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Lived Experiences of Former STEM Undergraduate Mentors of an Afterschool Mentoring Program: An Interpretative Phenomenological Analysis

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Abstract

Studies have identified gaps in the development of undergraduate students in science, technology, engineering, and mathematics (STEM). Students lack communication and problem-solving, impeding employment opportunities post-graduation. It is essential to prepare students for employment in STEM fields, as these fields remain in high demand and offer competitive wages for economic stability. Research has revealed that students gain critical thinking and problem-solving skills through students mentoring experiences. Evidence surrounding the inclusion of active learning strategies for in-classroom pedagogy has expanded in recent years, but the support mechanisms beyond the classroom remain unclear. Herein, we followed students for a decade after participation in our mentoring pre-professional training program, Nebraska STEM for You (NE STEM 4U). This phenomenological study utilized interviewing techniques and descriptive statistics to demonstrate how a midsized, metropolitan university STEM mentoring program supported the development of NE STEM 4U participants. We found that engagement in an after-school mentoring program provided participants with a model of mentorship. Participants also developed transferable professional and personal skill sets, including communication, perspectives, conflict resolution, and professional development.

Keywords

STEM, qualitative, phenomenology, afterschool program, undergraduates

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Lived Experiences of Former STEM Undergraduate Mentors of an Afterschool Mentoring Program: An Interpretative Phenomenological Analysis

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Studies have identified gaps in the development of undergraduate students in science, technology, engineering, and mathematics (STEM). Students lack communication and problem-solving, impeding employment opportunities post-graduation. It is essential to prepare students for employment in STEM fields, as these fields remain in high demand and offer competitive wages for economic stability. Research has revealed that students gain critical thinking and problem-solving skills through students mentoring experiences. Evidence surrounding the inclusion of active learning strategies for in-classroom pedagogy has expanded in recent years, but the support mechanisms beyond the classroom remain unclear. Herein, we followed students for a decade after participation in our mentoring pre-professional training program, Nebraska STEM for You (NE STEM 4U). This phenomenological study utilized interviewing techniques and descriptive statistics to demonstrate how a midsized, metropolitan university STEM mentoring program supported the development of NE STEM 4U participants. We found that engagement in an after-school mentoring program provided participants with a model of mentorship. Participants also developed transferable professional and personal skill sets, including communication, perspectives, conflict resolution, and professional development.

Keywords: STEM, qualitative, phenomenology, afterschool program, undergraduates

Introduction

Institutions of higher education face challenges in supporting undergraduate student development in science, technology, engineering, and mathematics (STEM) majors. Chen (2013) found that almost 50% of STEM undergraduate students leave the field within six years. Bettencourt et al. (2020) described how first-generation STEM students are at a disadvantage when deciding to pursue STEM schooling and careers due to factors associated with implications occurring in the life of the students before attending college. The development of undergraduate students in STEM can be improved by expanding access to high-impact practices, including experiential learning programs that occur outside of the classroom (e.g., experiential learning programs, and mentoring experiences; Kuh, 2008; Snodgrass Rangel et al., 2021). Research has revealed students gain content knowledge, critical thinking skills, organizational skills, and problem-solving skills by engaging in mentoring activities (Nelson & Cutucache, 2017; Nelson et al., 2017). More specifically, studies have shown that programs occurring outside of the classroom can support the development of undergraduate students in

STEM. Findings from Theobald et al. (2020) show engaging in active learning activities while in college support the development and retention of undergraduate students. Findings from Jin et al. (2019) show experiential learning opportunities such as mentoring decrease attrition rates among science undergraduate students. Bonner et al. (2019) described how mentoring experiences can support the development of undergraduates pursuing Bachelor of Science since the experience enables students to acquire skills to prepare them for the STEM workforce. Mentorship can be essential for STEM pre-professional training programs because it enables undergraduate students to acquire skills that can benefit their personal lives and professional careers (Irby et al., 2017).

Research efforts are largely concentrated on the impact of mentoring programs on mentees (Nelson & Cutucache, 2017; Snodgrass Rangel et al., 2021). Conversely, a dearth of studies has examined the influence of STEM mentoring programs on undergraduate student mentors, focusing on the benefits of the program on the mentors and their motivations to take part in the program (Nelson & Cutucache, 2017; Snodgrass Rangel et al., 2021; Sommers et al., 2021), with Leavitt et al. (2021) being a notable exception. Still, several questions concerning the impact of mentoring programs on developing mentoring skills require further exploration as there is a lack of longitudinal research in the scientific literature about the impact of mentoring programs on the career opportunities and advanced schooling of former STEM mentors post-graduation (Nelson & Cutucache, 2017). To date, few studies have focused on the impact of mentoring programs on former STEM undergraduate student mentors (i.e., Nelson & Cutucache, 2017). As STEM mentorship programs can assist with developing critical workforce skills, continued research regarding program outcomes, such as decisions regarding advanced schooling or education, career trajectories, and overall career preparedness post-participation should be completed utilizing larger sample sizes. These outcomes would be essential for understanding the decision-making processes undergraduate students in STEM undergo as part of their developmental process, as well as informing the benefits of experiential programs to administrators at institutions of higher education in the United States and the world at large. In addition, collecting information from mentors would support the mentors' development in their continued engagement with mentorship programs.

Literature Review

Employer surveys identify gaps in STEM undergraduate students' skills, such as developing critical thinking and problem-solving, thereby impeding employment opportunities post-graduation (Whiting, 2021). It is essential to prepare undergraduate students for employment in STEM fields, as these fields remain in high demand and offer competitive wages for economic stability across the nation (National Academy of Sciences, 2010; Stelter et al., 2020; Xu, 2016; Xue & Larson, 2015). School-based mentoring intervention programs have shown to foster professional development skills (e.g., communication skills, intrinsic desire to help others) that are essential for supporting the overall development of students in academia since mentoring programs play a significant role in participants' professional development (Irby et al., 2017; Kroll, 2017). However, this requires students to demonstrate ample understanding of their developmental process through their perceived experiences throughout their participation in the program to identify the support students require to matriculate toward their intended goals (Kram, 1988; Ragins & Kram, 2007). Studies report that taking part in mentoring experiences supports the professional development of individuals; as the mentoring experience plays a vital role in the developmental process for the conceptualization of mentorship (Kram, 1988) and its implications for undergraduate STEM students upon graduation (Nelson & Cutucache, 2017).

It is essential to capture the perceptions of former undergraduate students in STEM about their engagement in afterschool STEM mentoring programs to understand how experiential learning activities occurring outside the classroom supported their development after graduation. Due to the lack of longitudinal studies in the literature, the development of a follow-up study can enable researchers to identify the larger implications of the school-based intervention programs on former STEM undergraduate students across their professional careers (e.g., careers, advanced schooling). There is a need to explore the targeted effect of mentoring programs after the student's graduation to support the development and long-term impact of experiential learning programs on individuals pursuing STEM fields. This qualitative research paper aims to describe the impact of a pre-professional training and experiential learning program for undergraduates wherein they serve as mentors for youth in an afterschool STEM program.

NE STEM 4U

The Nebraska STEM for You (NE STEM 4U) is a pre-professional program for undergraduates that provides undergraduates with the opportunity to serve as mentors for K-8 students by engaging in after-school STEM activities (Cutucache et al., 2016).

This study focuses on the professional development of former participants of NE STEM 4U and how they conceptualize mentorship. Our goal is to contribute to the larger body of literature pertaining to the impact of experiential learning programs, more specifically, mentorship interventions on undergraduate students in STEM post-graduation. We used the following research questions to guide the study:

1. How do former STEM undergraduate student mentors describe their perception of mentorship after engaging in an afterschool STEM mentoring program?
2. How do former STEM undergraduate student mentors describe the impact of an after-school mentoring program on their professional development?

The Context of the Researchers (Researcher Positionality)

The first author's (PMO) positionality stems from her previous experiences as an undergraduate and current doctoral student in science, both in Puerto Rico and the mainland US. As an undergraduate, PMO was mentored by various academics in the field of wildlife biology. PMO focuses on STEM education and learning at the undergraduate level for her doctoral studies. PMO currently provides mentorship to STEM undergraduate students on how to facilitate STEM experiential learning activities for K-12 students.

While completing her Bachelor of Science, PMO developed a strong interest in informal education in STEM-related fields. As the author progressed through her undergraduate education, many of her classmates dropped out of their Bachelor of Science. Most students who continued to pursue their degrees were involved in extracurricular activities that promoted their participation in STEM, such as research experiences and mentoring programs. For her preparation as a doctoral student, she is focusing on components that support the professional development of individuals pursuing schooling and/or careers in STEM-related fields.

The second author (KVW) is a speech-language pathologist by training who is currently a doctoral candidate studying educational leadership. In addition to her doctoral education, she holds a dual bachelor's degree in Speech Communication and Political Science as well as a Master's degree in Speech-Language Pathology. She works in the international sector, serving

as a speech-language consultant at international schools, where she works with families on a global scale. She is interested in how educators can provide meaningful and equitable experiences to learners of STEM who present with speech and/or language disorders. Her role as an educator innately involves mentorship; therefore, she believes that developing mentorship skills through informal and formal programming is an important line of research. KVW was involved in a clinical mentorship as a speech-language pathologist and mentor's students intermittently. She also has been involved in formal and informal mentorships as a mentor and mentee regarding qualitative research.

The anchor author, whose lab generated the intervention and has supported the intervention through acquiring funding, staffing, training, and continuity for the past decade (CEC) is a faculty member at the institution described herein. CEC has been the beneficiary of mentoring throughout her career--from her early days as an undergraduate research mentee to and throughout an academic career providing mentoring to undergraduate and graduate students, faculty, staff, and partnership via mentoring with community partners as well.

Importantly, the intervention described within this longitudinal study is at the site of origin but has now been replicated across the state of origin and will be replicated at international sites in 2022. The anchor author is a faculty member and biomedical researcher turned discipline-based education researcher. She is the founding director of the University of Nebraska at Omaha STEM Teaching Research and Inquiry-Based Learning Center (UNO STEM TRAIL center). The UNO STEM TRAIL Center is "an administrative unit, it provides resources and materials to undergraduates, graduates, and faculty members at UNO and lifelong learners (reaching K-12 and adult learners) beyond. The Center does not control any curricula, as it is not an academic unit, but it does catalyze course innovations as center affiliates work through colleges to study and implement curricular change" (University of Nebraska at Omaha STEM TRAIL Center, 2021). All researchers involved with the current study are concerned with supporting students of all ages as they matriculate through STEM programs by providing quality educational experiences.

Theoretical Framework

We selected Vygotsky's Zone of Proximal Development Theory (Vygotsky, 1934), Kolb's (1984) Experiential Learning Theory (ELT), and Piaget's (1964) cognitive development theory as the theoretical framework since the present study aimed to understand the way former undergraduate STEM mentors reflect on and subsequently make meaning about their experiences in an afterschool STEM mentoring program and its impact on their professional development post involvement. Vygotsky's Zone of Proximal Development Theory (Vygotsky, 1934) was utilized since the theory stresses the importance of a teacher or mentor in simplifying concepts as a mechanism to support student learning. Kolb's (1984) Experiential Learning Theory (ELT) allowed us to explore the learning process and developmental growth of participants in our sample (Sternberg & Zhang, 2014) in relation to the experiential learning experience. Piaget's (1964) cognitive development theory enabled the researchers to further explore the critical thinking and transferable skills participants developed while taking part in NE STEM 4U (Fischer, 1980). We used Piaget's (1964) cognitive development theory to explain the impact of the participants' acquired skills on their professional development (e.g., careers, advanced schooling).

Method of Research

Qualitative Design

We followed the philosophical orientation of interpretivism to co-construct knowledge through interactions with participants and to make sense of the participants' experiences (Bhattacharya, 2017). Interpretivism can be described as "a methodological approach to social scientific study informed by such philosophies as phenomenology and hermeneutics, which focuses on how humans make meaning of their worlds." (Schwartz-Shea & Yanow, 2020, p. 2). We used interpretivism to combine our interpretations with the interpretations described by the participants. Additionally, we used an interpretative phenomenological analysis (IPA) to understand and interpret the participant's experiences (Smith et al., 1999). The IPA methodology allowed us to capture the participants' perceptions about the phenomenon of interest. We used IPA to explore our question of inquiry by capturing the extent to which an afterschool experiential learning program impacts participants long-term. The NE STEM 4U program offered a starting point to explore the larger impact of the program on former STEM undergraduate student mentors. The data were examined in two stages utilizing a double hermeneutic interpretation process, which allowed the researchers to blend the participant's and researcher's perspectives about the phenomenon (Pietkiewicz & Smith, 2014; Smith et al., 1999). The double hermeneutic effect allowed the researchers to take into consideration their reflexivity as investigators and second-order interpretation of the participant's responses in the development of the study to contribute to further mixing of interpretation and making of meaning (Mills et al., 2010).

IPA was the best method for the investigation since it allowed the researchers to explore, describe, and interpret how participants made sense of their experiences (Tuffour, 2017). This accounts for the impending evolvement of participants associated with the phenomenon, through the development of research questions, data gathering, and interpretation of findings (Thompson, 2021). This idiographic technique allowed us to focus on specific objectives of the program to obtain an in-depth analysis of the perceived lived experiences of former STEM undergraduate student mentors involved in an afterschool program and its impact on their professional development. The goal was to capture the essence of the participant's experiences and how they make sense of them, allowing the researchers to explore the phenomenon without limiting the participant's responses to a singular direction. Subsequently, the analysis was conducted using the qualitative software program, MAXQDA (2022 ed.).

Participants

We recruited former participants from the NE STEM 4U program. Specifically, participants were past undergraduate students majoring in a range of STEM disciplines (i.e., biological sciences, chemistry, physics, mathematics, engineering, and business/economics) who participated in an afterschool STEM mentoring program at a midsized metropolitan university in Omaha, Nebraska, United States. Participants were between the ages of 18 and 26 when they engaged in the mentoring program, but at the time of the study, participants were between the ages of 22 and 32. All demographic information was self-selected by the participants. While participants were provided the opportunity to identify as non-binary, all participants identified as either male or female. An array of racial/cultural backgrounds (e.g., Asian, Hispanic, African American) were present in the data set. The number of participants and percentages associated with these categories can be found in Table 1.

Table 1
Participants Demographic Information

Description	n	(%)	Description	n	(%)
Sex*			Highest degree obtained*		
Female	13	50	Advanced degree	10	38
Male	13	50	Bachelor's degree	16	62
Race			Current profession or schooling		
White	21	81	Non-STEM	1	4
Person of color*	5	19	STEM	25	96

Notes. Participants could select to identify as non-binary or not report their sex; however, all 26 participants identified as either female or male. None of the participants reported having intersex characteristics. We combined racial backgrounds and the acquisition of master's and doctoral degrees to protect the identity of the participants.

The Setting of the Site of Intervention

The study was conceptualized in Omaha, Nebraska, United States. The population of the city of Omaha consists of 50.7% females and 49.3% males, including 66.2% White, 14.1% Hispanic, and 12.1% Black individuals (U.S. Census Bureau, 2021). Specifically, the study was conducted at the University of Nebraska at Omaha (UNO). UNO has an undergraduate student population of 54% females and 46% males, of which 25% are underrepresented minorities (IPEDS, 2019). Undergraduate students include 64% White, 14% Hispanic, and 7% Black (IPEDS, 2019). UNO has a higher female percentage of undergraduate students. Still, the gender distribution of the participants of the study mirrors the identified gender of the population of Omaha. UNO's undergraduate student body closely mirrors Omaha's population race demographics. Compared to Omaha (66.2%) and UNO (64%), the study had an overrepresentation of Whites (81%).

Former STEM undergraduate participants of the mentorship program, NE STEM 4U were recruited for this study. NE STEM 4U provides undergraduates with the opportunity to serve as mentors for K-8 students by engaging them in after-school STEM activities. Undergraduates provide mentorship to just over 500 youth each year. NE STEM 4U is a pre-professional program for undergraduates started in 2012 as a pilot, with full expansion in 2013, with over 150 undergraduate STEM student mentors taking part in the intervention since its inception.

Data Collection

We recruited participants for the study by sending an invitation to 81 past graduates/alum that served as mentors in the NE STEM 4U afterschool mentoring program while enrolled at UNO. Past studies have revealed the response rate of former participants of programs is 15-39% (Allen, 2003; Eby et al., 2005); thus, the researchers expected approximately 25 participants to agree to take part in the study. To participate in the present study, participants were required to be former mentors in the NE STEM 4U program; thus, no current participants of the program did not meet the inclusion criterion to participate in this study. A non-randomized criterion-based purposeful sample selection was utilized to represent the perspectives of participants, as opposed to targeting a specific population (Smith et al., 2009).

We interviewed 26 former STEM mentors using a semi-structured interview schedule containing questions drawn from Nelson and Cutucache (2017; Table 2). Nelson and Cutucache's (2017) study explored the perceptions of former undergraduate students in STEM

of the NE STEM 4U mentoring program; however, the study was limited to seven participants. This study aimed to further develop the interview questions posed by Nelson and Cutucache (2017) to further investigate the impact of NE STEM 4U on former participants of the program.

A doctoral graduate student completed and recorded the interviews. Interviews were transcribed verbatim to analyze and interpret the transcripts using the hermeneutic phenomenological model proposed by Heidegger (1927). We utilized the analytical IPA process by Smith et al. (2009) to code and analyze transcripts. The coding and analysis process of the transcripts followed an interpretative phenomenological analysis approach.

Table 2
Interview Questions for Participants in the Longitudinal Study on the NE STEM 4U Intervention

Interview Questions
1. What does it mean to be a mentor? 2. Have you engaged in mentoring in your profession or current position? a. What does that mentorship look like? 3. Do you have mentors? a. Who are those people and why do you feel they are your mentors? 4. How do you perceive and describe the impact of the NE STEM 4U program on your professional development, both personally and professionally?

Data Analysis

First, the first and second authors immersed themselves in the data by reading and re-reading the transcripts while listening to the audio recordings. This provided a more comprehensive analysis by focusing on the participant. Second, the authors engaged in initial noting to generate initial notes and detailed comments on the data. We started by noting comments on the most complex transcript (Smith et al., 2009) based on the data read in the first step. In the third step, we developed emerging themes that both reflected a description of the participant's perspectives and the researcher's interpretation of the data; thus, applying a double hermeneutic analysis. The themes were organized chronologically in the order they emerged. This iterative process was then used across all participants. We utilized a codebook, which was developed as themes emerged after reviewing all cases. After developing the codebook, each author coded the cases independently.

Trustworthiness

We meet the validity criteria for our IPA study by asking KVW to conduct an independent audit to consider legitimate accounts about the responses from the participants that were both systematical and transparent. As discussed in the ethical considerations, KVW was not part of the data collection process of the study, nor was she involved during any point in the NE STEM 4U. We further ensured the trustworthiness of the study by completing inter-coder reliability with all twenty-six transcripts using the codebook. To ensure accuracy, each transcript was coded independently by the first and second authors. In the initial coding stage, coders showed an overall agreement of 51%. We solved disagreements through discussion, ultimately reaching an overall agreement of over 95%. The description of codes evolved throughout the coding process as examples were found in the data. After redefining the codes, all previously coded transcripts were re-examined to code the data with the newly defined codes. The coding was a highly iterative process, involving prolonged engagement and

exposure to each participant's individual transcript, allowing researchers to discuss their interpretations of the data. We ensured the trustworthiness of the findings by crystallizing the data using multiple ways of collecting data, including semi-structured interviews, inter-coder reliability, and employing the researcher's reflexive journal (Love et al., 2019). The first author engaged in reflective research diary notes after each interview and during the phenomenological interpretative process of analysis to account for and identify the researcher's orientation and biases (Love et al., 2019; Smith et al., 2009).

Ethical Considerations

The Institutional Review Board at the University of Nebraska Medical Center/the University of Nebraska at Omaha approved the study protocols, procedures, and (protocol #711-21-EX). The first author (PMO) interviewed participants who gave full informed consent to participate in the study. Before and during the interview process, participants were encouraged to inform the first author (PMO) if they had questions or inquiries about the study. The researcher informed the participants that they could withdraw from the study at any time if they felt uncomfortable or unable to continue taking part in the interview and that withdrawing from the study would not impact the participant's relationship with the researchers, university, or NE STEM 4U. Pseudonyms were created by the first author (PMO). To ensure confidentiality, the other co-authors (KVW, CEC) were blinded from the participant's personal information and were not part of the transcription process for the interviews. The first author (PMO) attempted to utilize names that were not gender-specific and that were culturally neutral, to mitigate the risk of bias. As the third author is the principal investigator and the director of the NE STEM 4U program (CEC), she did not have access to the participants' information. Additionally, she did not participate in data collection or analysis, only data presentation, visualization, writing, and editing.

Findings

We used our codebook to identify the conceptualization of mentorship and skills gained and interpreted by the participants via the experiential learning activity. We found that engagement in an after-school mentoring program provided participants with a model of mentorship. Participants developed professional and personal skillsets that promoted their overall development as STEM professionals. None of the participants share concerns or negative consequences from their experience in the program. Our themes include communication, perspectives, conflict resolution, and professional development.

Assertion 1: Engagement in NE STEM 4U Provided Program Participants with a Model of Mentorship

Involvement in NE STEM 4U provided participants with a model of how-to mentor. Seven program participants noted that Dr. Sisu, the program director, served as their mentor and subsequently taught them about mentorship. For example, Pongo stated that Dr. Sisu was a mentor to him and his involvement in the program and relationship supported his mentoring skills. He stated that involvement in the program, "helped me mentor a lot of kids that I wasn't really used to, I wasn't really used to being around kids. But it helped me grow, being more professional and more mature around kids and trying to make them become the best versions of themselves in the present and also the future." Program participants noted that participation in the program offered an introduction to mentorship. For instance, Stika stated, "NE STEM was a great low-pressure introduction to mentorship and what it means to be a good mentor,

which is that you're trying to meet the students where they're at and develop a positive relationship and shape them positively in any way that you can, even if it's just a tiny bit, or if it's a lot. Anything you can do is good." Involvement in the program offered an introduction to mentorship that program participants may otherwise not have been privy to.

Program Involvement and Conceptualization of Mentorship

Participants connected NE STEM 4U and the program director of NE STEM 4U, Dr. Sisu, to mentorship throughout the interview, suggesting that participation in the program impacted perceptions of mentorship. Across the 26-participant dataset, 23 participants mentioned NE STEM 4U, describing it as a positive experience. In the case of Sitka, a Ph.D. student in biological sciences, NE STEM 4U was an impactful experience shaping his overall perception of what mentorship is. This experience-based approach offered a deepened perspective regarding how mentorship should look. These findings align with Piaget's (1964) cognitive development theory since program participants constructed meaning through their involvement in the program:

> It has a lot more impact than I ever would have thought when joining NE STEM. In NE STEM in general, I learned what it means to be a mentor. Because the reason that I specified the two definitions of mentor that I gave earlier, which one is that its mentee focused and the kind of older version his mentor focus is because I thought that I was going to help people learn about, these middle school kids learn about science and go-to polish for science. And when I went to the schools, I realized that they just really wanted to have fun. (Sitka)

One participant, Naveen, a Ph.D. candidate in biological sciences, made note of NE STEM 4U when conceptualizing mentorship and how he began thinking about the role of mentorship during his time in NE STEM 4U. His experiences as well as his relationship with the program director, Dr. Sisu, resulted in an improved conceptualization of mentorship*:* "And I've remained in contact with Dr. Sisu and have got a lot of my early training in mentorship and my philosophy on mentorship through those early years in NE STEM" (Naveen).

Dr. Sisu was mentioned on 19 occasions by seven different participants, suggesting that she had a mentor-mentee relationship with over 25% of the individuals who participated in the program in either a formal or informal capacity. Several participants overtly noted that Dr. Sisu served as a mentor or currently serves as a mentor even after graduation. For instance, Naveen revealed that he remains in contact with Dr. Sisu. Pongo, a post-baccalaureate student and pharmacy technician, echoed that he also currently maintains contact with Dr. Sisu, who serves as a mentor. Anita, who was pursuing a degree as a physician assistant but is transitioning to business, indicated that Dr. Sisu served as a mentor, but Lady has not stayed connected with Dr. Sisu to the same extent as when she was in NE STEM 4U. Lady, a current undergraduate student, and former NE STEM4U participant, also mentioned that Dr. Sisu served as a mentor both personally and professionally. Dr. Sisu modeled mentorship, which served as a mechanism to train program participants who went on to experience how to mentor:

> I feel I can also go to Dr. Sisu for personal issues. I don't seem to have very many personal issues. I guess that's a blessing of mine, but I do have a good support network at home and things like that outside of that as well. I don't know your account like your mom, and you know people like that but they're also mentors and people that I look up to. (Lady)

Assertion 2: Participants Developed a Professional and Personal Skillset after Participating in an After-School Mentoring Program

We asserted that involvement in an undergraduate STEM mentorship program would foster skills that could be translated into careers. This was supported by participants with a unanimous consensus that NE STEM 4U developed an array of transferrable skills, such as communicating with individuals from diverse backgrounds and improving understanding of basic STEM content knowledge. This supports the assertion that program involvement may result in long-term benefits that support individuals as they matriculate past the context of an undergraduate degree. For example, current high school teacher Sarabi said: "I have to communicate with other teachers and case managers and administration every single day. NE STEM 4U perfectly prepared me for that more than I thought it would."

Communication and Transferable Skills

Anastasia revealed NE STEM 4U fostered the acquisition of skills that supported her organizational and management skills. Anastasia's statement serves as an example of how NE STEM 4U allowed her to extend the skills she acquired during her time in the program to professional settings beyond her undergraduate years. Anastasia also described how she gained skills that can be used and applied with other populations, regardless of the setting, revealing NE STEM 4U enables participants to obtain transferable skills such as communication. Her experience aligns with Kolb's (1984) ELT since she was trained, was reflective about the skills that were being developed, learned from her experiences, and subsequently generalized her experiences to other contexts:

> Professionally, I definitely developed organizational skills, having the responsibility of reaching out to community partners and facilitating events helped me to gain that skill of how to act and interact within a professional environment. I think probably those are the main ones. The interpersonal skills that more so came from really paying attention to classroom management, and how those skills can be translated to more general situations. And then professionally, just in terms of organization and management. (Anastasia)

Florian accredited his experience with NE STEM 4U in fostering communication skills, as he noted that he has differing perceptions than children and thus learned how to communicate more effectively with an array of individuals while also developing his understanding at a fundamental level. Like Anastasia, Florian thought more critically about his own understanding of the material he taught. He also made the connection that students require guidance to succeed, which aligns with Vygotsky's (1934) work on the zone of proximal development. His communication was critical for supporting students who may otherwise not be able to independently understand concepts:

> Another benefit that I got from my involvement in NE STEM...There's moreover from a professional viewpoint is thinking about science at a more fundamental level. Because I think in a normal class setting, in my class, college class setting, when you're learning about science, there are certain things that we tend to take for granted. Versus when you're trying to explain a concept to an 11-year-old. That 11-year-old doesn't have the same set of assumptions that you do. You really have to boil it down and go very deep into fundamentals and try to build the entire thing from scratch. I think that has helped me in that

> setting, in that sense too, to improve my ability to think about science at a deeper and more fundamental level. (Florian)

Perspectives and Conflict Resolution

The NE STEM 4U mentoring program enabled participants to acquire skills consistent with the highest stage of self-authorship, contextual knowing, by obtaining skills such as conflict resolution, taking other people's perspectives, and applying these perspectives to how they conceptualize mentorship. For example, Giselle revealed her experience at NE STEM 4U enhanced her ability to solve problems by gaining new perspectives from others. Giselle's perceptions about NE STEM 4U demonstrated she gained experiences that promoted the acquisition of attributes that supported the development of her self-authorship:

> I think the NE STEM program was helpful for me in developing how to work with others in a collaborative sense in teaching. Not only teaching with other people, but also in a way of developing lesson plans, collaborating, bouncing ideas off of each other, mentoring new people on the position. (Giselle)

Sebastian, however, described NE STEM 4U as it exposed him to a population of students that are in different situations than him growing up. NE STEM 4U allowed Sebastian to get involved with students from backgrounds that differed from his; thus, enabling him to have access to various viewpoints. Sebastian identified circumstantial differences between him and the OPS students he mentored; however, exposure to these individuals revealed that all children have similarities regardless of context. NE STEM 4U exposes participants, such as Sebastian, to environments that they may not otherwise have known existed. This opportunity provided new experiences that allowed him to further construct his own perceptions of the world around him, which aligns with Piaget's (1964) cognitive development theory:

> I came from a small town, and then coming here and going into the under-funded schools or schools that I guess didn't have the resources to teach as well as maybe my school did growing up. I never really saw things like that when I was growing up. You get an appreciation for some of those kids, because they might not be in the best situation, but they're still really good kids. And they're just the same as when I was growing up. (Sebastian)

Professional Development

Although participants in the NE STEM 4U program are financially compensated for the time spent mentoring K-8 grade students, one participant, Pongo, elected to volunteer for NE STEM 4U despite having the opportunity to be paid for his time. Pongo revealed that he believed that volunteering for NE STEM 4U assisted his professional development. Pongo's experience revealed NE STEM 4U contributed to his professional growth as a mentor because after engaging in the program his beliefs about mentorship shifted toward a student-centered approach to best support their development:

> Dr. Sisu gave me one of the biggest opportunities that I had, which was NE STEM 4U. And it wasn't just based on that I needed some extracurricular activities to apply for medical schools. But on top of that, when I actually volunteered there in NE STEM 4U, I feel like it developed me in a really professional way. And then it helped me mentored a lot of kids that I wasn't

> really used to, I wasn't really used to being around kids. But it definitely helped me grow, being more professional and more mature around kids and trying to make them become the best versions of themselves at the present and also the future. (Pongo)

Sarabi made note that NE STEM 4U has benefited her as a classroom teacher as it has taught her necessary administration skills as well as supported her ability to work with children. The program exposed her to children from an array of backgrounds and supported her ability to initiate and sustain relationships, a necessary skill for any educator. While she did not explicitly connect her role to mentorship, she did speak about the benefit of the program:

> And then professionally, the mentoring it helped me. Obviously, I'm a teacher. I'm working with kids. It helped me with working with kids. And being in that professional environment, but still being able to make and maintain these relationships with the kids, better at that professional level. But then also NE STEM 4U, I don't know if this applies because I was also an officer, which blends in with the mentoring, but it was just... NE STEM 4U was my first experience with being held accountable for a big job and making sure that I'm communicating with the right people, which is something that I have to do every day. I have to communicate with other teachers and case managers and administration every single day. NE STEM 4U perfectly prepared me for that more than I thought it would. (Sarabi)

Discussion

We investigated participation in an experiential learning program by providing a decade-long, longitudinal reflection on the impact metrics of the program. The data presented herein demonstrate that the NE STEM 4U program provides tangible benefits beyond a student's participation. For example, the program helped participants develop skillsets that could be applied to experiences as they enter an advanced schooling program or the workforce. Participation in NE STEM 4U supported students to explore skillsets they may otherwise have not been exposed to in their undergraduate experience. Taken together, NE STEM 4U provided a safe space for students to develop a skill that otherwise could not be independently learned, thus providing a zone of proximal development (Vygotsky, 1934).

Likewise, participants also were involved in mentoring; therefore, engaging in experiences that support learning (Kolb, 1984; Piaget, 1964). This practical application allowed participants to extend knowledge beyond theory, resulting in an intellectually stimulating and hands-on opportunity. All participants noted that they developed skills, including skills in the areas of communication, conflict resolution, administration, and perspective-taking while deepening their fundamental understanding of science, which is consistent with findings in previous works (Bonner et al., 2019; Nelson & Cutucache, 2017).

For example, Esmeralda expressed NE STEM 4U aided her ability to communicate complex medical concepts with a population that does not have her clinical background. Likewise, Giselle expressed that she acquired transferable communication skills such as teaching in NE STEM 4U that she used for her doctoral training in nursing. Similarly, Anita revealed her time in NE STEM 4U provided her with communication skills that allowed her to explain complex topics interactively. Kenai, who is the vice-president at a technology start-up company, described that involvement in the NE STEM 4U program supported his professional development by demonstrating the importance of patience. This skill set has been important as he engages in business opportunities.

In addition, some participants noted how NE STEM 4U fostered their overall development, including broadening perspectives. For example, Anastasia noted that NE STEM 4U supported her understanding of conflict resolution, specifically in applying this skill to her current context as a medical student since her role relies on working with a team of people to resolve problems. Anastasia also stated she learned leadership and classroom management which have been helpful as she has matriculated into her career. This was evidenced when she reported how these skills are being used currently.

We asserted that involvement in an undergraduate STEM mentorship program would foster skills that could be translated into careers. This was supported by participants with a unanimous consensus that NE STEM 4U developed an array of transferable skills, such as communicating with individuals from diverse backgrounds and improving understanding of basic STEM content knowledge. It is noteworthy that all participants acknowledged that they had obtained or developed beneficial, transferable skills post-involvement in the NE STEM 4U program. This supports the assertion that program involvement may result in long-term benefits that support individuals as they matriculate past the context of an undergraduate degree. This assertion is supported by the following statement from Sarabi: "NE STEM 4U perfectly prepared me for (the workforce) more than I thought it would."

In relation to mentorship, the participants described how the skills acquired while taking part in NE STEM 4U allowed them to effectively support mentees and learners from backgrounds that either resembled or differed from theirs. Florian expressed how the mentorship skills he learned at the NE STEM 4U program allowed him to tailor the way he provides mentorship and guidance to students from various educational levels. For example, by describing basic knowledge and background associated with science topics to K-8 students, as opposed to providing university-level concepts. As described by Florian, this phenomenon is opposed to the explanations he would provide to STEM undergraduates because it is expected that students at this level possess a basic understanding of scientific topics.

Strengths

There are several strengths to our research project. A wide range of career stages and academic degrees were represented in the project, including employed individuals and students pursuing advanced degrees. These factors may have added diversity to the broader applications of pre-professional STEM programs across multiple fields after college graduation. Participants from NE STEM 4U have been studied for multiple years, providing distinct perspectives on the program's evolution.

Limitations

The study has several limitations. Our study was conducted with individuals who attended the same institution to pursue their bachelor's degree in STEM; therefore, the participant's perspectives may be limited to the experiences acquired while completing college in a single institution. We acknowledge the bias in these data because they are inclusive solely of one location (i.e., the metropolitan university participant in NE STEM 4U), and only over 10 years. Due to the nature of conducting the interviews years after college graduation, the participants may have been influenced by external factors and experiences. Because of this, we may not have captured all details pertaining to the phenomenon under study.

Conclusion

The findings of the study shed light on the importance of taking part in pre-professional STEM programs while in college. Taking part in an experiential learning program such as NE STEM 4U can provide undergraduate students with an array of transferable skills. Participants may continue to use these skills after college graduation while engaging in the workforce and pursuing advanced schooling. The study demonstrates how regardless of major or career stage, pre-professional programs have a positive impact on the professional development of participants.

Future studies should focus on analyzing programmatic data about the experiences of participants in mentorship using mentoring theories such as the Triangular Model of Mentor Competence proposed by Johnson (2003). Using existing mentoring theories could aid to inform the development of codes relevant to the experiences of participants with mentees in relation to factors such as emotional balance, relationship structure, and peer mentorship, among others.

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