Scientific Thinkers STEM Outreach Program:

Impact on Volunteer's Skills and Diversity Awareness

Thesis

Presented in partial fulfillment of the requirements for graduation with honors research distinction in the undergraduate colleges of The Ohio State University

by

Kayleigh J. Queiser

Undergraduate

The Ohio State University

April 2021

Project Advisors: Dr. P. Chris Hammel, Department of Physics

Dr. Shirley L. Yu, Department of Educational Studies

Abstract

Scientific Thinkers STEM outreach program is an Ohio State University student organization for undergraduate and graduate students. Volunteers in the program deliver hands-on science experiments to local elementary students who are underrepresented in STEM fields. Scientific Thinkers is designed to spark interest in STEM for young students and cultivate interest in science that will extend beyond the classroom. However, it was previously unclear how Scientific Thinkers serves its volunteers, such as if they are benefiting in the form of personal and professional skill development. To determine personal growth and awareness of diversity issues in STEM, the researcher surveyed and interviewed Scientific Thinkers volunteers on the following topics: leadership skills, communication skills, and diversity awareness. An online survey was administered to 18 participants, with six of these participants completing a small focus group interview. Participants were categorized as either short-term or long-term volunteers, as well as general body or leadership volunteers. Analyses indicated that long-term participants had higher mean response values for leadership, communication, and diversity survey items than did short-term participants. Leadership participants also followed this trend; however, they had a lower mean value for diversity awareness survey items compared to general body participants. Significant differences were found for leadership skills between long-term and short-term volunteers and general body and leadership volunteers. Results suggest that Scientific Thinkers should increase attention towards developing its volunteer's leadership skills, given that there is already an indication of personal skill development. To retain current volunteers, the benefits of long-term commitment to the organization should be promoted. The results from this study support as Scientific Thinkers serves elementary students, it also impacts the skill development and diversity awareness of its volunteers.

Acknowledgements

I express my deepest thanks to my research advisor, Professor P. Chris Hammel, who supported this study and provided invaluable insight. I also express my gratitude to Dr. Shirley L. Yu, who provided instrumental feedback throughout this project and was key in its development. I would also like to thank Dr. Nandini Trivedi and the Center for Emergent Materials (CEM) at Ohio State, for their support of Scientific Thinkers, which inspired me to pursue this research study.

I would also like to deeply thank Michelle Richard, who has provided me with vital help and mentorship throughout my involvement with Scientific Thinkers and with this study. Additionally, I would like to thank the student leaders and members of Scientific Thinkers for their vital role in this research and for deeply positively impacting my experience here at Ohio State. I also acknowledge partial support from the Center for Emergent Materials: an NSF MRSEC under award number DMR-2011876.

Curriculum Vitae

June 2017 ……Hudson High School

May 2021 ……B.S. Biology, Honors with Research Distinction,

Magna cum laude, The Ohio State University

Fields of Study

Major Field: Biology

Minor Field: History

Table of Contents

List of Illustrations

Statement of Research Topic

Introduction

The researcher aimed to explore how The Ohio State University (OSU) student organization, Scientific Thinkers STEM (science, technology, engineering, and mathematics) outreach program, develops volunteers personally and professionally over their course of involvement. Scientific Thinkers provides undergraduate and graduate students with an exciting volunteer experience where they can share with elementary students their area of study and teach hands-on STEM lessons. The schools that Scientific Thinkers is partnered with have large populations of students that are part of underrepresented minority (URM) groups in STEM fields. This includes three racial and ethnic groups: blacks or African American, Hispanic or Latino, and American Indian or Alaska Native (National Science Foundation & NCSES, 2019). The goal of Scientific Thinkers is to excite these students about STEM topics and introduce them to aspiring student scientists from a variety of backgrounds (Scientific Thinkers STEM Outreach Program, n.d.). Ideally, students are inspired to learn more about scientific ideas, concepts, and careers as a result of the programming. Scientific Thinkers is clearly promoted to undergraduate and graduate students as an opportunity to serve the Columbus community; however, it is currently unclear how Scientific Thinkers serves its volunteers over the course of their involvement. It is also proposed that the program not only enriches elementary student's STEM education, but also develops its volunteer's personal and professional skills (Scientific Thinkers STEM Outreach Program, n.d.). This research study aimed to explore how volunteers develop over the course of their commitment to Scientific Thinkers, specifically in the areas of leadership, communication skills, and diversity awareness. Current and former volunteers were surveyed and interviewed to understand how their length of involvement and level of

commitment was related to changes in these three areas. The overall aim is to better tailor and promote Scientific Thinkers to undergraduate and graduate volunteers as a program that not only helps local elementary students but can also aid in self-development and awareness of current issues in the STEM field.

Background on Scientific Thinkers STEM Outreach Program

Scientific Thinkers is a STEM outreach program founded in 2010 and is affiliated with the Center for Emergent Materials (CEM) at OSU. The program became a student organization in 2018, one of the over 1,400 recognized by the University (Ohio State University, n.d.). Initially, Scientific Thinkers was only partnered with one Columbus elementary school and teacher but has since expanded to two additional elementary schools. Scientific Thinkers volunteers now reach more than 500 students annually at these schools. The primary goal of Scientific Thinkers is to work with science and mathematics teachers to develop and provide first through fifth grade students with hands-on science lessons. Undergraduate and graduate volunteers aid in this process by traveling to the elementary schools and teaching these lessons as a team (Scientific Thinkers STEM Outreach Progam, n.d.).

Scientific Thinker's mission is to allow students to "Meet a Scientist, Be a Scientist, and Think like a Scientist" (Scientific Thinkers STEM Outreach Program, n.d.). At the start of each visit, volunteers introduce themselves and explain their area of study at Ohio State. This can be challenging for volunteers given the complex nature and range of majors in the STEM field. The goal of the introductions is to allow the students to meet real-life scientists and to introduce new and interesting fields in STEM. Next, the volunteers work as a team to teach a lesson that aligns with their required curriculum. Here, volunteers must give the students sufficient background on

the topic and encourage the students to use the scientific method. Typically, the elementary school students form a hypothesis, engage in an experiment, observe results, record data, and form conclusions from the lesson. Students must think critically about the lesson, and volunteers are encouraged to ask challenging questions about the day's topic (Scientific Thinkers STEM Outreach Program, n.d.).

Following the science experiment, the volunteers are instructed to ask the students one or two thought-provoking questions relating to the lesson's topic. The volunteers are given some guidance to formulate such questions but are given the freedom to create their own. This activity also allows the volunteers a chance to think about the lesson themselves whilst leading a brief discussion with the students. Finally, volunteers are requested to assist in cleaning up the classroom and gathering unused supplies. After the lesson, they are emailed a survey to provide feedback on the activity and reflect on their experience (Scientific Thinkers STEM Outreach Program, n.d.).

School and Volunteer Demographic Background

Scientific Thinkers partners with three schools: Innis Elementary, Parkmoor Elementary, and Mansion Day School. Innis and Parkmoor Elementary are public schools that are part of the Columbus City School District, and Mansion Day School is a private school primarily for URM students (Mansion Day School, 2021). A recent (2019-2020) survey of demographic data from these schools was analyzed. Innis Elementary currently had 353 enrolled students, with 74% classified as URM students and 100% classified as economically disadvantaged because all students were on free or reduced lunch. Over half of Innis students are English Language Learners (ELLs), and 12% are identified as disabled (Ohio Department of Education, 2019,

2019-2020a). The term ELL refers to students who do not speak English as their first language and typically come from non-English speaking homes. Parkmoor Elementary has a total of 320 students: 69% are URMs and 100% are economically disadvantaged students. 11% of students are ELLs and 14% have disabilities (Ohio Department of Education, 2019, 2019-2020b). Mansion Day School has a more limited set of demographic data available, with 69 total students enrolled. 84% of Mansion Day's students are classified as URMs (Private School Review, 2021).

Student volunteers for Scientific Thinkers come from a wide variety of areas of study, ethnic backgrounds, gender identities, and level of schooling. According to 2019-2020 demographic data on 79 volunteers, 48% identified as female and 48% identified as male, with the remaining choosing not to identify. Most volunteers were engineering majors (37%) with the remaining self-reporting as physical science majors (35%), biological science majors (22%) and other, uncategorized majors (5%). Scientific Thinkers volunteers were also racially and ethnically diverse, with 10% identifying as African American, 23% Asian, 57% Caucasian, 4% Hispanic, 1% Latin American and 3% of Middle Eastern descent. The remaining volunteers chose not to identify.

Statement of the Problem

Pursuing a STEM degree in college is becoming increasingly more desirable. This can be attributed to a few factors, including that individuals with STEM degrees have a higher likelihood of employment, a higher median annual salary, and other positive economic outcomes when compared to those who pursue majors in non-STEM fields (Carnevale et al., 2015). However, the National Science Board reported in 2018 that the likelihood of choosing a STEM major in college is inversely related with being Hispanic, Black, or female. Pursuing STEM

degrees was also found to be inversely related with students coming from low-socioeconomic status (National Science Board, 2018). Furthermore, it is indicated that the proportion of students of color that pursue degrees in STEM does not reflect (and is far behind) the proportion of these individuals in the overall United States population (Whittaker & Montgomery, 2012).

It should also be noted that there is an inverse association between representation in STEM fields and ELL students (LaCosse et al., 2020). Although the number of students in the United States that speak English as a second language is increasing, representation of ELL students in STEM majors and fields still lags behind. Furthermore, there are substantial gaps in research as to why ELL students are underrepresented in STEM and in higher education ("The Status and Trends in the Education of Racial and Ethnic Groups," 2010).

URM and ELL underrepresentation in STEM is a complex and pressing matter. As of 2020, Scientific Thinkers is established at three local elementary schools with predominantly URM student enrollment (Ohio Department of Education, 2019-2020a, 2019-2020b). One aim of the Scientific Thinkers program is to reach students that lack representation in STEM and foster interest in such topics. The goal is for students to become interested in science and interact with “real-life” scientists, or undergraduate and graduate volunteers from a wide range of areas of study. Although not thoroughly investigated, Scientific Thinkers volunteers may make lasting, positive impacts on these students, driving them to explore more scientific ideas, concepts, and careers.

Scientific Thinkers is promoted to OSU students as an rewarding volunteer opportunity with a chance to make a difference in the Columbus community (Scientific Thinkers STEM Outreach Program, n.d.). While the benefit of the program to local elementary students is an

exciting, hands-on STEM experience, Scientific Thinkers has not publicized or explored any advantages of participation for its volunteers. Volunteer development as a result of participating in STEM Outreach programs at various universities has previously been investigated. These studies have reported correlations between length of participation and increasing level of commitment to STEM Outreach programs with improved communication and leadership skills (Anagnos et al., 2014; Ferrara et al., 2018). It is worth noting, however, that such outreach programs vary across universities, with differences in organizational goals, student commitment levels, and activities. Scientific Thinkers is a program unique to OSU, and the programming that student volunteers experience may lead to outcomes different from what was found in these studies. Given the nature of Scientific Thinkers, it was of particular interest to uncover how volunteers develop as leaders, scientific communicators, and how their awareness of diversity issues in STEM has changed as a result of their participation.

Purpose of the Study

It is currently unknown how Scientific Thinkers STEM outreach program serves to benefit its volunteers. Based on the goals of the outreach program, the researcher focused on volunteer development in leadership, communication skills, and diversity issues in STEM. The researcher surveyed and interviewed current and former Scientific Thinkers volunteers to gauge changes in these three areas over the course of their involvement with the program. It was also of interest how leadership, communication skills, and diversity awareness varied across lengths of volunteer commitment and level of participation and leadership in the organization. Understanding the relationships between these factors could help guide future volunteer training, outreach, and engagement.

Method

Research Design

To assess and improve the Scientific Thinker's STEM Outreach program's ability to help volunteers develop personal skills and perspectives on diversity in STEM fields, the researcher developed a mixed-method study. The study design is characterized as a non-experimental cross-sectional assessment, utilizing surveys and interviews to assess volunteers. Participants were invited to complete an online survey and were given the opportunity to opt-in to a small focus group. Both measures were designed to focus on the following topics:

1) Leadership skills and development

2) Scientific communication skills and development

3) Changes in awareness of diversity issues in STEM fields.

This project studied two different populations: undergraduate and graduate students who volunteer with the Scientific Thinkers STEM outreach student organization. The entire undergraduate and graduate Scientific Thinkers from Autumn 2017 to Autumn 2020 volunteer population was recruited through e-mail.

Data Collection Procedure

Following approval from OSU's Institutional Review Board (IRB), data collection was initiated. All data, which includes survey responses and audio recordings, were collected and stored digitally. Eligible participants, or current and former Scientific Thinkers volunteers, completed an online survey through Qualtrics, a web-based survey program. At the end of the survey, participants were recruited for a small focus group interview which would be held after

the online survey was closed. The focus group interview was semi-structured, with questions designed to allow participants to expand on some of the topics from the online survey. The student participants spent between 10 and 15 minutes completing the one-time online survey. The students that chose to participate in the focus group interviews spent no more than 60 additional minutes.

Recruitment

The target population for this study was current and former Scientific Thinkers undergraduate and graduate volunteers. Participants for this study were recruited non-randomly in a purposive sampling method. The Scientific Thinkers contact information database from Autumn 2017 to Autumn 2020 was cross-referenced to volunteer attendance records from this time. Volunteers from the contact database who also appeared at least once on the attendance record sheet were deemed as eligible participants and were deliberately selected for recruitment.

The eligible participants were recruited via a confidential e-mail (see Appendix A-B). Potential participants were informed that the purpose of the research was to help the organization gain a better understanding of how Scientific Thinkers helps develop student leadership and communication skills, as well as diversity awareness. The approximate duration of the study was noted as 10 to 15 minutes. Finally, potential participants were reminded that participation was completely voluntary, and that identifying information would be kept confidential. There were no incentives offered for participation. A follow-up e-mail was sent two weeks later to remind volunteers of the survey. No more than two emails were sent to each potential participant.

Sample

The researcher initially sought out 100 student participants for the study. This number roughly reflects the total amount of Scientific Thinkers volunteers that were contacted to participate in the online survey. Given typical survey return rates, and accounting for personal knowledge and participation in the program, the researcher anticipated 30 to 50 participants would complete the survey, including focus group participants. Following data collection, a total of 22 Scientific Thinkers volunteers participated, with 17 complete and 1 partially complete response. 6 total students opted-in and participated in the focus group interview. All participants submitted an informed consent form prior to participating in the survey and focus group interview (see Appendix C-D).

Measures

The online survey instrument was structured to first evaluate Scientific Thinkers-related demographic information, scientific communication skills, leadership skills, diversity awareness, then finally basic demographic information (see Appendix E). These categories were separated to give the survey a logical flow. Survey and focus group interview questions were developed referencing previous research which also investigated volunteer development and participation in STEM outreach programs (Anagnos et al., 2014; Aybar Martínez et al., 2019; Ferrara et al., 2018). Questions were designed to address various aspects of each category without becoming too time-intensive for participants. The semi-structured interview questions were loosely based on the online survey questions, allowing volunteers to give specific examples and personal experiences relating to each topic (see Appendix F).

Scientific Thinkers *Demographic Factors*

The independent variables in this study were the length of commitment to Scientific Thinkers and the level of involvement with the student organization. To measure these variables, participants were first prompted to answer some basic questions regarding their participation in Scientific Thinkers. Length of commitment was assessed by asking participants: "How long have you been involved in Scientific Thinkers?" and "How often do you volunteer with Scientific Thinkers?" To best represent the volunteer's duration of involvement with the organization, responses were categorized as a long-term volunteer if the participant selected "three semesters" or "four or more semesters" for length of involvement. The participant was categorized as a short-term volunteer if they selected "one semester" or "two semesters."

To measure level of involvement in the organization, participants were prompted with the following question: "What is your role with Scientific Thinkers?" To represent level of involvement, responses were categorized as either indicating basic involvement or higher-level (leadership) involvement. Participants that responded "committee member" or "executive board member" were categorized as pursuing a higher level of involvement with the organization. The justification for this classification is that committee members and executive board members are required to attend more classroom visits and are involved in the logistical operations of the organization. Participants that responded "general body member" were designated as having a basic level of involvement.

For the final portion of this section, participants were asked: "What goals did you have when you joined Scientific Thinkers?" Survey respondents were able to select as many goals as they desired, which included items such as "have fun," or "build my resume" or "improve my leadership skills." The purpose of this question was to assess student goals and indicate any

trends in volunteer's selected goals and possible relationships to skill development or diversity awareness.

Leadership Skills

Participants were next directed to answer questions regarding their perception of personal improvement in leadership skills. Leadership was evaluated using skills that are characterized as having the potential to develop. Questions were developed based off of the following skills: Collaboration, communication, problem solving, motivation, change management, and facilitation techniques (Kurec, 2016). Questions were phrased based on the nature of the student organization and expectations for volunteers while in the classroom. Participants indicated their level of agreement for seven questions on a 7-point Likert scale (1 = Strongly Disagree and 7 = Strongly Agree), noted in Table 1.

Table 1. Leadership Skills Survey Items

Skill(s)	**Question**
Communication	I saw improvements in my confidence and ability to speak in front of new people.
Collaboration	I have improved in my ability to work as a team with other volunteers.
Problem solving	I have seen growth in my ability to resolve conflicts among elementary students.
Motivation	I have improved in my ability to keep the students focused on the lesson.
Change management, Problem solving	I have improved in my ability to make changes and lead the group in a new direction when things do not go as planned.
Facilitation techniques, Motivation	I have seen growth in my ability to motivate students to actively participate and engage in the lesson.
Facilitation techniques, Motivation	I have seen growth in my ability to motivate volunteers to actively participate and engage in the lesson.

Communication Skills

Participants were prompted to further elaborate on development of communication skills. The focus for this portion of the online survey was primarily scientific communication skills. Proper scientific communication skills are vital for Scientific Thinkers volunteers, as their major role is to relay new and complex scientific ideas to students prior to the experiment. Effective communication skills were evaluated to create six survey questions, seen in Table 2. These skills were as follows: Correctness/Appropriateness, Conducive Environment, and Clarity of Thought and Expression (Akilandeswari et al., 2015). Survey participants indicated their level of agreement for 6 questions on a 7-point Likert scale (1 = Strongly Disagree and 7 = Strongly Agree), which are reported in Table 2.

Table 2. Communication Skills Survey Questions

Skill(s)	**Question**
Correctness / Appropriateness	I am more able to simplify complex scientific ideas.
Conducive Environment	I saw improvements in my ability to communicate scientific ideas that are new to elementary school children.
Conducive Environment	I have improved my ability to communicate STEM concepts in a way that elementary students find enjoyable or fun.
Clarity of Thought and Expression	I gained more confidence in my ability to explain technical concepts.
Correctness / Appropriateness	I have improved my ability to communicate what I am studying at Ohio State.
Clarity of Thought and Expression	I became more confident while speaking in front of an audience.

Diversity Awareness

To develop an understanding of how Scientific Thinkers volunteers became aware of diversity and representation issues in STEM fields, participants were prompted with seven

questions, reported in Table 3. These questions were developed based on Scientific Thinkers' outreach goals and the demographic composition of the schools. For example, Parkmoor elementary reported that 11% of its enrolled students were English Language Learners (ELLs). The questions were categorized as follows: Diversity and Representation (D & R) and ELL. Participants responded to 7 questions on a 7-point Likert scale (1 = Strongly Disagree and 7 = Strongly Agree).

Table 3. Diversity and Representation Survey Questions

Category(s)	Question
D & R	I am more informed about the importance of representation in STEM fields.
D & R	I am more aware about the lack of diversity in STEM fields.
D & R	I am more aware of strategies to facilitate excitement in underrepresented students about science.
D & R, ELL	I am more aware of challenges that immigrant or English Language Learning (ELL) students face.
D & R, ELL	I am more aware of ways to support immigrant or English Language Learning (ELL) students.
D & R, ELL	I have seen challenges that teachers face in teaching ELL students.
D & R	I am more conscious of the importance of diversity in my own community.

Demographic Factors

To end the online survey, basic demographic factors were assessed to better characterize the Scientific Thinkers volunteer participant group. These demographic factors were determined using existing literature, as follows: race (Baker et al., 2006), gender identity (Lindqvist et al., 2020), class rank, and area of study ("The SAGE Encyclopedia of Communication Research Methods," 2017).

Focus Group Interview

After participants finalized their survey responses, they were prompted to partake in a small focus group interview regarding their survey responses over a Zoom video call. Participation in the interview was voluntary. The focus group interview was semi-structured and led by the researcher. Six Scientific Thinkers volunteers elected to take part in the interview. Questions from the interview followed the format of the online survey, prompting students to further elaborate on areas of self-perceived skill development. Questions from the interview included: “How has participating in Scientific Thinkers impacted your leadership skills?” and “In what ways does Scientific Thinkers bring awareness to diversity in STEM for you?” The intended purpose of the small focus group interview was to allow students to expand upon their survey responses and address any areas that the survey may have missed. It was also included to allow participants to build off other volunteer’s ideas and include any shared perspectives. The interview was video recorded and then transcribed, and common themes from the discussion were extracted. Relevant quotations from participants illustrating these themes were reported.

Data Analysis

Following data collection, data were downloaded from the Qualtrics survey platform to IBM Statistical Package for the Social Sciences (SPSS) Version 27.0, 2020. The raw data were coded, and entirely incomplete survey responses were removed. Partially completed survey responses were retained. Survey respondents were placed in the following groups:

1. Leader (committee member, executive board member)

   OR

   General body member

2. Short-term volunteer (one-to-two-months of participation)

   OR

   Long-term volunteer (three-to-four or more months of participation)

Survey question items from the leadership, communication, and diversity and representation were then assessed for internal consistency. This was done by calculating Cronbach's alpha (α) to find the coefficient of reliability for the items in each of the three online survey sections. Items were considered to have an acceptable level of internal consistency if α was greater than or equal to 0.7. The Cronbach's alpha measure indicated that the survey items for leadership, communication, and diversity and representation awareness were of all acceptable levels of internal consistency ($\alpha \geq 0.7$). It was found that Cronbach's alpha for leadership skills items was $\alpha = 0.842$, communication skills items $\alpha = 0.847$, and diversity and representation awareness items $\alpha = 0.917$.

Next, descriptive statistics were calculated. Frequencies were calculated to better characterize the sample and determine what students' initial goals were when joining Scientific Thinkers. For the leadership, communication, and diversity and representation awareness items, variables were reported on a 7-point scale (1 = Strongly Disagree to 7 = Strongly Agree). Mean and standard deviation response values were calculated for leadership, communication, and diversity and representation awareness for each subsample. Lastly, a comparison of means was completed. An independent *t*-test with significance level $\alpha = 0.05$ was performed and analyzed to determine whether differences in these leadership, communication, and diversity and representation awareness existed between general body members and leaders, as well as between short-term volunteers and long-term volunteers.

Results

Demographic Factors

Basic Demographic Characteristics

There were 18 survey respondents, with one of these participants only providing Scientific Thinkers demographic information, goals of joining Scientific Thinkers, and self-perceived communication skill improvement data. The remaining responses were complete. Participants were allowed to select more than one race or ethnicity that they felt best described them. As reported in Table 4, 66.7% of the sample identified as White (*n* = 12), 5.6% as Black or African American (*n* = 1), 22.2% as Asian or Asian-American (*n* = 4), and 5.6% as Hispanic or Latinx (*n* = 1). For gender identity, 52.9% identified as female (*n* = 9) with the remaining 47.1% identifying as male (*n* = 8). Participants reported their class rank as follows: 29.4% (*n* = 5) were sophomores, 17.6% (*n* = 3) were juniors, and 23.5% (*n* = 4) were senior undergraduates. The remaining 29.4% (*n* = 5) of participants were graduate students. Lastly, participants were split between two areas of study: sciences (64.7%, *n* = 11) and engineering (35.2%, *n* = 6).

Table 4. Demographic Factors

Variable	Frequency	%
Race		
White	12	66.7
Black or African American	1	5.6
American Indian or Alaska Native	0	0.0
Asian or Asian-American	4	22.2
Native Hawaiian or Pacific Islander	0	0.0
Hispanic or Latinx	1	5.6
Other	0	0.0
Gender		
Female	9	52.9
Male	8	47.1
Class Rank		
Freshman	0	0.0
Sophomore	5	29.4
Junior	3	17.6
Senior	4	23.5
Graduate	5	29.4
Area of Study		
Sciences	11	64.7
Engineering	6	35.2
Liberal Arts and Humanities	0	0.0
Business and Economics	0	0.0
Other	0	0.0

Scientific Thinkers Demographic Factors

Table 5 illustrates the Scientific Thinkers-related demographic characteristics of the sample. A little over half (52.6%, $n = 10$) of the sample identified as general body members, which is the basic level of involvement. 10.5% identified as committee members ($n = 2$) and 36.8% ($n = 7$) identified as executive board members, which are more involved, leadership-oriented positions. Most participants reported being involved with Scientific Thinkers for one semester (42.1%, $n = 8$) or two semesters (26.3%, $n = 5$). The remaining participants had reported being involved with the organization for three semesters (15.8%, $n = 3$) or four or more semesters (15.8%, $n = 3$). In regard to frequency of volunteer service, 36.8% indicated they

visited the schools once a month (n = 7), 10.5% two times a month (n = 2), and 21.1% visiting three or more times a month (n = 4). Around 5.3% visited once a semester (n = 1) while 21.1% of participants visited schools twice a semester (n = 4).

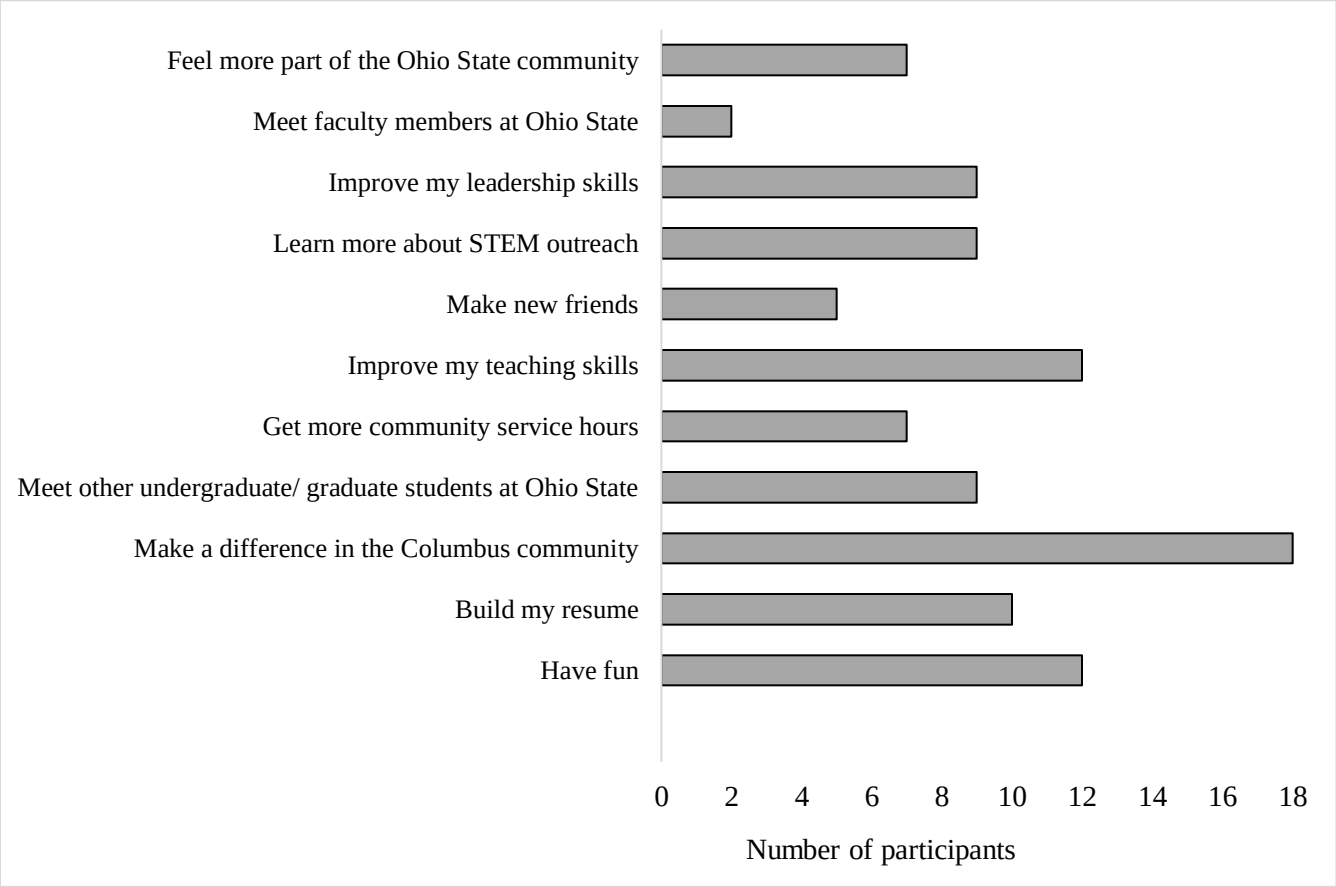
Table 5. Scientific Thinkers Demographic Factors

Variable	Frequency	%
Role		
General body member/volunteer	10	52.6
Committee member	2	10.5
Executive board member	7	36.8
Length of Involvement		
One semester	8	42.1
Two semesters	5	26.3
Three semesters	3	15.8
Four or more semesters	3	15.8
Frequency of Volunteer Service		
One visit a semester	1	5.3
Two visits a semester	4	21.1
One visit a month	7	36.8
Two visits a month	2	10.5
Three or more visits a month	4	21.1

Goals of Joining Scientific Thinkers

Participant's initial goals when joining Scientific Thinkers are addressed in Figure 1. Survey respondents for this section (n = 18) could select as many goals as they felt applied to them. All the survey respondents reported that they joined Scientific Thinkers to make a difference in the Columbus community. A similar number of participants (n =12) selected "improve my teaching skills" and "have fun" as goals. Half (n = 9) reported that one of their goals was to improve their leadership skills. The fewest number of students (n = 2) selected "meet new faculty members at OSU" as a goal. The remaining frequency of goal selections are reported in Figure 1.

Figure 1. Goals of Joining Scientific Thinkers



Descriptive Statistical Analysis and Comparison of Means

Short-term and Long-term Participants

Table 6 represents self-perceived changes in leadership skills, communication skills, and diversity and representation awareness for short-term and long-term participants. For self-perceived leadership skill improvement, short-term participants (n = 6) had a mean response of 4.86 (SD = 0.45) compared to long-term participants (n = 11) who had a mean response of 5.65 (SD = 0.72). Comparing these two groups using an independent t-test ($\alpha = 0.05$) indicated a significant difference between the two means for leadership skills, $t(15)$, p = 0.028. Regarding

self-perceived communication skill improvement, short-term participants (n = 7) had a mean response level of 5.52 (SD = 0.66) compared to long-term participants (n = 11), who had a mean response level of 5.83 (SD = 0.86). T-test results indicated no significant differences between the two means for communication skills, $t(16)$, p = 0.429. Lastly, for self-perceived improvements in diversity and representation awareness, short-term participants (n = 6) had a mean response level of 4.76 (SD = 1.52) compared to long-term participants (n = 1), who had a mean response level of 5.70 (SD = 1.02). Independent t-test indicated no significant difference between the means of these two groups, $t(15)$, p = 0.147.

General Body and Leader Participants

Self-perceived changes in leadership skills, communication skills, and diversity and representation awareness were also addressed for general body and leader groups, reported in Table 7. For leadership skills, general body participants (n = 8) had a mean response level of 5.00 (SD = 0.47) compared to leader participants (n = 9) who had a mean response level of 5.70 (SD = 0.79). These groups were compared using independent t-test ($\alpha = 0.05$), which indicated a significant difference between the two means, $t(15)$, p = 0.047. For self-perceived communication skill improvement, general body participants (n = 9) had mean response level of 5.57 (SD = 0.59) as opposed to leader participants (n = 9) who had a mean response level of 5.85 (SD = 0.95). Independent t-test did not indicate a significant difference between the means of these two groups, $t(16)$ p = 0.468. Lastly, for diversity and representation awareness, general body participants (n = 8) had a mean response value of 5.46 (SD = 1.36) compared to leader participants (n = 9) who had a lower mean response value of 5.29 (SD = 1.24). The independent t-test for these two groups indicated no significant difference between the means, $t(15)$, p = 0.781.

Table 6. Mean differences for leadership, communication, and diversity and representation awareness for short-term and long-term participants

	Short-term		Long-term				
	Mean	*SD*	*Mean*	*SD*	*t*-test	*df*	*p* (two-tailed)
Leadership	4.86	0.45	5.65	0.72	-2.424	15	0.028*
Communication	5.52	0.66	5.83	0.86	-0.811	16	0.429
Diversity and Representation Awareness	4.76	1.52	5.70	1.02	-1.530	15	0.147

Note. *$p < 0.05$

Table 7. Mean differences for leadership, communication, and diversity and representation awareness for general body and leader participants

	General Body		Leader				
	Mean	*SD*	*Mean*	*SD*	*t*-test	*df*	*p* (two-tailed)
Leadership	5.00	0.47	5.70	0.79	-2.169	15	0.047*
Communication	5.57	0.59	5.85	0.95	-0.744	16	0.468
Diversity and Representation Awareness	5.46	1.36	5.29	1.24	0.283	15	0.781

Note. *$p < 0.05$

Focus Group Interview Responses

There were 6 total focus group interview participants. 4 of these participants were categorized as both long-term and leadership participants. The remaining 2 were categorized as both short-term and general body participants. The interview was structured similarly to the online survey, with participants responding to prompts regarding leadership and communication skills, as well as diversity and representation in STEM. Representative comments from this interview are summarized in Table 8. The quotations from the focus group were then used to supplement and better understand the results from the online survey.

Table 8. Focus Group Interview Responses

Topic	Defining Statements/Remarks
Leadership Skills	"Being able to respond to change very quickly is something I've learned [from volunteering.]"
	"There's a period of time where you're looking to the person who is leading, but then you go off on your own with students and [each volunteer] must be a leader themselves."
	"I was not always comfortable delegating tasks and handling new situations. Now, I feel like I've improved in [those areas]."
	"Feeling like a leader for [a small group] of elementary students really developed my leadership skills."
Communication Skills	"You really learn how to communicate, especially with different kinds of people, specifically, children. [Scientific Thinkers] has trained my brain to adapt to different types of people that I meet."
	"[As a volunteer] you communicate with other volunteers, students, and the teachers. Over time, you learn to switch between different methods of communicating and become more effective at doing so."
	"You also have to make the volunteers more excited about what they're doing. This will then pass on to students and [will encourage volunteers] to come back and be more involved."
	"When we were doing introductions, I really had to think about what I study to break it down to [the students]. Not in a patronizing way, but in a way, they could understand it in terms of things that they experience every day."
Diversity and Representation Awareness	"There is a huge benefit to seeing real people doing science and having jobs and careers [in science]."
	"I think it's beneficial for the students to see the volunteer diversity in [Scientific Thinkers]. ... To see that many students that look similar to them shows them that they can be scientists in the future. The younger version of me would have been really happy to see that."
	"The majority of students at the schools we go to have students that are minorities and underrepresented in STEM. [These students] are able to see that they can be scientists and be in STEM."
	"There's not equal access to STEM [education]. I think it's great that this organization goes into these schools and provides more STEM time and provides that spark [of interest in STEM]."
Other	“The [elementary] students really surprised me about how much they know about science. I feel like I’ve learned a lot from them.”
	“It was great to see [other volunteers] and students come out of their shells and become more confident after a few weeks of volunteering.”

Discussion

This study aimed to evaluate how Scientific Thinkers volunteers develop following various levels and length of involvement with the program. The results from this study provide evidence that a relationship between increased length of involvement and level of leadership with Scientific Thinkers and some of the examined topics exists. With 55.6% of volunteers selecting “improve my leadership skills” and 66.7% selecting “improve my teaching skills” as a personal goal of joining Scientific Thinkers, it seems fitting that there were significant relationships indicated for self-perceived increases in leadership skills and two of the independent variables. Conclusions from these results and other topics in the study are supplemented with insightful comments from the focus group interview.

In general, long-term Scientific Thinkers volunteers in the sample had greater self-perceived improvements in leadership, communication skills, and diversity and representation awareness compared to short-term volunteers. In the case of leadership skills, it was noted that the differences between short-term and long-term volunteers was significant ($p = 0.028$). These findings draw on other literature which indicated significant differences between student organization involvement and leadership skills (Coscia, 2017; Mak & Kim, 2017; Smith & Chenoweth, 2015). These studies look at student organization involvement in a broad sense, while the current study specifies involvement in a STEM Outreach program. From these results, it seems evident that increased length of involvement in Scientific Thinkers helps to build leadership skills, particularly those that apply to classroom visits.

Similar to long-term participants, survey participants that held leadership positions had greater self-perceived leadership skills, communication skills, and diversity and representation awareness compared to general body participants. For leadership skills, the differences between

leaders and general body participants were significant ($p = 0.047$). A review of literature did not indicate any studies that examined the relationship between leadership roles in student organizations and personal skill development. However, this relationship seems to reflect the results for increased length of involvement in Scientific Thinkers. Those volunteers that dedicate more time with the organization are more likely to apply and be elected for leadership positions.

During outreach events, volunteers are encouraged to work as a team and guide the students through the lesson. Usually, teacher supervision is minimal, and volunteers are placed in charge of keeping the students engaged with the day's activity. As student volunteers become more familiar with the flow and discourse of the visits, it is likely that they become more comfortable motivating students, working with other volunteers to deliver the lesson, and navigating the lesson in a new direction when unpredictable changes occur. As one participant mentioned in the focus group interview:

> "Being able to respond to change very quickly is something I've learned [from volunteering.]"

This may explain the significant difference in leadership and length of involvement, as volunteers are placed in an environment where leadership is encouraged. This was noted by another participant in the group interview, who commented that over time, they became more comfortable delegating tasks and handling new situations. As for the significant difference in leadership level and self-perceived leadership skills, this association may be more obvious. Leaders in the organization are expected to act as models for more inexperienced general body members and motivate other volunteers to participate.

There were no significant differences for communication skills and length of involvement or leadership status. However, there was a slight increase in self-perceived communication skills for both long-term (M = 5.83) and leadership volunteers (M = 5.85) compared to short-term (M = 5.52) and general body (M = 5.57) volunteer participants. This finding could be explained by the nature of the classroom visits, which require volunteers to communicate effectively with students, other volunteers, and teachers. Volunteers must effectively describe what their area of study is at OSU in a manner that elementary students can understand. Additionally, volunteers are asked to explain the technical concepts behind the lesson plan in front of an audience. It seems appropriate that as participants report a longer duration of involvement with the organization, that they will become more efficient and comfortable with these tasks. As volunteers attend more visits, they become more familiar with the students, teachers, and other volunteers. As one focus group participant mentioned:

> “[As a volunteer] you communicate with other volunteers, students, and the teachers. Over time, you learn to switch between different methods of communicating and become more effective at doing so."

They also may learn new techniques to effectively communicate scientific concepts in a fun and engaging way. The same can be said for leader participants, who would be the most familiar with the teachers, students, and other volunteers. They are also well aware of technical concepts in the lesson plan from previous classroom visits. Hence, with more participation, comes an improved communication skillset.

For diversity awareness, there were also no significant differences in self-perceived increased awareness and length of involvement or leader status. For long-term volunteers,

however, participants noted a greater increase in awareness (M = 5.70) compared to short-term volunteers (M = 4.76). This may because long-term volunteers are more likely to have participated in school visits across all three elementary schools. This would mean these participants are more exposed to a variety of students, such as populations of ELL students at Innis elementary, and are more familiarized with the challenges that these students and teachers may face. This was documented in the focus group, as one participant states:

> "There's not equal access to STEM [education]. I think it's great that this organization goes into these schools and provides more STEM time and provide that spark [of interest in STEM]."

Furthermore, long-term volunteers may be more familiar with some of the goals of Scientific Thinkers, such as creating strategies to facilitate excitement in URM students about science. General body participants reported a greater increase in awareness (M = 5.46) than leaders (M = 5.29). This result was unexpected, as leaders had typically shown higher response values across all topics. This could be due to the organization's expectation of leaders to focus on volunteer and student engagement, as well as some administrative aspects of the club. This shift in focus may explain the non-significant difference, as general body members may be more attentive to the diversity and representation goals of Scientific Thinkers.

Limitations

There are a few limitations to this study to acknowledge. The online survey included 18 respondents, with 6 focus group participants. A larger sample size would allow for increased generalizability to the Scientific Thinkers volunteer population. Furthermore, a small sample size increases the probability of assuming false outcomes (Faber & Fonseca, 2014). Some potential survey participants entered into the survey and only completed the informed consent, while others only responded partially. This may indicate a need for improved communication with potential participants about the duration of the online survey. Furthermore, there is a potential for sampling bias for the survey portion of the study. Survey participants elected to participate in the focus group. The self-selected sample for the focus group may consist of participants that have had more positive experiences with the program or had higher self-perceived skill improvement.

Another limitation of this study is that the results are based upon self-reported perceptions of leadership and communication skills, as well as diversity awareness. Survey respondents may have over or understated levels of self-perceived improvement in these areas. There is a possibility of social desirability bias, where survey participants answered questions regarding skill improvement and awareness in an exaggerated manner. However, the volunteer's self-perceptions of these skills are still important to understanding how Scientific Thinkers assists in personal and professional development.

Although the survey questions were developed using established leadership and communication skill areas and had high internal consistency, it may have been useful to instead use an established survey instrument. Doing so could potentially improve the representation and interpretation of results for this portion of the study. Furthermore, one independent variable, frequency of involvement, could not be properly coded for interpretation due to confusing survey

language. More clearly defining frequency of involvement to survey participants would have provided another opportunity for further analysis. Finally, the online survey only asked a limited number of questions (6 to 7) for each topic. This may have created a very narrow definition of the examined areas (leadership skills, communication skills, and diversity and representation awareness). Although some participants were given the opportunity to expand on these topics during the focus group interview, not all participants participated in this portion of the study. It may be useful for future research on Scientific Thinkers to prompt participants with more questions to create a more accurate definition of these topics.

Implications and Conclusions

It is anticipated that the results from this study will help the Scientific Thinkers STEM outreach program improve their ability to help volunteers develop personal skills and perspectives on diversity in the STEM fields. Given the self-reported perceived improvements in leadership skills, it seems promising that the student organization has the capability to foster student leaders, assist in improving communication abilities, and bring awareness to diversity issues in STEM. It is implied that not only does the STEM outreach program help the elementary students that it is aimed at benefiting, but also the volunteers.

It is vital that Scientific Thinkers gathers and retains an enthusiastic and dedicated volunteer base. Therefore, it seems important that the organization should consider promoting the benefits of long-term and increased participation to its current and future volunteers. The sample only captured a portion of its volunteers, so it is likely that many have not yet reflected on this personal and professional development that could occur over the course of involvement. Although it may be apparent to many volunteers that the organization is aimed at helping local elementary students by delivering fun science lessons, they may not be aware of these other benefits. Revising Scientific Thinker's recruitment materials or launching an awareness campaign to highlight the potential for personal development may improve volunteer retention. Additionally, emphasizing Scientific Thinker's goal to foster interest in STEM for URM and ELL students and bring awareness to issues of diversity and representation may cultivate student interest and passion for the organization.

Both length of involvement and leadership status in the organization had significant impacts on self-perceived improvement in leadership. Therefore, it seems that increased attention should be given to fostering volunteer improvement in leadership skills. Scientific Thinkers

could develop workshops or programs for volunteers specifically aimed at addressing important qualities and actions of leaders, particularly in the classroom. Encouraging development in this area may encourage volunteers to be more confident while working with elementary students, other volunteers, and teachers in the classroom. With improved confidence during classroom visits may come more favorable attitudes about Scientific Thinkers, increasing volunteer retention and engagement.

References

Akilandeswari, V., Kumar, A. D., Freeda, A., & Kumar, S. (2015). Elements of effective communication. *New Media and Mass Communication*, *37*, 44-46.

Anagnos, T., Lyman-Holt, A., Marin-Artieda, C., & Momsen, E. (2014). Impact of engineering ambassador programs on student development. *Journal of STEM Education: Innovations & Research, 15*(3).

Aybar Martínez, K. K., Villarrubia, J. M., Rodriguez, G. J. P., & Santiago-Román, A. I. (2019). Work in progress: Education beyond borders - efforts of a student chapter to foster education and promote academic excellence in STEM fields. *Proceedings of the ASEE Annual Conference & Exposition*.

Baker, D. W., Cameron, K. A., Feinglass, J., Thompson, J. A., Georgas, P., Foster, S., Pierce, D., & Hasnain-Wynia, R. (2006). A system for rapidly and accurately collecting patients' race and ethnicity. *American Journal of Public Health, 96*(3), 532-537. https://doi.org/10.2105/AJPH.2005.062620

National Science Foundation. (2018). Science and engineering indicators 2018. In (Vol. NSB 2018-01). Arlington, Virginia: National Science Board.

Carnevale, A. P., Cheah, B., & Hanson, A. R. (2015). The economic value of college major. Retrieved February 15, 2021 from https://cew.georgetown.edu/cew-reports/valueofcollegemajors/#resources

Coscia, N. B. D. (2017). Student organization involvement and leadership development: Traditional-aged undergraduate students participating in academic student organizations. Indiana Wesleyan University.

Ohio Department of Education. (2019). *Enrollment Data*. Retrieved January 18, 2021 from http://education.ohio.gov/Topics/Data/Frequently-Requested-Data/Enrollment-Data

Ohio Department of Education. (2019-2020a). *Innis Elementary School*. Retrieved January 18, 2021 from https://reportcard.education.ohio.gov/school/overview/067744

Ohio Department of Education. (2019-2020b). *Parkmoor Elementary School*. Retrieved January 18, 2021 from https://reportcard.education.ohio.gov/school/overview/029181

Faber, J., & Fonseca, L. M. (2014). How sample size influences research outcomes. *Dental Press Journal of Orthodontics, 19*(4), 27-29. https://doi.org/10.1590/2176-9451.19.4.027-029.ebo

Ferrara, M., Talbot, R., Mason, H., Wee, B., Rorrer, R., Jacobson, M., & Gallagher, D. (2018). Enriching undergraduate experiences with outreach in school STEM clubs. *Journal of College Science Teaching, 47*(6), 74-82.

Kurec, A. (2016). Follow the leader: Developing great leadership skills. *Critical Values, 9*(4), 24-27. https://doi.org/10.1093/crival/vaw024

LaCosse, J., Canning, E. A., Bowman, N. A., Murphy, M. C., & Logel, C. (2020). A social-belonging intervention improves STEM outcomes for students who speak English as a second language. *Science Advances, 6*(40). https://doi.org/10.1126/sciadv.abb6543

Lindqvist, A., Senden, M. G., & Renstrom, E. A. (2020). What is gender, anyway: A review of the options for operationalising gender. *Psychology and Sexuality*. https://doi.org/10.1080/19419899.2020.1729844

Mak, J. Y., & Kim, C. (2017). Relationship among gender, athletic involvement, student organization involvement and leadership. *Women in Sport and Physical Activity Journal, 25*(2), 89-95. https://doi.org/10.1123/wspaj.2016-0003

National Science Foundation & NCSES (National Center for Science and Engineering Statistics). (2019). Women, minorities, and persons with disabilities in science and engineering. https://purl.fdlp.gov/GPO/LPS40632

Scientific Thinkers STEM Outreach Program. (n.d.). *How to volunteer*. Retrieved February 17, 2021 from https://u.osu.edu/cemscientificthinkers/info-for-volunteers/how-to-volunteer/

Scientific Thinkers STEM Outreach Program. (n.d.). *Info for volunteers*. Retrieved February 17, 2021 from https://u.osu.edu/cemscientificthinkers/info-for-volunteers/

Scientific Thinkers STEM Outreach Program. (n.d.). *Program overview*. Retrieved February 17, 2021 from https://u.osu.edu/cemscientificthinkers/

Private School Review. (n.d.) *Mansion Day School*. Retrieved February 17, 2021 from https://www.privateschoolreview.com/mansion-day-school-profile

Mansion Day School. (2021). *About.* Retrieved February 17, 2021 from https://mansiondayschool.org/about/

Scientific Thinkers. (n.d.). Retrieved February 17 from https://u.osu.edu/cemscientificthinkers/

SkillsYouNeed.com. (2018). *Leadership skills*. Retrieved February 17, 2021 from https://www.skillsyouneed.com/leadership-skills.html

Smith, L. J., & Chenoweth, J. D. (2015). The contributions of student organization involvement to students' self-assessments of their leadership traits and relational behaviors. *American Journal of Business Education*, *8*(4), 279-288.

The SAGE Encyclopedia of Communication Research Methods. (2017). https://doi.org/10.4135/9781483381411

The Status and Trends in the Education of Racial and Ethnic Groups. (2010). *Reading Today*, *28*(1), 34(31).

The Ohio State University. *Student activities*. Retrieved February 16 from https://activities.osu.edu/involvement/student_organizations/

Whittaker, J. A., & Montgomery, B. L. (2012). Cultivating diversity and competency in STEM: Challenges and remedies for removing virtual barriers to constructing diverse higher education communities of success. *Journal of Undergraduate Neuroscience Education: JUNE: A Publication of FUN, Faculty for Undergraduate Neuroscience, 11*(1), A44-A51.

Appendices

Appendix A: Formal Survey Recruitment Email to Scientific Thinkers Volunteers

The following was emailed to volunteers with Scientific Thinkers STEM Outreach Program:

Hello Current/Former Scientific Thinkers Volunteer,

Thank you for your commitment to the Scientific Thinkers STEM Outreach Program. We are conducting a survey of our volunteers regarding your experience with the program. Please consider participating in this study which will help us gain a better understanding of how the program helps develop student leadership and communication skills, as well as awareness of our diverse community here in Columbus.

This survey takes only 5-10 minutes to complete and will greatly benefit our student organization. Participation is completely voluntary, and your information will be kept confidential. Your feedback will help us improve your volunteer experience, as well experiences for future volunteers.

You can take the survey until [deadline] by following this link: [link]

If you have any questions, please contact:
Kayleigh Queiser
queiser.3@.osu.edu
or
Michelle McCombs
mccombs.75@osu.edu

Appendix B: Formal Focus Group Recruitment Email to Scientific Thinkers Volunteers

The following will be emailed to volunteers with Scientific Thinkers STEM Outreach Program:

Hello Current/Former Scientific Thinkers Volunteer,

You are receiving this email because you expressed interest in participating in the Scientific Thinkers STEM Outreach focus group interview. This portion of the study will give us a greater insight into your personal thoughts regarding the program and how it can be tailored to better suit our volunteers.

We will be meeting in small groups of 5-10 volunteers to further discuss your experience with the program. In order to facilitate a discussion, I (Kayleigh) will be present to ask a few questions regarding leadership, communication, and diversity.

If you agree to participate, please sign up for an available time from the [schedule attached]. We will confirm by email your appointed time. The location is [room] Physics Research Building, or if in-person meetings cannot be conducted, we will meet via Zoom. Participation is voluntary and your information will be kept confidential.

If you have any questions, please contact:
Kayleigh Queiser
queiser.3@.osu.edu
or
Michelle McCombs
mccombs.75@osu.edu

Appendix C: Informed Consent for Online Survey

The Ohio State University Consent to Participate in Research
Study Title: Scientific Thinkers STEM Outreach Program: Impact on Volunteer's Skills and Diversity Awareness.
Protocol Number: 2020B0293
Researcher: Kayleigh Queiser, Michelle McCombs, Prof. Chris Hammel

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate.

Your participation is voluntary.
Please consider the information carefully. Feel free to ask questions before making your decision whether or not to participate.

Purpose: The purpose of this research is to survey undergraduate and graduate volunteers about their experiences in the Scientific Thinkers STEM Outreach Program. Your responses to the survey questions will be used only in a statistical manner, with your identity kept confidential. Your participation may help improve Scientific Thinkers in the future, and we appreciate your willingness to contribute to the student organization's improvement.

Procedures/Tasks: You will be asked to complete one online survey about your experiences volunteering with Scientific Thinkers and your perceived development as a result of participating in the program. You may also opt-in to a focus group interview. If selected and you choose to participate in the interview, you will be interviewed for up to one hour with other Scientific Thinkers volunteers. You may be audiotaped and/or videotaped during the interview process.

Duration:
The duration of the survey is no longer than thirty minutes. You may leave the study at any time. If you decide to stop participating in the study, there will be no penalty to you and you will not lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with The Ohio State University.

Risks and Benefits:
There is minimal to non-existent risk to participating. Besides generally improving the Scientific Thinkers STEM Outreach Program for future volunteers, the benefits are that you may gain some insight into your own leadership and communication skills, as well as diversity awareness. Long term, this study is aimed at improving volunteer experience for this student organization.

Confidentiality:
We will work to make sure that no one sees your online responses without approval. But, because we are using the Internet, there is a chance that someone could access your online responses without permission. In some cases, this information could be used to identify you. Also, there may be circumstances where this information must be released. For example, personal information regarding your participation in this study may be disclosed if required by state law. Also, your records may be reviewed by the following groups (as applicable to the research):

- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices;
- The sponsor, if any, or agency (including the Food and Drug Administration for FDA-regulated research) supporting the study.

Future Research:
Your de-identified information will be stored confidentially and will not be used or shared for future research.

Participant Rights:
You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you are a student or employee at Ohio State, your decision will not affect your grades, employment status, or membership of the Scientific Thinkers STEM Outreach student organization.

If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By agreeing to participate, you do not give up any personal legal rights you may have as a participant in this study.

An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

Contacts and Questions:
For questions, concerns, or complaints about the study, or you feel you have been harmed as a result of study participation, you may contact Michelle McCombs, mccombs.75@osu.edu or Kayleigh Queiser, queiser.3@osu.edu.
For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact the Office of Responsible Research Practices at 1-800-678-6251 or hsconcerns@osu.edu.

Providing consent:
I have read (or someone has read to me) this page and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study. I am not giving up any legal rights by agreeing to participate.

To print or save a copy of this page, select the print button on your web browser.

Please click the button below to proceed and participate in this study. If you do not wish to participate, please close out your browser window.

Appendix D: Informed Consent for Focus Group Interview

The Ohio State University Consent to Participate in Research
Study Title: Scientific Thinkers STEM Outreach Program: Impact on Volunteer's Skills and Diversity Awareness.
Protocol Number: 2020B0293
Researcher: Kayleigh Queiser, Michelle McCombs, Prof. Chris Hammel

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate.
Your participation is voluntary.
Please consider the information carefully. Feel free to ask questions before making your decision whether or not to participate.

Purpose: The purpose of this research is to understand undergraduate and graduate volunteers experiences in the Scientific Thinkers STEM Outreach Program. Your responses during the focus group will help us with this understanding and will be used in a qualitative and quantitative summary, with your identity kept confidential. Your participation may help improve Scientific Thinkers in the future, and we appreciate your willingness to contribute to the student organization's improvement.

Procedures/Tasks: You have opted in to participate in a small focus group interview. If you choose to participate in the interview, you will be interviewed for up to one hour with other Scientific Thinkers volunteers. You will be audiotaped and/or videotaped during the interview process.

Duration:
The duration of the focus group is no longer than one hour. You may leave the study at any time. If you decide to stop participating in the study, there will be no penalty to you and you will not lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with The Ohio State University.

Risks and Benefits:
There is minimal to non-existent risk to participating. Besides generally improving the Scientific Thinkers STEM Outreach Program for future volunteers, the benefits are that you may gain some insight into your own leadership and communication skills, as well as diversity awareness. Long term, this study is aimed at improving volunteer experience for this student organization.

Confidentiality:
We will work to make sure that no one sees your online responses without approval. But, because we are using the Internet, there is a chance that someone could access your online responses without permission. In some cases, this information could be used to identify you. While we ask other group participants to keep the discussion in the group confidential, we cannot guarantee this. Please keep this in mind when choosing what to share in the group setting. Also, there may be circumstances where this information must be released. For example, personal information regarding your participation in this study may be disclosed if required by

state law. Also, your records may be reviewed by the following groups (as applicable to the research):

- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices;
- The sponsor, if any, or agency (including the Food and Drug Administration for FDA-regulated research) supporting the study.

Future Research:
Your de-identified information will be stored confidentially and will not be used or shared for future research.

Participant Rights:
You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you are a student or employee at Ohio State, your decision will not affect your grades, employment status, or membership of the Scientific Thinkers STEM Outreach student organization.
If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By agreeing to participate, you do not give up any personal legal rights you may have as a participant in this study.
An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

Contacts and Questions:
For questions, concerns, or complaints about the study, or you feel you have been harmed as a result of study participation, you may contact Michelle McCombs, mccombs.75@osu.edu or Kayleigh Queiser, queiser.3@osu.edu.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact the Office of Responsible Research Practices at 1-800-678-6251 or hsconcerns@osu.edu.

Providing consent:
I have read (or someone has read to me) this page and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study. I am not giving up any legal rights by agreeing to participate.

To print or save a copy of this page, select the print button on your web browser.

Please click the button below to proceed and participate in this study. If you do not wish to participate, please close out your browser window.

Appendix E: Online Survey Instrument

Note: Not all items will be administered in one sitting. We are submitting all potential lines of questioning for review. Items will be further selected to fit within the time allotted. In some cases, free-response questions might be changed to multiple choice. Items have been broken down into rough categories to aid in organization, but many questions could fit into multiple categories. For free-response questions, the response option is left black.

1. Please enter your OSU Last Name.# (Fill-in)
2. Please confirm your OSU Last Name.# (Fill-in)
3. What is your role with Scientific Thinkers?
   - General body member/volunteer
   - Committee member
   - Executive board member
4. How long have you been involved with Scientific Thinkers?
   - New member
   - One semester
   - Two semesters
   - Three semesters
   - Four or more (please specify)
5. How often do you volunteer with Scientific Thinkers?
   - One visit a semester
   - Two visits a semester
   - One visit a month
   - Two visits a month
6. What goals do you have when you joined Scientific Thinkers? Select all that apply.
   - Have fun
   - Build my resume
   - Make a difference in the community
   - Meet other students
   - Get more community service hours
   - Improve my teaching skills
   - Make new friends
   - Learn more about STEM outreach
   - Improve my leadership skills
   - Meet faculty members
   - Feel more a part of the Ohio State community
   - Other (Please specify)
7. Likert Scale Questions: <u>Scientific Communication Skills</u> (Strongly Disagree, Disagree, Somewhat Disagree, Neither Agree nor Disagree, Somewhat Agree, Agree Strongly Agree (1=Strongly Disagree; 7=Strongly Agree)
   - I have improved my ability to communicate what I am studying at Ohio State.
   - I am more able to simplify complex scientific ideas.

- I saw improvements in my ability to communicate scientific ideas that are new to elementary school children.
- I have improved my ability to communicate STEM concepts in a way that elementary students find enjoyable or fun.
- I gained more confidence in my ability to explain technical concepts.
- I became more confident while speaking in front of an audience.

8. Likert Scale Questions: Leadership Skills (Strongly Disagree, Disagree, Somewhat Disagree, Neither Agree nor Disagree, Somewhat Agree, Agree Strongly Agree (1=Strongly Disagree; 7=Strongly Agree)
   - I saw improvements in my confidence and ability to speak in front of new people.
   - I have improved in my ability to work as a team with other volunteers.
   - I have seen growth in my ability to resolve conflicts among elementary students.
   - I have improved in my ability to keep the students focused on the lesson
   - I have improved in my ability to make changes and lead the group in a new direction when things do not go as planned.
   - I have seen growth in my ability to motivate students to actively participate and engage in the lesson.
   - I have seen growth in my ability to motivate volunteers to actively participate and engage in the lesson.
9. Likert Scale Questions: Diversity and Representation Awareness (Strongly Disagree, Somewhat Disagree, Neutral, Somewhat Agree, Strongly Agree (Strongly Disagree, Disagree, Somewhat Disagree, Neither Agree nor Disagree, Somewhat Agree, Agree Strongly Agree (1=Strongly Disagree; 7=Strongly Agree)
   - I am more informed about the importance of representation in STEM fields.
   - I am more aware about the lack of diversity in STEM fields.
   - I am more aware of strategies to facilitate excitement in underrepresented students about science.
   - I am more aware of challenges that immigrant or English Language Learning (ELL) students face.
   - I am more aware of ways to support immigrant or English Language Learning (ELL) students.
   - I have seen challenges that teachers face in teaching ELL students.
   - I am more conscious of the importance of diversity in my own community.
10. With what gender do you identify?
    - African-American/Black
    - Asian/Asian-American
    - Caucasian
    - Hispanic/Latino/Latina
    - Native American
    - Other (Please specify)
11. What is your class rank?
    - Freshman
    - Sophomore
    - Junior
    - Senior

- Graduate

12. What best fits your area of study?
    - Sciences
    - Engineering
    - Liberal arts & humanities
    - Business and economics
    - Other (Please specify)
13. Would you like to provide feedback on any questions to the survey writers? (i.e. clarification of answers, comments about the questions asked, things you think could be improved, etc.) (Fill-in)
14. Are you interested in participating in a small focus group interview with 4-5 of your Scientific Thinkers peers regarding your volunteering experiences?
    - Yes
    - No

Appendix F: Focus Group Guided Interview

A semi-structured interview protocol will be utilized, with questions tapping into the following areas. Probes and additional questions will be utilized based upon information that students bring up.

1. In what ways do you feel Scientific Thinkers has benefited the students of Innis/Mansion Day School/Parkmoor Elementary?
2. In what ways do you feel Scientific Thinkers has benefited you?
3. How has participating in Scientific Thinkers impacted your leadership skills? After answer, give them a copy of the "Skills Good Leaders Need" infographic below and ask the follow-up question (SkillsYouNeed.com, 2018).
    a. Looking at the chart of 6 leadership skills, is there anything you would like to add that you did not address in your previous response?
4. Tell me a little about the improvements in your communication skills, if any, you have noticed since joining Scientific Thinkers?
5. In what ways does Scientific Thinkers bring awareness to diversity and representation in STEM for you?
    a. Why do you think this awareness is important?
6. What other personal developments, if any, have you seen in yourself that you can attribute to participating in Scientific Thinkers?
7. Are there any final comments about your participation in Scientific Thinkers that you would like to share at this time?