Facilitator Affect in a Drop-In, Teen-Led Community Science Learning Program

By:
Gloria A. Segovia,
Brett Nicholas,
Christine Nguyen,
C. Aaron Price

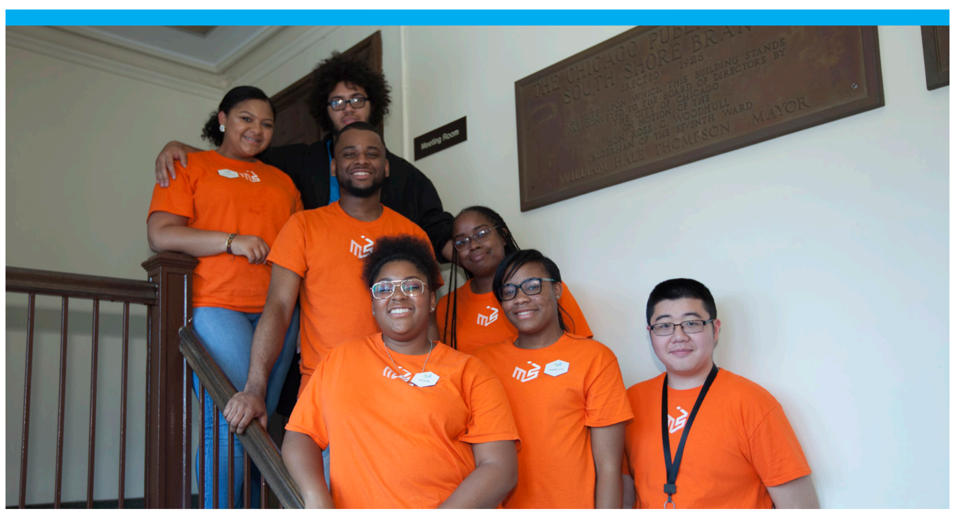
museum of
science+industry
chicago

Abstract

The Farrell Fellows Summer Internship program consists of teen educators leading science, technology, engineering and math (STEM) activities for children at libraries and park locations across Chicago. The goal of this study was to learn more about the families who attend the sessions and to also look for evidence of learning and how that may be related to the moods and attitudes of the teen educators. Data was collected through observations of the sessions, pre- and post-session surveys of 26 teen educators, and 90 surveys of the parents of participating children. Field notes were coded using the Dimensions of Success (DOS) rubric to measure 12 elements of learning in each session. Overall, we found learning differences between the types of activities presented by the teen educators, and that their overall moods had some an impact on learning gains of the children.

Introduction

Program Context



Every summer, the Museum of Science and Industry, Chicago (MSI) hosts an internship program called the Farrell Fellows. The program gives teens the opportunity to learn science, public speaking, and leadership skills[1]. The Farrell Fellow Interns travel from MSI to Chicago Public Library and Chicago Park District locations to lead STEM activities with elementary school-aged learners in community settings. To be eligible for this paid internship, teens must be at least 16 years of age and have completed no more than one year of college. Teenagers interview for the internship and are hired based on their communication skills, a basic understanding of inquiry education, and appropriate professionalism in an interview setting. Some of the candidates have

[1] https://www.msichicago.org/education/out-of-school-time/summer-interns/

participated in MSI's weekend-based, high school adolescent development program, but it is not a requirement for application or hiring. In addition to regular interns, lead interns are also hired. Lead interns have completed at least two years of undergraduate courses and must still be enrolled in college. Experience in a peer leadership position like a residence advisor, student government or other student organization is highly valued.

Once hired, the teens are trained on facilitating science activities and interacting with children in an educational setting. They are also trained in workforce development topics like professionalism, conflict resolution, and team building. The lead interns start two weeks earlier than the regular interns to help plan the training and manage logistics like materials management, partner communication, and daily scheduling. The teens are split into teams consisting of one lead and five regular interns.

After the training is complete, the teen educators travel to multiple locations each day to facilitate science activities. Their typical day starts at MSI where they do a team-building exercise or improvisation game as warm-up activity. Then they gather the materials they will need for the day's activities and board school buses that will take them to program locations. The programs are hosted by MSI's two partner organizations, the Chicago Public Library and the Chicago Park District. The parks and libraries participating in the program were selected by the leadership of those respective organizations. The first program is delivered at a park location. The activity lasts 60 minutes. After completion of the activity and cleanup is complete, the teens eat lunch at the park. In the afternoon, the teens travel via school bus from the park to the library and deliver another program that lasts 60 minutes. When that activity is complete, the teens come back to MSI to put materials away and reflect on the day.

The audiences at the two locations can be quite different. Since the park's day camp program is registration based, the same children are at the parks every day and their ages are known. Children in the day camp program are 6 to 12 and MSI requests specifically to work with children in the 6-to-9 age range. The park's day camps are also well attended and some locations have hundreds of participants. The participation numbers at the parks tend to be at, or slightly over, the recommended activity capacity of 25 participants.

At the libraries, the programs are presented as drop-ins where kids and families are welcome to participate but are not required to pre-register. They could be children who are at the library that day, with or without parents. Some families come specifically for the program, and the children's librarians also recruit from nearby summer camps (private, public and parochial). As a result the attendance size and composition varies widely at the libraries.

The teen educators were trained to deliver two different activities: Rainy Days and Mineral Madness.

Rainy Days is about the water cycle and makes personal connections to the topic through an arts activity. After introductions and an ice-breaker activity, the teen educators start a conversation about precipitation and the water cycle. The participants are divided into groups of five. Each group makes observations of a model of a part of the water cycle. Hot water (colored red) and cold water (colored blue) are placed in 16-ounce plastic cups (representing the atmosphere) and four-ounce paper cups (representing surface water). The four-ounce cups are placed on a plate with an

empty, clear 16-ounce cup inverted on top to cover them and trap air. A 16-ounce cup with hot or cold water is then balanced on top of the inverted cup. Four permutations of the model are created: hot surface water and a cold atmosphere; hot surface water and a hot atmosphere; cold surface water and a cold atmosphere; and cold surface water and a hot atmosphere. These models exhibits traits of different conditions found in Earth's water cycle like condensation and precipitation.

Participant groups make observations of the models with a teen educator providing prompts and asking guiding questions like, "Which model made the most water droplets, and why?" After all participants have had an opportunity to observe all the models, the whole group discusses findings and transitions to the second part of the activity, making a rain stick. While still in groups of five, participants are shown how to make a rain stick by poking t-pins through the sides of a cardboard tube and putting dry rice and beans inside. When sealed and inverted, this homemade rain stick mimics the sounds of traditional rain sticks made by indigenous people throughout the world.

While the rain sticks are being made, the teen educators are encouraging the participants to tell stories about weather events that the participants have personally experienced. Once the rain sticks are complete, the whole group uses them to mimic different kinds of precipitation events like gentle rain and loud storms. To wrap up the program the teen educators lead a discussion to reflect on what the participants did and learned. All the participants get to take their rain stick home with them.

The second activity, Mineral Madness, is an opportunity for participants to use scientific tests to identify different minerals. The activity starts out with introductions, an icebreaker activity and discussion about what they will be doing that day. Everyone is then split into groups of five. In these smaller groups, a conversation about the participant's prior knowledge of rocks and minerals takes place. Each group starts at a station that has a specific mineral test and every participant gets a chart to record the results of each test. There are five minerals and five testing stations. There is a teen educator at each station to help the participants and talk about what the test is for and how to do it.

The testing stations are: luster/color, streak, acid test, hardness, and magnetism. Each group moves from station to station and completes all the tests while recording the results on their chart. Once all the testing is complete, the whole group discusses the results and a teen educator helps match the results to the characteristics of the minerals. The minerals tested are quartz, calcite, magnetite, talc, and corundum. After a reflection discussion about what the participants did and learned, they are invited to select two minerals to take home to start their own mineral collection.

Literature Review

Many science centers run programs that engage adolescent youth to teach science to the public. Outcome evaluations and studies of such programs have been published by the California Academy of Science (2017), Exploratorium (Diamond, John, Cleary, & Librero, 1987), New York Hall of Science (Storksdieck, 2002), and the Museum of Science and Industry, Chicago (Price, Kares, Segovia, & Lloyd, 2018). Literature indicates that these programs are beneficial to the learner in many different ways. Teens acting in a peer leader/teacher role can support self-confidence (Luke, Stein, Kessler, & Dierking, 2007), communication skills (California Academy of Science, 2017; Chi, Snow, Goldstein, Lee, & Chung, 2010), and a higher science interest in STEM education and career pathways (Adams, 2014; Price, et al., 2018).

However, we have been unable to identify research studies about "drop in" science programs for children, or programs where learners can walk in and out for short periods of time. Search query terms we used include: science, youth, adolescent, drop in, summer, science instructors, STEM, facilitator, teen, teaching, after school, out of school, peer teaching, and cross age. These terms were also used to try to

find programs that utilize adolescents as an instructor of science.

Peer teaching occurs when the youth take the role as teacher to other youths (Gaustad, 1993). Peer learning occurs when there is interchanging information from both parties (Boud, 2001). When there is a substantial age difference among the teaching and learning youth, it is sometimes referred to as cross-age learning (Gaustad, 1993).

Peer teaching has been noted to help with positive social youth development. Lee (1996) states that having an ongoing supportive training program, at these organizations, is important for success. The teens found the work they were doing as meaningful. Later, Lee (2002) found that teens who facilitated programing reported feeling positive in their role as mentors to the children. This is impactful for teens in underrepresented communities because it provides them with the opportunity to serve a positive role in their community as a leader, teacher, learner, and organizer (Tucker-Raymond, Lewis, Moses, &Milner, 2016). The teens felt they empowered themselves and others, increasing outreach to the community they want to impact (Ripbringer, 2008; Lee, Murdock, & Paterson, 1996).

One of the few studies we found on drop-in programs reported that the children in their program valued having teens as facilitators because the teens were more likely to do the science tasks with them and they (the teens) were able to relate more to the children (Ponzio & Peterson, 1997). Children in programs with teen facilitators were found to have increased critical thinking skills, particularly among those who identify as female (Smith & Enfield, 2002). This was largely attributed to the training and support the teens received prior to their facilitation.

Bonner (2017) found that participants who indicated they know how to strategize as a facilitator and have a high perception of their roles as facilitators report stronger academic gains (in this case, higher test scores). In other peer programs, reported benefits include better organizational, leadership, and teamwork skills (Ripbringer, 2008). In another study, the teen educators in a 4-H program described their experience as educators for younger children and what they learned from it. Worker, Iaccopucci, Bird, & Horowitz, found that the experiences reported from the teens matched the youth development model of the 5-C's (competence, confidence, connection, character, and caring) through their growth in the program (2019). The 5'c of model indicates the characteristics youth need to develop positive youth development. These characteristics are a result of the environment promoting competence, confidence, connection, character, and caring between the program and the teens (Lerner et. al., 2005).

The moods of educators has been shown to be a powerful predictor of instructional behavior and, subsequently, the moods of their students (Becker, Goetz, Morger, & Ranellucci, 2014). Educator enthusiasm (Keller, Woolfolk Hoy, Goetz & Frenzel, 2016) and emotional self-regulation (Fried, 2011) in particular have been shown to have critical and long lasting impacts on student learning. But it is a two-way street. Emotions can influence teaching, and the teaching experience itself can influence emotion (Sutton, 2004). This can be especially true for adolescent youth who are undergoing rapid emotional development and still learning how to recognize and cope with strong, variable feelings.

Study

The research and evaluation team at the Museum collaborated with the Farrell Fellows program to study 1) evidence of science learning among the children during a drop-in session and 2) if teen moods prior to the session impact the STEM learning experience.

Methods

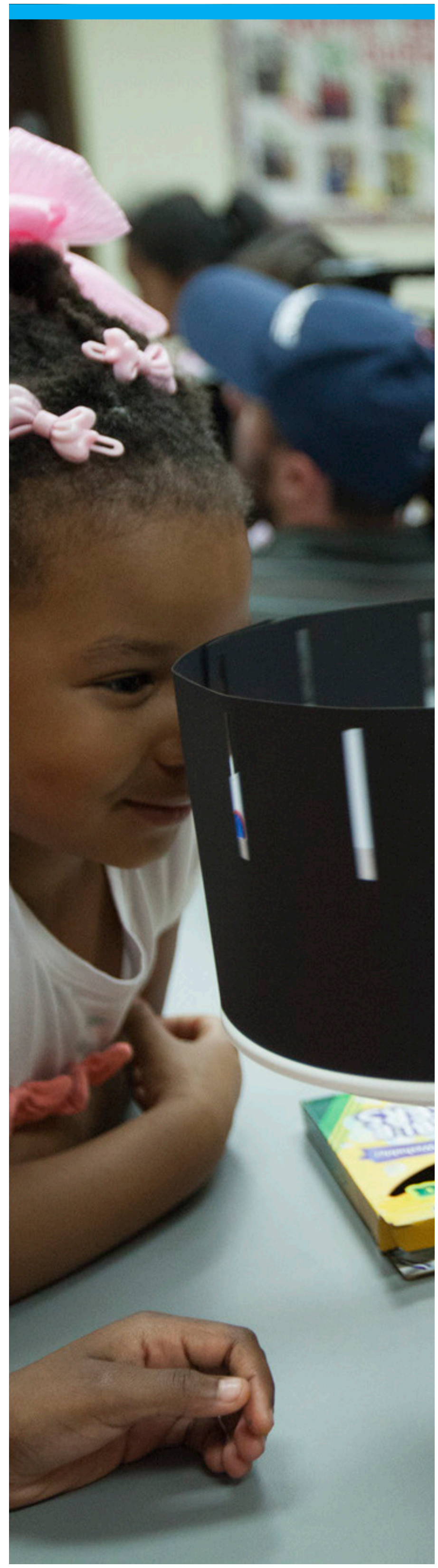
Data was collected through observation of the facilitation, pre- and post-session surveys of the teen educators, and surveys of the parents of the children participating. Observational data was collected using a rubric from the Dimensions of Success (DOS) framework (Dimension of Success, 2019; Shah, Wylie, Gitomer, & Noam, 2018) to assess the STEM learning experience in the space. DOS is a framework that identifies key aspects of a quality STEM experience using 12 different dimensions such as features of the learning environment, activity engagement, STEM knowledge/practice, and youth development in STEM (see Appendix A for complete list). Those four dimensions are rated into four categories representing increased learning: 1-Evidence Absent, 2-Inconsistent Evidence, 3-Reasonable Evidence, and 4-Compelling Evidence. Researchers using this rubric are required to be trained and certified by its developers at the Harvard University Partnerships in Education and Resilience (PEAR) Institute. Thus, the PI of this study, who also collected the observational data, was certified before this study began.

Surveys were collected from the teen educators and the session participants. Teen educators in the program (who facilitated in the Chicago Public Library and Chicago Park District locations) were asked to voluntarily participate in the study, which involved filling out a background survey once they were done with training and a daily anonymous pre/post survey when they went offsite for facilitation. Teens who were 16 and 17 were required to obtain parental consent while those 18 and over needed only to fill out a consent form. This study was approved by the Museum's Institutional Review Board.

The background survey asked the students about prior participation in the program, basic demographic variables, rating of their confidence to facilitate a session (ex: "I am confident in my ability to perform the role assigned to me"), and science questions about the content they were trained on and were to facilitate in the field (ex: "Which of the following is the major source of moisture that reaches or becomes part of Earth's atmosphere?").

The pre-session survey included a section modeled on the Russell Affect Grid (RAG - Appendix B). The RAG is a well-established, single-item measure of emotions related to pleasure and arousal (Russell, Weiss & Mendelsohn, 1989). It asks the participants to indicate on a two-dimensional scale from 1-9 how pleasant, relaxed, excited, and confident they felt. The pre survey also asked if they have any goals or concerns with that day's lesson. After the session was over, the teen educators filled out a post survey asking about what they learned in the space from the guests, each other, and/or their personal experience.

Additionally, parents were asked to fill out a survey about their child (Appendix C). The survey included topics about science interest,



(ex: "my child asks questions about science"), attitudes parents had about their child's education (ex: "my child's school is preparing them for success in the future") and the demographic information of their children.

There were 13 sessions (Table 1) in which data was collected. Locations were spread across geographic categorizations around Chicago (North, Central, South) as defined by the Chicago Public Library. Sites were chosen randomly within each location category.

Table 1: Site visit location and lesson (N=13)

Site Name	Location	Lesson
Albany Park	North	Rain
Archer Heights	Central	Rain
Blackstone	Central	Rain
Brainerd	South	Rain
Ellis Park	Central	Rain
Humboldt Park	North	Rain
King	Central	Minerals
West Belmont	North	Minerals
West Belmont	North	Rain
West Lawn	South	Minerals
West Town	Central	Minerals
Woodson	South	Minerals
Woodson	South	Rain

Participants

There were a total of 26 participants from the Farrell Fellows with an age range of 16-21 and an average age of 17.9. More than 61% were 18 and older. The majority (92%) participate or had participated in an existing Museum-based after-school program called the Science Minors and Achievers, which also adopts learning through teaching strategies. Many (70%) have also participated in the Farrell Fellows internship program before. Thus, most teen educators had some experience leading activities with the public before joining this program. Half of them identify as female (50%), 46% as male, 0% as nonbinary and 4% preferred not to say. About 42% identified as White, 39% Black/African American, 15% Hispanic/Latinx, and 8% Asian and Asian ethnicities. Eleven percent selected more than one race/ethnicity. There was unanimous agreement that they were trained and supported to succeed in the role (also they are confident they can perform) and only 15% expressed they were nervous. We received 26 post-training, 98 pre-session and 122 post-session surveys from these participants.

A total of 90 surveys were collected of parents of children who attended activities. The age range of the children who participated was 3-13 with an average age of 7.7. Over half (54%) of the children were female and 46% were male. Parents reported 43% of the children identified as Hispanic/ Latinx, 36% as Black/African American, 10% as White, 9% Asian and Asian ethnicities, and 3% American Indian/ Alaskan Native. Of the children, 38% attended a Chicago Public School. Thirty-eight percent of the parents reported that they had a Bachelor's Degree or higher. Eighty percent indicated that they knew about the session before they attended; anecdotally, this seemed mostly because of local signage and marketing through the library or park district branch.

Analysis and Results

Science Learning

We analyzed our DOS scores to look for evidence of science learning. Field notes were coded using the DOS rubric to give a rating score in each dimension and an average score in each domain. Scores range from 1-4, which 4 being the highest evidence of science learning and engagement. Tables 2 and 4 displays the average scores for each lesson. Table 5 displays the average factor scores for each site visited.

Table 2: DOS factor scores by lesson (N=13)

	Features of the Learning Environment		Activity Engagement		STEM Knowledge & Practices		Youth Development in STEM	
	Mineral Madness	Rainy Days	Mineral Madness	Rainy Days	Mineral Madness	Rainy Days	Mineral Madness	Rainy Days
N (sessions)	5	8	5	8	5	8	5	8
Mean (SD)	3.53 (0.38)	2.83 (0.50)	3.40 (0.15)	2.50 (0.69)	2.47 (0.38)	2.13 (0.78)	1.93 (0.15)	2.33 (0.59)
Composite Mean	3.10		2.85		2.26		2.18	

Table 3: DOS dimension mean scores (N=13)

Measure	M	SD
Organization	3.08	0.95
Materials	2.92	0.95
Space Utilization	3.31	0.75
Participation	3.46	0.66
Purposeful Activities	2.54	1.33
Engagement with STEM	2.54	0.88
STEM Content Learning	2.62	0.96
Inquiry	2.38	0.77
Reflection	1.77	0.73
Relationships	3.31	0.95
Relevance	1.62	0.77
Youth Voice	1.62	0.51

Overall the DOS scores were stronger in Features of the Learning Environment and Activity Engagement, while STEM Knowledge & Practices and Youth Development in STEM scored a bit lower. We ran a Mann-Whitney's U test to evaluate the difference in scores between the domains. We found a significant effect of Features in the Learning Environment[1] and Activity Engagement[2]. Mineral Madness had stronger scores in 3 of the 4 categories over Rainy Days. However, Rainy days had a higher score for Youth Development.

Table 4: DOS dimension scores by lesson (N=13)

		Mineral Madness (N=5)		Rainy Days (N=8)	
Domain	Measure	M	SD	M	SD
Features of the Learning Environment	Organization	3.00	1.22	3.13	0.83
	Materials	4.00	0.00	2.25	0.46
	Space Utilization	3.60	0.55	3.13	0.83
Activity Engagement	Participation	3.20	0.45	3.63	0.74
	Purposeful Activities	4.00	0.00	1.63	0.74
	Engagement with STEM	3.00	0.71	2.25	0.89
STEM Knowledge and Practice	STEM Content Learning	2.20	0.84	2.88	0.99
	Inquiry	3.00	0.00	2.00	0.76
	Reflection	2.20	0.45	1.50	0.76
Youth Development in STEM	Relationships	3.60	0.55	3.13	1.13
	Relevance	1.20	0.45	1.88	0.83
	Youth Voice	1.00	0.00	2.00	0.00

[1] The mean ranks of Mineral Madness was 10.0 and Rainy Days was 5.3; $U = 5$, $Z = -2.24$, $p < 0.02$, $r = -.62$.

[2] The mean ranks of Mineral Madness was 10.6 and Rainy Days was 4.75; $U = 2$, $Z = -2.73$, $p < 0.00$, $r = -.76$.

Table 5: DOS scores by site location

Site Location	Features of the Learning Environment	Activity Engagement	STEM Knowledge & Practices	Youth Development in STEM
Albany Park	3.7	3.0	3.0	2.7
Archer Heights	3.3	3.3	2.7	2.7
Blackstone	2.7	3.0	3.3	2.7
Brainerd	2.0	1.3	1.3	1.7
Ellis Park	3.0	2.0	1.7	2.7
Humboldt Park	2.7	2.3	1.3	2.0
King	3.7	3.7	2.7	2.0
West Belmont	3.3	3.3	3.0	2.0
West Belmont (2nd visit)	2.7	3.0	2.0	3.0
West Lawn	3.0	3.3	2.3	1.7
West Town	3.7	3.3	2.0	2.0
Woodson	4.0	3.3	2.3	2.0
Woodson (2nd visit)	2.7	2.0	1.7	1.3

We computed the pre-session mean mood/emotion scores for all teen educators at each location. We then computed a Pearson correlation coefficient to look for relationships between the DOS item ratings and those mean scores, all at the site level (Table 5). We found only three significant correlations, the first between the two variables "Reflection" and "Pleasant"[3] the second between the two variables "Reflection" and "Confident[4]", and the third between "Space Utilization" and "Relaxed"[5].

This means teen educators who reported to be more relaxed also had lower scores on their use of the physical space during the lesson. Also, teen educators who reported to feeling more pleasant and confident had higher scores on their use of reflection during the lesson. There were no other significant relationships.

There was a not a significant effect on their mood based on whether it was their first day facilitating or the last at the p<.05 level for all conditions; Pleasant[6], Relaxed[7], Excited[8], and Confident[9].

[3] $r = .719$, $n = 12$, $p = .008$
[4] $r = .697$, $n = 12$, $p = .012$
[5] $r = -.585$, $n = 12$, $p = .046$

Table 6: Summary of single order correlations, and standard deviations for dimensions of success and mood scores

Measure	Pleasant	Relaxed	Excited	Confident	SD
Organization	0.19	0.31	-0.42	-0.07	0.95
Materials	0.33	0.13	0.31	0.17	0.95
Space Utilization	-0.16	**-0.59***	0.01	-0.05	0.75
Participation	0.03	-0.33	0.04	0.42	0.66
Purposeful Activities	0.52	0.22	0.48	0.20	1.33
Engagement with STEM	0.49	0.20	0.26	0.14	0.88
STEM Content	0.46	0.07	0.12	0.44	0.96
Learning Inquiry	0.49	0.23	0.16	0.47	0.77
Reflection	**0.72****	0.42	0.31	**0.70***	0.73
Relationships	0.41	-0.11	0.32	0.09	0.95
Relevance	0.48	0.25	0.22	0.25	0.77
Youth Voice	-0.20	-0.26	-0.29	-0.11	0.51

Discussion

Overall, we found some evidence of science learning in each of the sites. DOS scores were stronger in Features of the Learning Environment and Activity Engagement, regardless of lesson type, but Mineral Madness had the higher scores. We think this could be because Mineral Madness lesson had stronger STEM content activities compared to Rainy Days. However, Rainy Days had a higher score for Youth Development and this could be attributed to the structure of the lesson allowing the children more control over their project.

We did not find a strong relationship between learning and the moods/emotions of the teen educators in our study. Moods throughout the weeks varied without a consistent measure heading in any particular trajectory. This suggests the session activities themselves did not have much of an impact on their moods/ emotions through each week. However, there was evidence that moods/emotions had a slight correlation with learning, particularly reflection. The only consistent relationship with learning we found was that teen educators spent more time on practices of Reflection when they felt more confident

[6] $F(13, 83) = 1.21, p = .29$
[7] $F(13, 83) = .66, p = .80$
[8] $F(13, 83) = 1.43, p = .17$
[9] $F(13, 83) = .55, p = .88$

and pleasant. Peer educators' attitudes are important because one study found that teens who had positive attitudes towards the children of the program had a higher impact towards disconnected children's academic performance, relationships, and behavior because the emotionally engaging mentorship fostered high levels of trust and empathy (Karcher, Davidson, Rhodes, & Herrera, 2010).

The difference between the lesson scores can be explained by how the content was presented. For example, Mineral Madness did not include a personal narrative in the lesson plan. Instead, children were given definitions lecture-style as they rotated among the tables. They ended up having trouble identifying the minerals on their own at the end of the lesson. However, the Rainy Day lesson had an explicit connection to each child's life. As the water cycle was described, teen educators made connections to hot water and condensation seen in showers and bathrooms. They also tied the lesson to Lake Michigan and how the lake has a great influence on the weather in Chicago. In one instance, it was currently raining outside and that was used as an illustration of the water cycle.

The children were shown to have a more positive experience when provided with a narrative/connection to the lesson. The teen educators established a more personal environment which encouraged higher engagement. The children were also given materials to take home, encouraging the learning to continue. For Mineral Madness, children were given two minerals to start their collection with encouragement of the teen facilitator: "Do you have a rock collection at home? That is something you can do. I think you're an expert." The children exhibited positive responses to the teen's positive encouragement and in some occasions proudly displayed their newly acquired minerals to each other and the other adults in the room.

Being pleased and confident in the space resulted in higher reflection in the space. The Reflection dimension focuses on "the extent to which activities support explicit reflection on the STEM content in which the youth have been engaged. This dimension also refers to the degree to which the quality of youth reflections is superficial or meaningful, and connection-building" (Shah et. al., 2018). With this in mind, the lessons with the connections made (the example of the story narrative

given by the teen and the shower example) displayed more engagement than the ones that did not.

One result from the comparison lists that the less relaxed in the space they were, the more the teen educators were focused on more on making sure the space is being used well. In this case, relaxation may have made the teen educators more complacent.

Some limitations of this study include a small sample size and a reliance on self-report survey data. Due to the short nature of the program and the need to have a certified observer (the certification process takes about two weeks of staff time to complete), we were only able to visit about one site per day for about three weeks. Also, our mood/emotion measure is based on self-report data. While the Russell Affect Grid is well established and also used in other out-of-school time projects (Falk, J. H., & Gillespie, 2009), it is still a subjective measure.

We were able to confirm one hypothesis in which having the teen educators make a connection with their audience created a deeper connection with the lesson. The kids were able to answer the questions at the end of each lesson and they were more inclined to ask their own questions throughout the lesson. We were not able to find evidence that mood over time had changed. Mood did impact their reflection in the space as well as how well they utilized the space.

Overall, more research is needed to include how the young children perceive the lesson from the teen and how they feel having a teen facilitator. Practitioners should use this information to shape their training program, particularly to ensure teen attitudes are positive towards the children and to develop training into a mentoring model.

Acknowledgements

This project and study was supported by funding from the National Oceanic and Atmospheric Association through the Teen Advocates for Community and Environmental Sustainability (Teen ACES) award (NA16SEC0080001).

Reference

Adams, J. D., Gupta, P., & Cotumaccio, A. (2014). Long-Term Participants: A Museum Program Enhances Girls' STEM Interest, Motivation, and Persistence. *Afterschool Matters*, 20, 13-20.

Becker, E. S., Goetz, T., Morger, V., & Ranellucci, J. (2014). The importance of teachers' emotions and instructional behavior for their students' emotions–An experience sampling analysis. *Teaching and Teacher Education*, 43, 15-26.

Bonner, S. M., Somers, J. A., Rivera, G. J., & Keiler, L. S. (2017). Effects of student-facilitated learning on instructional facilitators. *Instructional Science*, 45(4), 417-438.

Boud, D. (2001). Making the move to peer learning. *Peer learning in higher education: Learning from and with each other*, 1-21.

California Academy of Sciences. (2017). *Careers in Science Intern*. Retrieved from https://www.calacademy.org/sites/default/files/assets/docs pdf/cis_impactsoutcomes_2017.pdf

Chi, B., Snow, J. Z., Goldstein, D., Lee, S., & Chung, J. (2010). Project Exploration: 10-year retrospective program evaluation summative report. *University of California: Berkeley*, 1-82.

Diamond, J., John, M. S., Cleary, B., & Librero, D. (1987). The exploratorium's explainer program: The long term impacts on teenagers of teaching science to the public. *Science Education*, 71(5), 643-656.

Dimensions of Success | The PEAR Institute. (n.d.). Retrieved from https://www.thepearinstitute.org/dimensions-of-success

Falk, J. H., & Gillespie, K. L. (2009). Investigating the role of emotion in science center visitor learning. *Visitor Studies*,12(2), 112-132.

Fried, L. (2011). Teaching teachers about emotion regulation in the classroom. *Australian Journal of Teacher Education* (Online), 36(3), 1.

Gaustad, J. (1993). Peer and Cross-Age Tutoring. ERIC Digest, Number 79.

Karcher, M. J., Davidson, A. J., Rhodes, J. E., & Herrera, C. (2010). Pygmalion in the program: The role of teenage peer mentors' attitudes in shaping their mentees' outcomes. *Applied Developmental Science*, 14(4), 212-227.

Keller, M. M., Hoy, A. W., Goetz, T., & Frenzel, A. C. (2016). Teacher enthusiasm: Reviewing and redefining a complex construct. *Educational Psychology Review*, 28(4), 743-769.

K.J. Topping, D. Miller, P. Murray, S. Henderson, C. Fortuna & N. Conlin (2011) Outcomes in a randomised controlled trial of mathematics tutoring, *Educational Research*, 53(1), 51-63.

Lee, F. C., Lee, F. H., Murdock, S., & Paterson, C. A. (2002). *Teenagers as Teachers: Twelve Essential Elements* (Vol. 21613). University of California, Agriculture & Natural Resources.

Lee, F. C., Murdock, S., & Paterson, C. (1996). An Investigation of Strategies for Preparing Teenagers for Cross-Age and Peer Teaching Roles: Implications for Linking Research and Practice.

Lerner, R. M., Lerner, J. V., Almerigi, J. B., Theokas, C., Phelps, E., Gestsdottir, S., ... & Smith, L. M. (2005). Positive youth development, participation in community youth development programs, and community contributions of fifth-grade adolescents: Findings from the first wave of the 4-H study of positive youth development. *The Journal of Early Adolescence*, 25(1), 17-71.

Luke, J. J., Stein, J., Kessler, C., & Dierking, L. D. (2007). Making a difference in the lives of youth: Mapping success with the "Six Cs". *Curator: The Museum Journal*, 50(4), 417-434.

Ponzio, R. C., & Peterson, K. D. (1997, October 3). Adolescents as effective teachers of child science. Paper presented at the annual meeting of the Northern Rocky Mountain Educational Research Association, Jackson, WY.

Price, C. A., Kares, F., Segovia, G., & Loyd, A. B. (2018). Staff matter: Gender differences in science, technology, engineering or math (STEM) career interest development in adolescent youth. *Applied Developmental Science*, 1-16.

Ripberger, C., Bovitz, L., Cole, D., & Lyons, R. (2008). Teenagers as volunteer cross-age teachers in out-of-school programs: Introducing job readiness skills to middle school youth. *The International Journal of Volunteer Administration*, 24(6), 72-79.

Russell, J. A., Weiss, A., & Mendelsohn, G. A. (1989). Affect grid: a single-item scale of pleasure and arousal. *Journal of personality and social psychology*, 57(3), 493.

Shah, A. M., Wylie, C., Gitomer, D., & Noam, G. (2018). Improving STEM program quality in out of school time: Tool development and validation. *Science Education*, 102(2), 238-259.

Smith, M. H., & Enfield, R. P. (2002). Training 4-H teen facilitators in inquiry-based science methods: The evaluation of a" step-up" incremental training model. *Journal of Extension,* 40(6), n6.

Storksdieck, M., Haley-Goldman, K., & Jones, M. C. (2002). Impact of the New York Hall of Science career ladder program on its former participants. *vol, 21401*, 43.

Sutton, R. E. (2004). Emotional regulation goals and strategies of teachers. *Social Psychology of Education*, 7(4), 379-398.

Tucker-Raymond, E., Lewis, N., Moses, M., & Milner, C. (2016). Opting in and Creating Demand: Why Young People Choose to Teach Mathematics to Each Other. *Journal of Science Education and Technology, 25*(6), 1025-1041.

Worker, S. M., Iaccopucci, A. M., Bird, M., & Horowitz, M. (2019). Promoting positive youth development through teenagers-as-teachers programs. Journal of adolescent research, 34(1), 30-54.

Appendix

Appendix A: Dimensions of Success (Shah et. al., 2018)

Domain	Dimension	Rubric description
Features of learning environment	Organization	Focuses on the extent to which the facilitator delivers the observed activities in a way that reflects appropriate planning and preparation, through having the necessary materials readily available, being ready to accommodate to changing situations, and having smooth transitions to prevent time loss and chaos in the learning environment.
	Materials	Focuses on the extent to which the activities make use of materials that are appropriate for the particular youth in a program, aligned with intended STEM learning goals, and appealing to youth.
	Space Utilization	Focuses on the extent to which the program space is utilized in a manner that is conducive to STEM learning in an OST environment.
Activity engagement	Participation	Focuses on the extent to which the youth have equal access to the activities offered. Participation refers only to general participation (access to materials, prompting to participate and contribute, etc.) in the activities and does not consider the degree to which the youth are participating in STEM thinking/reasoning or inquiry practices.
	Purposeful Activities	Focuses on the extent to which activities are structured so that youth clearly understand the goals of each activity, and the connections between them; it also examines the degree to which the facilitator uses his/her time productively to best support youth understanding of STEM learning goals.
	Engagement with STEM	Focuses on the extent to which youth are engaging in hands-on activities that allow them to actively construct their understanding of STEM content. It also looks at whether or not the activities leave youth as passive recipients of knowledge from the facilitator or as active learners who interact directly with STEM content so they do the cognitive work and meaning-making themselves.

STEM knowledge and practices	STEM Content Learning	Focuses on the extent to which youth are supported to build understanding of science, mathematics, technology, or engineering concepts through STEM activities. Observers must consider the accuracy of STEM content presented during activities, the connectedness of STEM content presented during activities, as well as evidence of youth uptake of accurate STEM content based on their questions, comments, and opportunities to demonstrate what they learned.
	Inquiry	Focuses on the extent to which activities support the use of STEM practices. These STEM practices are usually used in the service of helping youth learn the science content more deeply. Stronger quality involves youth participating in STEM practices in authentic ways (versus superficially going through the motions of inquiry) to pursue scientific questions, address a design problem, collect data, solve an engineering task, etc.
	Reflection	Focuses on the extent to which activities support explicit reflection on the STEM content in which the youth have been engaged. This dimension also refers to the degree to which the quality of youth reflections is superficial or meaningful and connection-building.
Youth development in STEM	Relationships	Focuses on the extent to which the facilitator makes connections between the STEM activity and the youth's lives and personal experiences, other subject areas, or a broader context.
	Relevance	Focuses on the extent to which the facilitator has positive relationships with the youth and other facilitators as well as the extent to which youth have positive relationships with each other.
	Youth Voice	Focuses on the extent to which the STEM activities encourage youth to have a voice by taking on roles that allow for genuine personal responsibility and having their ideas, concerns, and opinions acknowledged and acted upon by others.

Dimensions of Success (DoS) was developed with NSF Funding by Gil Noam and team at The PEAR Institute

Appendix B: Pre and Post-Survey Teens
Pre-Survey

Date:______________________________

Time:______________________________

1. Please check which category best applies to your role in today's activity.

☐ Intern

☐ Lead Intern

2. How do you feel right now? Please circle one number per row.

Unpleasant ——————————————————— Pleasant

1	2	3	4	5	6	7	8	9

Stressed ——————————————————— Relaxed

1	2	3	4	5	6	7	8	9

Calm ——————————————————— Excited

1	2	3	4	5	6	7	8	9

Worried ——————————————————— Confident

1	2	3	4	5	6	7	8	9

3. Do you have any specific or unique goals for today's session?

☐ Yes

☐ No

If yes, please describe it/them:

4. Do you have any specific or unique concerns about today's session?

☐ Yes

☐ No

If yes, please describe it/them:

Note: If you want to be included in the drawing for a $25 gift card, remember to sign the separate participation sheet.

Post-Survey

Date:______________________________

Time:______________________________

1. Please check which category best applies to your role in today's activity.

☐ Intern

☐ Lead Intern

2. Did you <u>learn anything</u> in today's session from the following? Please circle one number per row.

From the guests:

No ———————————————— Yes

1 2 3 4 5 6 7 8

From other facilitators/volunteers:

No ———————————————— Yes

1 2 3 4 5 6 7 8

From my personal experience:

No ———————————————— Yes

1 2 3 4 5 6 7 8

3. Please provide an example of something you learned today from the session *(Optional)*.

4. If you had any personal goals for today, did you meet them?
Please circle one number or "N/A".

No							Yes	N/A
1	2	3	4	5	6	7	8	

Please describe it/them *(Optional)*:

5. Do you have any specific thoughts about today's session you'd like to share?

Note: If you want to be included in the drawing for a $25 gift card, remember to sign the separate participation sheet.

Section One: Place an "**X**" in the ***ONE*** appropriate column for each statement indicating how frequently **your child** has done the following things **in the past month**.

	Never 0			Sometimes 3			Always 6
1. …asks questions about science.							
2. …watches science programs on TV.							
3. …reads books, magazines, or websites about science.							
4. …does science activities at home.							

Section Two: Place an "**X**" in the ***ONE*** appropriate column for each statement **about your child** indicating the extent of your agreement or disagreement.

My Child…	Strongly Disagree 1			Neutral 4			Strongly Agree 7	I don't know
1. …is interested in a future science career.								☐
2. …enjoys science in school.								☐
3. …was happy to attend this activity.								☐

Section Three: Place an "**X**" in the ***ONE*** appropriate column for each statement.

	Strongly Disagree 1			Neutral 4			Strongly Agree 7
1. I like the school my child is attending.							
2. I feel involved with my child's school.							
3. My child's school is preparing them for success in the future.							
4. My child's school provides my child with a high-quality science education.							
5. I believe education will provide my child more opportunities in the future.							
6. The Museum is a source of science education for my *family*.							
7. The Museum is a source of science education for my *community*.							

Section Four: Parent/Guardian Demographics

1. Please check which category best applies to your role in today's activity.

- ☐ Less than high school degree
- ☐ High school degree or equivalent (e.g., GED)
- ☐ Associates degree (2-year or equivalent)
- ☐ Bachelor's degree (4-year or equivalent)
- ☐ Master's degree or equivalent
- ☐ M.D./J.D./PhD or equivalent
- ☐ Other (please specify): ____

Section Five: Demographics about Your Child

1. What is your child's gender?

☐ Female

☐ Male

☐ Non-Binary / Third Gender

☐ Prefer to self-describe ____________________________________

☐ Prefer not to say

2. What is your child's age? ________________________________

3. What grade is your child in? ______________________________

4. What type of school does your child attend?

☐ Charter

☐ Home

☐ Parochial

☐ Private

☐ Public

☐ Other (please specify): ____________________________________

4b. Does your child attend a Chicago Public School (CPS)?

☐ Yes

☐ No

☐ I don't know

5. Which racial/ethnic categories describes your child?

Mark ☐ one or more boxes AND print the specific race(s) and/or origin(s).

☐ **White –** Print origin(s), for example, German, Irish, English, Italian, Polish, French, etc.

☐ **Hispanic, Latino, or Spanish origin –** Print origin(s), for example, Mexican or Mexican American, Puerto Rican, Cuban, Dominican, Salvadoran, Colombian, etc.

☐ **Black or African American –** Print origin(s), for example, African American, Jamaican, Haitian, Nigerian, Ethiopian, Somalian, etc.

☐ **Asian –** Print origin(s), for example, Chinese, Filipino, Asian Indian, Vietnamese, Korean, Japanese, etc.

☐ **American Indian or Alaska Native –** Print origin(s), for example, Navajo Nation, Blackfeet Tribe, Mayan, Aztec, Native Village or Barrow Inupiat Traditional Government, Nome Eskimo Community, etc.

☐ **Middle Eastern or North African** – Print origin(s), for example, Lebanese, Iranian, Egyptian, Syrian, Moroccan, Algerian, etc.

☐ **Native Hawaiian or Other Pacific Islander –** Print origin(s), for example, Native Hawaiian, Samoan, Chamorro, Tongan, Fijian, Marshallese, etc.

☐ **Some other race or origin –** Print race(s) and/or origin(s)

Please specify:

Section Six: Please mark one box for each question.

1. Did you know this activity was taking place when you planned to visit today?

☐ Yes

☐ No

2. Has your child attended any other similar activity at this location that was sponsored by the Museum this summer?

☐ Yes

☐ No