Using a volunteerism framework to understand the motivations of university students who facilitate informal physics programs

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Many university students who participate in public engagement do so voluntarily through informal physics programs. The motivations and reasoning students have for volunteering in the first place and continuing to volunteer vary. For some students, volunteering in informal physics programs can influence their career path after leaving the program. For this research study, we interviewed university alumni about their past experiences as student volunteers and the career path they have had since leaving the program. We apply a volunteerism framework to our data to 1) see how it maps onto an informal physics context and 2) understand the evolution of volunteers’ motivations from their initial informal physics volunteer experiences to their present lives. As this study is meant to test the volunteerism framework, we will focus on alumni who continued into education-related careers given that informal physics programs are educational in nature.
I. INTRODUCTION

Physicists and physics students engage with public audiences through a variety of informal physics programs and activities like school visits, summer camps, open houses, public talks, after school programs, and more. Participation in these activities are often voluntary for both the participants and the facilitators. Many volunteers in informal physics programming are university undergraduate and graduate students [1, 2]. Some students volunteer repeatedly and for many hours in these spaces throughout their student careers, even though they are often not earning course credit or being paid [3–6]. We are working to understand the nature of the deep and meaningful experiences that students are having. Studies have looked at the impacts on university student volunteers and have found how some structures of informal physics programs support physics identity development, sense of belonging, and career-related skills [6–12]. Students have different career paths, some of which are education related, and their experiences from volunteering can impact the careers they pursue.

Some studies have looked at the motivations of university students who volunteer in informal programs, noting themes such as positive experiences, sharing science, professional development, and teaching opportunities [12, 13]. In particular, some studies have used community of practice [8–11, 14] and personas [15] frameworks to better understand the involvement of university students volunteers in informal physics programs. However, many of these studies analyze students as they are actively involved in their volunteering and do not look at the careers and long term impacts. Rothman et al. [6] found that current and former student volunteers reported an increase in motivational beliefs. Those motivations have strong ties to student excitement and development of interest and skills that are relevant to becoming a physicist [6].

Here, we interview alumni at various points in their professional careers about their past experiences volunteering in informal physics programs and how those experiences impacted them and their career paths. Our overarching research focus is on the different ways that informal physics programs can affect careers of volunteers. Our initial step in this preliminary study is to apply a volunteerism motivational framework to 1) see how it maps onto the informal physics space, and 2) understand how volunteers’ motivations evolve from their first volunteer experiences in informal physics to their present lives. Before applying to our larger data set, we first apply this framework to alumni whose careers ended up in educational fields. For the scope of this paper, we aim to answer the following: How do informal physics program experiences affect volunteers who go into careers related to education?

II. VOLUNTEERISM FRAMEWORK

For many facilitators, informal physics is not a part of their main job or responsibilities. For example, faculty may have teaching or research responsibilities while students may have coursework or other involvements. The work that most of the facilitators do in their informal physics programs is in addition to their main job or position [2]. We use the term student volunteer to describe the university students who are contributing to the functionality of these programs. In some cases, but not all, university students may be compensated for their involvement in their program, however, we still label them as a volunteer as their main position is being a student and their informal physics involvement is on the side.

Given that participation in informal physics programming is often in addition to one’s current job and responsibilities, there must be some motivations for the volunteer to 1) volunteer in the first place, and 2) to stay in that volunteer position. The volunteerism framework aims to understand those two points for volunteers more broadly. Clary and Snyder define six categories that describe motivations for volunteering (Values, Understanding, Enhancement, Career, Social, and Protective), as described in Table I [16, 17]. Pulling from foundations in psychology, this framework was tested with volunteers in public health, hospital programs, psychology programs, and business, with populations of volunteers being non-students, students getting course credit for their service, and students not getting course credit [16]. While this framework is aimed for volunteering more generally, Clary and Snyder acknowledge that these categories may appear differently based on the type of activity the volunteer is participating in [16]. This framework has been used in scientific spaces, such as citizen science programs and environmental sciences, but was adapted with some contextual renaming or some context-based additions [18–21].

For this pilot study, we want to test this framework in the context of informal physics programs to determine if it captures the motivations of student volunteers. Applying this framework to interviews with alumni helps to understand how those motivations connect to the volunteers’ career paths. Because we are testing the framework, we are applying it to a subset of our data. Given that informal physics programs are inherently educational, we first apply this framework on alumni who had a career in education.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Career</td>
<td>Preparation and experience for career-related endeavors.</td>
</tr>
<tr>
<td>Enhancement</td>
<td>Increasing positive feelings of oneself.</td>
</tr>
<tr>
<td>Protective</td>
<td>Reduced negative feelings from personal challenges.</td>
</tr>
<tr>
<td>Social</td>
<td>Building and strengthening relationships with friends and new people.</td>
</tr>
<tr>
<td>Understanding</td>
<td>Gaining and implementing new skills and knowledge.</td>
</tr>
<tr>
<td>Values</td>
<td>Belief that the person finds important to their life.</td>
</tr>
</tbody>
</table>
III. METHODS

For data collection, we contacted the lead facilitators of two informal physics programs: Traveling Physics and After School Physics. Both programs are housed at different large research universities. Traveling Physics is a traveling program that visits schools with hands-on physics experiments that were built by its team of primarily undergraduate student volunteers. After School Physics is an afterschool program that partners with multiple nearby middle schools and high schools. A team of undergraduate and graduate students and postdocs visit each school once a week to lead hands-on physics activities and explorations.

We contacted these programs about our study because 1) both programs have been around for decades, 2) both programs stay in contact with their alumni, and 3) the authors have previous involvement with these programs. Program leaders shared information of our study to their alumni contact lists in order to recruit participants to be interviewed. Connections with these participants snowballed to members from two additional programs who were also interviewed. In total, 25 interviews with alumni were conducted.

The approximately 30-minute interviews were semi-structured. Some interviews were conducted in person and some were done virtually on Zoom. We asked participants about their past experiences in their program, their career after leaving their university, skills important to their current work, and memorable experiences the participants had in the program, with other volunteers, and with audience members. For analysis, both authors independently coded the interviews with the volunteerism framework using the qualitative analysis program MAXQDA. Code units were full sentences in which the response met the definition of a framework category. A code could be multiple consecutive sentences, but not partial sentences. Sentences could include multiple codes. After each interview, the authors compared codes, to which there was a high agreement, discussed any discrepancies and documented common themes found within each category.

For the scope of this paper, we are only analyzing participants who volunteered in either Traveling Physics or After School Physics and who ended up in an educational-based career, whether that was formal, informal, or a combination of both. We will present each participants’ trajectory linearly, highlighting the different motivational categories that manifest throughout. The three participants we will discuss are “Amber,” “Mark,” and “Claire.”

Amber began her post-secondary career as a student at a two-year college. After taking an astronomy course, she decided to pursue a degree in physics at a large four-year research university where she volunteered at Traveling Physics. Her job trajectory went in many different directions. She worked as lab coordinator, worked in the tech industry, returned to school to pursue a teaching degree, left the teaching program to open up her own business, returned to the tech industry, then hired as assistant director for Traveling Physics.

Mark earned his bachelor’s degree in physics. As an undergraduate, he worked as a teaching assistant for the undergraduate labs. He went to graduate school to continue studying physics. As a graduate student, he volunteered at Traveling Physics. After graduate school, he worked at a university as a lecture demonstration specialist, where he teaches some classes and still participates in public engagement activities.

Claire was a neuroscience major as an undergraduate who wanted to go into education since early college. As an undergraduate, she volunteered in After School Physics. She is currently a middle school science teacher.

IV. APPLYING FRAMEWORK TO THREE CASES

Here, we will discuss the job trajectories of Amber, Mark, and Claire from when they volunteered in their respective informal physics programs to their current position. We present each persons’ story individually and chronologically, highlighting key instances where the participant mentioned one of the six motivational categories. We find that all six motivational categories are present across these three interviews. 

Amber: As an undergraduate, Amber got involved at Traveling Physics because her tutor was a volunteer there and he told her that she would enjoy volunteering with the program. Prior to volunteering in Traveling Physics, Amber had experience working with kids through nannying and daycare. Building from her enjoyment of working with kids, one of Amber’s original motivations for volunteering at Traveling Physics was because, “I get to come in, inspire some folks, and maybe get some young people interested in doing science.” Values like wanting to inspire young people is one of the motivators for Amber to get involved with volunteering, but additional categories also help retain her in the program.

As a student, Amber had jobs in retail and pizza delivery; however, “I was doing doing jobs that were just doing jobs.” She had Protective motivation for transitioning to Traveling Physics to reduce the negative feelings she had working at those other jobs. Instead, she wanted a job where she could use “my skill set that I thought I was good at. And so by joining [Traveling Physics], I could just concentrate on school but also enhance my physics learning. So I could go into, let’s say, my E&M class, and I’m struggling with this electricity and magnetism concept, and I could come back into [Traveling Physics] and say, ‘How does this work?’... So now I can move more into a career trajectory, versus I’m just doing jobs to pay the bills.” Traveling Physics was providing Amber with Understanding motivations by helping her to build upon her physics knowledge and skills. In addition, she sees these skills and knowledge to be more helpful in lining up with her Career trajectory compared to her other job experiences.

After earning her bachelor’s degree, she ran the undergraduate labs before getting a job in the tech industry. After being laid off, she returned to her alma mater to pursue a teaching degree. During this time, she worked again at Traveling Physics. Based on her past experiences in the tech industry, Amber came into Traveling Physics with some additional
motivations, specifically with her *Values* of inspiring women. “For me personally, because I am a woman in science and something I didn’t come to until I was in the tech industry, and I saw how few women there were that I worked with, my personal goal was to go out and inspire young women. So showing them and enabling them that they can do science.” After a semester of education courses, she decided that she did not want a formal educational career; however, she had built *Social* relationships with the other volunteers. One of these relationships led to her and another volunteer opening up a business together. Amber eventually left that business and went back to work in the tech industry.

Amber says that when she was back in the tech industry, “I was continually really trying to get back into [Traveling Physics] because I realized that was the thing I loved in life. I mean, even my coworkers would say, ‘You go do this thing’... ‘I was continually really trying to get back into [Traveling Physics], and all you do is talk about [it]. Why don’t you...’” Her love for Traveling Physics would be an *Enhancement* motivation, but it was one that developed over time and played a role in her wanting to return and stay involved. Not only was her love of Traveling Physics apparent to her, but her tech colleagues noticed and commented on her enjoyment of the program, even to the point of encouraging her to pursue the program professionally. She applied for multiple positions at Traveling Physics and ultimately was hired as an assistant director.

In our interview, Amber reflected on how her past volunteering experiences impacted her after graduating. While she learned some physics knowledge and skills by building experiments, she also says that volunteering “enabled me to be okay to continue to fail. It was okay to come in here and work on a project for an entire semester, and the project doesn’t work, and that’s okay...Gosh, when [my business] imploded, and we weren’t making any money and that was it, I was like, ‘I don’t know what to do,’ And I’m like, ‘Gosh, what would [Traveling Physics director] do?’ It’s like, ‘Oh, you learn.’ You pick up the pieces. You see what’s the thing you enjoy, and you use that as your guiding light to go forward.” Volunteering helped Amber to gain life skills in overcoming failure, and she used that *Understanding* later on in her career.

**Mark**

As an undergraduate, Mark was asked by the physics department to teach some of the introductory physics labs as a teaching assistant. This was one of the early moments where Mark learned that he enjoyed teaching. When he attended graduate school, the *Enhancement* from his undergraduate teaching motivated him to get involved in the introductory labs and working with the Traveling Physics coordinator. “[In undergrad], I knew how the lab ran, so I helped tell the teaching assistants the next time what we were doing and I would help set up the labs for everybody, started editing the manuals and realized, hey, I like this. So that’s why when I saw that when I got to [graduate school] with [Traveling Physics director], I was very willing to jump in and help and stay in that aspect of it.” In the introductory physics labs, his responsibilities included managing the lab spaces, teaching some of the labs, and leading the teaching assistants.

Mark’s motivations for volunteering were more than just feeling good. “I love physics. I love the doing of it, but if I couldn’t share it with somebody in some fashion, I don’t think I’d still be in it. That’s what I realized I liked, and I felt like I could do that if I was with teaching assistants, the lab students, and, and then ultimately outreach...I feel like I’m sharing it, not dispensing information.” A couple motivations overlap here. He *Values* the sharing of physics versus the dispensing of knowledge. He also determined that in order for him to stay in a physics *Career*, sharing physics with others was a necessary aspect for him. Volunteering helped him to *Understand* how to learn and share physics. “It changed the way I approach physics when I’m learning it. Because...when I’m learning it, I’m trying to make connections now...and help [others] see how it works. The concepts and the principles rather than just here’s some problem solving skills to get you through and graduate. Because that was more the drive of my undergraduate career. [Traveling Physics] was the flip. It was the reverse.”

Mark also had *Protective* motivations from not feeling trusted to do work in research labs. “In two research labs...they hardly gave me any responsibility or significant responsibility or asked me to do any. I didn’t feel like I was helpful, part of a team or useful. Joining [Traveling Physics], all of that switched. They were like, ‘hey, would you like to work on this or what would you like to work on? OK, pursue it.’ And then they gave guidance, but you got to explore with it and learn and try and maybe you came back and it was wrong and they give you advice and you go work on it some more.” Even when he was taking other coursework and labs as a student, Mark found the manuals and activities to be “cookbook” and that his role was more about “going through the motions. You were just another cog in a wheel...I’d never felt that in [Traveling Physics]. [I] always felt useful, appreciated, helpful.” Traveling Physics provided Mark a place where he felt trusted, able to contribute, and able to learn and apply his skills.

As a lecture demonstration specialist, he currently does demonstrations for physics courses and sometimes teaches courses. He also facilitates teaching workshops with K-12 teachers and does public engagement with K-12 schools. Mark reflects on how Traveling Physics impacted the *Career* path that he took. “I just want to emphasize again it did steer me [and] had a huge influence on where I’m at now. The outreach, the teaching, the trying to relate more to the public and the students rather than just going into research...I’m about teaching first and foremost. Everything I do is about that now.” As a form of *Enhancement*, Mark says “[Traveling Physics] made me who I am and I’m grateful for it.”

**Claire**

She was a neuroscience major who also studied sociology and science education. Since early college, she had been interested in pursuing an education career. This motivation stemmed from her *Values* of impacting kids and getting them interested in science. “I wanted to have more of a significant like role in in kids lives. And I also wanted to
incorporate my like love of science and so science education really kind of just put all of those together.” She saw an advertisement for After School Physics and joined because of her *Career* goals. “I’ve had that interest in education for a while. Especially trying to combine education, like with my own passion of science, I think I saw a poster for it and then I saw some people I already knew, like TA’s and LA’s also attending, and I wanted to check it out and I made a lot of cool friends with the group and some cool connections as well.” Here, *Social* was another motivation for Claire. She already knew people in that particular program and then she continued to make friends and connections through volunteering.

Claire describes her overall experience volunteering in After School Physics as “overwhelmingly positive” and that “it was really heartwarming to play with the kids.” These positive experiences are a form of *Enhancement*. Some of these positive feelings came from her *Social* relationships with the other volunteers, noting that “It was really cool to connect with other people that were interested in science education.” With a combination of student volunteers of varying academic ranks, many of whom were physics majors, Claire mentioned that “there was another girl that attended with me. Another undergrad. She was in like astrophysics, I think, but we really connected over being the younger ladies in [After School Physics]. I think we became really good friends.”

Even though Claire was a neuroscience major, she says that in her carpool rides to schools with the other volunteers that they would have a mix of science-related conversations. “It was really cool to just have, like, science discussions with people that can, like, keep up even if they’re not necessarily in the same discipline. But I felt like it was a lot of support.”

As a current middle school science teacher, Claire notes that education was already the *Career* path that she was going down. “[After School Physics] was one of the first moves I made to solidify myself in sort of a science education pathway. And so as I was exposed to pedagogy there, I was just starting to be exposed to it within my own courses. But it solidified the age group I wanted to work with. The subject matter I wanted to work with. And I think in some ways the demographic I wanted to work with as well.”

### V. DISCUSSION

Amber, Mark, and Claire represent three different types of educational career pathways. Within the three interviews, we find all six categories to be present; however, for each person, some motivational categories were more prominent than others and manifest in different ways. For example, Amber and Claire had some form of *Career* motivation but in different forms. Amber’s *Career* motivations began more with physics knowledge and skills which then evolved into pursuing education, while Claire’s *Career* motivations in education were solidified and narrowed down. Mark had prior teaching experiences that he found positive, but it was those in combination with his *Protective* motivations from his physics research lab experience that contributed to his pursuit of a career in education. Table II serves as a brief summary of how each category was present across the three interviews and which categories were most prominent for each person. The boldface highlights how that motivation connects to their current work.

There are several limitations with this study. In addition to the participants self-reporting their experiences, most of them are years removed from their time volunteering as students, so recollection of memories should be taken into consideration. In addition, while the alumni we discussed here ended up in education-related jobs, that is not the case for all alumni. We are encouraged by how well the framework illustrated the nuances in people’s motivations, and how those motivations evolved throughout their time in the program and into their careers. Similar to other studies that adapted the volunteerism framework to their own contexts [18–21], we find that this framework appears to appropriate for the informal physics context. Next steps include applying this framework to our larger dataset, which includes a variety of job trajectories, some of which include non-education focused pathways.


