Engagement in Practice: A Road Map for Academia and Non-Profit Collaboration

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Abstract

Understanding collaboration strategies among university researchers, non-profits, and industry organizations is crucial for developing robust research networks that will contribute towards the highest level of quality within research projects. This paper presents the approach of how a university team (professor and graduate students) collaborated with the National Society of Black Engineers (NSBE) to conduct a longitudinal analysis of a summer engineering program funded through an Early CAREER faculty award from the National Science Foundation's Engineering Education Broadening Participation (BPE) program. According to the literature, there is a great need for longitudinal analysis of STEM outreach programs, especially informal ones, and support students from historically excluded backgrounds. This paper contributes to the academia-non-profit partnership literature within the context of longitudinal studies by mapping out the strategies practiced, including ethical and equitable collaborating and networking with professionals from academia, non-profit, industry, and other higher-education-based institutions during the early phases of our study. We applied concepts from design thinking, systems thinking, community engagement, and collaboration ethics while focusing on the collaborative element in those concepts. We describe the team engagement, dynamics, characteristics, and methods for playing to each team member's strengths. Additionally, we share the challenges and constraints faced by the team during years 1 and 2 of the project and the changes implemented as a result. The overall results were assessed regarding team performance and progress toward the project. Results also include insight into team organization and structure and the team's interdisciplinary and multifaceted skillset. Best practices, successes, and areas of opportunity for leveraging multistakeholder collaborations were essential to our project. Our aim is to document our process as a road map for other university researchers who wish to collaborate with industry and non-profit organizations.

Keywords: Design Thinking, Systems Thinking, Collaboration Ethics, Community Engagement.

Introduction

Conducting collaborative research across multiple stakeholders can be considered a cumbersome task, which often requires room for adjustments and process improvement. Collaborating and communicating, especially in the context of longitudinal interdisciplinary research examining an educational program, which involves various stakeholders from different regions, can present unique challenges. Therefore, it is vital to highlight what such a collaborative process entails to reflect its level of complexity while demonstrating its achievability. Therefore, this paper shares a reflection and insights into conducting the initial phase of a National Science Foundation funded early CAREER faculty awarded project that entailed collaboration with the National Society of Black Engineers (NSBE) organization and various experts in our research domain.

In this paper, we first give a background into what our project is about and its motivation, then describe various details about it, including the people involved and associated tasks or milestones. Then we describe how we had applied various theoretical constructs to our project and how it helped to shape our thinking and propel the project forward. Next, we reflected on lessons learned and presented a roadmap of the steps we took to achieve our project milestones. We

demonstrate the realities and practicality of conducting our collaborative research process and bridging gaps between theory and practice, and this is a common principle communicated throughout the paper.

Background

This paper represents a derivative exploration within the broader context of a comprehensive longitudinal study examining the Summer Engineering Experience for Kids (SEEK), an initiative delivered by the National Society of Black Engineers (NSBE). NSBE has historically encountered a substantial need to investigate the enduring impacts of past SEEK participants, although their capacity to conduct such in-depth analyses has been limited. Their prior and ongoing inquiries predominantly revolved around camp evaluations, the perspectives, and experiences of participants (including mentors, students, and volunteers), the requirements of sponsors, and the formulation of strategic plans for subsequent camps.

National Society of Black Engineers (NSBE) created the Summer Engineering Experience for Kids (SEEK) program in 2007 with one site in Washington, D.C., to inspire Black students through the many diverse opportunities and wonders of STEM fields. SEEK is a free, complimentary three-week summer program that offers a fun and engaging educational experience for students in grades 3–5 that aims to provide high-quality learning opportunities to students from groups underrepresented in STEM who may not otherwise have access to extensive STEM education. Additionally, it aims to improve students' STEM identity and thereby encourage them to continue their studies in STEM fields. The National Society of Black Engineers (NSBE), established in 1975, endeavors to support and promote the ambitions of collegiate and pre-collegiate students and technical professionals in engineering and technology. Their mission is to promote the development of more culturally conscious black engineers who achieve academic excellence and professional success and make a positive impact on the community.

Recognizing the potential for a more extensive and robust investigation into the long-term outcomes of the SEEK program, NSBE sought to establish a collaborative partnership with university researchers. The goal of this collaboration was not only to address the inherent limitations of NSBE's resources, but also to elevate the visibility and impact of their research efforts. Joint publications, presentations, and projects arising from this collaboration were envisioned to contribute significantly to the dissemination of knowledge within both academic and professional communities, thereby amplifying the influence of the research outcomes and the impact of the program.

The synergy resulting from the collaboration between NSBE staff and university researchers was expected to bridge the gap between practical non-profit experience and theoretical academic approach. The NSBE staff, drawing from their practical perspectives, would complement the theoretical expertise of university researchers. This collaboration aimed to produce research outcomes that were not only academically rigorous but also highly applicable to real-world challenges, ensuring a well-rounded approach to investigating the impacts of the SEEK program.

The principal investigator (PI), from an academic institution previous NSBE involvement, who is leading this collaborative effort, has a deep-seated connection with both the research community and NSBE. Having previously served as the Senior Program Manager Director for Pre-College Initiatives within NSBE, the principal investigator brings an intimate understanding of the SEEK program. Additionally, they have conducted prior research focusing specifically on the academic outcomes of SEEK female participants. This background not only positions the principal

investigator as a valuable liaison between NSBE and the academic community but also underscores their commitment to advancing the understanding of the long-term effects of the SEEK program.

As the collaboration unfolds, it is anticipated that the combined strengths of practical insights from NSBE and theoretical expertise from university researchers will yield comprehensive findings. Ultimately, the partnership aims not only to enrich the academic discourse surrounding STEM education initiatives but also to inform the ongoing enhancement and refinement of the SEEK program for the benefit of future participants and the broader community.

Motivation

Research is essential in the development of both formal and informal educational systems, as it enables the assessment of the effectiveness of the initiatives and fosters continuous improvement in said initiatives at various levels. SEEK has offered the aforementioned programs to historically underrepresented students for the last three decades. To determine whether the funds invested in building systems have improved the quality of SEEK programs and STEM learning in historically underrepresented minority students, the NSF, NSBE, and researchers have collaborated to evaluate the quality of the outcomes of the youth participating in this program. The value of collaborative efforts is widely acknowledged, yet there is no established pathway outlined in the available literature to guide research teams, i.e., academics and the National Society of Black Engineers (NSBE) and facilitate collaboration. The absence of such a roadmap may result in missed opportunities for both groups. In fact, Durante (2022, p.532) revealed a scant body of literature on collaborative practices, particularly those aimed at research, and their associated challenges. This lack of available literature could be contributed to the inherent complexity and unpredictable nature of collaborative effort in research projects.

This paper aims to address the gap in existing literature on research teams by offering a clear route by exploring the methods for achieving successful and productive collaborative multidisciplinary research while working remotely, since virtual settings have become a reality since the Covid-19 pandemic. Thus, our research team developed a roadmap with a dual objective. First, it aimed to bridge the gap in the available literature by developing a comprehensive methodology for conducting collaborative research and facilitating communication among the various involved stakeholders. Second, this roadmap will serve as a tool to guide our research efforts in the ongoing longitudinal study of the SEEK program in collaboration with NSBE, allowing us to evaluate our progress and ensure that we are making headway in the appropriate direction.

Our roadmap integrated the theoretical principles of design thinking and systems thinking, while simultaneously grappling with the ethical challenges of collaboration, including responsibility, accountability, and authorship, and issues concerning community engagement. By reviewing the available theoretical literature, the research team can reflect on other experiences to gain valuable insights. Further, the research team hopes that sharing this roadmap will bolster interdisciplinary collaboration for future research based on the principles of the “open science framework”. The open science framework is a scientific movement spanning several disciplines which encourages research transparency to make research more reproducible and easier to build upon (Buecheler, Sieg, Fuchslin, & Pfeifer, 2010; Bowman & Keene, 2018; Sullivan, Dehaven, & Mellor, 2019). This endeavor was initiated in response to the requirements of the research project undertaken by the team, which necessitated examining pertinent issues that may have a bearing on the project's success.

Project Execution

a) People

University Researchers

The Primary Investigator (PI) is a university professor and the lead of collaboration and executive decisions regarding the project. To assist with the research, the PI hired at least two graduate students to work concurrently at a given time. The students hailed from engineering related backgrounds and sought to develop their research skills. One student was from a different university from that of the PI and specialized in survey development and quantitative analysis. Students participated in various milestones of the project such as survey development, data preparation, survey analysis, and database development. In addition to students, the PI works with a postdoctoral scholar to help with different aspects of the project. The team communicated through frequent virtual meetings.

Advisory Board

The advisory board members were selected based on the backgrounds and expertise of individuals related to the goals and objectives of the NSF-funded project. When considering the various areas of the grant (i.e., theoretical framing, research methodology, education plan, dissemination efforts), the individuals being considered for the roles had to have experience, positions, etc., that aligned with the areas of need. Each prospective member received an email from the principal investigator requesting their participation in the proposal. Within that email, a one-page overview of the project and the area they were asked to provide their expertise was provided. The group comprised individuals with knowledge around intersectionality, asset-based research, social capital theory, database development, large dataset management, and experience working with historically excluded individuals within engineering and STEM more broadly and policy-making within K-12 and higher education.

Each advisory board member is paid the same amount, and their requested work is equal. Additionally, every Advisory Board member's expertise is equally important to the overall success of the project. For example, being able to understand the role of social capital for participants who were involved with the SEEK program is just as important as using that information to conduct predictive analytics as a part of the dataset developed using the feedback from all participants.

NSBE Team

As a part of our eight-member advisory board for the grant, two of the individuals included leadership members from the NSBE organization. They included the Chief Programs and Membership Officer and the Director of Research. Each advisory board member was selected due to their expertise in engineering education research required for the CAREER grant research. As a part of that commitment, each member is required to attend a meeting once a year and will receive an honorarium of $1,000 for their time preparing for the meeting and completing any tasks requested by the core research team. During Years 1 and 2 of the projects, due to the heavy focus on data analysis linked to the data provided to us by NSBE, the two NSBE advisory board members were invited to attend our weekly team meetings that occurred once a week (however, not required). This provided them with an opportunity to provide insight into the progress we had made by the time of the meeting. Also, it allowed our team to ask clarifying questions around the

data we used (i.e. email addresses to contact participants). Their key contributions consisted of providing access to demographic data for past participants, contact information for students, parents, and mentors for had participated in the program, finalizing the survey questions (advisory board members all assisted with this) and assisting us with getting the Phase I survey out to the NSBE membership on a national level. The NSBE marketing team played a key role in our second round of survey outreach, which included providing sight on the marketing materials used for the survey outreach. Overall, the contributions of NSBE team members proved to be value-added in years 1 and 2 of the project. An example consists of ideas that the Director of research thought of potential future research related to informal engineering education programs, data collection, and longitudinal analysis linked to the SEEK program. or years 3 through 5 of the grants, our core research team will transition the meetings to once a month as the focus for year 3 is qualitative data collection and getting prepared for the development and execution of the education plan components of the CAREER grant.

b) Milestones

Survey Development and Administration

Phase I of the project entailed initial data collection and analysis. Prior to data collection, researchers, the advisory board, and NSBE collaborated to develop a survey designed for past nationwide SEEK participants. A thorough design, redesign, and review process was implemented to develop the survey using best practices. The survey was developed and deployed using Qualtrics.

Data from past SEEK participants, spanning from 2007-2019, were collected through the administration of an online survey via email. The survey comprised of Likert, open-ended, and closed questions to grasp an understanding of student and mentor experiences relevant to the impact SEEK had on their educational and professional pathways.

Pilot Testing

The initial survey developed for Phase I of the project was sent to SEEK participants who served as either a mentor, a student, or both within the program. Their feedback, along with feedback from the Advisory Board members, was used to make final changes to the survey before it went live for all individuals who qualified for the study.

Marketing and Participant Recruitment

The research team and NSBE team then worked together to design flyers to market the survey and participant recruitment. NSBE enabled connection to past SEEK participants. The survey was shared via email, NSBE, and the social media platforms of researchers. These efforts were also supported by the PI via their individual social media accounts and through their research lab social media accounts (i.e. Twitter – X).

Data Storage and Analysis

The data collected from survey administration was stored in secure devices accessible only by the research team in accordance with IRB regulations. University researchers conducted initial analyses of the collected data and conducted short presentations to the NSBE team. The initial analyses were conducted on data collected from responses to the quantitative questions. Data was collected using Qualtrics and analyzed using Microsoft Excel, PowerBI, and IBM SPSS. All data

was presented in an aggregate form to ensure that there was no identifiable information in the reports.

Roadmap Diagram

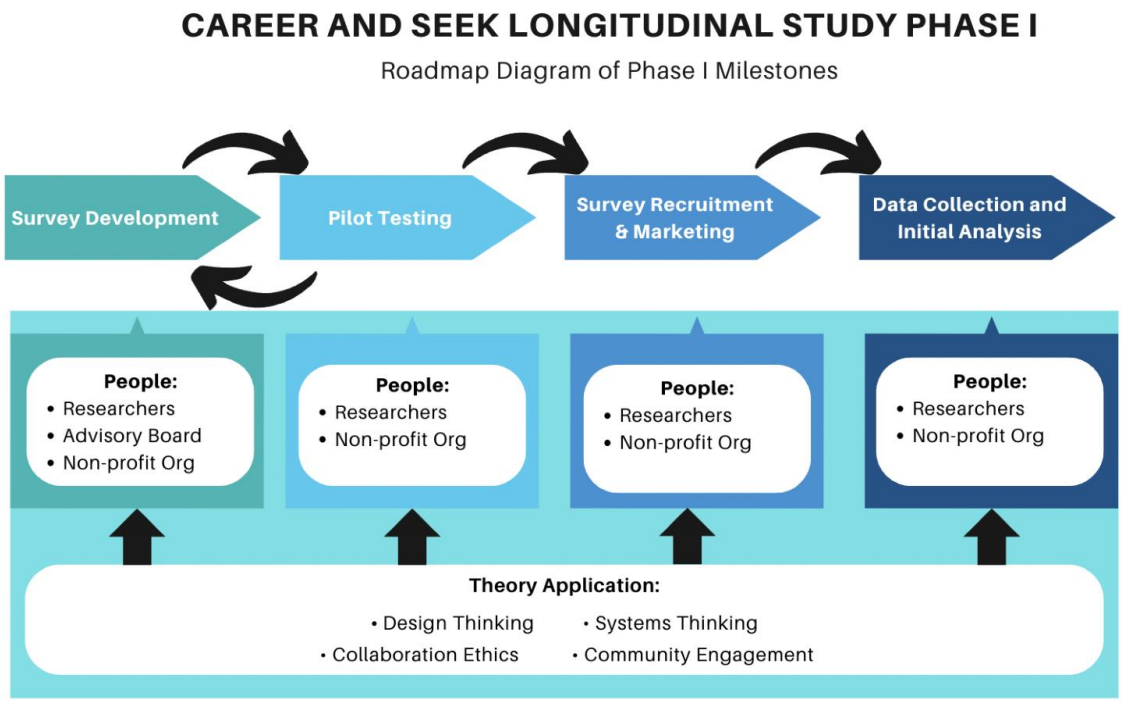

Diagram 1: This simplistic roadmap diagram depicts various milestones and the flow of achieving them, as well as the people involved and the theoretical concepts, we applied to immensely support the success of phase I of the project. The arrows on the milestones indicate the directional flow and can be cyclic for pilot testing. The people involved in each step of the milestones are indicated. The arrows above the theory application indicate that each of the theoretical concepts supported each of the milestones and the respective people groups involved. Each of the theoretical concepts in our roadmap diagram, as well as how they were applied in practice through our project are discussed in detail below.

Application of Theoretical Principles in Practice

Design Thinking

In the 1970s, the principles of design thinking began to emerge. Herbert Simon, in his 1969 book, "The Sciences of the Artificial," described design as a way of thinking. The term design thinking was coined by David Kelley in 1978 to encapsulate the thought processes and mindsets relevant to the design process. In 1992, scholar Richard Buchanan discussed design thinking as a science that should be aimed at integrating multiple disciplines to gather a holistic lens rather than working in isolation. Larsson (2003, p. 1) defines design as "as much a matter of getting different people to share a common perspective, to agree on the most significant issues, and to shape consensus on what must be done next, as it is a matter of concept formation." Historically, Bene and McNeilly (2020) argue that the discipline of Design Thinking (DT) had been restricted to specific industries,

such as engineering, architecture, industrial design, and software development, where it has been employed to create products, structures, and processes for individuals, involving gathering input and feedback from clients throughout the numerous iterations and refinements of the design process. Today, we find that, the theoretical foundation for design thinking is rooted in a variety of disciplines, including engineering and social sciences, which enables complex problem-solving through alternative, creative, and innovative ways (Foster, 2021; Buchanan, 1992; Dam & Siang, 2018; Huppatz, 2015, Razouk & Shoute, 2012). The integration of multiple viewpoints and the synergy of collective creativity are essential components that significantly enhance the effectiveness of Design Thinking (IDEO, 2012). Design thinking continues to evolve with the widely accepted approach, which follows the order of empathize, define, ideate, prototype, and test. This process is cyclic and continues until an efficient solution is achieved. Jain (2015) posited that advocates for design thinking view it as a "method of creative action" that does not follow the scientific method but is more focused on the goals, solutions, and societal implications. In research, design thinkers spend most of their time brainstorming and working on a solution, which promotes a creative and entrepreneurial research process (Jain, 2015). The creative and exploratory nature of design thinking in research makes the research process rewarding and beneficial not only for the quality of the final solution but also for the researchers themselves, given the human-centered nature of design thinking.

Application of Design Thinking in Practice

We applied concepts from design thinking in our research in many ways. Some of them include expanding the team's perspectives, learning from failure, and iterating until success is met. It was very important that our team spend ample time brainstorming for different milestones of the project. The advisory board of experts and the PI were very much involved in initially steering the project in the right direction and having large group discussions with university researchers and NSBE team on how to implement different sections in the most feasible manner. For instance, when developing the survey, there were virtual meetings with at least eight members from the advisory board present ready to provide expert insights on various areas such as communication and data analysis strategies. Having a group of experts with diverse skills and experiences helped to expand the team's perspective on achieving the phase I milestones of the project. Pilot testing the survey helped the research team to learn from failures. For example, when testing the survey found that it was necessary to make various questions mandatory so that our data can be more accurate. Building and testing the survey were done with a wide variety of perspectives and with iteration to get the best results. There were multiple iterations or versions of the survey, until we presented it in a human-centric design way for participants and got the only necessary data for the project. Overall, PI (team leader) fostered a teamwide mindset of creative action as the team worked together to achieve the milestones.

Systems Thinking

Similar to design thinking, system thinking also seeks a holistic approach to problem-solving but with the consideration of the intricacies of a system. Systems thinking examines the problem from a system's perspective by first understanding how the system works and how it can be improved (Miles, 2022). Cabrera et al. (2023) discussed the four waves of systems thinking history. The first wave occurred in the 1950s when it sought to objectify and quantify real-world systems. The second wave took place in the 1970s and was described as critical of the first wave, where more qualitative and interconnectedness of human and technical factors were incorporated. The third

wave (in the 1970s) focused on critical social theory to consider power relations and methodological pluralism. Lastly, the fourth wave (from the 2000s to the present) considered the oneness of social and cognitive structures and continued to develop connections between the mind and nature, which facilitates opportunities to advance the field. In education research, systems thinking is often associated with action research that aims to improve methods and support reflections on practices and approaches. Using the systems thinking approach to our longitudinal analysis studies, researchers can continuously reflect on and refine various aspects of the research project to leverage opportunities while considering systemic constraints.

Application of Systems Thinking in Practice

In terms of systems thinking in our research, the project's design was planned out by the PI and advisory board to facilitate a system that encompasses room for design thinking and iteration, as well as shared and cross-collaborative communication and access to resources for necessary parties within the team. How the team handled time, resources, and communication was vital as we applied concepts from systems thinking in our research. Regarding time management, we went with the mundane method of setting deadlines for deliverables for multiple tasks. When deadlines were set, the intricacies of everyone's schedules were considered, given that the team worked virtually and was from diverse occupations and locations in the US. Therefore, deadlines were announced and set way ahead to provide ample time for completion. Our team was also strategic in how we shared various resources among our team. This allowed for more efficiency in task completion. For instance, only our university researchers can edit the survey questions. If everyone in our team had access to editing the survey, this could have led to inefficiency. Therefore, as feedback was provided on the survey from the advisory board, NSBE team, and from pilot testing, the university researchers incorporated that feedback. Another important aspect of systems thinking is team communication. To ensure task accountability, the university meets weekly with the NSBE team to discuss progress and provide feedback and guidance on tasks for effectiveness. The PI also ensured that each team member had all the resources necessary to complete tasks. In one instance, this meant using the computer operating system that supports the various applications we used in our project. In general, the PI played a massive role in ensuring that all aspects of our research system were functional to support the efficient and effective completion of the project milestones.

Collaboration Ethics

Collaboration among researchers has become the standard practice, with independent work occurring infrequently. These collaborative efforts can enhance productivity and provide personal fulfillment; nevertheless, they also pose potential interpersonal and ethical challenges. Therefore, a set of principles governing their collaboration is necessary. As all interactions between individuals are mediated, it is crucial to identify the specific project that mediates a particular relationship and the ethical principles applicable to that relationship.

In general, collaborative work involves several communication risks, including cultural, individual, and disciplinary barriers. Another major risk in collaboration is choosing the right colleagues to work with. Roth (2007) discussed solidarity as a crucial aspect of collaborative research and defined solidarity as the team having something in common which encourages unity in a particular aspect, interest or aspiration. Collaborative ethics in the research context also entails the researcher-participant relations and whether both ends of the bargain are met. Roth (2007) also made an interesting point that in collaborative research, "the researcher and the researched" are united in the sense that they both agree to cooperate towards achieving a common goal. The

participants will not play a direct role in crafting the study; however, they will cooperate in a manner that facilitates the attainment of the study's objective. The highlight of that point is the notion of agreement. An agreement is often the result of a successful negotiation between two parties. Thereby implying that both parties understand and are satisfied with the agreement.

Henderson and Midgley (2010) suggest the development of strategies to maintain harmonious collaborations by identifying and examining the ethical concerns that may arise in one's research context or within a potential research team. To achieve this, team members are encouraged to reflect on the distinct interpersonal aspects of their research environment. It is recommended that if one is part of an existing team, they engage in conversations with their colleagues about these ethical concerns to explore ways to address these issues. This may include the establishment of clear guidelines on authorship, conflict resolution, and team membership.

Application of Collaboration Ethics in Practice

In our research, collaboration ethics involved playing to each team member's strengths, supporting diverse backgrounds and perspectives, compensating team members for their hard work and expert advice, and involving necessary parties in various parts of the project. Playing to the strengths of each team member was a very common theme throughout executing the milestones. In the initial phases of the survey development, there were virtual meetings with the university researchers and the advisory board, where breakout rooms were set up according to each team member's strengths so that the team could focus only on specific sub-tasks that matched their expertise. Together, the team supported and appreciated learning from each other's expertise, and everyone's contributions to the survey were considered and incorporated. Someone might have pinpointed an error or thought that was overlooked, and through these collaborative efforts, we were able to complete our milestones. Additionally, the advisory board and NSBE team had monetary compensation (as shared within the NSBE Team overview) for their time and expertise. This ensured that all parties were satisfied. Also, it is noteworthy that the NSBE team collaborated on aspects of the project during years 1 and 2. This was important for our collaborative ethics since the university researchers worked directly with data and impact relative to NSBE (non-profit organization). Please see the NSBE Team overview earlier in the paper for more information.

Community Engagement

Bringle and Hatcher (2002, p. 5) define community engagement as "the partnership of college and university knowledge and resources with those of the public and private sectors to enrich scholarship, research, and creative activity; enhance curriculum, teaching, and learning; prepare educated, engaged citizens; strengthen democratic values and civic responsibility; address critical societal issues; and contribute to the public good." Muwanguzi et al. (2023, p. 121) demonstrate that the importance of community engagement in higher education institutions has grown significantly in recent years as these institutions strive to fulfill their mission of educating students and serving their communities through research. Accordingly, through collaboration, universities and communities can effectively investigate critical social, economic, and environmental issues, while simultaneously offering valuable practical experiences and hands-on training in their respective fields of study. Gibbons et al. (1994) argue that the emphasis on engagement as a core value of the university reflects a fundamental epistemological position that underpins the shift in the locus of education to include the community. This raises significant questions about the construction of knowledge and what is deemed as valid knowledge within the academic sphere. It represents a departure from traditional academic knowledge generation, which is characterized by

pure, disciplinary, homogeneous, expert-led, supply-driven, hierarchical, peer-reviewed, and predominantly university-based practices, to engaged knowledge generation, which is characterized by applied, problem-centered, transdisciplinary, heterogeneous, hybrid, demand-driven, entrepreneurial, network-embedded, and other practices.

Application of Community Engagement in Practice

Community engagement was vital for the execution of our project, given that it is directly related to a non-profit organization. Community engagement builds upon collaboration ethics and stresses the importance of engaging with necessary stakeholders during project work. The significance of community engagement in our research cannot be stressed enough. It has implications for broadening the scope of academic research, lending to the practical implications of academia, connecting university researchers with the real-world experience of research participants, and expanding the voice of research beyond academia to people from various walks of life embodying different experiences. The broadening of academic research from formal spaces to informal spaces is vital for understanding the long-term practical implications of academia on an individual, especially regarding their career trajectory. Community engagement in our research with NSBE allows for gaining those kinds of greater insights. It also expands the voice of university research because the non-profit organization (NSBE) was actively involved in all phases and milestones of the study, allowing for a more practical and community-centered perspective and methods in research. Another aspect of community engagement tackled in the research was having potential participants' feedback on the survey's design through pilot testing, thereby not limiting the research activities to the university researchers and experts.

Lessons Learned

- One of the key lessons learned is holding space for iterative design. This means that in cross-collaborative projects like this, design thinking can be actualized by adopting a fail-first approach that allows for constant testing, feedback, redesigning, and rethinking implementation methods. The entire team, having this open mindset, allowed us to achieve our goals efficiently and purposefully, given that we could learn from failures. An example of this was previously mentioned where our situation of making certain questions in our survey mandatory was described.
- It is important to plan for design thinking and how it will affect the overall system of people and tasks involved in the project execution. Understanding the people in terms of their expertise and availability involved is crucial for any project and will certainly contribute to the effective and efficient execution of tasks. Additionally, being aware of the resources they need to complete tasks and foster communication also plays a substantial role in a successful project execution. An instance of this can be observed where we described technology compatibility issues with various software tools and our PI making sure all these system requirements, both technical and social, are met and resources are distributed with equity. These are all key areas that need to be planned for upfront to facilitate system thinking in collaborative research.
- Another mark of success is incorporating the NSBE (the non-profit organization) in all aspects of the project. The team was able to receive the support needed in terms of reaching the participants and keeping to the rules and regulations of the organization. This allows for full transparency between the university researcher and the non-profit organization.

Engaging experts from diverse fields also played a major role in ensuring the quality and robustness of products.

Implications and Future Work

Our findings highlight that there is an opportunity to increase knowledge within engineering and computing education to advance our knowledge of best practices when collaborating on research grants. Even though we focused on non-profit collaborators, general insights gained from our roadmap and application of the highlighted theories to practice can be useful to university researchers who wish to collaborate with industry, government, and other organizations in observing the benefits of applying theoretical constructs to practice. Particularly, when incorporating varying individuals across multiple higher education institutions in the public and private sectors, this work is rare, primarily due to not being required by many funders, to explain and map the process as you navigate through the life of a funded grant. Our findings highlight knowledge that can be gained to help current and future researchers as they navigate through their proposed goals, objectives, and outcomes within the grants that were submitted, especially those approved and funded by grantors. Based on findings from the literature, there is a need to explore how resource management and systematic thinking within the context of executing goals should be further researched as they are directly tied to engineering and computing education research. There is an opportunity to utilize theoretical and conceptual frameworks from management-related research within engineering and computing education research to achieve this goal.

Conclusion

We demonstrate the realities and practicality of conducting a collaborative research process and bridging gaps between theory and practice, and this is a common principle communicated throughout the paper. With a cross-collaborative project of this magnitude, a decision/systems-thinking approach has proven fruitful in executing phase I of the project. As demands for solving problems through research and/or practice increase, understanding how to develop quality collaborative approaches has also increased. This is even more important when collaborations, undergirded in communication and shared ethical principles, involve varying stakeholders across industries, such as in this case where university researchers, non-profit representatives, and industry partners come together in decision-making participation. This paper highlighted all the best practices, challenges, and areas of opportunities for utilizing such an approach during the ongoing life of the work.

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