

**Making It Real:  
Engaging Middle School Students  
with Earth Systems Connections**

**Summative Evaluation of  
'6 Degrees of Connection'**

Nurture Nature Center  
Easton PA

Report by  
People, Places & Design Research

# Making it Real: Engaging middle school students with earth systems connections

## Summative Evaluation of '6 Degrees of Connection'

Executive Summary . . . . .	1
A. Characteristics of Student Audiences . . . . .	10
B. The Challenge and Need Being Addressed . . . . .	11
1. Student interest in earth science is relatively low	
2. Interest in learning about earth system connections is low	
C. Perceptions of the SOS Program . . . . .	14
1. Ratings of program features	
2. What was most interesting?	
3. What was least interesting?	
4. Examples presented in the program were memorable	
5. Students' understanding of the examples of connections	
6. Students' perceptions about the impact of the program on them	
7. Perceptions about the length of the SOS presentation	
D. Value of the Creative Activity . . . . .	29
1. Ratings of various aspects of the activity	
2. What did students like most and least about it?	
3. Helping students to understand the idea of connections	
4. Assessments of students' creative work	
E. Students' Perceptions of STEM Careers . . . . .	39
1. Overall interest in a STEM career	
2. Did the program influence interest in specific careers that were mentioned?	

**People, Places & Design Research**  
Jeff Hayward and Christine Larouche  
Northampton MA  
February 2019



This report, commissioned by the Nurture Nature center, is supported by NASA under award Number NNX16AM18G. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration.



## Executive summary

---

'6 Degrees of Connection' is an informative and memorable program that combines a one-hour Science On a Sphere interactive presentation with a follow-up creative art activity – each aspect of which encourages middle school students to think of something that they've hardly thought of before: interconnections among phenomena on the planet, including the natural world and human activity.

The '6 Degrees of Connection' program was developed by the Nurture Nature Center - a community center dedicated to environmental education - in Easton PA in collaboration with the Maryland Science Center in Baltimore MD. With funding provided by NASA, these two organizations went through an extensive and thoughtful process of developing the concept, creating and testing prototype versions of the program, learning from those prototype versions and creating a final program. During that process the program leaders collaborated with Lehigh University which helped recruit student interns to develop content for the program and NASA's Maurice Henderson who acted as an advisor and subject matter expert.

The program was focused on earth science concepts and the theme of interconnectedness, relying on a personal relevance hook – the 6 degrees theme – to capture interest and motivation to further pursue STEM experiences and careers. The 6 degrees theme, inspired by Kevin Bacon's 6 degrees of separation game, underscores the idea of personal connections and interrelationships with consequences.

Key goals of the program for middle school student participants were:

1. Increase knowledge of Earth Systems and how they are interconnected
2. Maintain or increase interest/engagement in STEM subjects to prepare for STEM careers.
3. Increase personal engagement and connection to science through creative art activities.
4. Increase ability to explain chains of connections - how one event can lead to another and another and so on
5. Increase ability to perceive how global issues affect one locally and how local behaviors affect global Earth systems

This summative evaluation reports on the extent to which the '6 Degrees of Connection' program fulfills its goals and offers insights into other impacts of the program on middle school students. It is the third substantial audience study of the project, following the front-end research and the formative evaluation of two earlier prototypes.

The version of the program that was implemented for the summative evaluation sought to address issues that had arisen during the formative phase of the project. For example, although the program proved impactful, for instance, by making middle school students

more aware of interconnections, and more motivated to act to protect the environment, participants in the formative study:

- found the SOS presentation too long and not interactive enough
- had uneven recall of the topics that were presented
- had better recall and a better experience of the program if they participated in the '6 degrees' version that emphasized personal connections and included a creative activity designed to enhance science learning, than if they participated in a more traditional version of the program
- had a limited understanding of STEM careers

Building on these findings, the revised program that was analyzed in the summative phase was quite different: it used fewer and different topics, more in-depth on each, presented examples of scientists working in STEM careers, included, and was more interactive. For example, the interactivity was substantially enhanced by a segment of the program where students got up and gathered around the sphere to align themselves with the country where their shirt or t-shirt came from (many ended up standing by Asia). The STEM career highlights included short vignettes of men and women scientists talking about their career paths. The summative program also included the creative activity that proved successful in the formative phase.

The final program also focused on a different set of topics that were judged to be more appealing to students by the science interns developing the content and by members of the project team. The topics included:

- a visually compelling presentation about the sun, solar wind and solar flares, Northern Lights, and the ozone layer;
- the creation of a new interactive activity that made students aware of the environmental impact of wearing clothes made far away, due to transportation; and
- a section about climate change, causes and impacts
- information about waste and how our actions can help reduce the growth of garbage islands in the ocean.

In general, a summative evaluation is useful for a project team to understand how a project is connecting with its intended audiences, and to reflect on their major goals for a project, including thinking about implications for developing future projects. In that light, summative evaluations can advance the field of informal science education as well as offering the project team the direct experience of learning about the impacts of their work on their specific audiences. Ultimately, the project is served by identifying strengths, weaknesses, challenges compared to goals, and even unexpected sidelights or findings that may not have been directly expected from the original goals. This report is structured in that way.

## Program Audience, and Research Methods

Any evaluation is grounded in its sample of participants and the research methods used to seek insights about participant experiences. In this project, the audience was defined at the outset and continued to be the focus throughout the project: middle school students on a science-related school field trip. In the summative evaluation this meant 6<sup>th</sup> and 8<sup>th</sup> grade students – 5 classes, 166 students total. The research methods included three questionnaires plus the analysis of a creative activity that followed the Science On a Sphere (SOS) presentation. Two short questionnaires were administered on-site during the school's visit (one after the SOS presentation, one after the creative activity) and a longer questionnaire was administered in school classrooms within a few days after the program; analysis of the creative activity measured students' modeling of chains of connections. The content of the evaluation questionnaires included affective reactions to the program, awareness of Earth science connections in the SOS presentation, and self-reports of the impact of the program on future behaviors to help protect the environment, among other related topics. The specific questions asked are provided with each example of data cited.

## Findings

'6 Degrees of Connection' is an informative and memorable program that combines a one-hour Science On a Sphere interactive presentation with a follow-up creative art activity. The program evolved from initial concept (originally: '6 Degrees of Influence') through two fully-developed prototype versions and eventually to a re-invented final program that emerged from an iterative process of program development and audience evaluation. Evidence is presented to describe the multiple ways in which this project met its goals: the appeal of the Sphere, students' perceptions of the educational value of the program, the memorability and understanding of the program's content, students' ability to intelligently explain connections, and the added value of the creative art activity after the SOS presentation.

### A Challenge Affecting Student Engagement with this Subject

The subject of this program – interconnections and global relationships involving natural and human systems – is a difficult challenge. We can speculate that most adults don't understand much about environmental relationships,<sup>1</sup> and for middle school students this subject is part of an expanding awareness of the world they live in.<sup>2</sup> Therefore, as reported in the front-end research, this program is not building on students' existing interests nor on familiar understandings of how the world works. For example,

---

<sup>1</sup> The list of federal environmental policies that most of the public doesn't care about is extensive, while only Clean Air and Clean Water Acts seem to generate sufficient interest to be noticed, and even in those domains there is little outcry about protecting the environment unless it's associated with widespread health impacts.

<sup>2</sup> For example, in History, students learn about state history in 4<sup>th</sup> grade, and not about national and international history until later grades. For Earth systems, basic recognition of the existence and functioning of the natural environment, for example, comes before global issues; awareness of interactions across global phenomena depends on understanding basic issues first, and middle schoolers are in the middle of that expanding awareness.

- ◆ only 25% of students in the front-end research, formative evaluation and summative evaluations expressed clear interest in Earth science or environmental science;
- ◆ only 33% students in the initial front-end research gave good evidence of understanding chains of connections, even when the chains were about familiar phenomena such as snow storms or thunder; and
- ◆ less than 20% of the students in all phases of the project expressed a strong interest in learning about connections.

Therefore, interest and understanding generated by this '6 Degrees' program should be interpreted against this difficult starting point of low awareness and interest. Indeed, middle school students' low interest in the topic of Earth systems interconnections is not only a challenge, but also a reason why this program is so important.

### Appeal of the '6 Degrees' Program

In general, informal science programs depend on participants having an interest in them; such programs are not like school assignments where the students are required to learn the material whether they like it or not. Therefore, *appeal* is a fundamental foundation of a successful educational experience in informal science programs. The data from this summative evaluation show that:

- ◆ immediately after the SOS presentation students were especially impressed with the first major section of content: the sun, solar flares, and their connection to the Earth in terms of Northern Lights and the ozone layer (50% thought it 'very interesting' and another 40% thought it 'somewhat interesting' = 90% interest); students were also very impressed with the visual experience of the sphere and its projection technology (47% indicated 'very interesting' + 37% 'somewhat interesting' = 85% interest);
- ◆ later, back in their classrooms, about three-fourths of the students recalled the overall program as either 'very interesting' or 'pretty interesting' when asked about the Science On a Sphere presentation (82%), the creative activity (71%) and the combination of art with science (74%); and
- ◆ students in the summative phase were significantly less likely than students in the formative phase to rate the program as too long (45% vs 55% in the formative phase), suggesting that more students were engaged throughout the presentation, even though it lasted longer than the formative version.

### Students' Perceptions of the Educational Value of the Program

Self-reported educational value is an important foundation in assessing understanding. In this evaluation, roughly one-fourth of the students were very enthusiastic about the value of the program, and roughly another half reported some value in three of the program's goals:

- ◆ 81% indicated that this program helped them understand connections between Earth systems (24% 'very much' and 57% 'somewhat')

- ◆ 73% indicated that the program motivates them to take actions to help decrease the negative impacts of some of our human activities on the planet (23% 'very much' and 50% 'somewhat'), and
- ◆ 62% indicated that the overall program, very much (19%) or somewhat (43%), "made me feel more personally connected to Earth systems" (and similarly: 66% said that the creative activity "made me feel more personally connected to Earth systems").

Therefore, even though students did not express a strong interest in the topics of Earth systems and interconnections, these findings suggest that the '6 Degrees of Connection' program engaged students sufficiently for them to acquire a better understanding of the topic and to feel at least somewhat personally connected and responsible for caring for the natural world.

### Memorability and Understanding of the Program's Content

In the first-draft versions of this program – analyzed in the formative evaluation stage – memorability of the SOS presentation's content became an interesting indicator of students' understanding. Specifically, it was clear that there were too many topics and too much information, because students' recall of the topical sections was very uneven. In the summative evaluation, memorability of topics was again used as an indicator and the results were much improved – a substantial majority of students recalled each topic (from 62% to 86%), probably due to fewer topics each being presented longer with more visuals.

Such recognition and memorability of topics is one indicator of understanding; being able to state some knowledge about a topic is a further indicator. To pursue that aspect of understanding, students were asked to choose one example of an environmental connection and to explain what they knew about it. About half (44%) of the students gave relevant information in their own words – e.g., *When you don't use reusable water bottles it creates large garbage islands such as the Pacific garbage patch, or: If clothes were made far away they need to be transported which makes more carbon dioxide, or: Warmer [ocean] temperatures can increase the intensity of hurricanes because they thrive on warm water.* An additional third of the participants (32%) used words from their selected environmental connection without any additional explanation (perhaps they seemed to have obvious meaning), so the students might have understood something more about it but that wasn't clear from their answers.

### A Special Feature: the Creative Activity

The Nurture Nature Center has a commitment and history of using art to enhance science learning, and that was demonstrated in this project also. After the hour-long presentation of '6 Degrees of Connection' on SOS, students were engaged with a creative activity to make their own chain-of-connections mobile (see section D of this report for a photo of the materials). This activity offered an opportunity to apply the principles of '6 Degrees of Connection' – thus enhancing the science learning desired from the project and generating a physical output from that students that provided a way to measure that learning.

The creative activity prompted several outcomes that supported two key objectives of the project:

- ◆ demonstrating an understanding of the SOS presentation content by creating a chain of connections, meaning that students were able to apply the concept in a new context – an advanced level of learning; and
- ◆ enhancing the sense of personal relevance to environmental connections, because students were encouraged to make their chains of connections by building on something they know about, which often meant a personal behavior or situation.

The creative activity outcomes were facilitated by thoughtful planning: a worksheet was provided for students to think through their ideas about a chain of connections (see section D.1) and the activity featured fun materials (wildly colored shoelaces, clip art, markers) as well as the need to label and explain the relationships between each person's paper circles representing steps in a chain of connections.

### STEM Careers

In addition to the findings about students' engagement and understanding of Earth science connections, the evaluation process also revealed an unexpected tangential finding. Although NASA and NOAA seek to enhance interest in STEM careers by exposure to SOS programming, data from this project suggest that middle school students may have a limited understanding of STEM careers. This finding emerged during every phase of the project. In an open-ended question about any ideas they may have about a career, 49% of answers were coded as STEM related; however, when asked whether they would be interested in a career involving science, technology, engineering or math, only 33% were clearly interested. The health profession seems to be a primary omission in students' conception of STEM careers.

The addition, in the summative phase of the project, of features about specific STEM careers related to Earth Sciences, seems to have had some impact on students' interest in those specific careers. Students indicated that they had increased interest in two of the four STEM careers that were highlighted in the SOS presentation: marine biologist and engineer (the presentation mentioned engineers dedicated to technical solutions to environmental issues, e.g. designing solar panels and wind turbines).

### Conclusions and recommendations

The '6 degrees of connection' program largely fulfilled its stated goals:

1. Students increased their knowledge of Earth Systems and how they are interconnected:
  - by accurately recalling content from the presentation
  - by accurately explaining Earth Systems interconnections
  - by successfully creating mobiles that depicted chains of Earth Systems connections with personal relevance

2. Students maintained or increased their interest/engagement in STEM subjects to prepare for STEM careers:
  - Students' interest in certain STEM careers increased after seeing them highlighted in the program.
3. Students increase their personal engagement and connection to science through creative art activities:
  - Students expressed enthusiasm for learning science through a creative activity.
  - Students demonstrated an understanding of scientific concepts through art.
4. Students increased their ability to explain chains of connections - how one event can lead to another and another and so on.
  - Almost half the students could explain, in their own words, sophisticated chains of connections, and an additional third were able to repeat what they had heard about connections.
3. Students increased their ability to perceive how global issues affect one locally and how local behaviors affect global Earth systems.
  - Students indicated that they felt personally affected by Earth systems connections.
  - Students were motivated to help protect the environment through their actions.

*Recommendation 1*, regarding the use of Science On a Sphere: Future programs for middle school students should take advantage of this technology to engage them with scientific concepts. Middle school students who participated in the '6 Degrees of Connection' program were enthusiastic about the visual experience of the SOS presentation. Considering their stated low interest in the subject matter - interconnections of Earth systems - the fact that they mostly were engaged enough throughout the hour of the presentation to remember most of the content is a testament to the value of this technology to teach science ideas to middle school students.

*Recommendation 2*, regarding the participatory activity during the SOS presentation: If you want another option for engaging students with participatory activities, starting earlier in the program with a participatory activity might have value - e.g., asking students to stand up if their shirt /t-shirt comes from X country or continent. You could build on that by asking 3 students, with help from their friends, to speculate on the chain of connections that their shirt went through, from where did the material come from to where it was made to how did it travel and how did it reach you specifically? Then use the mid-program segment about gathering around the Sphere to stimulate their imaginations about possible careers in Earth and environmental science. Perhaps kids can pretend to be different types of scientists to try to solve a problem? or imagine where they might be working somewhere on the planet and what kind of problem they might be studying there?

*Recommendation 3*, regarding the possible value of future research and evaluation:

>> If it seems worthwhile and feasible to experiment with the placement, format, and content of interactive activities during the '6 Degrees' SOS program, some type of evaluation should be included to assess those initiatives.

>> Vignettes about STEM careers appear to have had some impact on students' interest, at least for a couple of the highlighted careers. Perhaps future science programs could try this approach for a variety of careers, varying the types of information that are presented in such vignettes to identify the most effective way to motivate students to engage with science topics and areas of endeavor.

These recommendations are the opinions of the evaluation consultants, and are speculative – not required. The project itself has met a difficult challenge and accomplished some substantial outcomes; the project team is clearly capable of creative program development and may arrive at other recommendations for future enhancements.

# Technical Report

## A. Characteristics of Student Audiences

OVERVIEW: An essential context for any evaluation is to be clear about the characteristics of people participating in the project, in this case: middle school students. A summary of this audience, and how it differed for the summative evaluation compared to other phases, is represented by these data:

- A total of 711 middle school students informed the three phases of research on the 6 Degrees of Connection program; there were 166 students participating in the summative evaluation phase.
- Due to issues with data collection at Maryland Science Center (MSC), no data were included about the program at MSC in the summative phase; all data for the summative evaluation phase came from the Nurture Nature Center in Pennsylvania.
- There were more 8<sup>th</sup> graders than 6<sup>th</sup> graders, which was different than the two previous phases; this situation limited our capacity to make comparisons across sites, across grades and across phases (formative, summative).
- On a positive note, there was nevertheless enough good data from which to draw some important insights about the effectiveness of the program for teaching about Earth systems interconnections to middle school students.

	<b>Front-end n=201</b>		<b>Formative n=344</b>		<b>Summative n= 166</b>	
	<u>n</u>	<u>%</u>	<u>n</u>	<u>%</u>	<u>n</u>	<u>%</u>
<b>Gender:</b>						
Female	117	58%	174	63%	96	58%
Male	84	42%	100	36%	67	40%
other			2	1%	3	2%
<b>Grade:</b>						
Grade 6	127	63%	193	57%	48	29%
Grade 7	26	13%	17	5%		
Grade 8	48	24%	127	38%	118	71%
<b>State:</b>						
PA	107	53%	255	74%	166	100%
MD/VA	94	47%	89	26%	0	0%

## B. The Challenge and Need Being Addressed

In each phase of the project, students' interests in school-related subject areas were assessed. Across the baseline, formative and summative phases of research and across the different school classes that participated, two of the program-related subjects – Earth science and environmental science – scored at the bottom of a list of 8 interest areas. These low levels of interest represent a huge challenge for this program.

Further, the students' level of interest is even lower when students are asked about their interest in the heart of the subject of the program: "thinking about environmental connections." Only 10% of students express a high interest in that topic, and a similar proportion say that they would be interested in learning more about environmental connections such as those that they learned in the program. Another big challenge.

Given the urgency of combating climate change and the responsibility that will inevitably fall onto this generation for finding solutions to environmental emergencies that will likely befall them in the future, it is essential to find ways to engage students with these topics.

## B. The Challenge and Need Being Addressed

### B.1. Student interest in Earth science is relatively low

**OVERVIEW:** In each phase of the evaluation process, students' interests in subjects relevant to global connections were assessed, using a cluster of five subjects: Earth science, environmental science, science, astronomy/space science and nature.<sup>3</sup> Students were simply asked about their interest in these subjects, so that there would be a context informing us about their general patterns of interest, perhaps to help interpret their reactions to the program.

The results were consistent across phases and across the different school classes that participated: non-STEM subjects such as music and art are of greater interest, and two of the program-related subjects – Earth science and environmental science – are two of the three lowest-rated interests (along with English). *These low levels of interest indicate a huge challenge for this program.*

<b>Topic</b>	<b>baseline</b>	<b>formative</b>	<b>summative</b>
	(these figures are the % of 'high interest' for each subject)		
<u>Non-STEM subjects</u>			
Music	41%	49%	48%
Art	42%	43%	47%
English	16%	25%	31%
<u>Subjects relevant to global connections</u>			
Astronomy/Space Science	38%	41%	41%
Nature	35%	38%	44%
Science	32%	35%	35%
Earth science	22%	26%	27%
Environmental science	17%	25%	24%
<u>Other STEM-related subjects</u>			
Computers	39%	46%	32%

<sup>3</sup> In the list of subjects presented to students on questionnaires, these five subjects were not presented together as a "cluster," they were distributed among other subjects. However, in the strategy for analysis of this question, it was intended that these five subjects would be grouped together as an indicator of interest in the topic of global connections.

## B.2. The challenge of low interest in Earth system connections

OVERVIEW: Middle school students who participated in the summative phase of the '6 Degrees of Connection' program were not very interested in thinking about environmental connections. Only about 10% indicate a high interest in thinking about connections, and experiencing this program did not change from a baseline (different students, 2 years earlier). This is part of the challenge and need for communicating connections among natural systems as well as nature-human connections.

***Please rate how interesting "the opportunity to think about connections" was for you:***  
(summative evaluation)

Very interesting	13%
Somewhat interesting	46%
Not very interesting	41%

***How interested are you in learning more about chains of connections like those that we just asked you about?***

	<u>Overall</u>	<u>Baseline</u>	<u>Summative</u>
High interest	8%	10%	5%
Medium interest	56%	55%	57%
Low interest	36%	35%	38%

## C. Perceptions of the SOS Program

Middle school students' perceptions of the '6 Degrees of Connection' program reveal several strengths of the program.

Students expressed enthusiasm for the Science On a Sphere visuals and enjoyed some of the content areas. Many especially enjoyed the content about the sun, solar flares and Northern lights, but a good proportion also mentioned content connected to climate change and to careers in science. Overall, three quarters of the students found the program was either 'very interesting' or 'pretty interesting.'

More importantly, on average, three-fourths of the students remember each example of connections presented in the program, which suggests that students were somewhat engaged throughout the entire program, more so than they were in versions tested during the formative evaluation.

Further, almost half were able to talk about an example of a specific connection in their own words in a coherent and accurate manner, mentioning some details about the connection that demonstrated a good understanding of it.

Finally, about three quarters felt that the program had impacted them, at least to some extent, by helping them better understand connections between Earth systems and by motivating them to take actions to protect the environment. About 60% felt that the program helped them feel more personally connected to Earth systems.

Criticisms of the program mostly reinforced the notion that students were not interested in learning about connections.

## C. Perceptions of the SOS Program

### C.1. Ratings of program features

**OVERVIEW:** Immediately following the SOS presentation, students rated the multiple aspects of it. They clearly appreciated the SOS visuals, and especially enjoyed the content about the sun, solar flares and Northern lights. Back in their school classroom, three-fourths of the students thought the whole thing was either 'very interesting' or 'pretty interesting.'

#### ***How interesting were the following features of this SOS presentation?***

(asked ON SITE) (shown in program order)

	<u>Very</u>	<u>Somewhat</u>	<u>Not</u>	<u>Don't Recall</u>
Science On a Sphere projection technology	<b>47%</b>	37%	15%	(3%)
The 6 Degrees theme	18%	48%	34%	(12%)
Example about Facebook friendships	26%	38%	36%	(5%)
The part about the sun, solar flares, Northern Lights, and the ozone layer	<b>50%</b>	40%	10%	(3%)
Interactive activity where you worked in teams to figure out the order of steps in a chain of connections, and we talked about laws that help reduce toxic emissions from vehicles	28%	34%	38%	(3%)
Section that talked about climate change, causes and impacts, and waste and how your actions can help reduce growth of garbage islands in the ocean	32%	40%	28%	(3%)
Examples of careers in earth sciences	29%	38%	33%	(7%)
Questions that the facilitator asked your group	15%	57%	28%	(21%)

#### ***Please rate how interesting these aspects of the program were for you:***

[asked LATER, back at school]

	<u>Very interesting</u>	<u>Pretty interesting</u>	<u>Not interesting</u>
Science On a Sphere presentation	29%	53%	18%
Creative activity	22%	49%	29%
The combination of art with science	25%	49%	26%

## C.2. What was most interesting?

OVERVIEW: Students' perceptions of the '6 Degrees' program reveal a wide variety of interesting features. The Sphere was most mentioned as a highlight of the program, but almost all of the other types of answers are about the content of the presentation. This variety of answers (and the uniqueness of verbatim answers shown below) indicates that teachers did not coach them about what to say.



***What was most interesting or relevant to you about the Science On a Sphere presentation?*** [asked LATER, in school classroom]

15%	SOS, the sphere
13%	global warming (especially visual of temperature change over time)
8%	solar flares, the sun
8%	litter, recycling, garbage in the ocean
7%	wind, ocean currents, weather patterns
5%	connections in general
4%	Facebook connections
4%	the creative activity
3%	clips of people working in STEM careers
3%	being personally connected
3%	negative impacts of human activity, pollution
2%	shirt tags activity
2%	coral reefs

**What was most interesting or relevant to you about the Science On a Sphere presentation?** (continued)

2%	6 degrees idea
2%	transportation connections, planes
1%	earthquakes and volcanoes
1%	presenter, explanations
1%	hurricanes
1%	actions to limit negative impact of human activity
1%	Northern lights, magnetic field
4%	other
12%	blank, nothing

**Sample of answers:**

*When they showed the social media part, and when the sun "exploded"*

*Facebook*

*When they showed how many hurricanes and volcanoes over the years*

*The connections*

*The coloring and seeing what they made*

*About the coral reefs*

*Creative activity and opportunity to think about connections*

*Where our shirts come from*

*Under the sea science about trash*

*How we got to move around*

*When you taught us about Facebook, about the people who were connected in technology*

*I like the videos of people following their dreams*

*That everyone has connections around the world*

*How the projectors worked*

*The hurricanes in the world*

*Seeing the sun*

*I really like just seeing the Earth projected on the sphere*

*The solar flares*

*Seeing the globe and the global warming that happens in the last years and the wave patterns*

*The sphere presentation*

*When they talked about the people who worked for NASA. Also solar wind/flares.*

*The technology representation since I use technology every day*

*I think the graphics and seeing how everything was connected was interesting*

*The slides where it showed us the changes over the years*

*The visual representation of the effects on the earth was very interesting*

*The pretty globe*

*When we learned about the trash and how pollution affects us*

*Climate change over time*

*The amount of pollution in the ocean*

*Seeing the weather patterns*

*When they showed the volcanoes*  
*The trash pollution*  
*Learning about corals*  
*It allows you to really see it on an earth, and when we found out where shirts were made*  
*The chains*  
*Seeing how much plastic was in the ocean*  
*Greenhouse gas presentation*  
*How it could be projected*  
*The idea of a sphere is cool and it gives you a better idea of what something might look like*  
*Seeing the earth on the sphere*  
*Trash islands and how pollution is taking over the earth*  
*The effects of pollution and climate change*  
*That there is so many waterways in the ocean that carry pollution (plastic) to a certain location*  
*The graphics on the sphere with the sun was interesting*  
*The 6 things*  
*How it showed a cause and effect system to show problems*  
*When the presentation showed the travel by flight of the whole world because you could see where most people travel*  
*Global warming and how it is affecting our world*  
*How the sphere worked as a globe and displayed content on it like a projector*  
*The lines that showed Facebook/connections*  
*When they showed us the airplanes that were flying all around the world*  
*How connected the world is*  
*It is more realistic as a sphere*  
*The magnetic fields*  
*Global warming*  
*Stuff about ocean and pollution*  
*The way to see the sun up close and to learn about the flares was interesting*  
*That the whole thing was 3d and you can hear clips of other people speaking*

### C.3. What was least interesting?

OVERVIEW: Three-fourths of the students had something to mention that was not interesting to them; this is completely normal, especially when asked directly to name something. However, four of the top five answers were not about the content – they were about the overall topic (as identified in chapter B, there was a pre-existing low interest in connections) and about the format: too long, too many facts, etc.

#### ***What was least interesting to you about the SOS presentation?***

[asked LATER, in school]

11%	connections, 6 degrees
9%	too long, too much sitting
7%	card activity, where the clothes come from, the chains
7%	global warming
7%	all of it not interesting to me
5%	presenter, too much talking, too many facts
4%	interviews, clips of scientists
4%	Facebook connections
4%	some images, e.g., wind, weather
3%	transportation
2%	litter, plastic pollution
2%	art activity
2%	the sun, magnetic field
2%	SOS, technology
1%	ozone, acid rain
1%	confusing, hard to understand
5%	other
26%	blank, nothing

#### Sample of answers

*The shipping of clothes*

*The thing with the cards*

*That everybody shirt was made from china*

*We were sitting in chairs*

*About the clothing*

*The beginning of the sphere presentation*

*The sun*

*The connections*

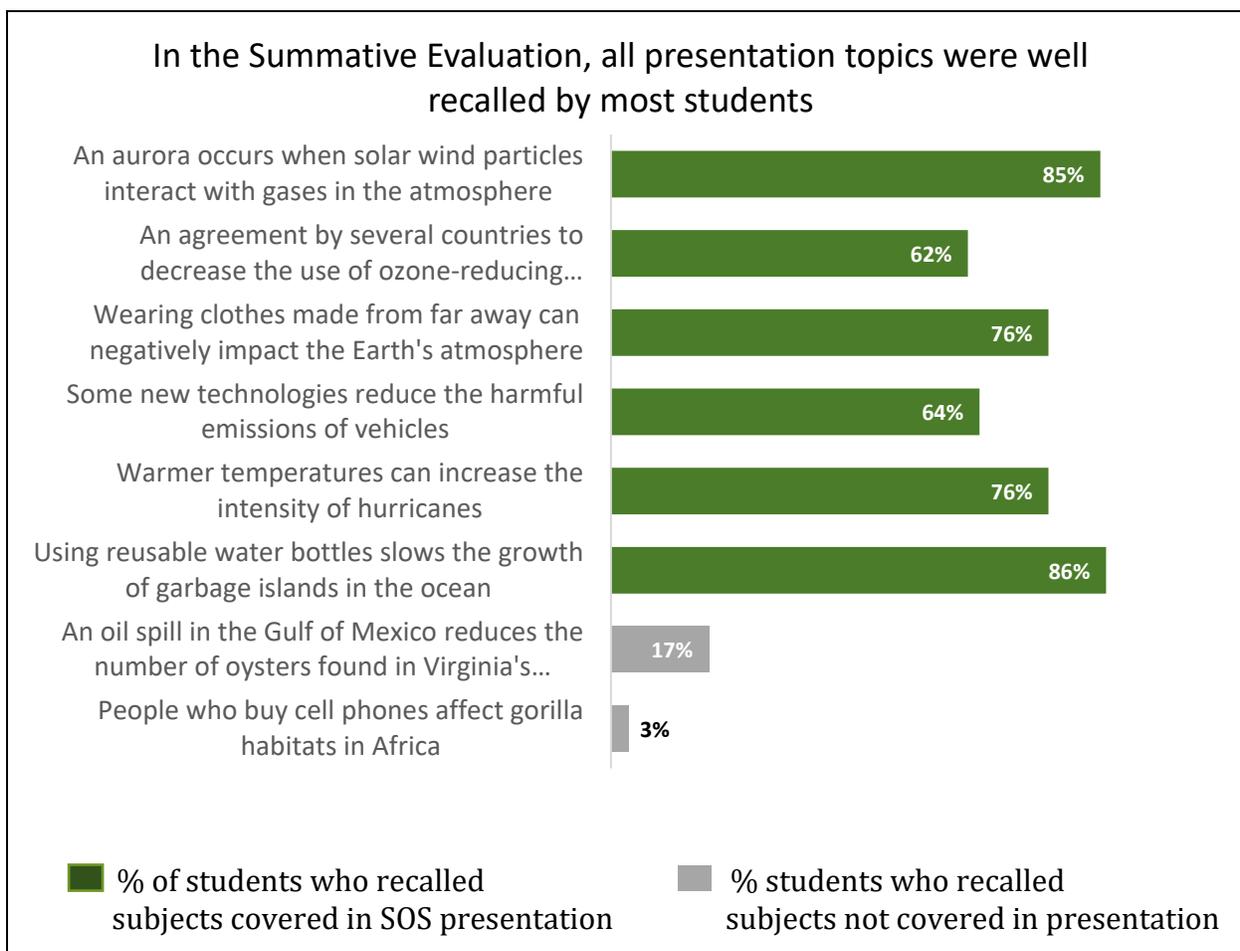
*Most of the stuff we learned so far*  
*The cards*  
*How I think affect other things*  
*The 6 connections*  
*The Facebook connection*  
*To find someone with the same color card*  
*Seeing the crust, mantle and core was boring because everyone knows that*  
*The part about talking*  
*The weather*  
*The interviews*  
*Finding our partners with the cards*  
*The chain with the cardboard where you had to find everybody*  
*Science*  
*The art*  
*Environmental waste*  
*The first part where it talked about how we are all connected*  
*Some of the graphs and maps were hard to understand*  
*The connections*  
*The outer space things*  
*Global warming*  
*The length of the presentation*  
*The matching cards was the least interesting*  
*The facts*  
*Global warming*  
*Wind patterns*  
*When she talked about how people communicate*  
*The interviews with people*  
*Global warming presentation*  
*Toward the middle of the presentation they ventured away from the topic*  
*The connections*  
*The information on global warming*  
*When we talked about garbage*  
*The conversation about the ozone layer*  
*The thing where it showed where things are sent*  
*The constant replay of the years passing to show any difference*  
*How we are connected*  
*The actual topic*  
*I couldn't understand her 2/3 of the time*  
*The pollution*  
*Very long and we could not move around*

*The temperature changes*  
*The whatever creates pollution/transportation and people (because I already know it)*  
*There was too much talking*  
*Just shorten the talking part a little bit*  
*The long presentation*  
*Global warming portion*  
*About earth's protective barrier from the sun's rays*  
*When people were talking about their careers*  
*When she explained about the use of water bottles*  
*The project that had to be done after the presentation*  
*The pictures that popped up in little boxes*  
*The transportation of goods*  
*The chain/six point thing*  
*Stuff about how we are all connected*  
*Weather patterns*  
*The speaking parts from other people got boring and a little repetitive*  
*The recordings of the people*  
*Sitting most of the time*  
*The length of the presentation; too long*

## C.4. Examples presented in the program were memorable

**OVERVIEW:** An average of three-fourths of the students remember each example of connections presented in the program (ranging from 62% to 86%). These results suggest that students are paying attention to the entire program, more so than they were in the formative evaluation, where students had difficulty remembering some of the topics (see graph, next page).

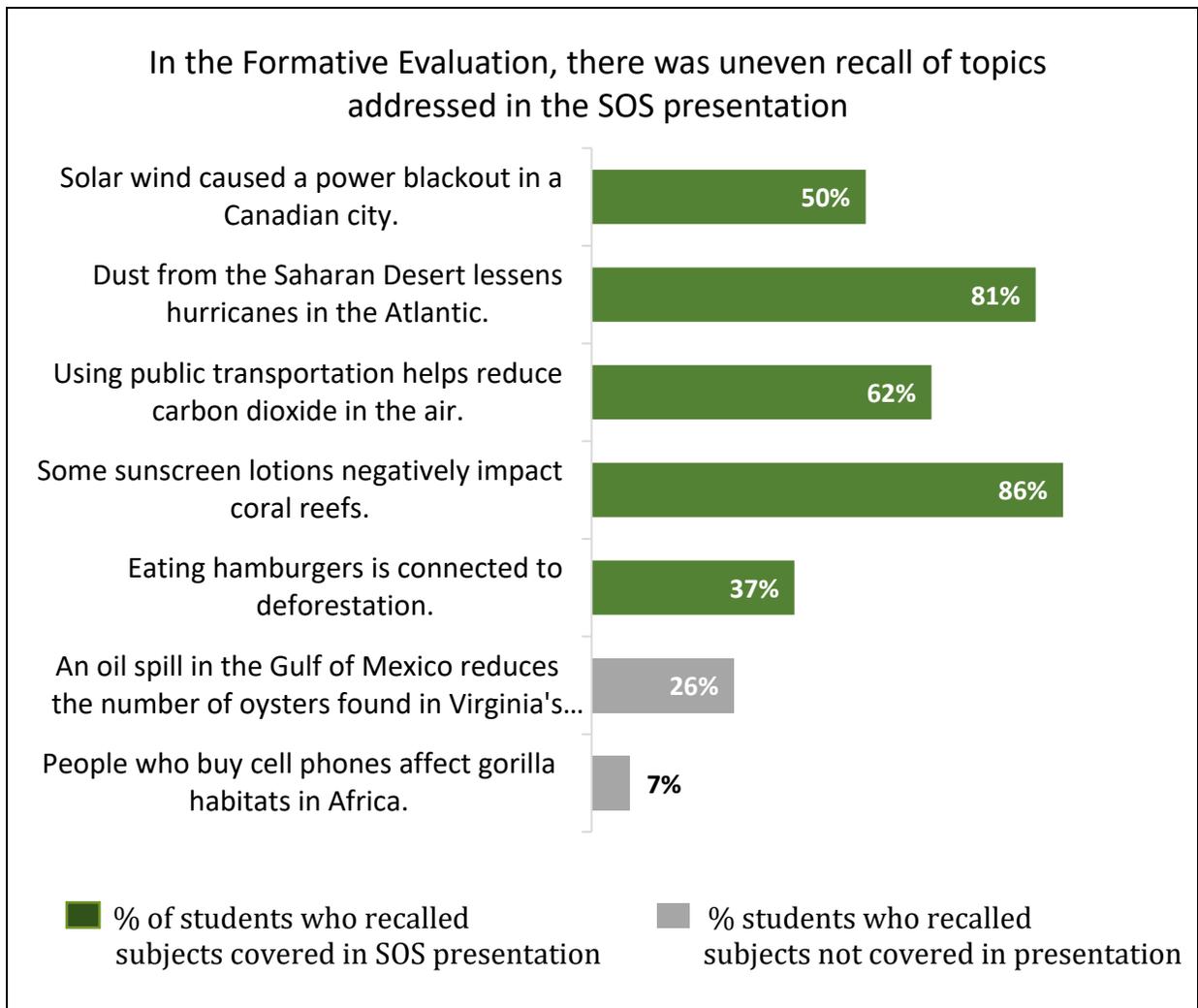
***Below are examples of interconnections of earth systems that may or may not have been described in the SOS presentation. Do you remember hearing something about those connections during the presentation?***<sup>4</sup> [asked LATER, back in school].



The two examples of connections asked in this list of topics that were NOT in this program were clearly distinguished by students in their recall of program content (only 17% and 3% guessing that these were included), further supporting the conclusion that all of the topics presented were memorable.

<sup>4</sup> In the two graphs, topics are shown in the order in which they were addressed in the SOS presentation.

For comparison to the summative evaluation, this graph from the formative evaluation shows very uneven recall of topics addressed during the SOS presentation.



## C.5. Students' understanding of the examples of connections

OVERVIEW: Following students' recall of the range of topics in the 6 Degrees SOS presentation, they were asked to formulate in their own words something that they know about a connection that they heard in the presentation. This type of question goes beyond simple recall of topics, and almost half of the students cited something specific that they retained from the program (another third repeated some part of a topic, instead of using their own words to "explain what you know" as requested). Reviewing these answers offers good feedback about the messages students took from the presentation.

**Choose one of the eight examples and explain what you know or remember hearing about that connection:**

[asked LATER, back in school]

- 44% recalled details from the program, knew something
- 32% just repeated the information in the question item (it's unclear whether they were actually citing learning, or just identifying the topic)
- 3% gave inaccurate information
- 15% other/unclear
- 4% blank, no answer

**What students know about plastic bottles and garbage in the ocean:**

(41% chose to explain this example; these are only the substantive answers)

Main themes: it's harmful to wildlife, the Pacific Garbage Patch, plastic water bottles are a huge contributor

*Fish can get stuck in nets and they can also eat all that garbage*

*We need to stop using plastic bottles or by 2050 there will be more plastic than fish in the water*

*Plastic water bottles are a big part in ocean pollution*

*Plastic ends up in our oceans and harms wildlife*

*In a year the average American drinks enough water bottles to wrap around the world 20 times*

*People throw away plastic water bottles somewhere and sometimes that is in the ocean where animals eat it and die from it*

*Even with huge garbage islands, there is still more floating about*

*There is a place called the pacific garbage patch*

*We have garbage islands and a lot of it is plastic*

*I did a project about the great pacific garbage patch in my steam seminar class*

*Using metal water bottles helps reduce the amount of trash being dumped into oceans.*

*More people are using recyclable water bottles that eventually get thrown in the ocean that then harms animals in the environment*

*I heard something about people can use edible water wrappers to reduce waste*

*Using reusable bottles is harmful because otherwise the waste enters the ocean and effect marine life negatively*

*When you don't use reusable water bottles it creates large garbage islands such as the pacific garbage patch*

*Garbage and plastics in the ocean can kill animals*

*Garbage is very negatively impacting marine life*

*Plastic bottles don't fully decompose and fish can eat them which will then hurt us*

### **What students know about clothing from far away:**

(chosen by 19%)

Main themes: transportation uses fuel, creates more emissions

*By wearing clothes from far away it requires it to be shipped which takes up fuel*

*It negatively impacts the environment because of the harmful fuels/gasses released into the air*

*The gasses and fuel used to deliver clothes from far away negatively impacts the atmosphere*

*Wearing clothes made far away requires transportation which creates greenhouse gases that cause global warming*

*It needs oil and pollutes the airways*

*The shipping of the product causes more pollution than if they are made in the US*

*The gases emitted into the air when the transportation happens can negatively impact earth's surface*

*The transportation of the clothing causes more fuel emissions*

*All of our clothes were made in different places*

*The travel for the clothing releases pollution*

*Wearing clothes made far away can negatively impact the Earth's atmosphere because of the transportation of the items.*

*The emissions used to get it over to the US are harmful*

*Wearing clothes from other places is bad because they have to use fossil fuels to get to the US*

*If clothes were made far away they need to be transported which makes more carbon dioxide*

*The planes that carry the clothes give out CO2 which warms up the atmosphere*

**What students know about auroras:**

(chosen by 12%)

Main themes: it happens more near the poles

*Because they said that when aurora occurs solar winds particles interact with gasses and it might look pretty but it's dangerous*

*I know solar winds cause auroras in Antarctica*

*When solar winds they react in the atmosphere you get a reaction at the poles where the magnetism is the strongest*

*Auroras form by the poles and they're beautiful to look at*

*Auroras only happen in the atmosphere*

*You can't see the aurora when there's light pollution*

*Auroras occur when solar articles interact with gases in the atmosphere. Auroras are lights with the ozone layer that show in the north and south poles.*

**What students know about hurricanes:**

(chosen by 12%)

Main themes: higher intensity means more destructive, warm water feeds hurricanes, global warming

*Hurricanes can be increased intensity due to warmer temperatures, and cause more damage*

*The more carbon dioxide is released, the air get warmer and the category for the hurricanes gets higher*

*Global warming is making our earth hotter and because of this more deadly hurricanes are happening around the world*

*Warmer temperatures can increase the intensity of hurricanes because they thrive on warm water*

*Warmer temperatures can cause more destructive natural disasters*

**What they know about vehicle emissions:**

(chosen by 9%)

Main themes: electric cars are better for the environment

*Some new technologies reduce the harmful emissions of vehicles because it runs on electric I've heard of electric cars.*

*Electric cars are better for the environment than regular gas cars*

*Electric cars don't run on gas*

*New solar and battery powered cars don't release harmful materials into the environment*

*Electric / hybrid cars help reduce carbon emissions*

*Because Teslas and other electric cars are better for the environment*

*Teslas have been made to help*

*Some battery-powered cars are made, and they don't pollute the world as much*

*There are cars that are electric, so they don't give off emissions*

## C.6 Students' perceptions about the impact of program on them

**OVERVIEW:** One of the principal goals of the '6 Degrees of Connection' program was to encourage middle school students to recognize and think about how global connections are impacting them. The summative evaluation results show this, at least to some extent, in several ways:

- ◆ students felt that the program helped them better understand connections between Earth systems ('to some extent' with one-quarter saying 'very much');
- ◆ they indicated that the program motivated them to take actions to protect the environment ('to some extent' with one-quarter saying 'very much'); and
- ◆ almost two thirds came away feeling more personally connected to Earth systems (almost half indicating 'to some extent' and one-fifth saying 'very much').

This pattern of 'to some extent' being the dominant answer for changes in attitude is quite reasonable for viewing a program with a considerable amount of new information, seeking a shift in how students understand the world and many interconnections that were just introduced to them.

***Do you agree with these statements or not really?***

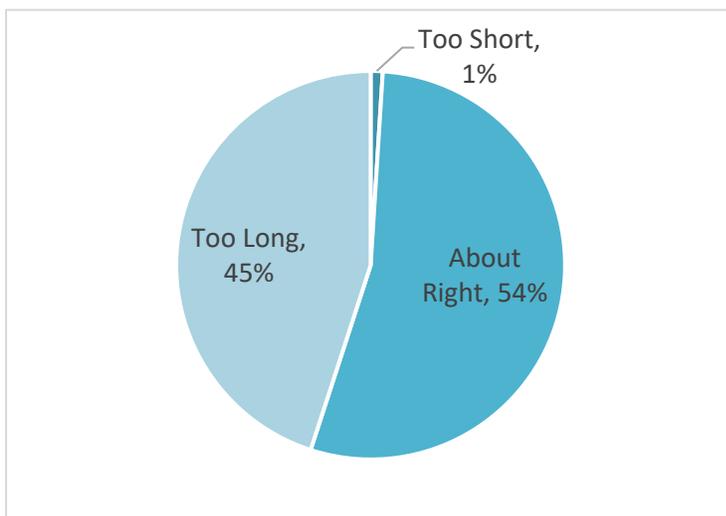
***Overall, the program . . .***

	<u>Very much</u>	<u>To some extent</u>	<u>Not so much</u>
Helped me better understand connections between Earth systems	24%	57%	18%
Motivated me to take actions to help decrease the negative impacts of some of our human activities on the planet	23%	50%	26%
Made me feel more personally connected to Earth systems	19%	43%	38%

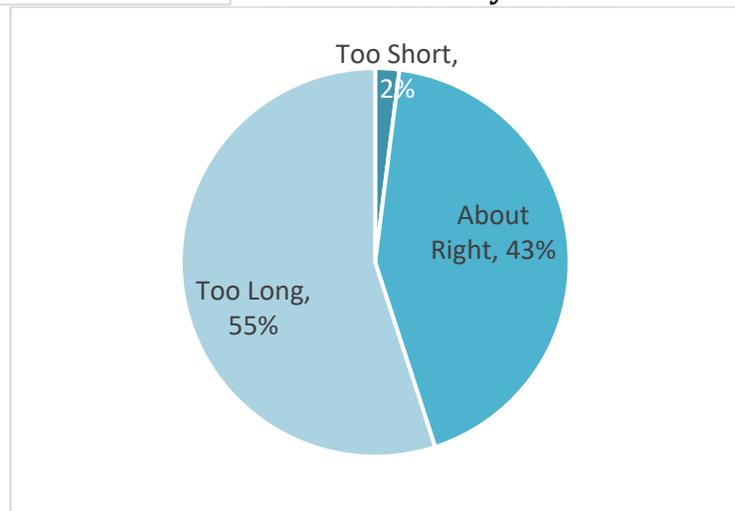
## C.7. Perceptions about the length of the SOS presentation

OVERVIEW: Perceptions of the length of a program can be an indicator of how interesting a program is, or it can reflect the interaction of the program format with their interest in the subject matter. Considering the challenges identified earlier (students' low interest in Earth science, etc.), it is not surprising that about half of the student participants thought the SOS presentation was too long. However, what's really interesting is that the final program significantly reduced the proportion of students who thought the program was 'too long' *even though the program was in fact longer!*<sup>5</sup> This indicates that the final program was more interesting than the versions tested in the formative evaluation phase.

### Summative Study Results



### Formative Study Results



<sup>5</sup> In the formative stage, the SOS presentations varied from about 25 minutes to about 45 minutes (different presenters). In the summative evaluation stage, the same presenter was used to standardize the format, but the program was about 60 minutes.

## D. Value of the creative activity

The creative activity proved to be a very powerful vehicle for helping students develop the ability to create connections and to feel personally connected to them.

Assessments of different aspects of the chains of connections observed in students' mobiles, showed that students mostly demonstrated connections that included earth systems in their creative work. They presented connections that were accurate, and mostly personal, suggesting that they, for the most part had acquired an understanding of earth systems interconnections consistent with the goals of the '6 Degrees of Connection' program.

The creative activity was appealing to students in many ways. They embraced the challenge to connect personally with Earth systems and make their own connections, using a library of clip-art and other creative materials. Students appreciated the brainstorm sheet, indicating that it helped them organize their thoughts about logical chains of connections.

Criticisms concerned mostly unclear explanations or instructions, the limited selection of clip art, and the quantity of time to complete the project.

## D. Value of Creative Activity

### D.1. Ratings of various aspects of the creative activity

OVERVIEW: The way the creative activity was structured was found to be helpful by students. For example, they overwhelmingly thought that the brainstorming sheet was helpful in creating their chains of connections that later became a mobile (see two examples in the next two pages). They also thought the materials provided were 'just right'. Three quarters of the students enjoyed the activity at least somewhat.

#### *How interesting was the activity?*

very interesting	34%
neutral	56%
not interesting	10%

#### *How much did you enjoy doing the activity?*

a lot	28%
somewhat	45%
neutral	21%
not at all	6%

#### *Were the materials provided . . .*

not enough	10%
just about right	82%
too much	8%

#### *Was the brainstorming sheet helpful?*

yes	83%
no	17%

#### *Were the instructions clear?*

yes	82%
no	18%



**Brainstorming sheet: Example 1**

### Your Connections –

**A Creative Project for the 6 Degrees of Connection Program**

10/27

We hope you enjoyed the presentation on interconnectedness and that it got you thinking about ways you are connected to the rest of the world. Here we will spend about 45 minutes to reflect on what we learned and show your own personal connections through a creative exercise.

- Overview:** Use the six circles of various sizes on cardstock paper to design, color, and collage your different topics/events that are connected to each other and ultimately connect to you. After you have created your circles you will use a shoelace to string the circles together to show how they are connected. Bottom right is an example of what a completed Chain of Connection looks like.
- Brainstorm:** To get started, brainstorm your ideas for each circle on this page. Think about things you see, use, and do every day and trace how they are connected to other places, Earth systems, and things. It could be tracing where your breakfast came from, or the effects of a storm and flooding on your home. Think of all the ideas that were presented in the program you just saw. You don't have to use all six circles but try to use as many as you can. Don't forget to draw connections between the circles.
- Design:** Use the colored pencils, markers, glue, and sheets of images to illustrate each topic/event in your chain of connections on the precut circles. Make sure you write what the topic/idea/event is around the edge of the circle. You can also put "What You Can Do" action items on your circles. Be creative! Use images and words.
- Connect:** Use a shoelace to connect all your circles (the shoelace should be knotted and threaded through the center of the circle). Make sure a knot is on the underside of each circle. If there are multiple connections from one circle you can use another shoelace or cut yours in half – sometimes the chain becomes a web.
- Share:** Discuss your connections with your classmates and see what they came up with.

Brainstorm here!

2

TOPIC:

Reduced amount of food need to be bought.

4

TOPIC:

~~More to~~  
more clear air produced throughout.

6

TOPIC:

Healthy ~~people~~ <sup>people</sup> in ~~best~~ good condition.

1

TOPIC:

Family: Grew a garden including tomatoes, and carrots.

3

TOPIC:

No land would need to be cleared for farming.

5

TOPIC:

Healthy environment

**6 DEGREES OF CONNECTION:**  
Understanding the Interconnectedness of Earth Systems

**Brainstorming sheet: Example 2**

**3/26**  
**Your Connections –**  
 A Creative Project for the 6 Degrees of Connection Program

We hope you enjoyed the presentation on interconnectedness and that it got you thinking about ways you are connected to the rest of the world. Here we will spend about 45 minutes to reflect on what we learned and show your own personal connections through a creative exercise.

**1. Overview:** Use the six circles of various sizes on cardstock paper to design, color, and collage your different topics/events that are connected to each other and ultimately connect to you. After you have created your circles you will use a shoelace to string the circles together to show how they are connected. Bottom right is an example of what a completed Chain of Connection looks like.

**2. Brainstorm:** To get started, brainstorm your ideas for each circle on this page. Think about things you see, use, and do every day and trace how they are connected to other places, Earth systems, and things. It could be tracing where your breakfast came from, or the effects of a storm and flooding on your home. Think of all the ideas that were presented in the program you just saw. You don't have to use all six circles but try to use as many as you can. Don't forget to draw connections between the circles.

**3. Design:** Use the colored pencils, markers, glue, and sheets of images to illustrate each topic/event in your chain of connections on the precut circles. Make sure you write what the topic/idea/event is around the edge of the circle. You can also put "What You Can Do" action items on your circles. Be creative! Use images and words.

**4. Connect:** Use a shoelace to connect all your circles (the shoelace should be knotted and threaded through the center of the circle). Make sure a knot is on the underside of each circle. If there are multiple connections from one circle you can use another shoelace or cut yours in half – sometimes the chain becomes a web.

**5. Share:** Discuss your connections with your classmates and see what they came up with.

**Brainstorm here!**

TOPIC:  
 -ate a ham (from a pig) for breakfast  
 -came from a plastic wrapper

TOPIC:  
 -I threw away the plastic wrapper in a garbage can

TOPIC:  
 -garbage was picked up from garbage and transported to a dump

TOPIC:  
 -rain washes garbage into rivers and lakes

TOPIC:  
 -rivers and lakes go to ocean and dispense garbage into ocean

TOPIC:  
 -fish and other aquatic life eat the garbage

precut circle  
 knot

**Clarity of instructions**

Although 82% of the students indicated that the instructions were clear, some didn't think so, and their explanations might offer some hints for implementing the program in the future<sup>6</sup>.

(if instructions not clear) **What was unclear?**

Themes: confused about what to do, the order, how to string them together

*When they were talking about the Earth's surface*

*I was confused*

*They were talking about stuff I don't know*

*The work I didn't understand*

*I didn't hear any instructions*

*Brainstorming*

*What we had to write down*

*I don't like the idea part*

*The directions*

*Everything; I got stressed; overwhelmed*

*They were fast but I eventually got it*

*How each step related to each other*

*Confusing*

*What we had to do*

*How to loop the cards together*

*They just needed to be explained a little more*

*The explanation*

*I wasn't sure what to do*

*The knots*

*They didn't say what to do on each one*

*The exact instructions*

*The knots*

*I just didn't quite understand what we were doing*

*The order they go in*

*I was confused*

*I didn't know which circle goes first*

*The order, and where everything (info) needed to be*

*How to string and the amount of time we had felt like we were being rushed.*

---

<sup>6</sup> Some of the confusion was likely due to the incorrect instructions that a teacher gave students following the presentation by the workshop facilitator.

## D.2. Most-liked and least-liked about the creative activity

**OVERVIEW:** Many aspects of the creative activity were appealing to students. Coloring and using clip-art topped the list, but several students also mentioned learning about connections and creating their own chain of connections. Criticisms concerned mostly unclear explanations or instructions, the limited selection of clip art, and the quantity of time to complete the project.

### ***What did you like about the program<sup>7</sup>?***

20%	coloring, the clip-art
17%	the creative activity, the craft project
12%	hands-on, interactive
12%	learning about connections, helped me understand
10%	creating our own chain of connections
8%	interesting, fun, entertaining
5%	learning about my personal connections
4%	working with friends, brainstorming
4%	simple, well-organized
7%	other (globe, lunch, getting out of school, clothing tags, etc.)
7%	nothing



### Sample of answers:

*When we did the paper and put it on the string  
I liked that we got to make our own chains of connections*

*The fun activities*

*The coloring and putting things we want on the papers*

*How we know what effecting the earth*

*The 3d project*

*It was fun and entertaining*

*I like about it that you can have fun*

---

<sup>7</sup> On the post-creative short form which students responded to immediately after doing the creative activity, this question was supposed to be talking about JUST the creative activity, but many students misunderstood, and cited the creative activity as what they liked best about “the program” or mentioned the globe, and other things about the overall visit)

*The art*  
*I got to talk*  
*I showed how events cause another*  
*Got to do something interactive*  
*That I could create a chain that relates to me*  
*That it was interactive and we were able to make something*  
*The pretty colors*  
*It put connections into my perspective*  
*It gave us time to be creative*  
*The craft*  
*It was hands-on*  
*I liked creating our own chain*  
*That we got to do an activity to help understand*  
*I liked coloring the picture*  
*The brainstorming*  
*Nothing besides the coloring and being with friends*  
*The artistic part*  
*That everything was very thought out and organized*  
*I liked that it was interactive*  
*I like that we were able to create our own steps*  
*It was a fun little project to do and it helped me understand how things are affected in the environment*  
*How I learned more in depth what the causes and effects of pollution are*  
*The hands on activity*  
*We got to work in groups*  
*Coloring*  
*I liked having time to collaborate and attempt to understand the topics more*  
*The crafting part*  
*We were able to make something and apply what we learned*  
*That I can talk to my friends*  
*How organized it was and that many materials were provided*  
*It made you think about how you are hurting the environment*  
*Choosing what chain we wanted to make*  
*That we could color the pictures*  
*How organized it is and the simplicity of it*  
*I like the construction part (putting everything together)*  
*The hands on learning*  
*The crafts we got to do to understand the concept they were teaching*  
*Making my own pictures on the circles*  
*The coloring and figuring out what affected what*  
*The hands on of making your own pic*  
*It was easy*  
*It was very creative and made you think*  
*It was fun knowing the process of things I do*  
*The idea of it*

***Is there anything you would change?***

Themes: need more time<sup>8</sup>, more clip-art options, better explanations

*To not make it so long*  
*Yes more movement more activity*  
*Different cut out sheet*  
*A tad shorter during some parts*  
*More instructions*  
*The time limit*  
*More simple way to do it*  
*Have the pictures already have color*  
*I would add more circles*  
*Maybe more useful pictures*  
*A better activity*  
*Have more picture options*  
*Make the clipart easier to cut out*  
*Clearer explanations*  
*Make the directions clearer*  
*The activity which took too long*  
*I would change the time limit*  
*Different cut out examples*  
*Yes, I would like more time for the activity*  
*The amount of people*  
*More time for activity*  
*The instructor*  
*More time*  
*I would change the setup*  
*Maybe my coloring skills*  
*Yes the shoestring is bad*  
*Better directions*  
*Less clipart, more space*  
*Add more clipart so I could color more*  
*More materials*  
*More clipart choices*  
*More time; add pencils*  
*More time*  
*More hands on activities*

---

<sup>8</sup> In some classes, the creative activity was rushed due to late arrivals, which reduced the time to complete the activity.

### D.3. Helping students to understand the idea of connections

OVERVIEW: Although middle school students had little interest in learning about connections, two thirds of the students reported that the creative activity helped them understand chains of connections. Two thirds also said that it helped them feel like 'I am connected to earth systems' at least to some extent.

***Did this activity help you understand chains of connections?*** [asked ONSITE]

yes	<b>62%</b>
neutral	30%
no	8%

***Did using the model – with drawing tools and images – help you better understand how systems are connected?*** [asked LATER, back at school]

yes	32%
not sure	58%
no	10%

***It helped me feel like I am connected to earth systems*** [asked LATER, back at school]

a lot	26%
to some extent	40%
not so much	34%

## D.4. Assessments of students' creative work

OVERVIEW: The team of scientists and educators at the Nurture Nature Center assessed different aspects of the chains of connections observed in students' mobiles.

As shown in the data table below, middle school students mostly demonstrated connections that included a connection that was personal to them. They largely succeeded in constructing mobiles that included 3 links more<sup>9</sup>, and that included earth systems connections. These results suggest that students, for the most part, had acquired an understanding of earth systems interconnections consistent with the goals of the '6 Degrees of Connection' program. Grade 8 students were significantly superior to 6<sup>th</sup> graders in depicting earth systems connections and in producing mobiles with 3 or more correct links.

### Evaluation of creative projects

	Overall (n=178)	6 <sup>th</sup> grade (n=48)	8 <sup>th</sup> grade (n=130)
Connections are personal	76%	65%	79%
Mobile includes 3 or more correct links ** <sup>10</sup>	74%	52%	<b>84%</b>
Mobile depicts Earth systems connections **	67%	35%	<b>78%</b>
Connections include a topic from the SOS show	45%	35%	53%
Connections are copied	21%	28%	4%

<sup>9</sup> Students were encouraged to create mobiles with 4 circles or more, which translates to 3 links or more.

<sup>10</sup> The double asterisks (\*\*) in a table are used to indicate a statistically significant difference at the  $p < .05$  level of confidence between figures shown in two adjacent columns. The higher value in statistically significant pairings is bolded. Double plus signs (++) are used to indicate a difference that is significant at the less stringent level of  $p < .10$ , meaning that it is 'borderline' as a notable result, but may have some intuitive value if it is part of a larger pattern that keeps recurring.

## E. Students' perceptions of STEM careers

Students across the three phases of program development had a limited grasp of what constitutes a STEM career. They were significantly more likely to mention a career that qualified as a STEM career when asked to name a likely career for themselves than to express a high interest in 'working as a scientist, an engineer, or some other work that involves Science, Technology, Engineering, or Mathematics (STEM)'

When it came to their interest in specific STEM careers, students reported that they were more interested, following their participation in the program, in two of the four careers that were featured in the presentation: marine biologist and engineer.

This finding suggests that the inclusion of featured careers in the summative version of the program may have positively impacted students' STEM career interests, at least for specific career paths.

## E. Students' Perceptions of STEM Careers

### E.1. Overall interest in a STEM career

OVERVIEW: As was the case for students in the baseline and formative studies, students in the summative study had a limited grasp of what constitutes a STEM career. When asked to name the career that they would be interested in, 49% named a career that qualified as a STEM career. However, only 33% of students said they had a high interest in '*working as a scientist, an engineer, or some other work that involves Science, Technology, Engineering, or Mathematics (STEM)*'

***Give us an idea about the type of career you might want to pursue:***

[asked LATER, back in school]

26%	doctor, vet, nurse
24%	scientist, engineer, programmer
2%	other STEM-related: architect, accountant, statistician
49%	TOTAL STEM
16%	artist, performer, musician, designer, photographer
13%	other professions (lawyer, teacher, journalist)
10%	trades: police, firefighter, army, hair dresser
3%	athlete
7%	other: business owner, shop clerk, farmer
12%	blank, don't know

***How interested would you be in working as a scientist, an engineer, or some other work that involves Science, Technology, Engineering, or Mathematics (STEM)? [LATER]***

High interest	33%
Medium interest	50%
Low interest	17%

## E.2. How did the program influence interest in specific careers?

OVERVIEW: The appeal of STEM careers that involved Earth science issues increased for two of the four careers that were mentioned in the SOS presentation: marine biologist and engineer (the presentation spoke of engineers who work on the technical solutions to environmental issues --designing solar panels and wind turbines). A third career, NASA scientist maintained its appeal. Other featured STEM professionals were a NASA physicist and a marine debris professional (oceanographer), but the interest in these careers did not increase. Nevertheless, the fact that two that were mentioned increased in appeal for students suggests that the program did impact students' interest in Earth Systems-related STEM careers.

***Considering the interconnections around the planet as you saw in this program, does that make you more or less interested in the following examples of careers? [LATER]***

	<u>Change</u>	<u>More<sup>11</sup></u>	<u>Same</u>	<u>Less</u>
Engineer	+	<b>31%</b>	46%	23%
Nurse or Doctor	+	30%	52%	18%
Marine biologist	+	<b>30%</b>	50%	20%
Veterinarian	=	22%	56%	22%
NASA scientist	=	22%	54%	24%
NASA physicist	-	18%	50%	<b>32%</b>
Environmental scientist	-	17%	47%	36%
Research scientist	-	15%	49%	36%
University professor	-	13%	53%	34%
Weather forecaster	-	13%	49%	38%
Science teacher	-	12%	52%	36%
Environmental activist	-	12%	50%	38%
Marine debris professional	-	11%	50%	<b>39%</b>
Agricultural scientist	-	11%	48%	41%
Renewable energy specialist	-	8%	51%	41%
Science illustrator	-	6%	53%	40%
Science writer	-	5%	49%	46%

<sup>11</sup> Numbers in bold black font indicate a featured career whose appeal increased following the program (i.e. there are more students who said that the career was more interesting to them after viewing the program than students who said that they were less interested in it). Numbers in bold red font indicate careers that were featured in the program whose appeal decreased, based on students' self-reports (i.e. more students said that they were less interested in the career following the program than students who said that they were more interested). The nature of the change (whether positive, negative or even) is indicated with +, - and = symbols in the table.