The University of Michigan's M-STEM Academies Program: Examining the Social Community of Future Engineers

Joi-Lynn Mondisa, Joanna Millunchick, Cinda Davis, Darryl Koch
University of Michigan
Ann Arbor, USA
jmondisa@umich.edu, joannamm@umich.edu, csdavis@umich.edu, koch@umich.edu

***Abstract*—A social community framework is used to examine the program elements of the University of Michigan's (UM) M-Engin Program, an undergraduate engineering mentoring program, to provide insights about its social community elements. At this initial research stage, a methodical analysis of the program data (e.g., analytics, features, elements, and artifacts) was performed to create a portfolio to begin to understand the role of social community within the M-Engin Program. From this research, we can learn how to better serve members of various program communities by identifying opportunities for improvement. Future research will include conducting informal interviews with the program's coordinators and surveying and interviewing program participants.**

Keywords—social community; mentoring; underrepresented students

I. INTRODUCTION

Over the next decade, the United States will need to produce approximately one million additional science, technology, engineering and mathematics (STEM) professionals to meet workforce demands [1, 2]. Existing undergraduate mentoring programs produce STEM graduates to help address this need [3-5]; yet there is a lack of understanding about how the elements and functions of these programs produce beneficial outcomes to increase the number of STEM professionals. One such example of this is the University of Michigan's (UM) STEM Academies Scholars Programs (M-STEM) Academy which is comprised of two undergraduate mentoring programs for underrepresented populations: M-Sci (for science majors) and M-Engin (for engineering majors). Within these programs, undergraduates are mentored, supported, and encouraged to persist in STEM fields to increase retention and graduation rates; yet there is a paucity of research about the communal aspects of the programs' elements that contribute to beneficial outcomes for participants.

Research studies indicate that mentoring programs may be conducive to creating social communities within the programs which may contribute to the successful retention and graduation rates of community members [5-8]. Similarly, the M-Engin Program may possess social community elements that assists in the persistence of program members in STEM fields. Specifically, the M-Engin Program may be comprised of elements that foster the academic and personal development of program members resulting in increased social support to produce beneficial short and long-term outcomes which comprise a social community among members. Subsequently, examining elements of undergraduate minority mentoring programs, such as the M-Engin Program, can help to identify ways to improve mentoring programs with the goal of creating more STEM professionals to increase and diversify the impending workforce.

In this research study, a social community framework [7, 9] is used to examine the program elements and participant outcomes of the M-Engin Program to provide insights about its social community and how to potentially increase the fostering of social community within the program. The study's research question is what insights can be gained in applying a social community framework to examining the program elements and participant outcomes and features of the UM M-Engin Program? Anticipated results will provide initial insights about what aspects of the M-Engin Program may be most beneficial and how might these aspects benefit program participants especially in fostering a social community. Ideally, future research will provide information about social community within the M-Engin Program in regards to what is working, why it is working, and how it is working.

II. THE HISTORY OF THE M-ENGIN PROGRAM

Driven by a desire to create a highly trained and diverse technical workforce, the University of Michigan launched the Michigan STEM (M-STEM) Academy in the summer of 2008 in a joint program between the College of Engineering and the College of Literature, Science, and the Arts [10]. Originally the M-STEM Academy initially focused on engineering students and later established the M-Bio Program (now called the M-Sci Program) and now designated M-Engin Program. M-STEM programs are modeled after the Meyerhoff Scholars Program at the University of Maryland, Baltimore County (UMBC), a nationally recognized mentoring program that provides talented STEM undergraduates with academic, financial, and personal support [11, 12].

The M-STEM Academy aims "to strengthen and diversify the cohort of students who receive their baccalaureate degrees in STEM with the ultimate goal of increasing the number and diversity of students who are well prepared to seek career opportunities or to pursue graduate or professional training in the STEM disciplines and then succeed in this new global economy." The M-Engin Program is designed to maximize the academic, personal, and professional success of students, with the goal of preparing them for the engineering global workforce.

M-STEM Scholars participate in a residential summer program to prepare them explicitly for the new expectations and requirements of rigorous college science courses. The summer program focuses especially on the quantitative and communication skills that are both so necessary in STEM disciplines. During the summer program M-STEM Scholars also participate in workshops on a wide range of topics critical to personal and professional success, as well as engage in community-building social activities. The goal of the summer program is to build a strong community of scholars that will establish the social and academic support networks essential for the future success of these students. Over the following two years, academic coaches closely monitor the progress of M-STEM Scholars and help with academic planning, success strategies, and personal challenges. Scholars participate in carefully-designed co-curricular activities to enrich their academic pursuits and they meet weekly in peer-led study groups associated with their science courses.

M-STEM Scholars also engage in research starting in their first or second semester, and participate in a paid research or internship experience during the summer between their first and sophomore years. M-STEM Academies faculty and staff also work closely with the UM's Office of Financial Aid and both colleges to identify additional scholarships for high-achieving M-STEM Scholars, potentially replacing the work-study awards and loans they might typically have received during their junior and senior years. M-STEM Scholars are also assigned high priority for scholarships funded from departmental endowments.

The M-Engin Program's programmatic outcomes such as grade point averages (GPAs) and retentions rates are well documented [10, 13, 14]; yet this research extends the line of inquiry to examining the role of social community in participant outcomes to help identify and address participants' needs and the role of specific program elements.

III. Conceptual Framework: Social Community

A social community is an environment where like-minded individuals engage in dynamic, multidirectional interactions that facilitate social support [7]. Specifically, minority mentoring programs have elements (e.g., program values, access to faculty and peers, formal and informal activities) which assist and encourage interactions among like-minded individuals. Consequently, social support is fostered among program members which produces beneficial participant outcomes (e.g., resiliency, communities of practice, social capital) for members. In using a social community (SC) framework to examine elements of the M-Engin Program, we can: 1) gain an understanding of the role of social community in the program and 2) identify beneficial program elements of minority mentoring programs to better design programs and increase cost-effective programming.

IV. Methods

This work-in-progress research involves using a conceptual framework (i.e., social community) to examine data about the UM M-Engin Program (e.g., program features, elements, and artifacts). Specifically, the data analyzed includes quantitative data about the program, published articles and the program website. Future data to be analyzed will include program learning analytics compiled by the program's directors and information gathered from informal interviews with program coordinators.

At this initial research stage, a methodical analysis of the program data was performed to create a portfolio of the program and to examine the program's elements through the lens of a social community framework. First, the researchers reviewed the M-STEM Academy Program website and identified elements about the program that aligned with categories of the social community framework. Then, salient articles about the M-Engin Program [10, 13-15] were reviewed and elements of the information were coded based on how they aligned with the components of the SC framework. Next, the coded elements were used to create questions that will be used to conduct informal interviews with the M-Engin Program coordinators to provide more in-depth details about the program. The questions relate to specific aspects of the SC framework and related program elements. Some questions about the program are:

1) How did you choose which components of the Meyerhoff Scholars Program to model the M-Engin Program after and why?

2) In what ways do you setup access to faculty and peers?

3) What are some of the difficulties in scheduling group activities? How do you deal with these difficulties?

4) Do you/how do you create institutional and faculty buy-in?

This initial research can help to identify program elements that align with the social community framework in preparation for applying the model in conducting future research.

V. Results

In examining several artifacts, articles, and details about the M-Engin Program with an SC framework, it appears that M-Engin has program elements and participant outcomes that align with the concept of social community, see Table 1.

TABLE I. Portfolio Analysis of the M-Engin Program using a Social Community Framework

Program Elements	**Portfolio Categories**	
	Definitions [7]	***Examples of these elements in the M-Engin Program [10, 13-15]***
Program values	• Convey the importance of attaining a graduate education. • Collabo-rating with	• **M-STEM Program Values:** 1) Character, 2) Family, 3) Respect for History, 4) Responsibility for M-STEM Legacy, 5) Responsibility to the M-STEM Family, 6) Responsibility to the

Program Elements	Portfolio Categories	
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	others to solve problems collectively. • Conducting oneself in a professional and ethical manner.	Community, 7) Leadership and "Followership", 8) Team Excellence, and 9) Individual Excellence. • **Classroom collaborations:** Students learn to collaborate on a project for Prof. Joanna Millunchick's class, "Crossing the Boundaries. • **Professional exposure:** Exposure to the vast numbers of professional opportunities in science, engineering, and mathematics. • **Participant selection:** Participants are selected based on cognitive variables (e.g., high school GPA, SAT/ACT scores, first generation college status, family income). • **Shared values and interests**[a]: Students shared disciplinary/professional interests, principles such as a strong work ethic, and identities/backgrounds.
Faculty and Peer Access	• Having access to faculty and peers that allows interaction and engagement with like-minded others in academic and social situations.	• **Sense of Community:** Supportive community of like-minded scholars. • **Advising and Academic Coaching:** During the first academic year, students are teamed with an academic advisor, a peer mentor, and an academic coach. • **Group scheduling:** Students participate in group scheduling with M-Engin peers for core courses and participate in specially designed academic sessions. • **Family meetings:** Students participate in monthly group meetings to address topics relevant to M-Engin scholars. • **Program Community (Living):** Students live together their freshman year in a single residence hall and participate in classes in mathematics, computer programming, communication skills, and a hands-on engineering concepts course. • **Peer Study Groups, Tutoring and Supplemental Instruction:** Students engage with peers in study groups as well as receive supplemental instruction in first and second year STEM courses. • **Mentors:** Students are assigned mentors in their fields of study.
Formal and Informal	• Tutoring, informal study groups, and	• **Summer transition program:** A pre-freshman, six week program to prepare students for

Program Elements	Portfolio Categories	
	Definitions [7]	*Examples of these elements in the M-Engin Program [10, 13-15]*
Group Activities	small group TA sessions. • Activities that provide academic assistance and informal outlets through gathering and networking opportunities.	transitioning to UM academic experience. • **Research opportunities:** Students have opportunities to work in research settings (e.g., a paid research experience at the University or another institution, a paid corporate internship, community-based research projects, or employment with the M-Engin summer program). • **Family meetings:** Occurs monthly throughout the academic year. These evening meetings frequently involve speakers and/or activities to develop academic and professional skills. These meetings also help foster a sense of community that is vital to the success of the program. • **Informal activities:** Program website features pictures of students engaging in informal activities (e.g., ice skating, at the football stadium, etc.) and references to other activities (e.g., writing assignments can take you anywhere in M-STEM, such as a visit to the Natural History Museum). • **Program supports**[a]: Students rated summer program supports very highly; most helpful in preparing for first term of study: tutoring, computer engineering, supplemental instruction, and academic skills' sessions.
Participant Outcomes	**Portfolio Categories**	
	Definitions [7]	*Examples of these elements in the M-Engin Program [10, 13-15]*
Building Resiliency	• Persisting in the face of obstacles, or bouncing back from hardship.	• **Safe environment for rebounding**: It is proposed that the program may provide a potential opportunity for students to learn and fail in the safety of community.
Engaging in Communities of Practice	• Engaging with collections of like-minded individuals sharing similar experiences and social resources.	• **Engagement in a small world network**[a]**:** Students' participation in a localized network makes the campus feel smaller. • **Mutuality/ mattering**[a]: Students feel a sense of closeness with cohort members and experience trusting and supportive reciprocal relationships.
Building Social Capital	• Resources and benefits that are available to	• **High ratings for program components**[a]**:** At the end of their first year, M-Engin students gave high ratings to several components of the

Program Elements	Portfolio Categories	
	Definitions [7]	*Examples of these elements in the M-Engin Program [10, 13-15]*
	someone based on their relation-ships and networks.	academic year program such as: o Social supports o Information about career options o Academic support and skill development o Information and experiences that confirmed their choice of major

[a.] Based on data from prior qualitative interviews with 2013 M-STEM cohorts, n=23.

VI. Discussion

In regards to social community, the M-Engin Program promotes interaction through its program's values and activities and provides access to peers and faculty in formal and informal settings which allows program members to build resiliency and social capital through community engagement. The M-Engin's program values invoke collaboration with others in the classroom and program community and promotes professional, ethical conduct which are consistent with social community elements. Also, M-Engin members have access to faculty and peers in formal and informal capacities such as through coaching and mentoring sessions and living with other members in residence halls. This accessibility provides opportunities that encourage interactions and engagement between members which may explain how social community begins to develop within the program. In addition, members can build resiliency in the safe comforts of a smaller network where they can develop a sense of closeness through engaging in community. As a result, they may also increase their ability to be resilient as well as their social capital. Thus, M-Engin Program elements and features may contribute to the fostering of social community within the program. Using an SC framework to examine the M-Engin Program begins to uncover examples of program elements and features that provide opportunities for interaction and engagement which are beneficial to program members' development and the creation of a social community.

VII. Future Work and Implications

In future research, we will use a mixed methods approach: quantitative (surveys, student data, and learning analytics) and qualitative methods (coordinator and participant interviews). Specifically, a modified adaptation of an online survey instrument, the Social Community (SC) scale [9], will be administered to program participants to collect quantitative data about their experiences. This scale will feature Likert survey items about program elements and participants' connectedness, resiliency, engagement in communities of practice, and ability to build social capital. Using a social community lens, future research questions will address: 1) what are the outcomes and experiences of participants within the social community of the UM M-Engin Program, and 2) how do participants' outcomes and experiences in a social community vary across different groups within the UM M-Engin Program?

This research builds on the existing work of the first author's previously published SC framework by using this model to examine the UM M-Engin Program to provide new insights about what can be learned about STEM mentoring. From this research, we can learn how to better serve members of various program communities by identifying opportunities for improvement. This can assist in understanding how to better design mentoring programs to foster the creation of social community to assist in increasing and retaining underrepresented minorities to enhance the future engineering workforce.

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