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An NSF AGEP Program's Unintended Effect on Broadening Participation: Transforming "Non-STEM" Graduate Students into Engineering Education Faculty, Researchers, K-12 Educators, and Advocates

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Introduction

The National Science Foundation's Alliances for Graduate Education and the Professoriate (AGEP) program has a focus on increasing the numbers of underrepresented minorities (URM) who will get STEM PhDs and go on to become professors and enhance the nation's competitiveness.[1] By examining the roles that graduate student AGEP participants from disciplines other than science, technology, engineering, and mathematics (STEM) play in engineering education in general, and to become engineering education faculty, researchers and advocates in particular, it is imperative to know and understand the motives which drive this phenomena.

Historically serving students within STEM fields, the AGEP for our state, PROMISE: Maryland's AGEP, has taken the initiative to broaden its reach to include participants from various disciplines that include science, education, and the humanities, in addition to opening up professional development activities to all graduate students regardless of race, class, discipline and culture. Founded in late 2002, with programmatic activities beginning in 2003, the PROMISE AGEP was led by one of the universities that had special emphases on diverse student recruitment and retention in STEM fields, with partnerships with the state's flagship campus, and the medical campus.[2] These schools, the University of Maryland Baltimore County (UMBC), the University of Maryland College Park (UMCP), and the University of Maryland Baltimore (UMB), are institutions within the University System of Maryland. The effort to broaden the participation of the AGEP was initially viewed as an anomaly, as programs that are designed to attend to students in science, technology, engineering, and math, are generally restricted to those disciplines. The choice to include students from all disciplines, was based on a few factors:

1. Enrollment and retention data from the three initial campuses that comprised the PROMISE AGEP: The numbers of graduate students from underrepresented minority backgrounds (African-American, Hispanic/Latino, Native American/American Indian/Native Alaskan, Native Hawaiian/Pacific-Islander) from all fields, and from all three universities, was already low. Our leadership teams on the three campuses did not want to alienate any students of color, and wanted the AGEP program to be viewed as a resource for all graduate students of color. The sub-phrase, "it takes a village" was frequently cited in meetings, with the recognition that we needed to facilitate strong connections between students from all disciplines.

2. Students from other disciplines asked to participate: In April 2003, the PROMISE AGEP operation consisted of a leadership team, an NSF proposal, a director, and an empty office. A listserv email had been distributed to the graduate students, indicating that there was a newAGEP program that supported students who were in STEM fields. The first student who came to ask for a broader reach was from the the lead university, UMBC'sDepartment of Public Policy. As we invited more students to be involved, we learned that some of the students from the other fields even had peripheral interests in STEM. This student from Public Policy later received funding

from the National Institutes of Health because his research had biological implications, and we later learned that his younger brother was interested in engineering.

3. Historical experience from the National Society of Black Engineers (NSBE): One of the authors from this paper recalls her experience in a collegiate chapter of the National Society of Black Engineers that allowed students from the humanities and other fields to participate, since they were looking for places and spaces to connect with other academics of color. Similarly, there were students outside of engineering who participated in the annual national conference of NSBE. These students who were not in engineering, while interested in their own desires to connect, also served as vigorous supporters of the engineering students.

These three items suggest that a factor for inclusion can be bidirectional. Students of color from all disciplines want to be supported, and students of color from all disciplines provide support to others, regardless of the discipline. The PROMISE AGEP for Maryland is now in a transformation phase, and is part of the "AGEP-T" group of institutions that is seeking to increase the numbers and diversity of graduate students in STEM who go on to academic careers. Our AGEP now includes all 12 institutions from the University System of Maryland, and our data and experiences with the program show that while students have pride in their disciplines, they are not territorial, and they show strong support for the achievements of others.

Inclusion provides a sense of community and critical mass of scholars for the URM STEM students. The numbers of URM graduate students in STEM is low, and the numbers of URM graduate students in engineering and IT fields is abysmal. According to the National Science Foundation's report for the National Center for Science and Engineering Statistics, there were 77,301 engineering graduate students in 2012, of which 63.9% were white, and 13.3% were comprised of a combination of URM graduate students from Hispanic or Latino, American Indian or Alaska Native, Black or African American, and Native Hawaiian or Other Pacific Islander groups.[3] Due to the low numbers of URM graduate students in STEM fields and engineering disciplines, our AGEP has included students from other disciplines to foster a sense of community. This practice of including people from several backgrounds and disciplines in the PROMISE AGEP's activities has yielded an interesting and unintended effect on the career trajectories of the non-STEM participants.

Using data from 10 non-STEM PROMISE AGEP alumni who served as "representative informants," our phenomenological study examines the PROMISE AGEP's allowances for connection with students from engineering disciplines, the program's influence on their sense of commitment to the PROMISE AGEP program and their non-STEM discipline, their feelings of safety (physical, psychological, emotional, professional) as they participated, the extent to which they provide a safe atmosphere for those whom they now mentor, and how the PROMISE AGEP met their needs. In addition, we propose that the PROMISE AGEP's adherence to the Psychological Sense of Community (PSOC) model provides a community psychology perspective on factors that influence our non-STEM participants to become engineering educators.[4]

Background

The National Science Foundation's Alliances for Graduate Education and the Professoriate (AGEP) program on the national level is intended to increase significantly the number of domestic students receiving doctoral degrees in the sciences, technology, engineering, and mathematics (STEM), with special emphasis on those population groups underrepresented in these fields (i.e., African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians or other Pacific Islanders). In addition, the AGEP is particularly interested in increasing the number of minorities who will enter the professoriate in these disciplines. Specific objectives of the AGEP program are (1) to develop and implement innovative models for recruiting, mentoring, and retaining minority students in STEM doctoral programs, and (2) to develop effective strategies for identifying and supporting underrepresented minorities who want to pursue academic careers.

There are no studies of which the authors are aware that demonstrate the unintended effect that transform non-STEM graduate students into engineering education faculty, researchers, K-12 educators, and advocates. However, utilizing McMillan and Chavis' (1986) PSOC, we have been able to integrate and offer the possibility to demonstrate why this unintended effect is occurring with non-STEM participants in the PROMISE AGEP. Use of the PSOC model as a conceptual framework for the PROMISE AGEP is an example of an "unintended effect." PSOC was introduced to PROMISE: Maryland's AGEP by a former graduate student in Psychology who had an advisor who studied PSOC with nested communities, sub- and macro- community support, in the context of diversity and social justice.[5, 17]

The PSOC model, which examines membership, influence, integration, fulfillment of needs, and shared emotional connections, is a model typically applied within living communities.[6, 4] However, more recently, PSOC has been applied within academic and professional environments such as colleges and universities, as well as internship experiences and other pre-professional contexts.[7] The PSOC framework lends itself well to such applications because these are contexts in which participants tend to be heavily engaged, and in which they are continually developing a sense of their personal identity within a broader social culture which is perceived to heavily impact their opportunities to succeed.[4]

For example, in their review, McMillan and Chavis (1986) noted that the then-current sense of community research highlighted the structural factors of "informal interaction (with neighbors), safety (having a good place to live), pro-urbanism (privacy, anonymity), neighboring preferences (preference for frequent neighbor interaction), and localism (opinions and a desire to participate in neighborhood affairs)" (p. 6). Based on these factors, the authors proposed that sense of community is comprised of four themes: membership, influence, integration and fulfillment of needs, and a shared emotional connection. Membership is the aspect of belongingness that accompanies healthy communities. Influence is the both the feeling of having significant impact on the community as well as the value or significance of the community for its members. Integration and fulfillment of needs comprises the resources - physical and psychological - that serve to reinforce group members. Finally, shared emotional connection is the commitment that members have to one another, resulting from and contributing to their shared spaces, experiences, and time together.

Within relational communities such as professional groups, which are not always associated with location or neighborhood (i.e., territory), the informal interactions that allow members to interact in a social capacity beyond their structured educational regimen have been found to establish not only a preference for more interaction and a feeling of emotional safety, but these have also predicted future continued participation - or localism - and a sense of being known or a significant part of the community (seen as the opposite of pro-urbanism).[8] Specifically within our AGEP, we noticed an outgrowth of professional and social connections that began with a program structure that deliberately combined professional development for the academy along with community-building components. Examples from our professional development community include concepts of "bondedness," being connected to other members of the community, and "rootedness," commitment to staying within the community, which fit the PSOC model.

The PSOC framework also contributes to our study in its consideration of contextual factors such as economic access. Members of disadvantaged communities, those most likely to be especially vulnerable to detrimental effects on their social identities, interpersonal relationships, and their overall ability to make progress toward professional and personal gains, also tend to feel less psychologically empowered, (i.e., they feel less social support and a lowered sense of community compared to wealthy community members).[9] However, their experience is nuanced and can be understood further. Among those with the lowest income, participation in empowered communities is a stronger predictor of social support and sense of community than among high income members. In contrast, participation in communities and organizations tends to yield sociopolitical control - associated with effectiveness in accomplishing goals and having influence - to a greater degree among the wealthy. When considered jointly, however, the support and sense of connection achieved with greater participation in a supportive, effective community or organization has the potential to mediate the relations between involvement and empowerment for those who are economically disadvantaged. This strengthened connection might enhance opportunities for them to "flip the balance," such that community members with the least financial means can be the most helped in achieving influence and personal advancement over time.[9]

These outcomes are especially valuable for our PROMISE AGEP, which was designed to equalize the economic playing field such that participants of all social and economic backgrounds receive holistic support for professional and interpersonal connection. Participants in the AGEP who are in distressed circumstances are able to access guidance and means to continue their education and involvement in their graduate program and the PROMISE AGEP. The current study has examined the effects of the PROMISE AGEP's support in leading non-STEM professionals to become unlikely advocates for engineering education.

Methods

This study uses a phenomenological approach as its qualitative research method to study "phenomena." The method allows the authors to conduct a qualitative analysis of data, where we are placed as researchers to answer the question, "What is it like to experience one thing or another?" It is the aim of any researcher in general, and phenomenologists in particular to describe as accurately as possible the phenomenon that is being studied. According to the authors Welman and Kruger (1999, p.189), "the phenomenologists are concerned with understanding

social and psychological phenomena from the perspectives of the people involved.[10]" Ultimately, by examining multiple perspectives, according to Van Manen,[11] the researcher can start to form generalizations of what something specific is like as an insider. Using this particular methodology, Hycner observes that one cannot impose a specific method on the phenomenon to be researched, in that doing so, will diminish the honesty of the data. However, as with any qualitative methodology, phenomenology has guidelines that assist the researcher in getting at the essence of the phenomenon being described.[12]

With this specific set of data, the researchers followed Creswell,[13] and highlighted what stood out as "significant statements," sentences or quotes that provided an understanding of how the representative informants experienced the phenomenon being examined as they fit into the PSOC framework.[13] Next, the researchers developed "clusters of meanings" from the significant statements and quotes and identified themes among the text. In addition, the researchers wrote textual and structural descriptions that detailed what the representative informants experienced and how the context or setting influenced how the representative informants experienced the phenomenon. Finally, the researchers developed a composite description based upon the textual and structural descriptions that presents the essence of the phenomenon.[13]

Specifically, UMBC, the lead institution for our state-wide Maryland AGEP developed a website that solicited information from 20 representative informants via email to post to the website to observe responses of participants from the PROMISE AGEP graduate students and alumni who currently participate or have participated in the NSF AGEP program in Maryland, but had research and received graduate degrees in fields that are not traditionally considered STEM. From those 20 emailed representative informants, we utilized 10 responses. The use and limit of 10 responses provided us with enough information wherein no new data was being produced. In phenomenological terms, this effect is identified as data saturation.[14] In addition, we sought responses from PROMISE: Maryland's AGEP alumni in the social sciences. Representative informants were asked to share the field of study, in addition to leaving their responses to a set of guiding questions on the website set up for the study. Those guiding questions included:

1. What did you know about STEM (in general, engineering in particular) research or advocacy before participating in the PROMISE AGEP?
2. Do you do any work, formal or informal with STEM research or advocacy?
3. How has the PROMISE AGEP influenced your participation in STEM research or advocacy?
4. Are you working in an area of STEM research of advocacy now?
5. Do you have any plans to do any work in STEM research or advocacy in the future?

Representative informants were chosen by using homogeneous sampling, which is a purposive sampling technique,[14] which according to Welman and Kruger[10] is the most important kind of non-probability sampling. The selection of the representative informants being homogeneous was made based upon those individuals having had experiences related to the phenomenon that we were researching.[16] In addition, with homogenous sampling, variation is reduced and analysis of information is made simpler.[14]

Similarly, the use of phenomenology as a research method for our study was imperative in that it gave us the opportunity to gather meaning from several individuals based on their "...lived experiences of a concept or a phenomenon."[13] This method best suited our means of data collection and further data analysis, because it allowed us to collect data from individuals who represented non-STEM graduates and allowed us to develop a "composite description of the essence of the experience for all of the individuals involved."[13] As such, it allowed the data analysis process to be an "interpretive process,"[13] in which the researchers were able to make an interpretation of the meaning of the lived experience of the representative informants. In addition, the specific qualitative methodology of phenomenology allowed for the assessment of a small sample size.

Results

Our unintended, positive discoveries demonstrate "transformative change,"[16] in which the interplay between educational research and practice via exposure to STEM development programs has led to cross-disciplinary skills, relationships, and mentorship that benefit engineering education. To identify whether or not PROMISE: Maryland's AGEP adhered to the PSOC model and provided the unintended effect of broadening STEM participation among non-STEM alumni, we analyzed the 10 representative informants' responses from the website that the researcher's set up. Those 10 representative informant responses were coded twice by two separate coders to ensure inter-coder reliability using the PSOC framework as guiding themes. Table 1 provides a summary of the 10 participants' degrees, and ways in which they have contributed to the STEM enterprise. The summary in the table shows Ph.D. alumni and current graduate students from education and humanities fields, all within a College of Education, or a College of Arts, Humanities, and Social Sciences within our state. None of the respondents had graduate programs from a college that housed an engineering discipline.

Table 1: Examples of 10 PROMISE AGEP participants from the humanities and education disciplines who participated in PROMISE: Maryland's AGEP as graduate students, who have engaged in STEM advocacy in general, and support of engineering in particular.

Subject	Discipline of degrees	Professional or personal advocacy for STEM, post AGEP participation, during and/or after graduate school (includes current positions)
1	Higher Education Administration (PhD)	Professor, conducting research on minority males in engineering; publishes in conference proceedings for the American Society for Engineering Education (ASEE), and the Journal of Engineering Education
2	Instructional Systems Development (MA), Instructional Design and Technology - School of Education (PhD candidate)	Researcher in technology, contributor to literature and knowledge base for engineering education; has published work in conference proceedings for ASEE and the Latin and Caribbean Consortium of Engineering Education Institutions (LACCEI)

3	Language, Literacy, and Culture (PhD)	Researcher at the CONICET (Argentina). The National Scientific and Technical Research Council (CONICET) is the main organization in charge of the promotion of Science and Technology in Argentina.
4	American Studies (PhD)	For the past three years, worked as a program coordinator then a teacher at a STEM high school in a large urban area with a population that is 99% African-American; Worked with institutions such as US FIRST Robotics Competition as part of the job as the program coordinator for the Office of Out-of-School-Time, the program provided students with rigorous hands-on skills development in engineering; presided over our school's partnership with the ACE (Architecture, Construction and Engineering) Mentors Program, which brought professionals in these fields to our school to work with high school students and mentor them in learning and gaining hands-on exposure to these fields.
5	Higher Education, Student Affairs, and International Education Policy (PhD)	Assistant to the Superintendent of a county school system, Officer of Diversity, Latina/o Affairs
6	Human Development, emphasis on reading and literacy (PhD)	Assistant professor of education, coordinator of STEM education for teacher preparation; currently planning a collaborative proposal with other faculty and administrators for a STEM Center at the request of the institution. Over the course of the last two years, collaborated with faculty in Engineering to write grant proposals for programs that would provide professional development for teachers in Washington DC in Science and Engineering. Also volunteered for an organization that works with teachers to create NGSS aligned curriculum for the DC Public School district.
7	Language, Literacy, and Culture (LLC), PhD Candidate	Familiar with STEM, engineering in particular (spouse and close friends are engineers); was a college administrator for close to 10 years prior to entering the LLC PhD program; intends to teach and will inevitably have STEM students in courses; hopes that interactions with those students will continue to encourage them to focus on their successful graduation in a STEM field while incorporating the things they have learned from my courses.

8	Early Childhood Special Education (PhD)	Prior to involvement in the AGEP, was not aware of the low representation of minorities in STEM in higher education; became acutely aware of the importance on increasing awareness as a Graduate Assistant in the AGEP office; infused science, technology, engineering and math into her own research; currently a Research Associate and coordinator for a county-wide education program; suggested and guided several doctoral students to focus on the programs offered in the various counties that promote and encourage participation in STEM activities; currently discussing the potential for research with the administrators of two private school chains, which embed STEM into the curriculum; participation in the AGEP significantly changed the supervision of "Early Childhood Student Teacher Interns" due to advocacy of technology to assist students with disabilities, teaches trainees about the ease of integrating scientific, technological, mathematics and engineering terms into the curriculum.
9	African-American History	Founded a newsletter for the AGEP program as a graduate student which profiled URM engineering student achievement; current English professor at a university, working with students on their writing and critical thinking skills and laying the groundwork for students, including students majoring in STEM; Informally advises students of color from STEM fields who seek advice based on cultural connections; Shares information on STEM with family and friends who have interests in biology and technical careers.
10	Language, Literacy, and Culture, PhD Candidate	Provides professional development for participants in the Black Engineer of the Year national conference.

Table 2 below provides the major categories presented in the PSOC framework, brief definitions and key terms, and descriptive quantitative results of the number of responses that fit within each category. The information presented in the table showcases results, which are discussed below with examples of each category provided in participants' own words.

Table 2: Results of phenomena observed in "non-STEM" data, based upon PSOC framework

Categories (McMillan & Chavis, 1986)	Short definition	Key terms	Results
Membership	Belongingness	Boundaries, emotional safety, sense of belonging and identification, personal investment, common symbol system	11 mentions by 6 respondents
Influence	Impact by members on the group, and impact on members of group by the organization	Feeling influential draws one to community; community encourages conformity, cohesiveness; conformity a source of closeness, internal drive for "consensual validation" (p. 12) - so influence is bidirectional between community and individuals	17 mentions by 9 respondents
Integration and Fulfillment of Needs	Physical and psychological resources	Reinforcement and need fulfillment equals strong community; status, success, competence functions of community; shared individual values, organized and prioritized; good fit among members, own and others' needs met	10 mentions by 7 respondents
Shared Emotional Connection	Commitment to and belief in other members' shared experience, spaces, history.	Shared history identification; contact hypothesis; quality of interaction; closure to events; shared valent event hypothesis; investment; effect of honor and humiliation on community members; spiritual bond	4 mentions by 3 respondents

We found several themes across the respondents that fit the PSOC model - all mentioned experiences in the AGEP that corresponded to the category of influence. Influence was, in fact, the most mentioned of all four major categories, with 17 mentions. It was mentioned by 9 out of 10 respondents. Examples of experiences involving influence include:

> So, I am actually supporting STEM by helping them to become better writers for the field. I can also say that I have be-friended a graduate student of color in biology that was a little lost in her new department. So, I have been advising her based on what I learned about STEM, about funding sources, and other necessary resources through the AGEP program in our state.

Another respondent stated:

> As Research Associate and coordinator of four Maryland School County Education Doctorate’s I have suggested guided several doctoral students to focus on the programs offered in the various counties that promote and encourage participation in STEM

> activities. Suggestions have ranged from looking at curriculum, earned grades, and so on across various levels of the county school system.

The next most common category was membership, with 11 separate mentions across all respondents.6 out of the 10 respondents made statements that corresponded with the membership category. Examples of this included was when one respondent stated "I can't remember how I learned about our state's AGEP, but I do remember checking to make sure that it was ok for me to participate, being in the field of education." In addition, another example that was similar across all of those whom fell into the membership stated:

> I distinctly wanted to be involved as I had little interaction with peers in my previous graduate programs. At the welcome dinner I had the opportunity to meet faculty of color as well as students in a variety of programs and departments on campus. This initial meeting and interaction provided the environment for me to meet my future mentors and form friendships that have been instrumental in my success as a student

.

The third most frequently mentioned category was integration and fulfillment of needs with 10 separate total mentions 7 out of the 10 respondents referred to experiences that fit this category. Examples include:

> So, not only was I a participant and mentor, I had a solid understanding of the mission through my work planning and helping to implement the workshops, research symposia, and conferences hosted by PROMISE. I attended nearly every event. I even wrote and edited a newsletter in which I interviewed STEM students, featuring them and their success. STEM students across all three University of Maryland campuses were my friends — we talked, wrote, and socialized together. We attended conferences together. Because of this, I am well versed in STEM and the resources that support STEM students. I am able to share that information with nieces and nephews interested in biology and technical careers, with friends children with engineering majors, and with students here at my university.

Finally, the least mentioned category was shared emotional connection with 4 total mentions across respondents and 3 respondents out of 10 made statements that fit this category. Examples of their relevant statements include:

> I plan to continue working in the areas mentioned above, and hope to expand my research to some international studies in STEM Education. I hope to use my experiences to improve the preparation of teachers in STEM, and to advocate for strong STEM curriculum at the grade school and university levels.

In addition, another respondent stated, 'In many ways PROMISE created the structure to help one another, uplift one another, learn from one another and to this day (beyond graduation), remain connected to one another."

Discussion

It is important to note that while coding, the researchers only made one code per statement rather than including multiple codes. This was done to keep the data simple given the length of the responses. However, the majority of the statements did contain multiple categories. This is important to consider since the PSOC framework's categories are not mutually exclusive. On the contrary, they tend to be correlated, so, for example, the influence that an organization or community can have on a member can also improve feelings of connectedness and address emotional needs. Overall, the members of the PROMISE AGEP emphasized both the effects that the program had on their opportunities and professional development, as well as the impact that they were able to have on others.

The authors of this paper have research backgrounds in engineering, sociology, and human development. Human development is not a traditional STEM field, and at the University of Maryland College Park, the flagship university for our state, the department that houses this discipline is now called the Department of Human Development and Quantitative Methodology, and is within the College of Education. This co-author shares her own experiences, and they are similar to those in our sample. She says the following:

> I didn't know a whole lot about the demands of STEM research or advocacy before participating in the AGEP. Prior to my grad studies in education, I was a biology major - briefly - in a living-learning program for STEM that included engineering components. However, I never developed an identity in the sciences. The living-learning program was still developing and did not understand how to help me identify with the STEM goals in a way that made me feel included. Eventually, our group project focused on education, and I didn't think much about STEM or engineering again until I interacted with other graduate students in the AGEP who loved what they did. As a direct result of my participation in the AGEP - attending workshops and retreats that address the demands and opportunities of STEM practice and research - I am able to speak some of the language of engineers and engineering educators, and I can connect with them on common issues. In particular, I am aware of challenges for underrepresented groups for opportunity selection, advancement, and promotion.

The co-author also discusses learning from others in engineering, and the influence of the interactions on current advocacy and efficiency in a career that focuses on professional development for faculty.

> My graduate accountability partner was a mechanical engineering student who shared a lot of my same struggles but also taught me about what she did as an engineer and how she had to push to get help from her advisor. I met her at an AGEP dissertation completion retreat and was introduced to her deliberately by one of the dissertation coaches. I might never have spoken with her on a deep level otherwise, even though we were sitting in the same room for three days. I also connected over the past year with a faculty member in STEM who invited me to work with him on a needs assessment of his research program. I learned about the research framework that his team used and our conversations led to my contributing several considerations for the developing assessment. He also challenged me to outline my own research agenda, which I still

> pursue, so our interaction was mutually beneficial. I have therefore focused many of my interactions on creating better opportunities for STEM students and faculty to create a professional system around themselves that pushes them forward, similar to our state's AGEP as the original best-practice model. This system includes accountability for goal-directed productivity, relaxing social outlets, high expectations for achievement, and effective decision-making based around holistic ideals that keep one balanced in both career and life in general.

Like others who participated in our survey, one of our co-authors who was not in a traditional STEM field, and received a PhD from a College of Education, is currently working with engineers through professional development research and program coordination. She describes her work as follows:

> My current work is with faculty who span all disciplines at my university. I have to be able to command the respect of students and faculty in biochemistry, computer science, and electrical engineering in order to help them improve their teaching practice. If I am able to present pedagogical research in their discipline. e.g., in journals that address the teaching of engineering specifically, then I am garnering the buy-in of my audience. I have been in their classrooms and professional development meetings, and my background in educational psychology alone would not be enough if I could not speak from experience of having learned from and studied with physicists and engineers who back up my expertise.

Our data also show that participants felt that they were able to engage in research that contributes to closing the gap between STEM fields and their discipline, which is traditionally outside of STEM. One participant noted that being involved in the AGEP facilitated an opportunity and desire to stay connected to the latest trends in instructional technology and software, which can be used to enhance the teaching and learning experience, as well as the professional development of faculty and students. We also had participants outside of the 10 respondents profiled here, who provided data showing that there were other connections that contributed in advocacy in STEM. For example, a researcher in Community and Applied Social Psychology has work that focuses on the efficacy of STEM programs (university, K-12, community) in increasing representation of URMs in STEM across educational levels, professions and institutions. This psychologist is conducting evaluation research on the adaptation of program to support URMs in STEM in two universities. Another researcher in the humanities had concentrations in gender and women's studies. While this researcher was neither in STEM nor a member of an underrepresented group, the work in gender and women's studies was used to inform processes and programs in our university's ADVANCE program for women faculty. The researcher participated in some of the programs of PROMISE as a graduate student, and has since conducted research in broadening participation in engineering, with contributions to the knowledge base and literature for the Women in Engineering Proactive Network (WEPAN), the Latin and Caribbean Consortium for Engineering Education Institutions (LACCEI), and the American Society for Engineering Education (ASEE).

Recommendations for Promoting Interactions Between STEM and Non-STEM Students

During the course of this research project, we've been asked some very important questions about interactions between STEM and Non-STEM graduate students that lead us to share the questions, and provide some answers by offering some recommendations for promoting interdisciplinary interaction. The questions are as follows: Do STEM students value the interactions with Non-STEM Students? What kinds of professional development activities attract diverse disciplines, and diverse ethnicities? How can positive interactions between the disciplines be promoted? The five recommendations and the discussion below include answers to these questions and provide steps that can be taken to develop an inclusive graduate student community on campus.

1. Institute a level of centralized, campus-wide professional development.
2. Develop seminars that contain content that all graduate students need such as public speaking, financial literacy, responsible conduct of research, academic integrity, tips for successful degree completion.
3. Invite the campus at large, contacting faculty and staff within the departments to let them know which aspects of the seminar are most beneficial for their students.
4. Promote positive interactions between the disciplines by collaborating with the graduate student association and graduate student senate, and having them assist with implementation of initiatives.
5. Offer the seminars and workshops annually, with a curriculum.

Many engineering departments have seminars or workshops that serve their students directly, but UMBC and the PROMISE AGEP at-large have found success with connecting the disciplines within colleges of engineering, humanities, and social sciences by developing a centralized unit within the graduate school that has responsibility for professional development for all graduate students. This "Graduate Student Development" unit at UMBC has authority to post campus-wide announcements, discuss opportunities and options with chairs, graduate program directors, and graduate program directors in all departments, and send notices to all graduate students. The campus-wide workshops also benefit from having a centralized, and regular facilitator for the workshops. While the speakers and panelists vary from event to event depending on the topic, each monthly workshop is facilitated by a person who opens the workshop with an introduction of the topic and speaker(s), assists with Q&A by acknowledging participants' departments, and closes the session. The facilitator also meets the students, and actively promotes introductions among the students to increase opportunities for networking. Activities are also widely advertised on social media platforms.

Seminars which have worked well for UMBC, UMCP, and UMB through the PROMISE Summer Success Institute (SSI),[2] which also attract underrepresented students, international students, and majority students from multiple disciplines, often serve students at a variety of levels, e.g., first year, M.S. thesis year, Ph.D. candidate. Some of the most popular PROMISE AGEP SSI workshops include the following: "Financial Essentials: Savings and Debt," offered by TIAA-CREF; "Making the Mental and Emotional Switch from Undergrad to Graduate School: A New World," offered by visiting faculty known as "Mentors-in-Residence;" and "The Dissertation House," which has been working with students from a variety of fields for nearly 10 years. Workshops such as these attract students from all demographics - various disciplines and ethnic groups, and the PROMISE AGEP has been able to build a sense of community among the

students who participate, even when the audiences have participants who have not attended other sessions.

Workshops and seminars need time to become embedded into the culture of departments and universities. Therefore we've taken time to promote the professional seminars and workshops at meetings of the various administrative councils and campus-wide meetings such as the UMBC University Retreat, and the UMBC Graduate Student Senate. In addition, upcoming workshops are on each monthly agenda of UMBC's meeting of the Graduate Program Directors. Further, select sessions for the both the PROMISE SSI and the UMBC Graduate Student Success Seminar Series (which are open to all graduate students within the University System of Maryland), are offered annually, which allow departments to plan for them and encourage students to attend. As an example, several departments include programs for The Dissertation House within their materials for orientation, and promote the related seminars as resources that are endorsed by the department.

Formative evaluations from the seminars and workshops over the years show that both the STEM and Non-STEM students believe that the campus-wide approach contributes to a sense of community. The STEM students have noted that they appreciate learning about other research areas, and meeting people from other disciplines. Students have found that they are able to share in seeking the mutual goal of pursuing an advanced degree, but they are also able to learn more about one another's interest outside of campus.

The STEM and Non-STEM connections continue at the postdoctoral level in PROMISE and at UMBC where postdoctoral professional development sessions are also open to all disciplines. The postdoctoral fellows attend the seminars to learn, but also to connect to a community so that they don't feel isolated. STEM and Non-STEM postdocs attend seminars such as "The Postdoctoral Writing Suite," where they have a chance to work on manuscripts, "Understanding Your Reach," where they learn about increasing their scholarly network, "The Individual Development Plan (IDP)," and "Planning Your Career." The sessions that provide training for teaching opportunities also include students and postdocs from different disciplines. The PROF-it (Professors-in-Training) program, which is part of the PROMISE AGEP, covers broad topics such as "Learning Styles," "Developing a Curriculum," and "Developing a Teaching Portfolio." The postdocs have interactive discussion sessions where they discuss their perspectives on topics, based on their disciplines. Having several disciplines in the room promotes multidisciplinary approaches, and facilitating connections between the researchers from various areas has also led to the appreciation of rigorous research among the various disciplines. In some cases, we promote "academic inter-generational" workshops that group graduate students and postdoctoral fellows, but they still include a variety of disciplines. The conversations and interactions between scholars from several disciplines that evolve from these structured professional development events have led to both collaborations and friendships, which contribute to the sense of community to we sought to develop in the first place.

There may be some factors that predispose people who are not in STEM fields like the life sciences or engineering to become advocates for STEM if their research methodologies are similar. For example, students in the social sciences who are exposed to the scientific method can appreciate the science within STEM research at large. Engineering Education is one of those

fields that includes faculty who have a variety of backgrounds, including the humanities. Many of our Non-STEM participants had research in areas such as education, cultural competence, diversity, languages, history, and various forms of ethnic literature. Our research showed that scholars from different fields were attracted to seminars that provided a connection to a particular need, whether that need was community, or content knowledge, and they were attracted to events where they felt that they could build upon their knowledge and add value. Given support, encouragement to engage, and acknowledgment of their value to the STEM enterprise, the Non-STEM graduate students and postdoctoral fellows in our AGEP participated and became active mentors. As research becomes more interdisciplinary, Non-STEM scholars have even more opportunities to contribute to advances within the engineering disciplines. Relationships with these scholars can be cultivated during the "formative" graduate student years, which have the potential to lead to meaningful contributions later.

Limitations, Conclusions, and Future Directions

Using the qualitative method of phenomenology for this project posed several limitations. First, phenomenology does not produce generalizable data. It specifically examines a certain population. This is in part due to the small sample size and the researcher having the ability to say that these particular experiences were typical. Similarly, it is difficult to prevent and even detect the bias of the researcher. This comes into play when the researcher does not know when to input his or her experience.

Regarding the overall suitability of the framework, the PSOC model was very helpful for understanding the AGEP program's various levels of support on its members. In particular, as we analyzed the connections that developed among STEM and non-STEM community members, we saw evidence of all four broad model categories. The use of participants' own words ensured that their experience was documented with authenticity, minimizing the potential for researcher bias. Yet, their statements often included exact terms that are common to PSOC, such as how their needs were met through the AGEP program, how they were able to influence others and how the program influenced them, and overall, how their sense of being part of a community made all the difference in their participation in and commitment to STEM and engineering initiatives and advocacy, even for those with some previous exposure to STEM education.

The purpose of this project was to show that students who are not conducting research in STEM, or pursuing degrees in STEM disciplines, can become advocates for and contributors to the STEM enterprise if they are invited to participate or actively engage in STEM-based programs. So often, programs that are designed to support students in STEM are strictly limited to students in those disciplines. However, groups such as the National Society of Black Engineers (NS?BE), the Society for Hispanic Professional Engineers (SHPE), the American Indian Science and Engineering Society (AISES), and the National GEM Consortium have attracted students from disciplines other than science and engineering, especially on campuses where students are seeking cultural connections. In these cases, the desire to have a cultural connection may trump the desire to seek a professional connection. Further, when students are invited to participate in an organization based on a cultural or gender context, they may choose to engage regardless of the professional content. By promoting a culture of inclusion among students from all disciplines, and by welcoming students from all disciplines to participate in the PROMISE

AGEP, the participants in the program are exposed to the AGEP's mission and goals. The mission of the PROMISE AGEP for Maryland is to increase the numbers and diversity of graduate students in STEM who get a Ph.D. and go on to academic careers. The students who participate in the activities of the program, regardless of discipline or racial background, are privy to the mission and are invited to assist in fulfilling it. While they are not able to fulfill it directly given the nature of their backgrounds, they are able to contribute to the mission by providing encouragement and advocacy to others in the target population, i.e., URM in STEM.

A specific example of a future effort includes working with the teaching and learning centers at the universities in Maryland, such as the Teaching and Learning Transformation Center (TLTC) at the University of Maryland College Park, to support teaching practices in STEM and other disciplines. Both the TLTC at UMCP and the Faculty Development Center at UMBC have members of staff with faculty backgrounds in STEM and Non-STEM fields. A TLTC effort includes supporting STEM educational practices like helping teaching faculty to create opportunities for active, student-centered learning that accommodates diverse backgrounds, and creating contexts for their students to aspire to become researchers and faculty. This is one way to assist with repairing that proverbial leaky pipeline.There are also plans to connect engineering faculty with graduate students and colleagues who shares similar interests in teaching research at other universities The findings from this study indicate the necessity to continue to explore the relationship and impact that STEM has on other entities, whether intentional or unintentional. In addition, it would be useful to see if this phenomenon is bidirectional. Future studies could include other social science models to see if the essence of the phenomenon in those cases is as strong as we found here with our use PSOC. Similarly, future studies measuring the unintended effect of STEM participation on non-STEM alumni could use other sampling techniques (i.e., snowballing) and participants (i.e., focus groups or individual interviews).

In our case, the unintended effect of the PROMISE AGEP is that several students chose paths within their own careers that directly influence STEM recruitment and retention, which goes beyond the process of generally encouraging the success of their STEM graduate student peers. Table 1 shows that several of our "non-STEM" participants became educators with positions of leadership in their careers. As educators, the proliferation of sharing "STEM as a career option" has a multiplying effect, because our participants have been in positions that affect research conducted within "non-STEM" academic departments, collaborative and interdisciplinary university programs, developing streams of research within and between colleges on a campus, and K-12 school systems. This level of active engagement with the career, post-PhD, demonstrates that students outside of STEM should be invited to engage in STEM programs, because their involvement can have a multi-tiered effect: 1) encouragement of the success of their STEM peers based on perceptions of a psychological sense of community that were experienced during graduate school, and 2) personal and professional advocacy, and contributions to policy based on their developed perceptions of rootedness and bondedness to the mission, vision, and goals of broadening participation in STEM.

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