

IMPACTS OF A KINESTHETIC ASTRONOMY AFTERSCHOOL PROGRAM
ON STUDENTS' INTEREST IN STEM TOPICS

by

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ABSTRACT

Astronomy is a multidisciplinary field, rich in history, broad in content, and universally appealing to students of all ages and backgrounds. Through the study of astronomy, students can gain a deeper appreciation for science, technology, engineering, and math (STEM) and how these fields intersect, ultimately enabling us to explore space and learn about our universe. Few formal educators take college-level astronomy courses, and those who do often find the complexity of the subject matter too difficult to convey to elementary school students. The goal of this educational research project was to supplement classroom curriculum during an afterschool program. Informal education environments reward curiosity and engagement, and encourage exploration and inquiry. Through this project, the researcher hoped to increase students' interest in the STEM subjects and to build students' self-efficacy towards learning about and doing science. The researcher partnered with five Before and After School Enrichment Camps in Larimer County, Colorado. The week-long program focused on structured exploratory and kinesthetic activities encouraging students to make observations, build models, predict outcomes, and develop explanations. Based upon the data from the surveys and assessments, it was difficult to determine if a change had occurred as a result of the treatment. High fluctuations of attendance levels over the course of the study may have had an impact on the overall results. Qualitative data indicated that a change had occurred in the level of students' interest in and knowledge of STEM and space-related topics after the program. Many students, unprompted, began taking charge of their own learning and developed methods for their journey towards lifelong learning.

INTRODUCTION AND BACKGROUND

Astronomy is one of the oldest sciences, dating back several millennia. In ancient times, peoples' lives depended upon a basic understanding of the sky because it served as their compass, clock, and calendar. Today, many of the fields pushing the limits of technology and theoretical research trace their origins to the study of the stars.

Astronomy is a multidisciplinary field and the breadth and depth of the content enables students to conceptualize how seemingly disjointed subjects come together at the forefront of science and technology. On a more personal and aesthetic level, students are drawn to the beauty of the night sky and connect with the stories of the constellations.

For almost two decades, I have shared the night sky with people of all ages and backgrounds during public outreach events while working or volunteering at observatories and planetariums. As an informal science educator with the National Aeronautics and Space Administration (NASA), I managed a large volunteer network with a goal of supporting and inspiring informal science education professionals at museums, science centers, and planetariums across the country. NASA missions and discoveries integrate science, technology, engineering, and mathematics (STEM) and provide captivating content for informal education programs that engage audiences of all ages, backgrounds, and levels of scientific understanding.

Surprisingly, few aspiring teachers take college-level astronomy courses and often rely on field trips to local planetariums and science centers to bring the content to life. Therefore, the goal of my educational research project was to supplement elementary classroom curriculum during an afterschool program designed to diminish the perceived

complexity of astronomy. By facilitating exploratory experiences, encouraging investigation, and helping students connect concepts in an environment that rewarded curiosity and engagement, my goal was to increase their interest in STEM topics and build students' confidence in their ability to learn about and do science.

I partnered with the Before and After School Enrichment (B.A.S.E.) Camp, a program in Larimer County, Colorado with a mission to provide affordable, safe, and accessible childcare and enrichment programs. The activity-based programs support the classroom and develop academic, athletic, artistic, and communication skills. The camps were located onsite at elementary schools in the Poudre Valley School District that had a total elementary school student population of 12,223 students. A break down of male and female students was not available. The racial demographics were 73% White/Caucasian, 19% Hispanic, 3% Asian, 1% Black, 0.5 % American Indian, 0.1% Hawaiian or Pacific Islander, and 3.5% of students were of two or more races (Poudre School District Race and Ethnicity Student Data, 2015). Thirty-five percent of students were eligible for the free and reduced lunch program (Poudre School District Free and Reduced Student Data, 2015) and 11% of students were English language learners (Poudre School District English Language Learners Data, 2015). Partnering with B.A.S.E. Camp gave me the opportunity to share my passion for astronomy while supporting classroom instruction. This led to my focus statement: will students' self-efficacy towards science and interest in STEM increase as a result of participating in exploratory and kinesthetic activities focused on astronomy during an afterschool program?

CONCEPTUAL FRAMEWORK

Science literacy is critical for citizens navigating life in the twenty-first century, but few recognize the full impact a lack of understanding can have on personal decisions about medical treatments, environmental issues, utilization of technology, and voting on public policy decisions (Duncan & Arthurs, 2012). The National Science and Technology Council recognized the gravity of the situation and formed a committee to address these concerns. The committee produced the Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-year Strategic Plan (2013) which stated, “Particular agencies, because of their mandates and goals, have specific expertise and assets to bring to the Federal STEM education investment...NASA has exciting assets associated with space exploration...” (p. 6). The plan went on to state that due to these assets the agency could and should support the STEM effort by teaching mission-related science and engineering (National Science and Technology Council, 2013).

Other governmental organizations, such as the National Optical Astronomy Observatory, a Federal Funded Research and Development Center supported by the National Science Foundation, responded to the mandate and designed educational programs accordingly. The National Optical Astronomy Observatory focused on improving scientific literacy and increasing technological competencies. These goals would be achieved primarily through providing additional teacher support, professional development, enhanced educational materials, and development of programs to deliver science content to large groups (Pompea, Walker, & Sparks, 2014).

The National Research Council's Committee on Learning Science in Informal Environments stated informal or free-choice learning environments were critical to increasing the general public's appreciation for and understanding of science topics (2009). Moreover, the Academic Competitiveness Council's report stated that alongside K-12 and higher education, informal education was integral for raising the science literacy of our citizenry and ensuring the United States remains a leader in the STEM fields (U.S. Department of Education, 2007). The Association of Science and Technology Centers (ASTC) lists almost four-hundred institutions in the United States that present innovative science programming to general audiences and students during out-of-school time on a regular basis ("Find a Science Center," n.d.). Additionally, there are countless smaller institutions not represented by ASTC that strive to fill the gaps in scientific literacy. Many community-based organizations provide afterschool and summer programs and are federally funded through the 21st Century Community Learning Center (U.S. Department of Education, 2016). Other organizations such as the Before and After School Enrichment (B.A.S.E.) Camp, are supported by their local government, private donations, philanthropic foundations, and community-minded businesses ("B.A.S.E. Camp Funding Sources," n.d.).

The Afterschool Alliance reported the number of students attending afterschool programs in the United States increased from 6.5 million in 2004 to 10.2 million in 2014 (n.d.). Despite the national increase, a state specific report from the Afterschool Alliance, reported that only 15% of students in the state of Colorado participate in afterschool activities or programs (2016). Yet, 52% of Colorado parents felt afterschool programs

with STEM content could help their children develop interests and skills in those subjects (Afterschool Alliance, 2016). The America After 3PM Full STEM Ahead report (n.d.) supported parents' feelings and stated, "Afterschool programs have emerged as a dynamic and vibrant setting for innovative STEM education" (p. 6).

The multidisciplinary nature of astronomy encompasses STEM content and also engages students across a wide breadth of topics including the arts, history, and culture (Glickstein, 1994). On an individual level, it presents reoccurring, nightly learning opportunities for peoples of all ages, backgrounds, and locales (Ward, Sadler, & Shapiro, 2008). The subject captivates our hearts, minds, and imaginations given the beauty of the sky and the practical applications to our daily lives as well as the philosophical questions astronomy seeks to answer (Bailey & Lombardi, 2015; Percy, 1995).

The Next Generation Science Standards emphasize the importance of viewing science as the mechanism to explain the natural world (NGSS Lead States, 2013). Astronomical phenomena can be difficult to understand due to the sheer scale of our planet, the sun, solar system, and the complexity of orbital mechanics that defy the seemingly intuitive explanations we observe (Ward et al., 2008). Understanding the seasons, diurnal rhythms, lunar phases, and shifts in constellations are important for understanding our planet and can lead to the emergence of scientifically-oriented habits of mind (Cartsten-Conner, Larson, Arseneau, & Herrick, 2015).

The Framework for K-12 Science Education identified crosscutting concepts important to science and engineering areas including: patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and

function; and stability and change (National Research Council, 2012). All of these can be addressed through the study of astronomy. Furthermore, the inherent observational nature of astronomy lends itself to teaching students the process of science including data collection, recording observations, and making predictions, ultimately resulting in the formation of models (Ward et al., 2008). Movement focused and kinesthetic activities can enhance students' spatial reasoning skills, problem solving abilities, and the formation of accurate scientific models while engaging socially with their classmates (Slater & Morrow, 2010).

Pompea et al. (2014) stated, "teachers are the gatekeepers to improving science education programs" (p. 4). Few elementary school teachers have training in astronomy topics and they often believe the subject relies too heavily on math and physics or requires technical equipment, thus they hesitate to incorporate it in their lesson plans (Percy, 1995). Percy remarked that simple, cheap, hands-on equipment and activities work best for teaching astronomy topics to students. Astronomy teaching partners design and facilitate highly engaging activities that make astronomy more tangible for students, ultimately increasing their interest in STEM majors and career fields (Miranda, 2012).

METHODOLOGY

The goal of my educational research project was to increase students' interest in astronomy and STEM topics by participating in structured exploratory and kinesthetic activities during an afterschool program. The K-5th grade students who participated in the research project were from five separate Before and After School Enrichment (B.A.S.E.) Camps, in the Poudre Valley School District in Larimer County, Colorado

($N=51$). Due to the nature of informal education and free choice learning environments, students voluntarily participated in the activities. Thus, attendance varied on a daily basis and participation rates declined significantly toward the end of each day and later in the week. Therefore, a comparison group was not feasible in this setting. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix A).

The treatment occurred over five consecutive days, Monday through Friday, at each of the five B.A.S.E. Camp locations:

- O'Dea Core Knowledge Elementary School – January 30-February 4, 2017
- Ponderosa Elementary School – February 6-10, 2017
- Saint Joseph Catholic School – February 13-17, 2017
- Tavelli Elementary School – February 27-March 3, 2017
- Lopez Elementary School – March 6-10, 2017

Each of the five sessions over the week-long program was focused on structured exploratory and kinesthetic activities with the intention of encouraging students to make observations, build models, predict outcomes, and develop explanations.

The first session conducted on Monday focused on Earth and sun topics. A simplified kinesthetic spin day and night activity had students become a living model and reenact the movements of the Earth and the sun. Students took turns portraying each solar system body and mimicking diurnal motion, rotation, and tilt. The activity highlighted the respective scale and position of the Earth and sun in the solar system relative to one another, plus Earth's orbit around the sun, and the reason for the annual cycle of the seasons.

The second session held on Tuesday concentrated on the Earth's moon. The movement-based Earth, moon, and sun system activity emphasized the difference between rotation and revolution. The activity also concentrated on the approximate distances, speeds, and time periods involved in order to derive predictable motions of the bodies. Lunar features and phases were discussed during the assembly of the flip moon books. During the crater formation activity, predictions were made based upon the different sizes and weights of the impactors as to the resulting size, shape, and depth of craters created. The craters were measured and visually compared with those found on the moon. Erosional processes were also highlighted during the activity.

On Wednesday, the activities concentrated on constellations, including predictable motions within the celestial sphere as experienced from Earth, time determination and navigational uses, and the artistic and cultural interpretations of star patterns. The assembly of star wheels, also known as planispheres, culminated with an indoor practice session using glow-in-the-dark stars to mimic the southwestern nighttime sky. A kinesthetic star distance activity involved some students mapping out the stars of the Big Dipper asterism as other participants moved through and around their classmates to gain insight into the visible changes of the patterns as students' distance and perspective shifted. The session concluded with a book reading that chronicled how other creatures are impacted by nocturnal human activity and light pollution.

The focus of the fourth session on Thursday was for each student to create a scale pocket solar system that emphasized the distances of each planet from the sun and the Earth. A lengthy discussion focused on comparing and contrasting the planets through

the aid of a picture book and illustrations. Other types of astronomical objects including asteroids, comets, star clusters, nebulae, and galaxies were also introduced.

The final session on Friday focused on a telescope demonstration and an observing session, weather permitting. In the event of inclement weather, the telescope was set up indoors and students observed a picture placed at the opposite end of the gym. Additionally, the activities conducted earlier in the week were repeated upon request.

Due to the nature of informal education and afterschool programs, a broad age range of students participated in the program. The students in this study tended to be comprised of younger grades, mostly kindergarten through 2nd graders. Therefore, the assessment questions and Likert-style survey responses for each instrument were simplified. Additionally, assessments were not administered via paper and pencil. Instead, a moveable apparatus with small flip charts was utilized (Figure 1). Questions were printed on a flip chart and attached to the structure at a student's eye level. The possible responses were written on another flip chart each with corresponding bags below the responses. Each student received a small paper star that was color-coded to the question. The students were asked to place their star in the bag corresponding to the response that made the most sense to them.



Figure 1. Data collection apparatus.

In order to measure students' individual beliefs about their ability to understand and capacity to do science, a Self-Efficacy Towards Science Survey was administered on the first day of the program (Appendix B). Students responded by selecting *I Agree* ☺, *I Don't Know* ☹, and *I Don't Agree* ☹. The results for the students at each B.A.S.E. Camp were combined and visually represented in pie charts.

Similarly, to assess students' interest in science, technology, engineering, and math, the Interest In STEM Topics Survey was administered pre-treatment (Appendix C). Students responded by selecting *I Agree* ☺, *I Don't Know* ☹, and *I Don't Agree* ☹. The results for the students at each B.A.S.E. Camp were combined and visually represented in pie charts.

In order to establish a baseline of content knowledge and to determine if any learning occurred as a result of the treatment, daily Content Pre- and Post-Assessments were given Monday through Thursday and consisted of four questions each (Appendix D). The data for students at each school was combined and analyzed to determine if the

treatment had an overall effect. Individual student responses were not paired due to the erratic participation and attendance levels. Simple descriptive statistics were calculated to determine the average mean gain for each question.

In order to obtain qualitative data about students’ feelings, opinions, and beliefs about their participation in the program, approximately 10% of students from each B.A.S.E. Camp were selected at random to voluntarily participate in a Semi-Structured Interview at the end of the treatment (Appendix E). Themes were identified from the qualitative data and used as evidence to support other project findings.

The Instructor Daily Observation Journal provided additional qualitative data (Appendix F). After each day’s activities the energy and engagement levels of the students, collaborations between students, quality of questions, misconceptions, and any challenges with completing the activities were recorded. B.A.S.E. Camp teachers also provided feedback about the activities and instructor’s teaching methods on the Teacher Feedback Form on Impact of Program (Appendix G). Of the five teachers who received the survey, all responded.

Data collection strategies are summarized in Table 1.

Table 1
Data Triangulation Matrix

<i>Focus Question</i>	Will students’ self-efficacy towards science and interest in STEM increase as a result of participating in exploratory and kinesthetic activities focused on astronomy during an afterschool program?			
	Data Source 1	Data Source 2	Data Source 3	Data Source 4
<i>Sub-categories</i>				
1. Increased interest in STEM topics	A pre- and post-attitude Likert-style survey	Semi-structured interviews	Instructor observation journal	Teacher feedback on long-term impact

2. Improved self-efficacy towards science	A pre- and post-attitude Likert-style survey	Semi-structured interviews	Instructor observation journal	Teacher feedback on long-term impact
3. Broadened understanding of astronomy concepts	Content pre- and post-assessments	Semi-structured interviews		

DATA AND ANALYSIS

The pre-attitude results of the Self-Efficacy Towards Science instrument indicated that 72% of students liked to learn about science, 77% believed it helped them understand their world, and 60% liked to discuss science with their friends ($N=51$) (Figure 2). These findings were corroborated by qualitative data from the Instructor Observation Journal that detailed a comment on the second day of the program at Ponderosa Elementary. A female student who was leaving prior to the start of the activities said, "Oh no! I'm missing out on science today." Also, during the fourth week of the program, a student waiting at the door of Tavelli Elementary exclaimed, "Astronomy is here!"

The pre-attitude results of the Self-Efficacy Towards Science Survey also suggested that students were evenly divided about whether or not they believed the majority of people could understand science. Of the students who responded to the survey, 32% stated that they agreed most people could not understand science, 32% did not know, and 36% did not agree with the statement ($N=51$) (Figure 2).

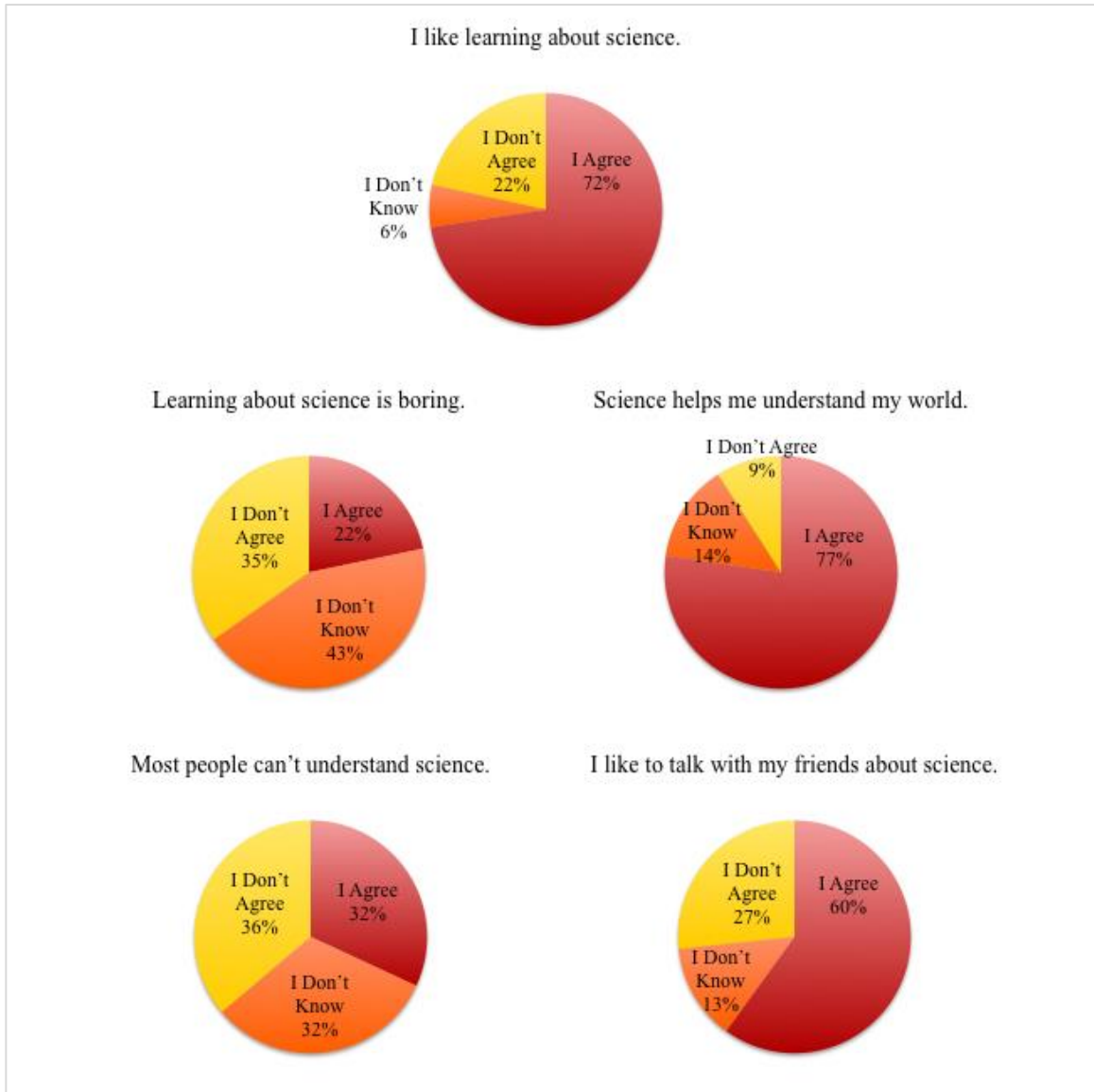


Figure 2. Frequency of responses on the pre-attitude likert-style survey Self-Efficacy Towards Science, ($N=51$).

Students also expressed interest in topics related to science, technology, engineering, and math (STEM) as shown in the pre-attitude results of the Interest In STEM Topics Survey (Figure 3). In particular, 89% of students indicated that they liked to build things and 63% thought math was a fun subject. Of the students who responded to the survey, 54% believed that they hadn't learned enough about science ($N=42$).

Although 64% believed that technology aided in their learning, 51% stated that they liked computers, but didn't want to understand how they worked.

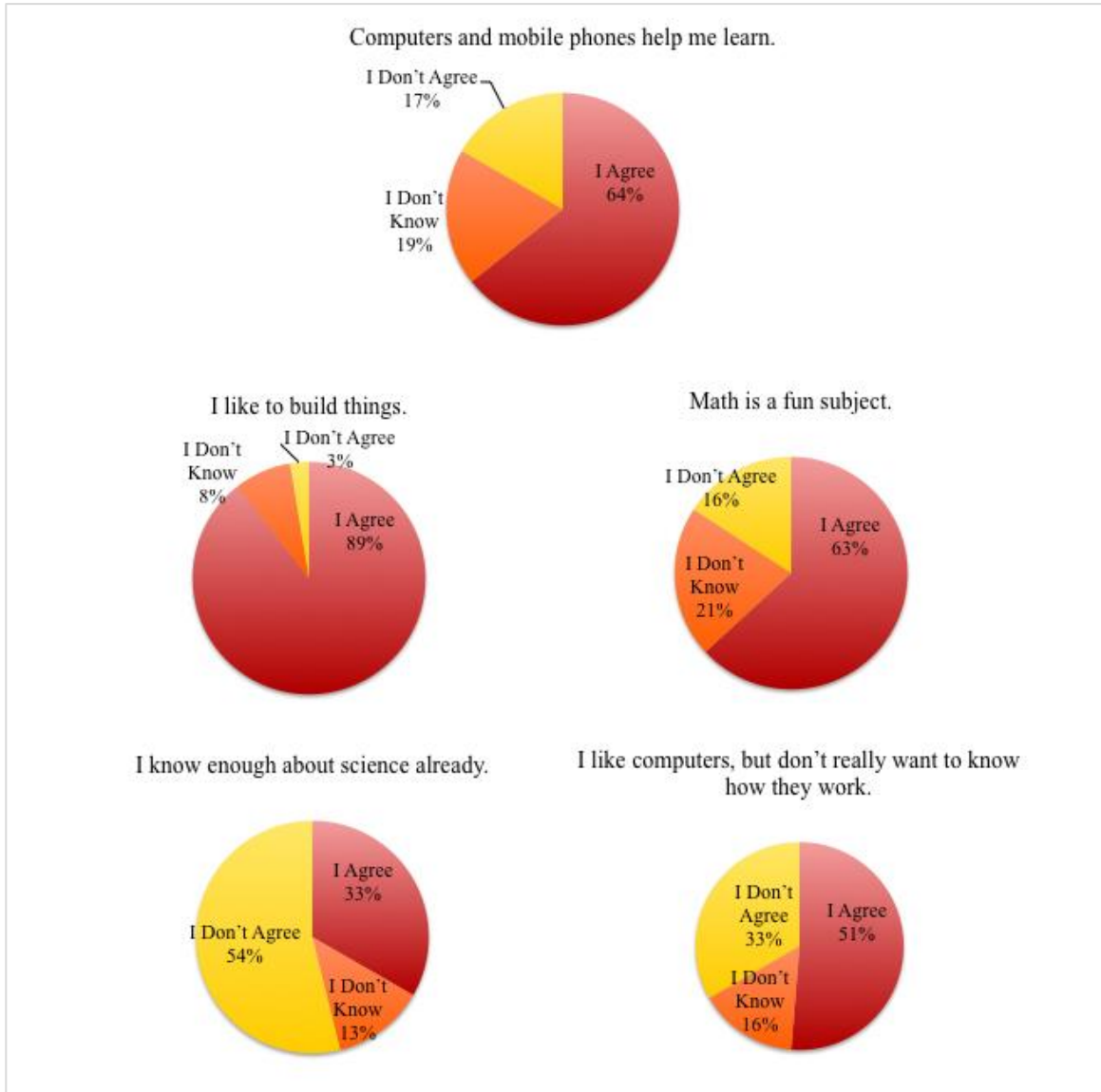


Figure 3. Response frequency for pre-attitude likert-style Survey Interest In STEM Topics, (N=42).

Students were encouraged to participate in the content pre- and post-assessments and the daily activities, but did so of their own accord. Illnesses, snack time, homework, and other mitigating factors contributed to the difficulty of collecting data and

maintaining a consistent sample size from the pre-surveys and pre-assessments to the post-surveys and post-assessments. Attendance varied on a daily basis and participation rates declined significantly towards the end of the day and later in the week. Despite these challenges, many of the students were engaged in the activities. During the fourth day of the program at Tavelli Elementary, a bell rang indicating a parent had arrived to pick up a student. A female student who was participating in the activities told a friend sitting next to her, “Oh, I hope it isn’t for me.”

The results of the combined Content Pre- and Post-Assessments Day 1: Earth demonstrated that students’ knowledge of the shape of the Earth, the reason for the seasons, and the heliocentric structure of our solar system increased slightly as a result of the treatment (Figure 4).

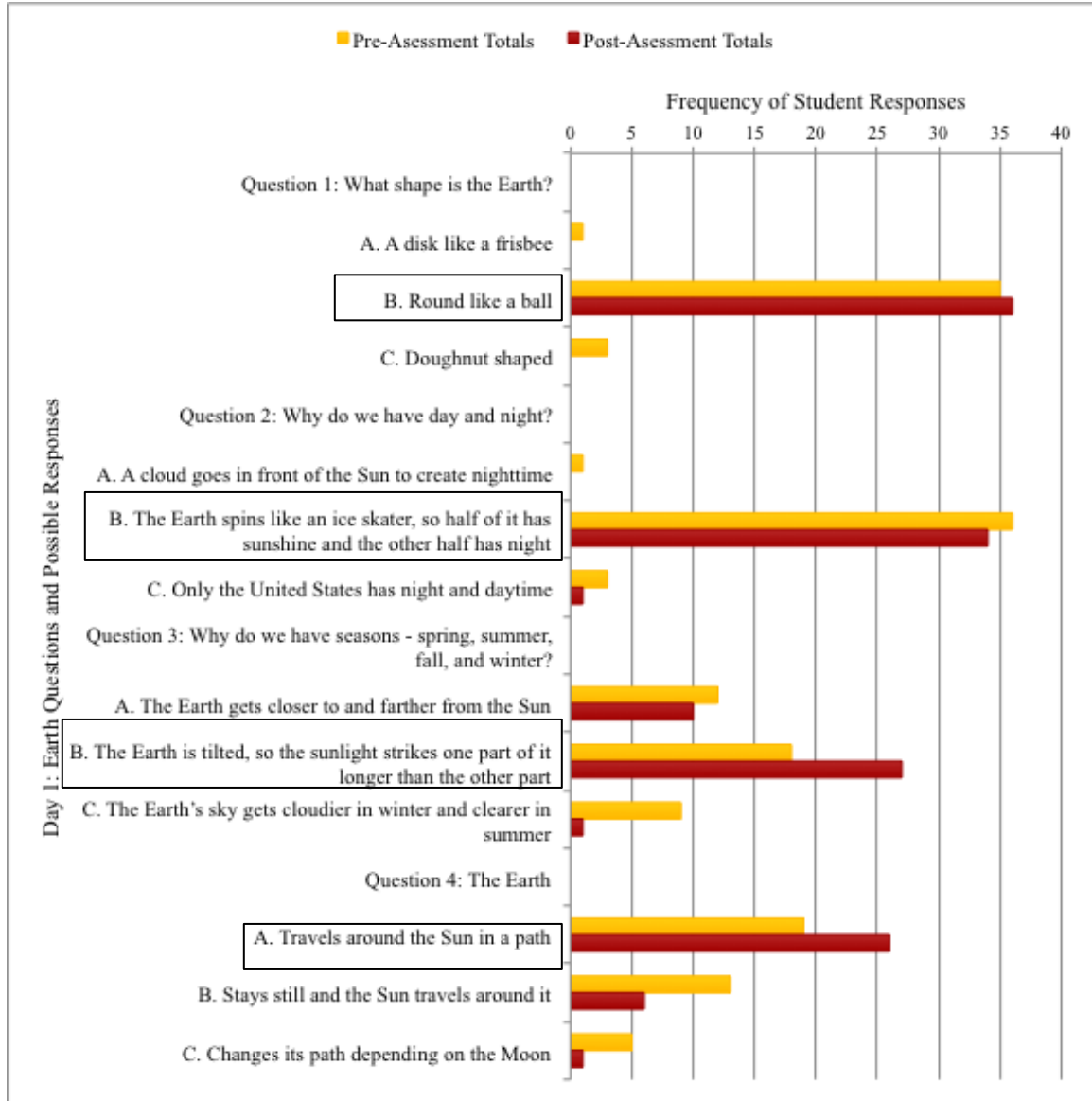


Figure 4. Frequency of responses for the content pre- and post-assessment Day 1: Earth, (N =pre 40, post 33).

The combined Content Pre- and Post-Assessments Day 2: Lunar suggested that despite the treatment, misconceptions about the shape of the moon and its phases were still present (Figure 5). The decrease in sample size from the pre- to post-assessment could have had an effect on the results.

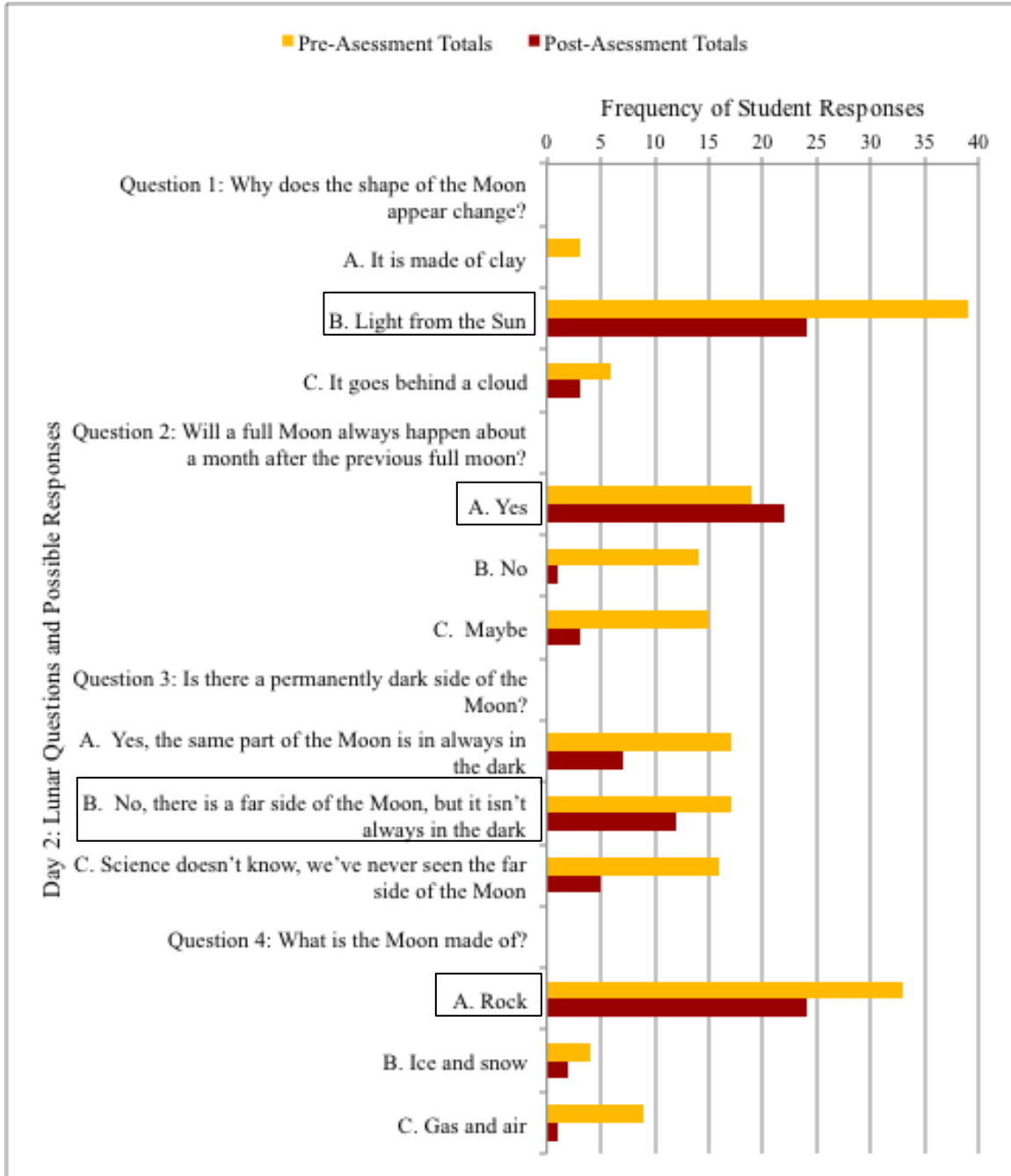


Figure 5. Frequency of responses for the content pre- and post-assessment Day 2: Lunar, (N =pre 50, post 24).

The results of the combined Content Pre- and Post-Assessments Day 3:

Constellations and Day 4: Astronomical Objects were difficult to determine due to a 62%

and 85%, respectively, decline in attendance prior to administering the post-assessment (Figures 6 and 7).

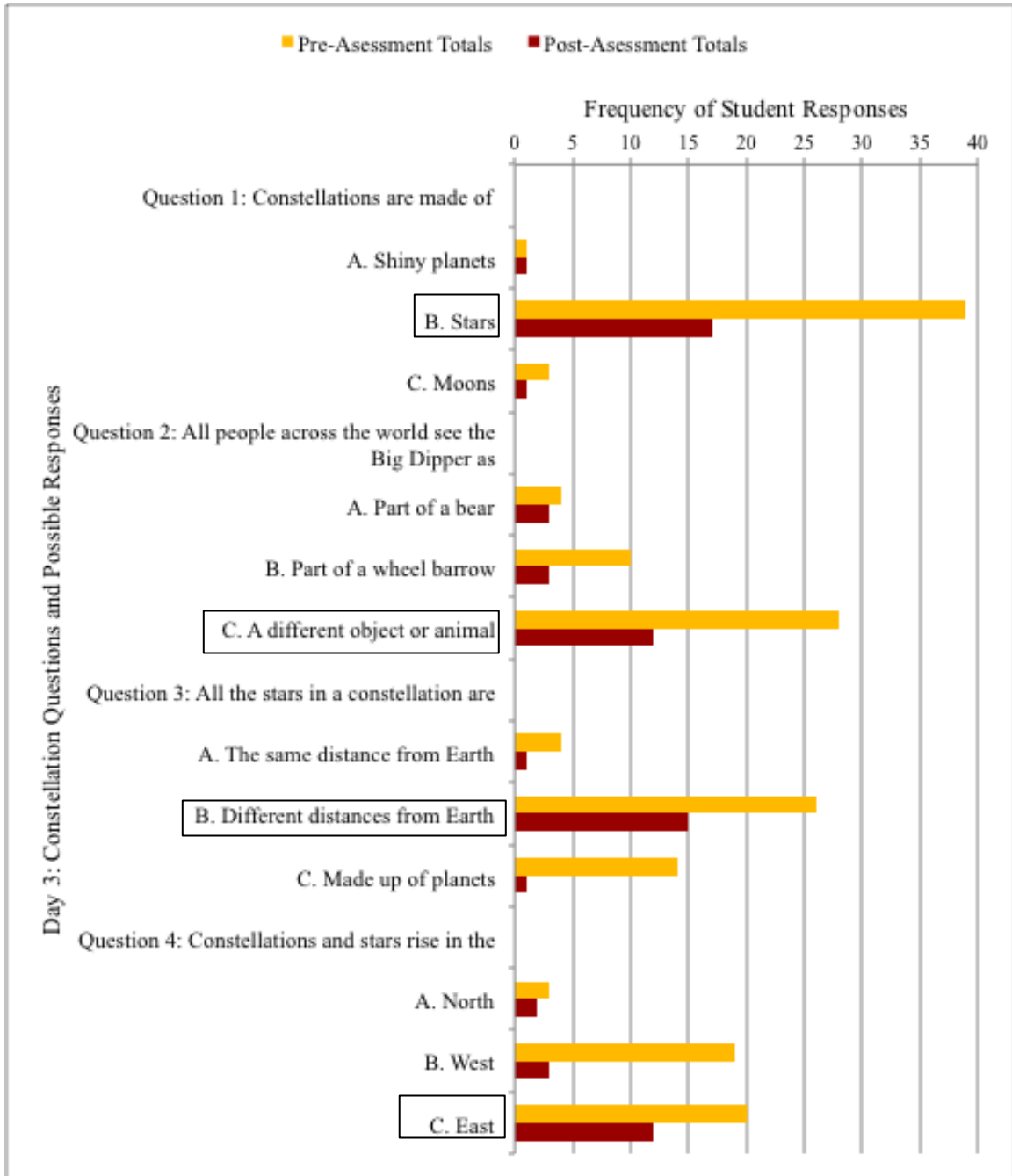


Figure 6. Frequency of responses for the content pre- and post-assessment Day 3: Constellations, (N=pre 44, post 17).

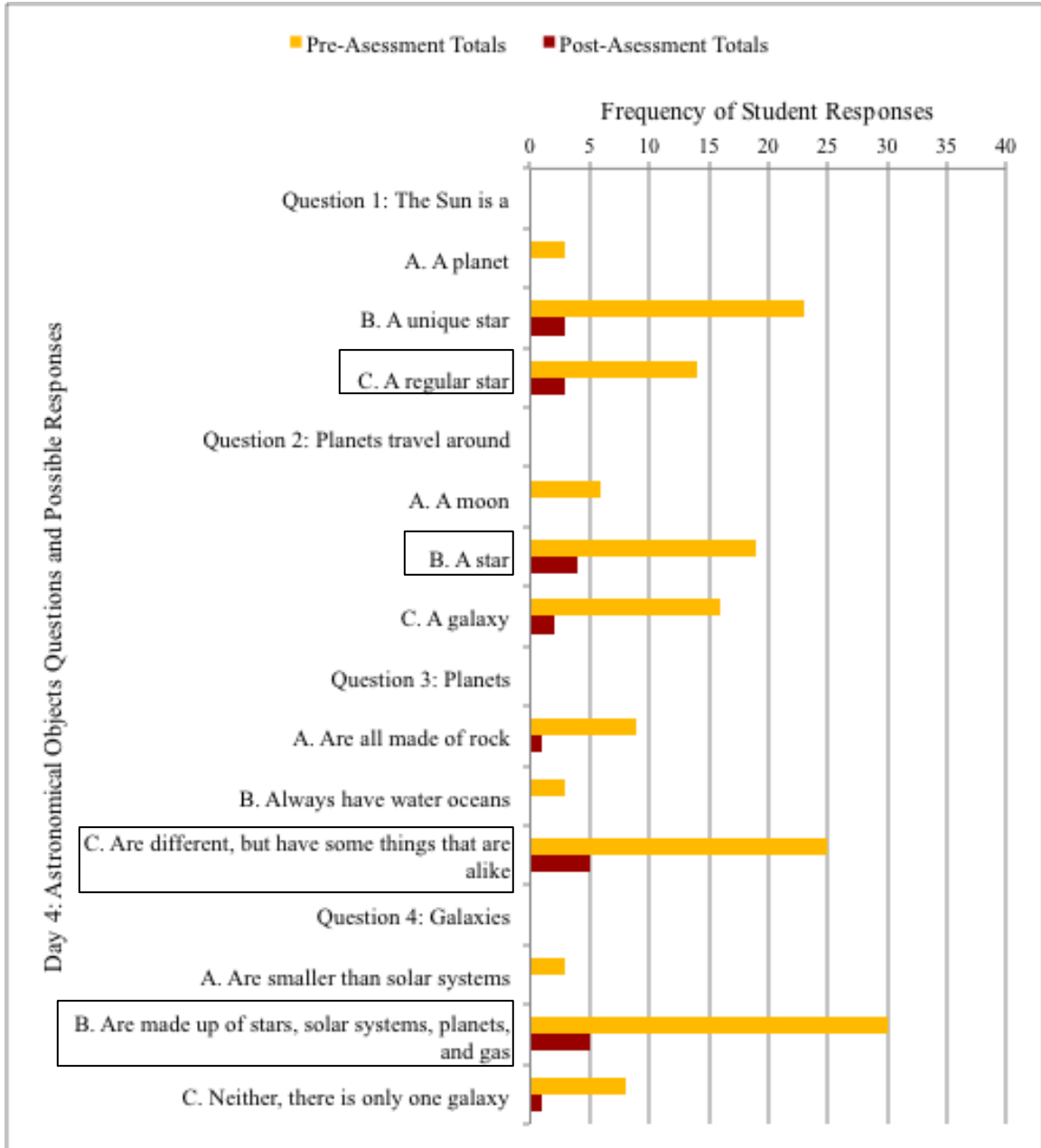


Figure 7. Frequency of responses for the content pre- and post-assessment Day 4: Astronomical Objects, (N=pre 41, post 6).

Post-treatment data for the Self-Efficacy Towards Science and Interest In STEM Topics instruments could not be administered due to low attendance rates and changes in the student population that occurred from the beginning of the treatment to the end. However, comments from the Teacher Feedback Forms on Impact of Program indicated

that overall interest had increased. “Kids kept asking if our presenter was coming back,” “Our students have begun to ask more questions about space and space travel,” “I attribute all of our students interest in this subject to the program,” and “She [the instructor] got kids interested in presenting [to other students] about astronomy!” The results from the Teacher Feedback Forms on Impact of Program indicated that 100% of teachers felt the program enhanced students’ understanding, provided opportunities for interaction, and the kinesthetic activities aided in the learning process (Figure 8).

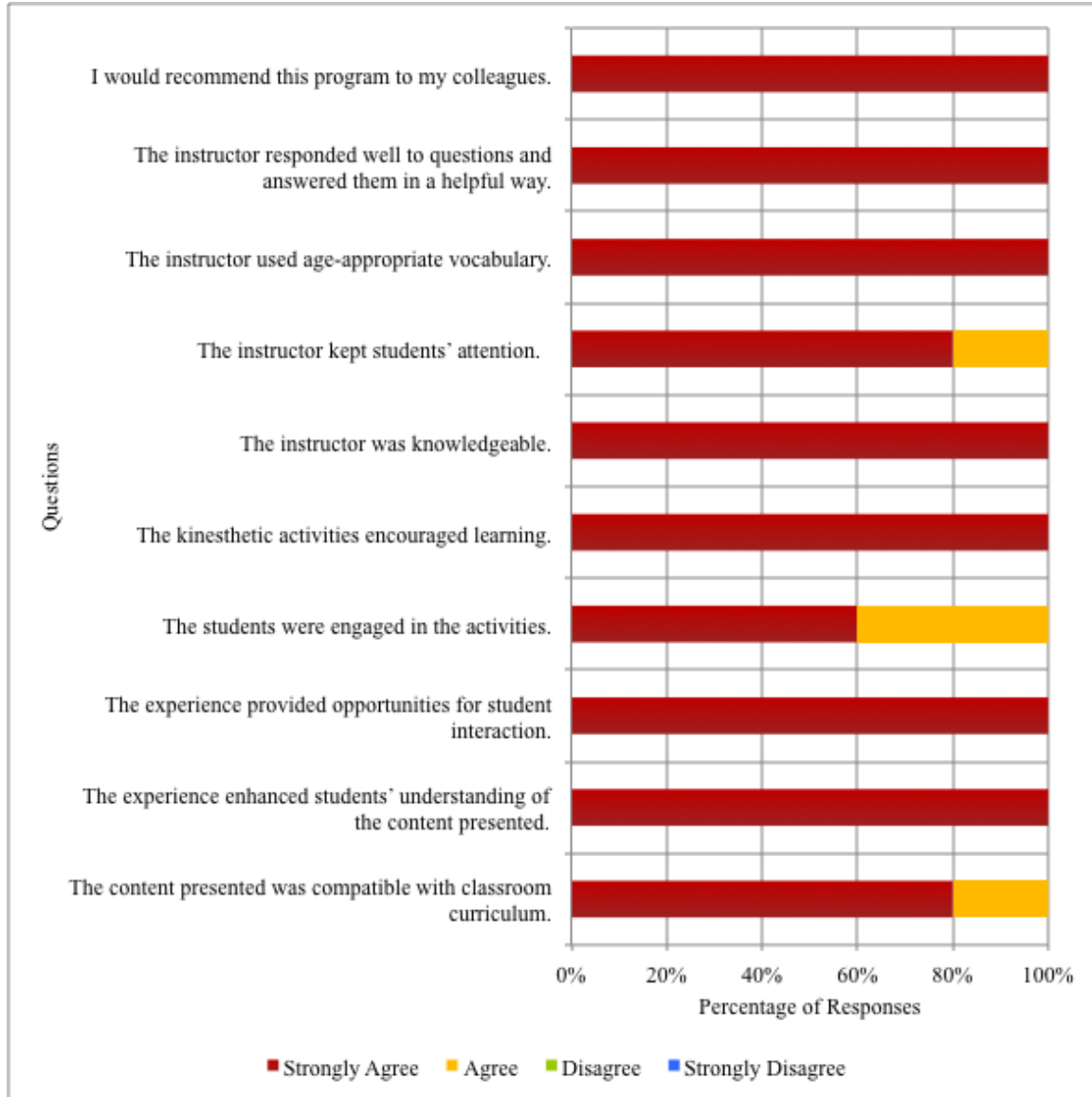


Figure 8. Teacher responses to questions about the program, ($N=5$).

Details from the Instructor Observation Journal also mentioned that students began checking out books from the library related to science, specifically earth science, geology, and astronomy and brought them to the program to show the instructor and their friends. Qualitative data from the Semi-Structured Interviews also indicated a shift in interest and engagement. When asked if they would like their friends to be able to participate in the

program, Tazjia, 3rd grade, replied, “Yes, my friends and my baby sister, so she'll know what nebula are and when people ask she won't have to say I don't know.”

INTERPRETATION AND CONCLUSION

The focus of my capstone project was to increase students’ self-efficacy towards science and their interest in science, technology, engineering, and math (STEM) topics by participating in exploratory and kinesthetic activities focused on astronomy during an afterschool program. According to the Afterschool Alliance, afterschool programs have made gains in providing supportive environments for students to help them achieve more in school and in life beyond their school years (2016).

Based upon the data from the daily Content Pre- and Post-Assessments it was difficult to determine if a change had occurred as a result of the treatment. However, comments from the Teacher Feedback Forms on Impact of Program indicated that a change had occurred in the level of students’ interest in and knowledge of STEM and space-related topics after the program. One teacher reported, “Our students have begun to share more of their own knowledge about space.” Another teacher wrote, “They [students] know what the moon is made of and location of the planets.” Another instructor explained that several of her students had become motivated to learn more about astronomy topics on their own and asked for permission to present the information to their classmates.

Additionally, as a result of the treatment, students’ interest in STEM topics did increase overall despite the difficulty of collecting post-treatment survey data and

maintaining sample sizes. The Instructor Observation Journal from March 3, 2017

detailed the following account after the students viewed the moon through the telescope.

As I wrapped up the week with the students, I asked them, “After this week of astronomy activities would you say you were more or less interested in science?” Of the 15 students still in attendance, 14 exclaimed and said they were more interested in science. The student who hadn’t responded positively said, “I didn’t like it, but now I think its okay.”

The National Science Teachers Association’s Position Statement on Informal Science Education (1998) highlighted the influential nature of informal learning experiences to, “spark curiosity and engage interest in the sciences during school years and throughout a lifetime” (p. 30). According to Miranda (2012), partnerships between astronomers and teachers can positively influence the motivation level of students and increase the level of questions that students ask, plus classroom partners can make the content more realistic, meaningful, and scientifically accurate. Comments received from the Teacher Feedback Forms on Impact of Program stated, “The students loved all the activities and lessons; very engaged” and “Our students have begun to ask more questions about space.” As Ashmann described, when students establish new frames of reference and role-play the positions of the sun, Earth, and moon and the respective relationships to one another, misconceptions can be addressed (2012). The treatment focused on providing structured exploratory and kinesthetic activities and the survey results from the Teacher Feedback Forms on Impact of Program showed that 100% of the teachers felt the kinesthetic activities encouraged learning.

VALUE

The typical American spends less than five percent of their lifetime in formal education settings and the majority of learning occurs outside of school time. Informal environments provide opportunities for students to participate in activities and learn at their own pace without pressures or constraints. In terms of science content, opportunities to learn in free choice environments during childhood “significantly contributed to adult science knowledge” and informal learning experiences in adulthood represented “the single greatest contributor to adult science knowledge” (Falk & Dierking, 2010, p. 489).

Structured informal education programs, such as this project, have a greater impact when engagement and attendance are sustained. Over the course of my project the sporadic attendance of students became a challenge. Additionally, the students who participated in the pilot project conducted in December of 2016 during the winter session of the Before and After School Enrichment Camp were more focused than the afterschool groups. This was likely due to the older ages of students than those in the afterschool program. In the future, I will identify specific age groups of students and collaborate more closely with teachers in order to achieve our desired outcomes.

In spite of these challenges, students who participated in my capstone project learned about astronomy, strengthened their interest in STEM topics, and felt they could learn about and do science to a greater degree than before. The program also encouraged many of the students to take the initiative to develop new approaches for determining what they wanted to learn, how they wanted to learn it, when they wanted to study it, and

with whom they wanted to share this knowledge, clearly launching them on their own journey of lifelong learning. A study conducted by the California Science Center indicated that after a visit, most of an individual's conceptual understanding of science continued to grow for two or more years after their informal learning experience (Falk & Dierking, 2010). Comparable outcomes have been found in afterschool programs.

I am no exception to these findings that detailed the power of informal education programs to encourage self-directed study and sustained interest. Almost twenty years ago, during an informal education program at the Denver Museum of Nature and Science, I was reintroduced to science, specifically astronomy. This experience sparked an enduring interest in space sciences and inspired a successful career change to that of an informal science educator.

Through the course of my capstone project, I have developed and refined my instructional practices and reflective techniques. I have grown professionally and become a more structured and purposeful science communicator while preserving my easygoing, animated style. Distilling complex information down into its core components and translating it for others in an engaging way that inspires excitement is my passion, but this program has taught me how to better design, facilitate, assess, refine, and evaluate activities and informal programs. Taking the time to objectively examine my instructional practices in a more holistic and comprehensive manner has increased my effectiveness as an instructor. Ultimately, this will enable me to have a greater impact as I share the wonders of the universe with all students, K through gray.

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APPENDICES

APPENDIX A
IRB EXEMPTION FORM



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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 c/o Microbiology & Immunology
 Montana State University
 Bozeman, MT 59718
 Telephone: 406-994-6783
 FAX: 406-994-4303
 E-mail: cherylj@montana.edu

Chair: Mark Quinn
 406-994-4707
 mquinn@montana.edu
Administrator:
 Cheryl Johnson
 406-994-4706
 cherylj@montana.edu

MEMORANDUM

.....

TO: Carla Johns and John Graves
FROM: Mark Quinn *Mark Quinn eq*
DATE: November 22, 2016
SUBJECT: "Impacts of an Inquiry-Based, Kinesthetic Astronomy After School Program on Students' Interest in Stem Topics and Self-Efficacy Regarding Science Concepts" [CJ112216-EX]

The above research, described in your submission of November 22, 2016, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

PRE- AND POST-ATTITUDE LIKERT-STYLE SURVEY

SELF-EFFICACY TOWARDS SCIENCE

Survey Questions	I Agree ☺	I Don't Agree ☹	I Don't Know ☹
I like learning about science.			
Learning about science is boring.			
Science helps me understand my world.			
Most people can't understand science.			
Science is too hard.			
I like to talk with my friends about science.			

APPENDIX C

PRE- AND POST-ATTITUDE LIKERT-STYLE SURVEY

INTEREST IN STEM TOPICS

Survey Questions	I Agree ☺	I Don't Agree ☹	I Don't Know ☹
I like learning about science.			
Computers and mobile phones help me learn.			
I like to build things.			
Math is a fun subject.			
I know enough about science already.			
I like computers, but don't really want to know how they work.			

APPENDIX D
CONTENT PRE- AND POST-ASSESSMENTS

Day 1: Earth Content Pre- and Post-Assessment

What shape is the Earth?

A. A disk like a frisbee

B. Round like a ball

C. Doughnut shaped

Why do we have day and night?

A. A cloud goes in front of the sun to create nighttime

B. The Earth spins like an ice skater, so half of it has sunshine and the other half has night

C. Only the United States has night and daytime

Why do we have seasons - spring, summer, fall, and winter?

A. The Earth gets closer to and farther from the sun

B. The Earth is tilted, so the sunlight strikes one part of it longer than the other part

C. The Earth's sky gets cloudier in winter and clearer in summer

The Earth

A. Travels around the sun in a path

B. Stays still and the sun travels around it

C. Changes its path depending on the moon

Day 2: Lunar Content Pre- and Post-Assessment

Why does the shape of the moon appear change?

A. It is made of clay

B. Light from the sun

C. It goes behind a cloud

Will a full moon always happen about a month after the previous full moon?

A. Yes

B. No

C. Maybe

Is there a permanently dark side of the moon?

A. Yes, the same part of the moon is in always in the dark

B. No, there is a far side of the moon, but it isn't always in the dark

C. Science doesn't know, we've never seen the far side of the moon

What is the moon made of?

A. Rock

B. Ice and snow

C. Gas and air

Day 3: Constellations Content Pre- and Post-Assessment

Constellations are made of

A. Shiny planets

B. Stars

C. Moons

All people across the world see the Big Dipper as

A. Part of a bear

B. Part of a wheel barrow

C. A different object or animal

All the stars in a constellation are

A. The same distance from Earth

B. Different distances from Earth

C. Made up of planets

Constellations and stars rise in the

A. North

B. West

C. East

Day 4: Astronomical Object Types Content Pre- and Post-Assessment

The sun is a

- A. A planet
- B. A unique star

C. A regular star

Planets travel around

- A. A moon

B. A star

- C. A galaxy

Planets

- A. Are all made of rock
- B. Always have water oceans

C. Are different, but have some things that are alike

Galaxies

- A. Are smaller than solar systems

B. Are made up of stars, solar systems, planets, and gas

- C. Neither, there is only one galaxy

APPENDIX E
SEMI-STRUCTURED INTERVIEWS

1. Which activity do you feel was the most fun?
2. How did the activities help you remember what you learned?
3. What was one thing you didn't know before this week started that you know now?
4. Would you like your friends to be able to participate in this program? Why?
5. If applicable - How did operating the telescope make you feel?
6. What else would you like me to know?

APPENDIX F
INSTRUCTOR DAILY OBSERVATION JOURNAL

School and Date	Act	Reflect	Evaluate	Notes
	Restate the goal of instruction today?	Overall what was the energy and engagement level? Any difficulty with instructions? Collaborating? Good questions? Are they trying to finish the activity early?	What can I do to further engage students? How can I make the instructions easier to understand? How can I facilitate question asking and inquiry better?	Who took charge today? Did they help others? Were there other students who seemed to struggle with the content? What was the feedback from the teachers?
O'Dea Core				
Jan. 30				
Jan. 31				
Feb. 2				
Feb. 3				
Feb. 4				
Ponderosa				
Feb. 6				
Feb. 7				
Feb. 8				
Feb. 9				
Feb. 10				
Saint Joseph				
Feb. 13				
Feb. 14				
Feb. 15				
Feb. 16				
Feb. 17				
Tavelli				
Feb. 27				
Feb. 28				
Mar. 1				
Mar. 2				
Mar. 3				
Lopez				
Mar. 6				
Mar. 7				
Mar. 8				
Mar. 9				
Mar. 10				

APPENDIX G

TEACHER FEEDBACK FORM ON IMPACT OF PROGRAM

Please complete the questionnaire below. Your responses will help me evaluate the effectiveness of the program and aid in the development of new programs.

Please provide your response to following statements.	Strongly Agree	Agree	Disagree	Strongly Disagree
The content presented was compatible with classroom curriculum.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The experience enhanced students' understanding of the content presented.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The experience provided opportunities for student interaction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The students were engaged in the activities.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The kinesthetic activities encouraged learning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The instructor was knowledgeable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The instructor kept students' attention.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The instructor used age-appropriate vocabulary.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The instructor responded well to questions and answered them in a helpful way.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would recommend this program to my colleagues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Describe any changes in your students' level of enthusiasm and interest in science- and space-related topics after the program.

Describe any changes in the level of your students' knowledge of STEM and space-related topics after the program.

Can you attribute any changes in the students' interest or knowledge directly to the program?

What are your suggestions for improvement?

Name of School: _____
(optional)

Thank you for taking the time to fill out the questionnaire!