14] showed that family engagement improves classroom dynamics and increases teacher expectations, student-teacher relationships, and cultural competence, regardless of student's age groups. Parents and other primary caregivers are expected to play an increasing role in their children's education and teachers are implored to develop partnerships with families and to increase families' involvement in education [12], [30]. Home-based involvement often includes motivational activities such as supporting children and setting standards or expectations, socializing children in school behaviors, and cognitive activities such as specifically training children to read and solve mathematics problems [17], [52]. School-based involvement often includes volunteering at school, involvement in school governance, helping with afterschool and extracurricular activities, and communication (parent-teacher conferences & newsletters), [16], [43], [52].

In this study, we take into consideration the historical narrative of engineering, its impact on engineering education, including at the K-12 level. There are many challenges for the integration of engineering into traditional K-12 curriculum. To begin, understanding the standards for engineering is critical. A common engineering standard that is being adopted is the Next Generation Science Standard (NGSS). (NGSS) requires educators to shift their practices from teacher-centered to student-centered to improve student learning [29]. Challenge one, implementing NGSS requires educators to have domain-specific science and engineering developing pedagogical content knowledge (PCK), which is necessary to adapt their pedagogical practices "to allow students to practice and apply the range of skills that scientists and engineers use when engaged in inquiry and problem solving" [25]. The second challenge, there are certain pedagogies that align better with engineering education. Engineering science integration models and education innovations are two types of pedagogies that are commonly used in STEM. Blumenfeld et al. [13] noted that knowledge acquired by students becomes more meaningful through asking questions, researching, solving, debating, sharing, analyzing, synthesizing, and designing during the project period. These components are demonstrated within these two pedagogy types. The most commonly one used for K-12 are education innovations. An educational innovation is defined as instructional and curricular elements that have not traditionally been implemented as part of classroom practices yet but are considered to be effective for enhancing learning [33]. Nadelson et al. (33) presented nine types of educational innovations: project-based learning (PBL), student-centered learning, place-based learning, curriculum integration, integration of instructional technology, family involvement, Inquiry, core STEM, and 21st century skills. A third challenge to K-12 engineering teaching is that of connecting students' lives to engineering content. Researchers note the impact of explicitly centering the personal relevance to students' everyday experience in K-12 engineering education [18], [20], [48]. In what they described as “transformative experience” (TE), Heddy and Sinatra [20] found that paying attention to the interests of students in shaping possibilities for engineering applications is necessary. Pugh [44] also showed that a transformative experience occurs when students apply what they learn in school to their everyday life in a way that enriches their experience. When students apply what they learn in class to their everyday experience, they are more likely to recognize the personal relevance of the content and in turn their motivation and achievement will increase [44]. This also reflects students engaging in authentic engineering.

One of gaps that emerged from this literature review is the limited research on the relationships between the four major stakeholders (students, parents, teachers, and researchers) in STEM education. Our study brings together these stakeholders who are instrumental to youths’ engineering education experiences. We are particularly interested in how parents, youth and teachers bring different resources and expertise to middle school engineering. To guide our study, we draw on the Rightful Presence for justice-oriented learning framework.

Conceptual Framework: Rightful Presence for justice-oriented teaching and learning

The grounding framework for this study is Rightful Presence. Rightful presence, as a justice-oriented political project, focuses on the processes of reauthoring rights towards *making present* the lives of those made missing by the systemic injustices inherent in schooling and the disciplines [7]. This framework contains three tenets. The first tenet focus is: *Allied political struggle is integral to STEM learning*. Within this tenet, the student, and the teacher work together to challenge and transform what participation in STEM entails in ways that humanize participation and value students as cultural and whole people [51]. Re-authoring rights has been used as another name for this tenet. Second tenet is: *Rightfulness is claimed through presence: making justice/injustice visible*. The focus of this tenet is recognizing when injustices happen in the STEM learning environment and addressing them through making them visible. Third tenet is: *Collective disruption of guest-host classroom relationships: amplifying the sociopolitical* [8]. This tenet stresses the responsibility of all parties (e.g., more powered teachers and less powered students) collectively working to seed new, more just norms in classroom teaching and learning culture. Providing everyone with a certain degree of power in that space. In this study, we are interested in exploring the ways an engineering for sustainable communities (EfSC) curriculum that is co-designed with families, might support students’ simultaneous development of engineering and STEM epistemic knowledge and their rightful presence in STEM. We ask: (RQ1) How are engineering knowledge and practices co-constructed during the co-design and enactment of a sustainable communities (EfSC) curriculum that took place in the classroom and in RPP meetings? (RQ2) What are the resulting outcomes to students’ engineering experiences?

Context

Astro middle school is a Title 1 school where 100% of the student population are students of color. The student population is on free or reduced lunch. 90% of the student body and their families face housing insecurity. The teacher we have partnered with is a black African American woman, named Ms. D, with 27 years of experience as an educator. Ms. D chose the student participants and their families for the RPP meeting based on their classroom effort, workmanship, expertise, and their willingness to help other students. These were also the students who were more reticent in the classroom and Ms. D hoped that participating in the study would give her students a louder voice due to their quiet nature. All the names presented in this study are pseudonyms.

Methodology

For this study we utilized a research-practice-partnership [56] approach. We engaged in research-practice-partnership (RPP) and participatory design methodology with parents, youth, and Ms. D to co-design and implement an Engineering for Sustainable Community curriculum (EfSC) across 4.5 weeks of daily 60-75 minutes engineering lessons. The co-design RPP sessions were Saturday meetings with Ms. D, four participating students and their parents, and three researchers. Three RPP meetings took place (each 90 minutes), before the start of, in the middle, and after the end of the curriculum enactment. The co-designed engineering curriculum was enacted in two 7th grade classrooms (33 students). The EfSC curriculum contained milestones such as introduction to engineering, sustainable communities, renewable energy sources, engineering skills-circuitry, community survey (creating and data analysis), engineering design challenge.

Data sources from both RPP sessions and classroom implementation included field notes, audio and select video recording, artifacts, teacher, parent, and student interviews. There was eighteen days of audio recording and fieldnotes of classroom instruction. Student interviews consisted of four focus groups that utilized a semi-structure format for approximately thirty minutes in length. The teacher interview was approximately thirty minutes in a semi-structured format. The selected videos were either of the interaction of the teacher and students, students and students, or students, parents, and teacher. We engaged in grounded theory analysis [50] which involved multiple stages and levels of coding based on constant comparison procedures, guided by the RP framework. There were two researchers involved in the coding process. The first level of coding involved open coding of the following:

1. Experiences that had prominent performance, in talk and actions, by students and teacher during the reenactment of the EfSC curriculum that is focused on the middle school community of Astro,

2. Knowledge and practices that students drew upon during the creation of their engineering artifacts,

3. Conversations and experiences of the students and their parents related to STEM and interactions with the community of Astro,

4. Conversations during STEM activities done by students and their parents together during RPP meetings

Themes that emerged from the open coding included: 1) What students and parents define and characterize as STEM and engineering; 2) the ways of participation by students and parents, through the EfSC curriculum and parent RPP meetings; 3) the ways in which concerns about the Astro community informed students' engineering designs; 4) how familial interaction affected the creation and transfer of engineering knowledge. We then engaged in axial coding across the four themes above, guided by the RP framework, to answer the following:

a. Was there evidence of the Rightful Presence tenets during a prominent performance? If so, who, where, when, and how?

b. What are the contributing factors that allowed Rightful Presence to take place?

EfSC Curriculum

The EfSC Curriculum [6] an NGSS standards aligned curriculum with two connected, engineering design units focused on engineering for sustainable communities. The two design challenges are: 1) Designing and iterating an electric art card for a loved one; and 2) Innovating and iterating sustainable green-energy powered solutions for the school community. The EfSC approach directly connects teachers and students to their local school community, and values learning engineering and doing engineering with and for community towards building a healthier and more just world. Key science content in this unit included types of circuit and how energy flows through them, energy transformation and types of renewable and non-renewable energy sources. Table 2 below gives a snapshot of the key foci across the 10 lessons.

Table 2: Lesson flow and foci of the EfSC curriculum.

#	Lesson	Key Focus	Integration of Community Perspectives
1	Introduction	Big Ideas in Engineering for Sustainable Communities **Lesson 1:** Introduction	Examining & discussing how youth their age use community ethnography as a part of engineering design
2–3	Iterative Design Cycle 1	Using iterative design cycles to make electric art cards for family/friends, powered with green energy sources **Lesson 2:** Designing Electric Art **Lesson 3:** Sustainable Electric Art	Generating Community Narratives
4–9	Iterative Design Cycle 2	Defining problems and designing solutions through community ethnography **Lesson 4:** Engineering Design Cycle **Lesson 5:** Design Challenge **Lesson 6:** Initial Design **Lesson 7:** Design Optimization with Community Feedback **Lesson 8:** Prototyping Designs **Lesson 9:** Refining Your Prototype	Using community ethnography as a part of engineering design Surveys & observations of peers & community members Dialogs with community on project ideas/design Observation
10	Community Sharing	**Lesson 10:** Sharing Engineering Designs	Community Narratives

Findings

To answer RQ 1- How are engineering knowledge and practices co-constructed during the co-design and enactment of an EfSC curriculum in the classroom and RPP meetings? – we illustrate the importance of localizing engineering within Astro community experiences and concerns and youths' families, as central to the co-construction of engineering knowledge and practices. In addition, porous boundaries between the classroom and RPP meetings facilitated the mobilities of parental, teacher and youth engineering expertise, widening where engineering mattered, to whom, and deepening collective, intergenerational community engineering expertise. In conjunction, we learned how this STEM experience impacted the parents and students view of one another and future STEM participation. To answer to RQ 2 – What are the resulting outcomes to students' engineering experiences?", we conjecture on the impacts of rightful familial presence as vital in students' own seeding of their rightful presence in middle school engineering through the EfSC engineering activities. In what follows, we present the findings first drawn across data types in Section I. Then, we delve deeper into one family – Willam and his mother Susan, to give an in-depth example.

I. Authentic Engineering toward Rightful Presence

A) Localizing Engineering in the Astro Community.

Making engineering relevant to a "student's world" allows them a wider on ramp to develop engineering knowledge and practices that are authentically contoured to their everyday spaces and experiences. The Astro school community is a part of the student's everyday world. Students co-constructed a community survey with support from Ms. D and researchers. Then they were able to administer the survey to their school community, including students, school staff, and parents. The survey yielded 190 responses and consisted of the following questions:

1. What category best describes you? (students, staff, faculty)

2. What challenges related to a healthy and happy school/class community do you think are most important (select 2 or 3)?

3. What other problems related to happy school/class and healthy communities do you think are important? (open-ended question)

4. What are the most important things we should be thinking about to make sure that our design idea is environmentally friendly (select 2)?

5. What are your ideas for engineering designs students can make that could help solve these problems? (open-ended question)

Analyzing the survey data in class, the students learned that many of their peers had the same concerns as them for their school community (see Figures 1 and 2).

Questions #2: What challenges related to a healthy and happy school/class community do you think are most important (select 2 or 3)?

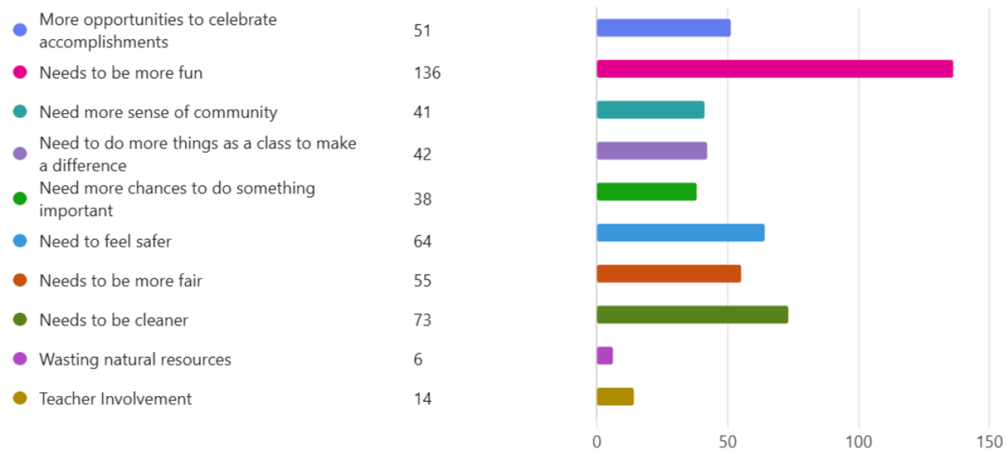


Figure 1: Results from question 2 of the Astro school community survey

The top five responses for question 2 are: 1) needs to be more fun, 2) needs to be cleaner, 3) need to feel safer, 4) needs to be more fair, and 5) need to do more things as a class to make a difference.

Question #4: What are the most important things we should be thinking about to make sure that our design idea is environmentally friendly (select 2)?

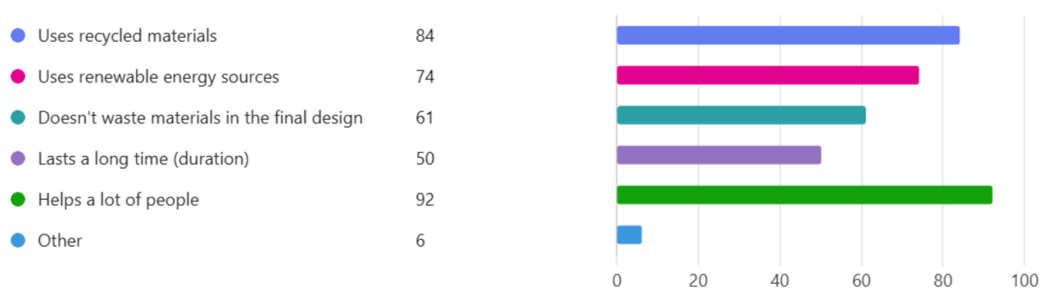


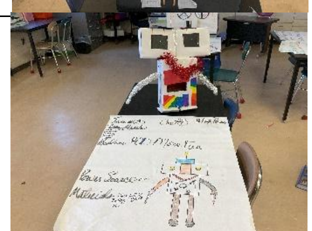
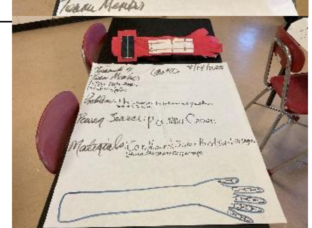
Figure 2: Results from question 4 of the Astro school community survey

The top five responses for question 4 are: 1) helps a lot of people, 2) uses recycled materials, 3) uses renewable energy sources, 4) doesn't waste materials in the final design, and 5) lasts a long time. Some of the responses that were given for question 3 are needs, cleaner, safer environment, bullying, communication with teachers, fun class, and free time.

Through surveying the Astro community, the students were able to identify shared concerns and discuss the nature of these concerns in Ms. D's science classroom. For example, Why is "School needs to be more fun" the top concern? In what ways is school not fun for a majority of students? What are the consequences of a lack of fun in school to student learning and well-being, to their health and happiness? How is perpetual unfun-ness lead to an unsustainable Astro school community? What innovations might students engineer to address this shared concern?

The innovation design challenge required the students to engineer a functional prototype of the innovation that addresses one of the concerns in the data analysis and to present to their innovation to the school community. Students were placed in groups of four or five. Samples of the innovations are shown in Table 3.

Table 3. Examples of Innovations that were created

Group	Concern from Survey	Innovation	
Zink	More Fun	Trashket Ball	
Sarah	More Fun	Robot (LED Eyes)	
Alaina	More Fun	Flame Thrower	
John	Needs to be Cleaner	Mechanical Hand with LED Lights	
William	Needs to be Cleaner	Trash Eater	

At the end of the EfSC unit, students hosted a showcase for the school and community guests that included parents. When reflecting on their EfSC experience, students Alaina and Ken highlighted the pride they felt in being able to actually create a functioning prototype that addresses a real community issue:

Researcher: What made you the most proud of from the curriculum?
Alaina: Well, I think it was when people were interacting with the project when I was presenting it with my group.
Researcher: At the showcase?
Alaina: yes
Researcher: What made you most proud of that?
Alaina: How people were using it. People were throwing the paper balls in the hole. It was cool to see how many play and how many didn't want to play.
Researcher: Is there anybody else?
Ken: I actually contribute to a project.

Ken and Alaina's innovation was Flame Thrower to address more fun. Students were also proud of their engineering knowledge and practices, both designing components of their prototype and trouble-shooting technical issues for a finished project. As Sarah, John and Zink explained when asked what they were most proud of in their work for the EfSC unit:

Sarah: "Probably the lights. Because someone had broken it. And we fixed it."
John: "Finishing the project"
Harold: "The design of the lights. We had five lights. It worked at first and then it stop. Then we got it working again."
Zink: "Finishing the project."

Through these EfSC activities, students were able to author their rights as experts in the sustainability of their community and engineering design (Rightful Presence Tenet 1). Through innovating specific, functioning prototypes for community-identified issues. Further, the creation of the survey and the results made visible the concerns of the students' school community, many of which were unjust such as issues pertaining to lack of safety and fairness (Rightful Presence Tenet 2). Collaboration of the students and the teacher to present the design prototypes and survey data to the school staff and students' peers disrupted the typical order of power where the teacher holds more power (Rightful Presence Tenet 3). In these ways, students were seeding a more rightful presence in the school community and a rightful presence in their science class as well.

From this set of responses, the students are sharing how they utilized their technical knowledge to addressed problems that occurred during and after the construction of their project. In reference to RQ 1, addressing shared community issues is contingent on students' developing engineering knowledge that is in turn being co-constructed through solving specific technical challenges (e.g., lighting problems) and through communicating to their community how their innovations work (e.g., showcase presentation). In the act of presenting, community knowledge is further deepened as the audience learns from the presenter about their innovation and the presenter learns from audience through their questions, which are important for iterative engineering design. Below is a comment from Julie during the focus interview. Julie recalled a moment when a student asked her a question from the showcase. Julie's group had constructed a robot that take suggestions for fun activities to do in the classroom. The concern they addressed was needs to be more fun.

Julie: *"During the showcase, one person asked a question about the robot. So, I told them that for the robot, you can write on a small paper and put it in the front of the robot with the open hole. Someone asked, what if they don't put their name on the paper? My mind went blank for a second. Then I said you can make it anyway. You don't have to write your name on it."*

Julie and her group did not take in consideration if the notes did not have a name on it in the design of the innovation. She had to decide if it would affect the operation of the innovation.

In reference to RQ 2, the students were not just gaining technical knowledge but other skills that are required for engineering. Skills such as a team player, completion oriented, willingness to contribute ideas, problem solving, and leadership. Peter, another student, shared with us, *"I was good at somethings and my team members were good at other things."* By overcoming the technical challenges and presenting at the innovation showcase, students experience authentic engineering and may be more open to pursuing STEM experiences further.

B) Localizing engineering within the family

In understanding the student's community, we also paid attention to how their family showed up for them in their STEM learning. The RPP meetings gave us the opportunity to witness how students interact with their families in the context of engineering for sustainable communities. Since the families who participated all had working parents some of whom had more than one job, the RPP meetings provided an opportunity for parents to actively engage with their student's engineering learning. At RPP meetings parents not only heard, but also saw in real time and experienced engineering activities for themselves, with their children. As Zink's father, James explained, *"It's been good and eye opening. We don't go to school with them. It's easier for them to come home and hear what they did in school today. and then say okay. But to actual engage with them and to do it. It gives us a better advantage point of this, what you really did… I think it is fun.."*

Within these interactions, we witnessed familial resources not typically sought nor valued in STEM classrooms: families' cultural wealth, experiences, and knowledge that were relevant to engineering. These aspects are important because it shows the rich familial resources and parents' interest and care for their youths' STEM learning. At every RPP meeting, one of the agenda items is to have the parents and students work together on an engineering activity. This interaction allowed us to explore the relationships between engineering and familial interactions and the impact of such on students' engineering experiences. During RPP meeting 1, youth and parents worked together to build scribble bots without any prior experience, and we saw how parents and youth each contributed ideas and tackled problems. Another parent, Michael, described his participation as "*a very cool experience. I learned something new. It's kind of interesting too. It makes me want to do more research."* Another parent, Sandra, exclaimed at the end of as session, *"Why do we have to stop. We are having so much fun!"*

At RPP meeting 2, the students and parents worked together to create electric art cards for someone special in their life, an activity that the students had undertaken in the classroom as part of the EfSC curriculum. The students had learned how to create three types of circuits (simple, series, and parallel) within the classroom. Therefore, students were arguably positioned to take more of a leadership role in teaching their parents how to make an electric art card. The movement of engineering knowledge and familial knowledge were demonstrated through the teaching and construction of the art card bidirectionally between students and parents. While some students did teach their parents paper circuitry, other parents brought their own prior experiences to bear on trouble-shooting circuits in their cards. When discussing who to make the card for, parents also contributed important familial knowledge about the potential recipient in their family whom families wanted to gift the card. Therefore, engineering knowledge and familial knowledge moved between the classroom and the RPP setting. Laughter and enthusiasm from both parents and youth were amply present at each RPP meeting. As James puts it in his reflection of his experience, *"I like working with my kid!"*

Parents therefore viewed the time at the RPP meeting as a fun but informative time. They learned that being part of their child's STEM learning process helps them to understand what their child is learning and how they can help them, while also reminding parents of their own interests and expertise. Through engineering with their parents, the students learned that they had the potential to teach their parents new information, and that they are willing to learn. William described his mother as "a good student" and Jessica learned that her father had a knowledge set that she was unaware of, saying "He *(her dad) actually knew more than I thought. He was able to help me troubleshoot why my lights would not come on." Another student, Don, appreciated his father's help, explaining that "he was supportive and creative."* A major outcome for the students is knowing that their parents support them and believe in them. Figure 3 and 4 show pictures from RPP meeting 1 and RPP meeting 2.

The last and final RPP meeting focused on the co-construction of the students' innovation design that would address a specific community concern identified through the survey. This gave the parents the opportunity to support their child's design plan through asking questions and engaging in iterative design, as we detail with William and his mother, Susan, in the next section.

Figure 3. RPP meeting 1 Scribble Bots (a simple, motorized robot that moves on its own using vibrations to create, random artistic drawings on paper)

Figure 4. RPP meeting 2 Electric Art Cards

II. An in-depth example of families Building Together: William and Mom Susan

During the RPP meetings, we were able to witness how parents were a source of support for the student in the creation of engineering knowledge. RPP meeting 3, parents were able to help their child navigate through the process and challenges of bringing an idea concept to reality. During the meeting, the parents were responsible for assisting their child in the construction of an innovation design. All the materials for the construction were provided.

An example is William, an African-American boy, and his mother, Susan. William and his peers wanted to address the concern, effluvium problem, which was revealed from the school community survey. Their concept was named the Trash Eater. The original design was a mobilized trash collector. This concept could be used in any classroom to collect trash. It consisted of a parallel circuit with two LED lights that is powered by a solar panel. It was designed with four wheels for mobility and suction for trash collection. During the RPP meeting 3, the students brought in their sketch-up and the start of their innovation construction. William explained to his mother the innovation concept with the use of sketch-up. William had not started the construction and does not have an idea of how to construct the details (mobility and suction) within his innovation. As he began working with the cardboard for the body, the unsureness of what the body should look like began to settle in. The challenge for William, is he had very detail aspects of the design in his mind and on paper but could not translate them into construction. After moments of quietness and cutting cardboard, he said it could be anything that cleans. He has a concerned look and so does his mom. She began to show signs of frustration.

William: "It could be anything that cleans"
Susan: "You have to know what are you building in order to build"
Susan: "You can't do a project if you don't have a plan."

Susan realized that her son needs help. She told him that even when she does her arts and crafts, she has a plan and purpose for them. She began take the lead and start defining the purpose of the innovation based on William's requirements from the sketch-up. Through this example, Susan is showing her son that you can refine you design if the initial idea is not aligned with your criteria. This action is part of the engineering design cycle. She helps him navigate through this process by asking him a series of questions.

Susan: "What is it supposed to do? It recycle trash/metal? How are we going to fix it? What are you to do? What do you want to build?"
Susan took a breath and said in a frustrated tone.
Susan: Once trash is collected, where is it going?

William grabs a piece of cardboard, and they begin to work together in constructing the Trash Eater. With the help of his mother, William's innovation purpose was still the same but with a modify design. The mobility and suction was removed from the design. Instead, the innovation was the combination of a dust pan and trash box. To use it, one would sweep the trash up the ramp into the box. Once the box is full, then it should be dumped. Through her personal experience of constructing arts and crafts, Susan was able to help William navigate the challenges of engineering (concept to reality). Demonstrating to her son that her knowledge base (cultural wealth) was instrumental in the construction of the Trash Eater. The resulting innovation was still an example of authentic engineering for his school community.

Figure 5. Trash Eater Construction

Figure 5 shows the progression of the construction of the Trash Eater to the presentation at the showcase. Susan made it a priority to attend the showcase.

Discussion

The enactment of the EfSC curriculum gave the students an opportunity to do authentic engineering through localizing engineering within the Astro community and their families. Through this enactment, it allowed the students to acknowledge the concerns of the school community and to provide a solution to them. All three of the Rightful Presence tenets were demonstrated throughout EfSC experience. The students reauthored their rights from being observers of their school community to students that were concerned about their community and who were willing to take action for improvement through engaging in rigorous engineering design. This action positioned them as experts of their community sustainability and in their engineering learning-Tenet 1. The injustices students were experiencing as part of going to school at Astro were made visible through the co-construction and administering of the school community survey-Tenet 2. Collaboration of the students and their parents at the RPP meetings and students and the teacher in school to present the design prototypes and survey data to the school staff and students' peers disrupted the typical order of power (the teacher being the most powerful)-Tenet 3. The engineering knowledge students developed were integrated with familial knowledge at the RPP activities. Through the RPP meetings, students demonstrated to their family the engineering knowledge they learned and was able to build on that knowledge by teaching their parents and working together to refine their prototypes-Tenet 1. In this process, families were able to pinpoint areas they could help more with their student in their engineering learning-Tenet 2. The disruption occurred when parents and students worked together on the engineering activities as equals (normally, parents being the more powerful) and exchanged engineering knowledge. For example, Susan realized her son is detailed oriented in his ideas and thought process, however, he needs help in bringing those ideas to reality. Her solution is to have him participate in more STEM opportunities and to help her with arts and crafts. In addition, as families engaged in the activities, it provided an atmosphere of safeness. This atmosphere mimic the concept of "At the Table" but with a STEM context. At the table concept is based on the idea of family coming to the table, "breaking bread" (having a meal) and sharing the thoughts of the day. It provided a place where tough conversations could be had without judgement. It symbolizes support and love by making time available for this meeting. In this safe place, RPP meetings, allowed parents, teachers, and students to share their concerns about the science learning environment at Astro without judgement. Also, it gave the partnership between parents, teachers, and students an opportunity to be enhanced in STEM-discipline-consequential ways. The question arises then: How do we created more opportunities for family engagement in engineering education for working class families? This partnership has the potential to change the narrative of what engineering looks like for their students. A new narrative of engineering being a possibility for the students.

Familial presence during the enactment of EfSC curriculum allowed the students to reposition themselves as having a rightful presence in their school community and their science learning. Students reauthored their rights (Tenet 1) in the following ways 1) Being an expert in the new found knowledge of engineering design, 2) Sharing and teaching engineering expertise to their family, 3) Being a collaborator with family to construct innovation design, and 4) Presenting the purpose of the innovation design and the process to the school community. The parents reauthored their rights as being legitimate collaborators, stakeholders and advocates who have wisdom and knowledge to bring to the table of their child's engineering learning. The injustices that were made visible (Tenet 2) is the injustice of such an environment being unsustainable was made visible by the students' community survey data. Rightful presence work is contingent on allied political struggle involving the more powered teacher and less powered parents and students (Tenet 3). This study also points to the affordances of positioning parents as legitimate partners to their children's STEM learning and how parents could be consequentially involved beyond classroom walls.

Conclusion

This study showed that authentic engineering with minoritized youth can be designed by localizing engineering in students' school community, with familial presence. Such an approach allowed students to engage in engineering learning that seed their rightful presence in middle school STEM learning. This way of engineering is a departure from the modes of canonical engineering by centering youths' relational ties with their school and their familial ties as strength and resources on which engineering is contingent. Our study also shows the importance of more opportunities for families to do engineering together outside of the traditional school hours. We hope that this study illustrates how such a collaboration might take place and helps push the field forward as we work towards justice-oriented STEM teaching and learning in middle schools.

References

[1] Alemán, S. M., & Olivo, F. D. M. (2019). Guided by the Itzpapalotl spirit: Chicana editors practice a form of spiritual activism. Frontiers: *A Journal of Women Studies*, 40(1), 245-271.

[2] Anderson, J. L. & Kullman, E. (2020, February 19). K-12 engineering teachers lack education system support. The Hill.

[3] Barab, S. A., Squire, K. D., & Dueber, W. (2000). A coevolutionary model for supporting the emergence of authenticity. *Educational Technology Research & Development,* 48(2), 37–62.

[4] Billett, S. (1994). *Authenticity in workplace learning settings*. In Stevenson, J.C. (Eds.), Cognition at Work: The Development of Vocational Expertise, 36-75. Adelaide: National Centre for Vocational Education Research.

[5] Buxton, C. A. (2006). Creating contextually authentic science in a "low-performing" urban elementary school. *Journal of Research in Science Teaching, 43*, 695–721.

[6] Calabrese Barton, A., & Tan, E. (2015). FAM JAM: Supporting Powerful Learning in Middle School STEM. *Engineering for Sustainable Communities Curriculum*. Retrieved February 21, 2025, from www.engineeriam.org

[7] Calabrese Barton A., Tan E. (2019). Designing for rightful presence in STEM: Community ethnography as pedagogy as an equity-oriented design approach. *Journal of the Learning Sciences*, 28(4-5), 616–658.

[8] Calabrese Barton, A., & Tan, E. (2020). Beyond equity as inclusion: A framework of "rightful presence" for guiding justice-oriented studies in teaching and learning. *Educational Researcher*, 49(6), 433-440. https://doi.org/10.3102/0013189X20927363

[9] Ceballo, R., Maurizi, L. K., Suarez, G. A., & Aretakis, M. T. (2014). Gift and sacrifice: Parental involvement in Latino adolescents' education. *Cultural diversity & ethnic minority psychology*, 20(1), 116.

[10] Cech, E. (2013). Culture of disengagement in engineering education? *Science, Technology, & Human Values*, *39*(1), 42–72. https://doi.org/10.1177/0162243913504305

[11] Cheville, A. (2014, June). Defining engineering education. In *2014 ASEE Annual Conference & Exposition*, 324-357.

[12] Christenson, S. L., & Reschly, A. L. (2009). *The handbook of school-family partnerships for promoting student competence.* New York, NY: Routledge, Taylor & Francis Group.

[13] Blumenfeld, P. C., E. Soloway, R. W. Marx, J. S. Krajcik, M. Guzdial, and A. Palincsar. (1991). Motivating Project-Based Learning. *Educational Psychologist*, 26 (3–4): 369–398.

[14] Boberiene, L. V. (2013). Can policy facilitate human capital development? The critical role of student and family engagement in schools. *American journal of Orthopsychiatry*, 83(2-3), 346.

[15] Boonk, L., Gijselaers, H. J., Ritzen, H., & Brand-Gruwel, S. (2018). A review of the relationship between parental involvement indicators and academic achievement. *Educational research review*, *24*, 10-30.

[16] Epstein, J. L., & Sanders, M. G. (2002). Family, school, and community partnerships. In M. H. Bornstein (Ed.), Handbook of parenting, vol. 5: *Practical issues in parenting* (pp. 407–437). Mahwah, NJ: Erlbaum.

[17] Grolnick, W. S., & Slowiaczek, M. L. (1994). Parents' involvement in children's schooling: A multidimensional conceptualization and motivational model. *Child development*, 65(1), 237-252.

[18] Guzey, S. S., Moore, T. J., Harwell, M., & Moreno, M. (2016). STEM integration in middle school life science: Student learning and attitudes. Journal of Science Education and Technology, 25(4), 550–560. https://doi.org/10.1007/s10956-016-9612-x

[19] Heddy, B. C., & Sinatra, G. M. (2013). Transforming misconceptions: Using transformative experience to promote positive affect and conceptual change in students learning about biological evolution. *Science Education*, 97(5), 723–744.

[20] Heddy, B. C., Sinatra, G. M., Seli, H., Taasoobshirazi, G., & Mukhopadhyay, A. (2017). Transforming college success: Making learning meaningful to at-risk students. Educational Psychology, 37(5), 565–581. https://doi.org/10.1080/01443410.2016.1150420

[21] Hill, N. E., Castellino, D. R., Lansford, J. E., Nowlin, P., Dodge K. A., Bates, J. E. & Petit, G S. (2004). Parent academic involvement as related to school behavior, achievement, and aspirations: Demographic variations across adolescence. *Child Development* 75(5), 1491–1509.

[22] Hill, N. E., & Torres, K. (2010). Negotiating the American dream: The paradox of Latino students' goals and achievement and engagement between families and schools. *Journal of Social Issues*, 66, 95–112.

[23] Hill, N. E. (2011). Undermining partnerships between African-American families and schools: Legacies of discrimination and inequalities. *African American childrens mental health, 1*, 199-230.

[24] Hill, N. E., Witherspoon, D. P., & Bartz, D. (2018). Parental involvement in education during middle school: Perspectives of ethnically diverse parents, teachers, and students. *The Journal of Educational Research*, 111(1), 12-27.

[25] Hughes, A. J., & Partida, E. (2020). Promoting preservice stem education teachers' metacognitive awareness: Professional development designed to improve teacher metacognitive awareness. *Journal of technology Education*, 32(1), 5.

[26] Hsu, M., Purzer, S., & Cardella, M. E. (2011). Elementary Teachers' Views about Teaching Design, Engineering, and Technology. *Journal of Pre-College Engineering Education Research (J-PEER)*, 1(2), Article 5.

[27] Ishimaru, A. M., Torres, K. E., Salvador, J. E., Lott, J., Williams, D. M. C., & Tran, C. (2016). Reinforcing deficit, journeying toward equity: Cultural brokering in family engagement initiative. *American Educational Research Journal*, 53(4), 850–882.

[28] Lopez, G. (2001). The value of hard work: Lessons on parent involvement from an (im) migrant household. *Harvard Educational Review*, 71(3), 416-438.

[29] Love, T. S., & Hughes, A. J. (2022). Engineering pedagogical content knowledge: examining correlations with formal and informal preparation experiences. *International Journal of STEM Education*, 9(1), 29.

[30] Mapp, K. L., & Kuttner, P. J. (2013). Partners in Education: A dual capacity-building framework for family–school partnerships. Retrieved from http://www.sedl.org/pubs/framework/FE-Cap-Building.pdf

[31] McCall, C., & Edwards, C. (2021). New perspectives for implementing grounded theory. *Studies in Engineering Education*, *1*(2), 93-107. https://doi.org/10.21061/see.49

[32] McGee, E. O. (2020). *Black, brown, bruised: How racialized STEM education stifles innovation*. Harvard Education Press.

[33] Nadelson, L., Sias, C. & Seifert, A. (2016). Challenges for integrating engineering into the k-12 curriculum: Indicators of k-12 teachers' propensity to adopt innovation. *American Society for Engineering Education*, 1-16.

[34] NCES, 2019. https://ncses.nsf.gov/pubs/nsb20223/demographic-attributes-of-s-e-degree-recipients

[35] NGSS Lead States. (2013). *Next generation science standards: For states, by states*. National Academies Press. https://doi. org/10.17226/18290.

[36] National Association for Family, School, and Community Engagement. (2010). *Family Engagement Defined*. https://nafsce.org/page/definition

[37] National Center for Science and Engineering Statistics. (2019). Women, minorities, and persons with disabilities in science and engineering: 2019. Alexandria, VA: National Science Foundation.

[38] National Research Council. (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165.

[39] Oldenziel, R. (1999). *Making technology masculine: Men, women and modern machines in America 1870–1945*. Amsterdam University Press.

[40] Oliva, N., & Alemán Jr, E. (2019). A muxerista politics of education: Latina mother leaders enacting educational leadership and policy advocacy. *Educational Policy*, *33*(1), 67-87.

[41] Paredes Scribner, S. M., & Fernández, E. (2017). Organizational politics of parental engagement: The intersections of school reform, anti-immigration policies, and Latinx parent organizing. *Educational Policy*, *31*(6), 895-920.

[42] Park, S., & Holloway, S. D. (2013). No parent left behind: Predicting parental involvement in adolescents' education within a sociodemographically diverse population. *The Journal of Educational Research*, 106, 105–119.

[43] Pomerantz, E. M., Moorman, E. A., & Litwack, S. D. (2007). The how, whom, and why of parents' involvement in children's academic lives: more is not always better. *Review of Educational Research*, 77(3), 373-410.

[44] Pugh, K. J. (2002). Teaching for transformative experiences in science: An investigation of the effectiveness of two instructional elements. *Teachers College Record*, 104(6), 1101–1137.

[45] Riley, D. (2008). *Engineering and social justice: Synthesis lectures on engineers, technology, and society*. Morgan and Claypool.

[46] Savery, J.R., & Duffy, T.M. (1995). Problem based learning: An instructional model and its constructivist framework. *Educational Technology, 35*, 31-38.

[47] Secules, S. (2019). Making the familiar strange: An ethnographic scholarship of integration contextualizing engineering educational culture as masculine and competitive. *Engineering Studies*, 11(3), 196–216.

[48] Shahali, E. H. M., Halim, L., Rasul, M. S., Osman, K., & Zulkifeli, M. A. (2016). STEM learning through engineering design: Impact on middle secondary students' interest towards STEM. EURASIA Journal of Mathematics, Science and Technology Education, 13(5), 1189–1211. https://doi.org/10.12973/eurasia.2017.00667a

[49] Slaton, A. E. (2010). *Race, rigor, and selectivity in US engineering: The history of an occupational color line*. Harvard University Press.

[50] Strauss, A., & Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Sage

[51] Tan, E., & Barton, A. C. (2023). *Teaching Toward Rightful Presence in Middle School STEM*. Harvard Education Press.

[52] Toren, N. K. (2013). Multiple dimensions of parental involvement and its links to young adolescent self-evaluation and academic achievement. *Psychology in the Schools*, 50, 634–649.

[53] Wallace, M. (2013). High school teachers and African American parents: A (not so) collaborative effort to increase student success. *The High School Journal*, 96(3), 195-208.

[54] Wang, J., Dyehouse, M., Weber, N. R., & Strobel, J. (2012, June). Conceptualizing authenticity in engineering education: A systematic literature review. In *2012 ASEE Annual Conference & Exposition* (pp. 25-340).

[55] Watkins, J. (2023). “That is Still STEM”: Appropriating the Engineering Design Process to Challenge Dominant Narratives of Engineering and STEM. *Cognition and Instruction*, 1-31.

[56] Welsh, R. O. (2021). Assessing the quality of education research through its relevance to practice: An integrative review of research-practice partnerships. *Review of Research in Education*, *45*(1), 170-194. https://doi-org.libproxy.uncg.edu/10.3102/0091732X20985082

[57] Wilson, S. (2008). *Research is ceremony: Indigenous research methods*. Black Point, Nova Scotia, Canada: Fernwood Pub.

[58] Winn, W. (2002). Current trends in educational technology research: The study of learning environments. *Educational Psychology Review, 14*(3), 331-351.