Investigating the Impact of Curiosity Machine Classroom Implementation:

Year 2 Study Findings

Prepared by:

Victoria Bonebrake
Kelly Riedinger
Martin Storksdieck

Center for Research on Lifelong STEM Learning
Oregon State University
254 Gilbert Hall
Corvallis, OR 97331

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Executive Summary

This report describes key findings from the classroom implementation study of the Curiosity Machine (CM) design challenges during the Fall 2017 and Spring 2018 semesters at Barack Obama School of Leadership and STEM (BOS) and Michelle Obama School of Technology and Arts (MOS) in Illinois. The study was designed to address the following research questions: 1) Can approaches around engineering design challenges have a significant impact on students' STEM identities, possible selves, self-efficacy, interest in learning about STEM, and academic performance; and 2) Is there an impact from participation on parents/caregivers' understanding of their children's thinking about STEM?

We used a pre-post survey to understand any changes that resulted for students and caregivers as a result of participating in the CM challenges. We used a comparison group of students from the same schools who did not participate in the design challenges to estimate time effects on students that are unrelated to the CM design challenges. Survey data was complemented by classroom observations. In our analysis, we accounted for such variables as attendance, GPA, standardized test scores, and grades from school records provided by the district.

Key study findings include:

- There were no significant changes overall on most of the student outcome measures from pre- to post-, or from treatment to comparison as a result of the classroom implementation. Measures that did not change included STEM (learner) identity, Possible Selves, Interest in (STEM) Learning, or Beliefs about STEM.

- While there were no statistically significant changes overall on self-efficacy, we did find a statistically significant difference in the treatment group of students' constructive coping and resilience as compared to the comparison group. [Students' constructive coping and resilience served as proxies for self-efficacy].
- Scores for a scale that measured "purpose and relevance of science" stayed steady in the treatment group, but declined in the comparison group, a measurement effect that indicates that student's perspective on the value of science actually increased in the treatment group.
- Students' academic performance measures (e.g., GPA, test scores, grades, attendance) were primarily used as explanatory or background variables. And as expected, these measures did not change over time or were different between the treatment and comparison group.
- While we did not find statistically significant changes in the caregivers' perspective of their children's thinking about STEM from pre- to post on psychometric scales, we nonetheless saw positive results in caregivers' answers to open-ended questions about the program's impact on their children.

While the overall findings suggest that there were limited changes from the pre- to post-survey on the identified constructs of the study, especially when analyzed against the comparison group, we conclude that the study did not indicate a lack of program benefits. Prior research on many of the constructs (e.g., identity, self-efficacy, beliefs) indicate that they require ongoing and repeat engagement before an intervention has a measurable impact on these constructs and their measures on survey instruments used for this study. We also find that three measured constructs that stayed steady in the treatment group, but declined in the comparison group, indicate positive program impact on participating youth. We recommend, though, that program leads identify more proximate outcome measures that are sensitive to the student experience. We also recommend that approaches towards measuring student outcomes be used that are more specific to the individual student participents, using “asset-based” measures that allows participants to state what, if anything, changed as a result of participation. Asset-based measures require a more elaborate study design than was possible here, but it is highly recommended for programs in which simple pre-post measures can, misleadingly, show little effect.

Another notable finding of the study was the difference in satisfaction with the experience. Caregivers showed very high levels of satisfaction, and students who participated and completed the surveys in Family Science (afterschool) events expressed high levels of satisfaction. That was not true for students in the classroom experience who on surveys expressed modest levels of satisfaction with the experience. While the students in each of the groups are not necessarily the same, it does suggest that context matters: the students seemed to enjoy activities done in afterschool time (and hence in a less structured environment without expectations of student academic performance) more than the same or similar activities done within the context of classroom instruction.

Introduction

The Center for Research on Lifelong STEM Learning at Oregon State University collaborated with Iridescent Learning to conduct a study of the implementation of engineering design challenges in two Illinois Schools – Barack Obama School of Leadership and STEM (BOS) and Michelle Obama School of Technology and the Arts (MOS)[1] – using the Curiosity Machine program. The Curiosity Machine program is designed as an engineering design challenge to motivate students for STEM topics and ideas, create "possible selves" as STEM learners and STEM users (including seeing oneself in a STEM career), and increase or stabilize a sense of self-efficacy for STEM. This report describes key research findings that resulted from the implementation of engineering design challenges in two settings across the schools: in Family Science events[2] held in Fall of 2017, facilitated by the classroom teachers at both sites, with students in grades 4-8 and their families; and in the classroom during Spring 2018, also facilitated by teachers, with students in grades 4-8 at BOS and MOS.

Study Context

The intervention included the implementation of five Family Science after-school sessions and three in-class design challenges, estimated to be anywhere from 2-16 contact hours for students. Family Science consisted of a series of 5 evening events, while in-class sessions were designed to be covered in three separate classroom sessions. Key to the engineering design

[1] Although Curiosity Machine programming occurred in both BOS and MOS during Year 2, usable data from MOS were not received by the evaluation team. The results in this report only reflect the experiences of students at BOS unless otherwise stated.

[2] We collected pre-post surveys from the Fall 2017 implementation of the family events and pre-post surveys of the Spring 2018 classroom implementation. However, we received so few student post-surveys from the family events that our sample only included 6 participants, limiting our ability to draw any inferences.

challenge was that students were asked to make their designs explicit, then test and revise their designs as needed. Students were also supported by engineers who volunteered to mentor students during the design challenges.

Research Questions

The research study focused on measuring outcomes for students, especially related to so-called affective outcomes such as interest, identity and self-efficacy. We hypothesized that students' participation in hands-on engineering design challenges, building on challenges completed with their families as part of the fall Family Engineering program, would result in positive impacts on these affective outcomes for students but not necessarily influence their broader academic performance (grades, GPA). Additionally, program leads posited that participation would result in increased interest in future STEM engagement (e.g., STEM careers and degree programs), as well as higher-order cognitive skills such as persistence, creativity, and curiosity. Furthermore, participation in the program was meant to improve youth participants' perception of engineering design and help students practice one of the key tenets of design: model, test, revise. [Due to the nature of the study, the degree to which participation influenced basic understanding of design principles was not measured]. The following research questions guided the study:

1. Can approaches around engineering design challenges have a significant impact on students':
    a. STEM identities (e.g., how students think of themselves in science);
    b. "Possible selves" (see STEM as a component of their own career or future learning pathways, e.g., course taking in STEM areas);

c. Self-efficacy (e.g., beliefs in their abilities in STEM subject areas, self-perception of confidence in STEM);
d. Interest in learning about STEM;
e. Students' academic performance (e.g., grades, test scores in science, math, ELA) and overall engagement in school (e.g., changes in attendance)? [Note: this is meant as a control measure; we did not expect that participation in the program could impact these measures].

2. Is there an impact of participation on parents' understanding of their children's thinking about STEM?

Research Design and Data Collection

The study was based on a complementary, mixed methods design (Creswell, 2013): complementary data were collected using both quantitative and qualitative data collection strategies that occurred in parallel in order to provide a comprehensive understanding of the Curiosity Machine program. Quantitative data were used to test the research questions, while the qualitative data provided detailed and nuanced accounts of students' experiences in the program and helped in interpreting resulting program outcomes.

The implementation study described in this report used a pre-post design with a treatment and comparison group. Students in the treatment group were those who participated in Curiosity Machine design challenges in their classrooms and/or in Family Science events. Students in the comparison group belonged to parallel classes in the same schools that did not experience the treatment. Data collection efforts included:

- Pre- and post-surveys administered before and after the implementation of the design challenges;
- Attendance records from Fall Family Science events;

- Attendance records from Spring classroom implementation;
- Design Challenge participation from Spring classroom implementation;
- Classroom observations;
- Compiled district data (e.g., GPA, truancy rates, standardized test scores, grades).

Data Analysis

As a first step in our analysis process, we matched students' responses on the pre- and post-surveys and categorized them into groups based on their level of participation in the Curiosity Machine programming over the school year: comparison group, family science participation only, classroom implementation only, and participation in both family science and classroom implementation. After this initial step, our sample included a total of 105 students with the following breakdown:

- Family Science and Classroom (n=11);
- Family Science (n=6);
- Classroom (n=42);
- Comparison (n=46).

That means, a total of n=17 students participated in Family Science Events, and a total of n=53 students participated in classroom implementation of Curiosity Machine.

The study also included a group of 13 parent/caregivers who participated in Family Science events. Table 1 displays the various student groups that participated with each of the treatment levels identified.

Table 1: Student Study Participant Groups

Treatment Group: Family and Classroom (n=11)	a) Participation in Fall 2017 Family *Curiosity Machine Events* b) Participation in Spring 2018 Classroom *Curiosity Machine* programming
Treatment Group 2: Family Event Only (n=6)	a) Participation in Fall 2017 Family *Curiosity Machine Events* b) No participation in Spring 2018 Classroom *Curiosity Machine* programming
Treatment Group 3: Classroom Only (n=42)	a) No participation in Fall 2017 Family *Curiosity Machine Events* b) Participation in Spring 2018 Classroom *Curiosity Machine* programming
Comparison Group (n=46)	a) No participation in Fall 2017 Family *Curiosity Machine Events* b) No participation in Spring 2018 Classroom *Curiosity Machine* programming

The pre-post survey instrument was designed to address the following key constructs: learner identity, STEM learner identity, future engagement and career, constructive coping and resilience, cognitive engagement, purpose and relevance of science, and competence and self-efficacy. The survey was previously tested and validated in another study conducted by O'Connell et al. (2016).

Table 2. Classroom Student Survey Constructs and Sample Items

Construct	*Sample Items*
Learner Identity	• I am persistent • I am curious
STEM Learner Identity	• My friends think of me as someone who likes science related things • My teacher thinks of me as someone who likes science related things
Future Engagement / Career	• I could imagine studying science or engineering in college • I want to be a scientist or engineer when I'm older
Constructive Coping and Resilience	• If I don't understand something, I ask for help • If a problem is really difficult, I just work harder
Cognitive Engagement	• I wonder a lot about how things work • I like to talk about how things work with family and friends
Purpose and Relevance of Science	• Science and engineering help solve problems • I believe that engineering can help make the world a better place
Competence and Self-efficacy	• With enough effort, I could succeed in science and engineering • I am pretty good at math

All of the survey data was entered into Qualtrics, an online survey platform. The quantitative survey data were analyzed using tools in Microsoft Excel to generate descriptive statistics and the statistical software package SPSS to generate inferential statistics. SPSS was used to generate descriptive statistics of the participation and attendance data to understand dosage for students in the treatment group.

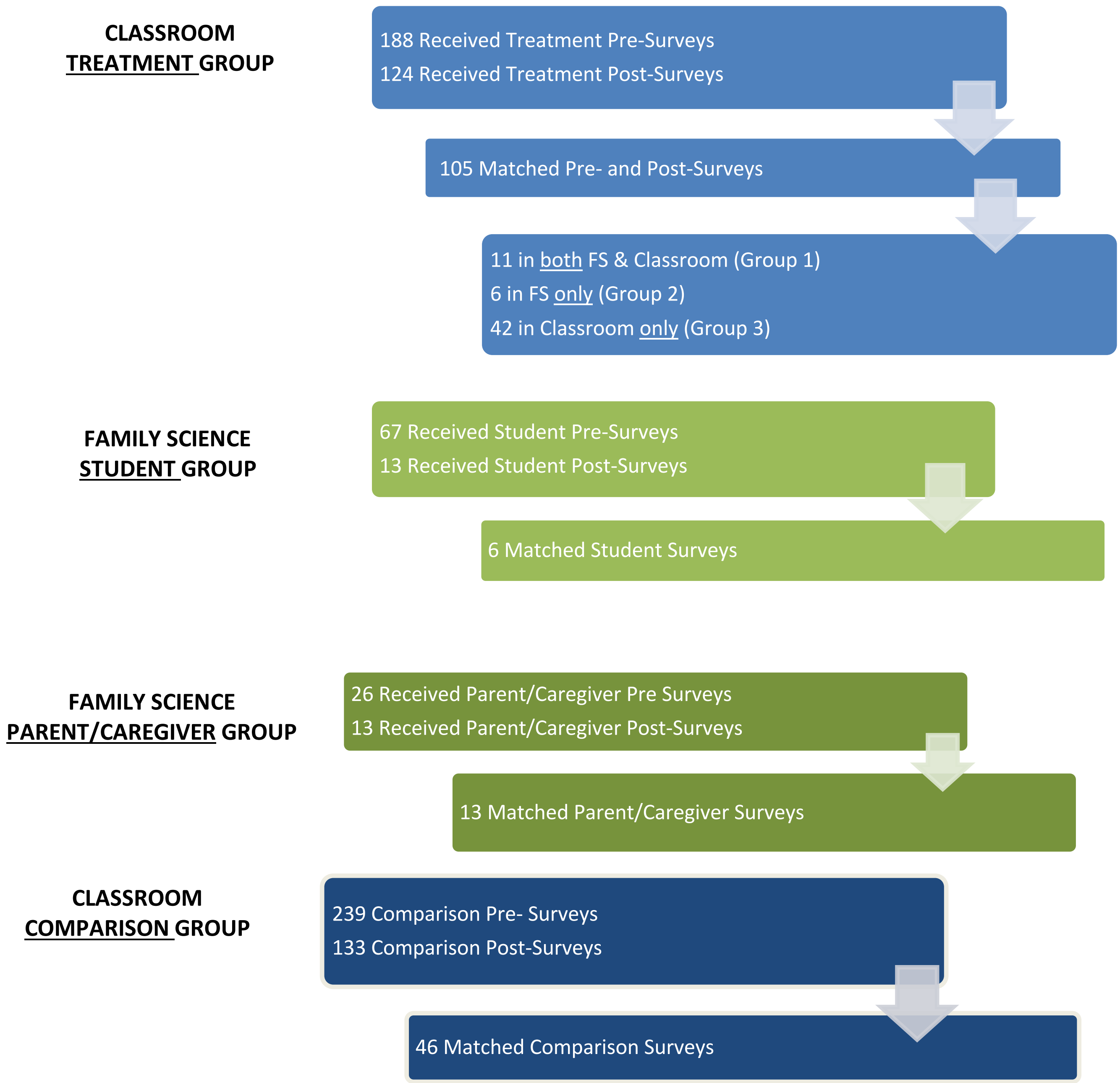
Study Implementation Challenges

Findings reported here are synthesized from the sample[3] of data from students at BOS: 59 matched pre- and post-treatment, 46 matched pre-and post-comparison, and 13 matched pre-and post- caregivers. Figure 1 shows how the data were sorted and matched, effectively limiting the sample sizes for each group prior to analysis. OSU and Curiosity Machine team met at the end of year 1 to identify strategies to promote the return of data from teachers at both schools in the study. For example, OSU worked directly with their IRB office to simplify the consent process to the extent possible, a member of the Curiosity Machine team went to schools to collect data in-person, and both teams created a document with step-by-step guidance for teachers to collect survey data. Teachers were given pre-addressed and pre-paid envelopes to mail completed surveys. Although these strategies were implemented, there were still substantial challenges in gathering a full set of matched pre-post data from the schools. In fact, the participating teacher from MOS was twice unable to mail surveys to the team. It is not clear whether the surveys were lost in the mail (twice), whether they were never mailed, or whether they were never completed. Unfortunately, this level of unforeseeable data loss prevented the research team from collecting larger numbers of student data, and prevented a comparison of school/teacher context.

A power analysis indicated that a sample size of over 20 for student data was acceptable for finding medium to large effects, and could offers initial evidence that the Curiosity Machine program resulted in some expected outcomes such as increased self-efficacy through constructive coping and resilience. However, the overall findings should be interpreted conservatively as they represent only a slice of students from one of the two available test sites[4].

[4] A power analysis suggests that an ideal sample size would be n=188, composed of a roughly equal sample from both BOS and MOS. We did collect data from an adequate sample at BOS and the data analyzed and interpreted

Figure 1. Narrowing of Sample Sizes Through Sorting and Matching



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here focuses on these students. However, given the limitations of the overall sample, conclusions drawn from the study should be interpreted with caution.

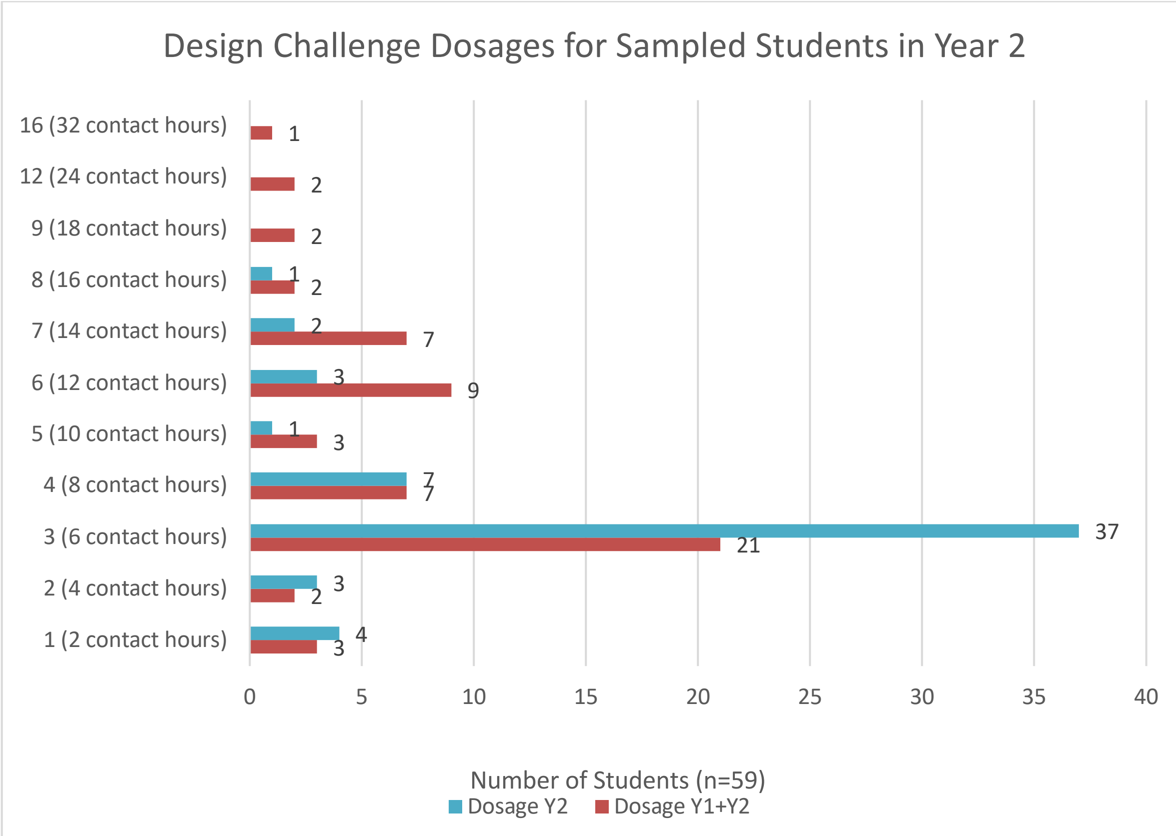
Key Findings

Design Challenge Dosage as a Key to Understanding Outcomes

The dosage data represents the total number of Design Challenges that students participated in across the Family Science nights (offered for 5 weeks total/10 total contact hours) and the Classroom Implementation (offered at 3 Design Challenges/6 contact hours). That is, a student could have participated in a maximum of altogether eight design challenges, representing 16 contact hours of programming during the study year. This number could double for students who participated in the full program during the previous year, However, as displayed in Figure 2, three (3) Design Challenges (6 contact hours) was the most common number completed among students in the treatment group, when accounting for treatment received across both years (n= 21). That is, most students in the program did about half or less of programming than was intended, severely limiting outcome levels that should be expected. We also reviewed attendance records from the first year of the study (academic year 2016-2017) and included this to understand overall dosage for students who participated in prior Curiosity Machine Design Challenges. Even when including the Year 2 attendance data, students, on average, participated in 3 design challenges (6 contact hours) across both years.

Due to issues with data collection described above, it was not possible to analyze data by levels of participation to reveal what full participation might have resulted in. The study, therefore, needs to be understood as impacts of the program under subpar implementation conditions.

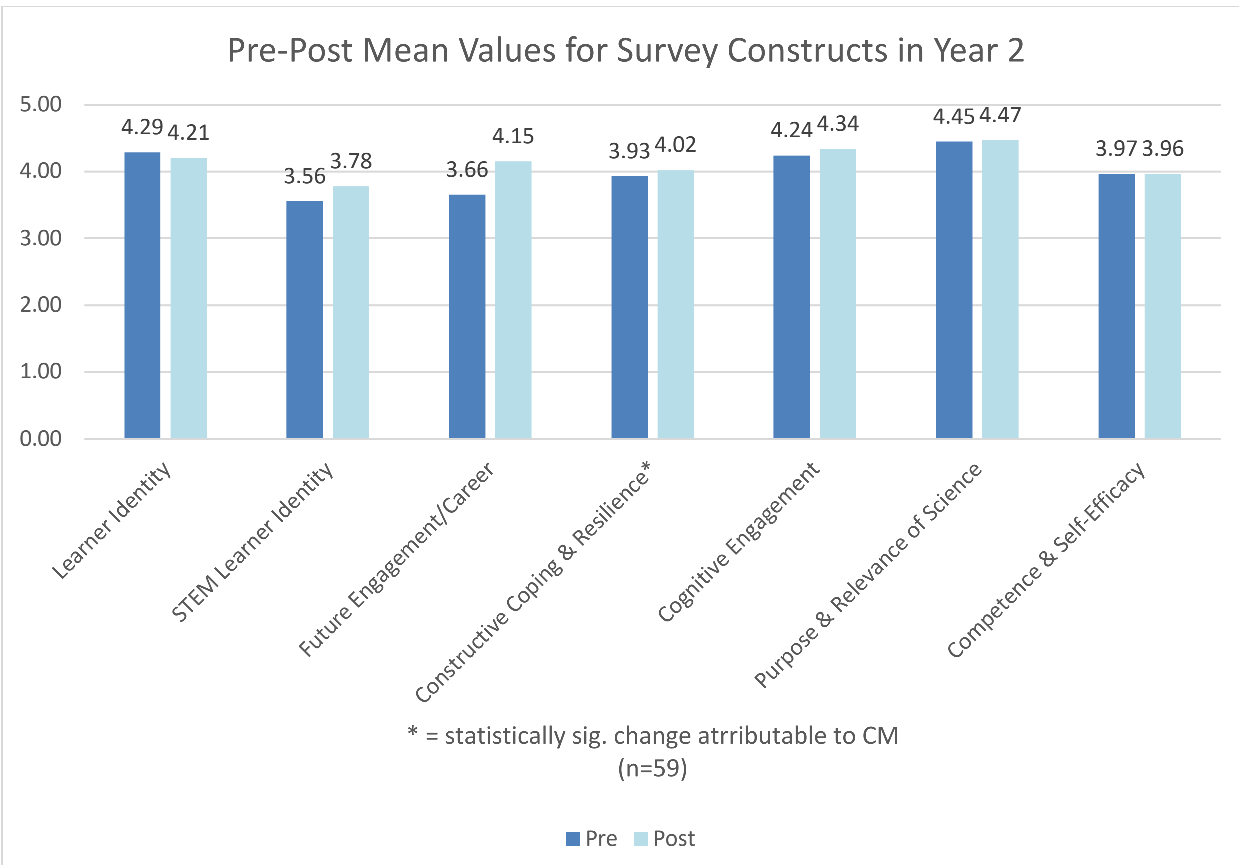
Figure 2. Design Challenge Dosage for Students in the Treatment Group



Overall Survey Findings

Figure 3 displays the mean values from the pre- and post-survey for each of the survey constructs and Table 3 shows the same data for treatment and comparison. As illustrated in the figure, there were some minor changes for some constructs such as *STEM learner identity, future engagement and career, and cognitive engagement*, but these differences were not found to be statistically significant when compared to differences in the comparison group. We did, however, find a significant difference between the comparison and treatment for *constructive coping and resilience* that can be attributed to Curiosity Machine. It is worth noting that the relatively "flat" outcomes for most constructs, while they are not ideal, are still acceptable. In fact, almost all constructs have major so-called "ceiling effects" in which students in the pre-survey were so positive that there was not much room to grow. All the constructs with pre-survey results of close to 4.0 or above will suffer from this effect. It predicts that chance will see the scores decline between pre and post. Staying steady, therefore, is an indication of positive outcomes.

Figure 3. Pre-Post Mean Construct Values, for Students in the Matched Treatment Sample



We further explore each construct and related findings from our analysis in the next section. Table 3 shows the mean scores pre and post for treatment and comparison and statistical significance of differences for each construct from pre to post and comparison to treatment for alpha <5%. Narrative descriptions continue below.

Table 3. Classroom Student Survey Constructs and Sample Scales (for BOS only)

	Treatment (n=59)		Comparison (n=46)	
	Pre	Post	Pre	Post
Learner Identity	4.29	4.21	4.11	4.03
STEM Learner Identity*	3.56*	3.78*	3.13	3.29
Future Engagement / Career	3.66*	4.15*	2.86	3.26
Constructive Coping & Resilience	3.93	4.02	3.96*	3.59*
Cognitive Engagement	4.24	4.34	4.12	4.16
Purpose & Relevance of Science	4.45	4.47	4.24	3.99
Competence & Self-Efficacy	3.97	3.96	3.64	3.54

* Indicates the results were statistically significant at $p < .05$

Table 3 shows the mean scores for seven constructs of a matched student sample for the Barack Obama School. The data indicate that scores for learner identity remained unchanged; STEM learner identity increased slightly in the treatment and the comparison group; future engagement and career orientation increased considerably in both groups; constructive coping and resilience stayed constant in the treatment group, but declined in the comparison group; cognitive engagement stayed about the same in both groups; purpose and relevance of science and competence and self-efficacy stayed constant in the treatment group, but declined in the comparison group.

Declines in scores are likely attributable to a measuring effect in which participants in the pre- survey overestimated their answers and subsequently correct them during the second iteration of the same questionnaire, a common effect. The comparison group exhibits this effect clearly on two variables (coping and resilience; purpose and relevance of science) and to a lesser degree with a third variable (competence and self-efficacy). In this reading of the data, just keeping scores steady pre to post should be interpreted as a positive effect, and increasing scores (even if slightly) could be interpreted as a relatively strong effect of the treatment, if the comparison group is not showing the same results. In those cases, changes were possibly influenced by outside factors not captured in the study itself. In that sense, we can conclude positive effects from the treatment for the following two variables: coping and resilience and purpose and relevance of science. In the following we will discuss the measures in more detail.

STEM Identities. Two constructs on the survey, learner identity and STEM learner identity, aimed at understanding how student's identities as learners and STEM learners might have been influenced by Curiosity Machine's design challenges. We found a statistically significant difference from pre- to post- in students' responses about their STEM learner identities, but since there was also an results in the comparison group, we cannot attribute this change to the children's experience with the program.

Possible Selves. One construct on the survey, future engagement and career, aligned with the research question about possible selves. There was a statistically significant difference from pre- to post-, but again, this change could not be attributed to the program since scores also increased for comparison group.

Self-Efficacy. Two measures were used to estimate student self-efficacy: "constructive coping and resilience" and "competence and self-efficacy". There were no statistically significant differences from pre- to post- on either construct. However, there was a statistically significant difference between the treatment and comparison group since the scores in the comparison group declined, suggesting participation in Curiosity Machine might have had a positive effect on students' constructive coping and resilience.

Interest in STEM. "Cognitive engagement" was used as a proxy measure for students' interest in STEM. Overall, there was no difference in scores pre- to post- or between treatment and comparison group for the construct.

Beliefs about STEM. There were no differences in pre- to post-survey results or between treatment and comparison group scores for students' understanding of purpose and relevance of STEM.

Academic Performance

We used compiled data from the district to examine any effects of participation in Curiosity Machine programming on students' academic performance specifically related to: school attendance, GPA, and standardized test scores. This data was primarily as independent or explanatory variables for exploring the effect of Curiosity Machine upon students. We assumed that there would be no positive impact reflected in these scores, but we also hoped to find no negative impact.

Table 4. Pre-Post Academic Performance Data

		Pre	Post
GPA	Treatment (n=58)*	2.61	3.21
	Comparison (n=220)*	1.75	2.70
Attendance (# of absences)	Treatment (n=58)*	5.2 days	7.4 days
	Comparison (n=220)*	6.2 days	11 days
Math Test Scores	Treatment (n=114)	732	728
	Comparison (n=133)	715	719
ELA Test Scores	Treatment (n=114)	741	741
	Comparison (n=272)	729	729

* Indicates the results were statistically significant at $p < .05$

Table 4 displays mean values for the treatment and comparison groups on each of the academic performance indicators. We found that there were some statistically significant changes from the beginning to end of the school year for students in the treatment and comparison groups (e.g., increase GPA, but also decrease in attendance). However, when we compared treatment group changes to those in the comparison group, we did not find any statistically significant differences between treatment and comparison group in the way that change occurred; that is, change was similar in both groups. This indicates that Curiosity Machine did no harm to students in regard to these constructs, while also indicating that the changes in academic performance were not likely a result of the Curiosity Machine program.

Classroom Outcomes

Student Satisfaction & Impressions: Students who participated in the classroom design challenges (Treatment Groups 1 and 3) gave the Curiosity Machine program a net promoter score of -25 on a scale of -100 to 100, indicating a lack of interest in promoting or participating further in the program. This is because a substantial number of students (19%) rated their overall satisfaction a 7 or 8 on the 10-point scale, indicating that they felt passive about their experience; while 53% indicated a lack of interest in future participation through CuriosityMachine.org. Students did not provide further explanations for their ratings. Table 6 shows the average responses given to the classroom student questions about satisfaction.

Table 6. Average Classroom Student Satisfaction Ratings

On a scale of 1 to 10, please rate…	*Average Score (n=53)*
… your overall satisfaction with the Curiosity Machine Design Challenges?	7.0
… how likely is it that you will complete additional design challenges on CuriosityMachine.org?	5.9
… how likely are you to recommend the program to a friend?	7.2

Despite this finding, and although their construct changes were most often insignificant as compared to the comparison group, students did indicate that they learned as a result of engaging in the design challenges in their classrooms and were able to identify specific ways in which they felt they benefitted from the experience. In open-ended questions about their experience, classroom students were prompted to write about the most important thing they learned and the way(s) in which they have benefited from Curiosity Machine programming in their class. Their responses were as follows:

What do you think is the most important thing you learned as a result of participating in the Curiosity Machine Design Challenges in your class?

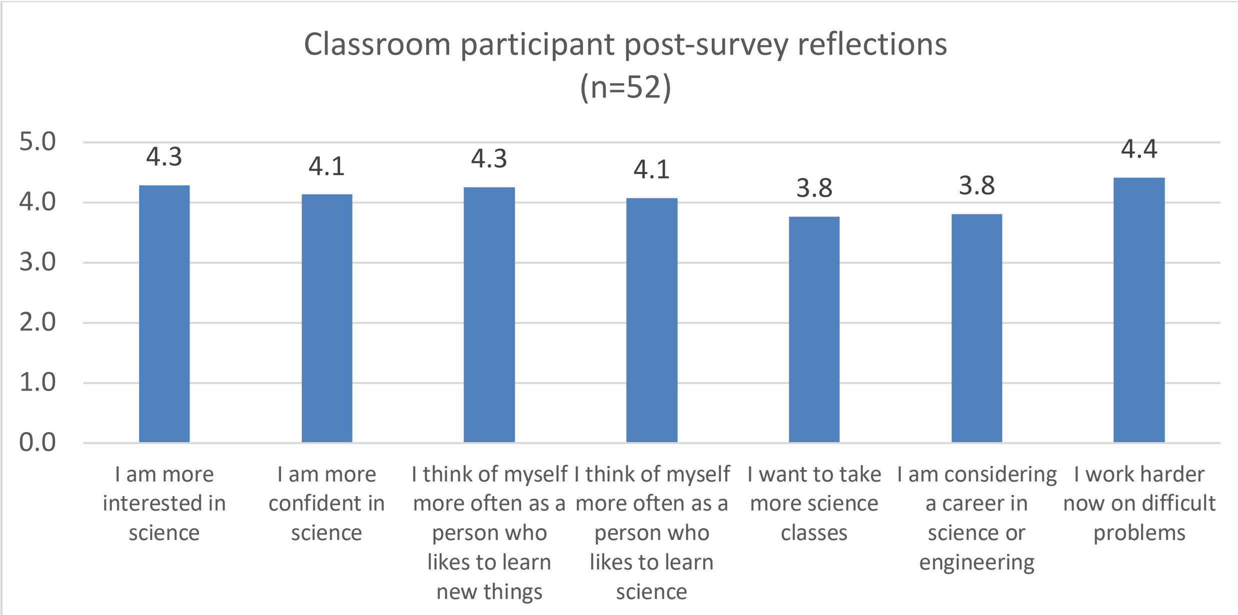
- Acquiring science knowledge: "*The most important thing I learned is when we learned about lightning."*
- Learning to cope/be resilient: *"I think the most important thing I learned is not to give up."*
- Acquiring Science/Engineering skills: *"I learned how to build things that are in the world with little materials, not strong materials and they persevere."*
- Developing identity as a learner: *"I think the most important thing I learned in the curiosity machine event is I should ask more questions and explore more."*
- Building & Design: *"I learned how to make a crossbow"*
- Teamwork: *"The most important thing I learned in the design challenge is to work with your teammates and try to tackle down big challenges."*

In what way(s) do you think you benefited from participating in the Curiosity Machine Design Challenges in your class?

- Acquiring science knowledge: *"I think it is awesome to learn how life works, and how projects work."*
- Building and design: "*I learned a lot more like how to make a water filter"*
- Learning about teamwork: *"What I got good at out of working with team mates is to see how I can use what they can do to make something great."*
- Learning to cope/be resilient: *"I think the design challenges benefitted me to work harder and to focus on new things that are different from others."*
- Developing learner identity: *"I changed the way I think of things since those challenges"*
- Participating in the science/engineering process: *"I learn more things about how things work and I make things better when I do them."*
- Future Engagement and Career: *"If I grow up and want to be an engineer it will benefit me in all different ways.*
- Realizing the purpose and relevance of science: *"I think I benefited from participating in the curiosity machine design challenges because we can probably help people in the real world."*
- Enjoyment: *"I think I had more fun and learned more about it."*

In the classroom post-survey, students (from Treatment Groups 1 and 3) were asked to reflect upon their dispositions after participating in the classroom design challenges. Figure 4 shows the average ratings given by students. Students gave generally high ratings on the scale (1 being totally disagree and 5 being totally agree), suggesting that classroom participants overall perceived some positive change in their dispositions toward science and engineering.

Figure 4. Classroom student post-survey reflections



Family Science Student Outcomes

Student Satisfaction and Impressions. While the post-survey sample for Family Science students was very small (n=13), the response about their experience from these students was warm; their positive experiences were reflected in both their survey rankings and their narrative answers. Students who participated in the family events (Treatment Groups 1[5] and 2) gave the Curiosity Machine program a net promoter score of 54 on a scale of -100 to 100, indicating overall satisfaction and moderate interest in promotion or father participation. Table 7 shows the average responses given to the classroom student questions about satisfaction.

[5] Students in Treatment Group 1, those who participated in both Family Science and classroom design challenges, provided two sets of pre- and post-surveys: one set of surveys taken in each setting. The responses reported in this section reflect those from Treatment Group 1's Family Science post- surveys.

Table 7. Average Family Science Student Satisfaction Ratings

On a scale of 1 to 10, please rate…	*Average Score (n=13)*
… your overall satisfaction with the Curiosity Machine Design Challenges?	9.4
… how likely is it that you will complete additional design challenges on CuriosityMachine.org?	7.6
… how likely are you to recommend the program to a friend?	9.3

In open-ended questions about their experience, students were prompted to write about the most important thing they learned and the way(s) in which they have benefited from Curiosity Machine Family Science events. Their responses follow and generally reflect similar themes to responses from students who only completed the classroom design challenges.

What do you think is the most important thing you learned as a result of participating in the Curiosity Machine Family Science program?

- Teamwork: *"Working together is important. Teamwork is very important for these challenges."*
- Building and Design: *"How to build machines."*
- Science Knowledge: *"The more force you put on a project the farther it goes."*
- Purpose and Relevance of Science: *"What I think is more important is problem solving things that include things that will help us in life."*
- Questioning/Thinking Skills: *"I learned how to think outside the box."*
- Learning to cope/be resilient: *"The most important thing I learned participating in Curiosity Machine was even if you fail a Curiosity project you should never give up and always keep trying no matter what."*

In what way(s) do you think you benefited from participating in the Curiosity Machine Family Events?

- Enjoyment: "*I think the benefits are learning new things and having fun, fun, fun, fun."*
- Acquiring Science Knowledge: "*I also have benefitted by learning new and exciting ways to complete Curiosity Projects."*
- Socializing/Family Time: *"We got to spend more time with people in the family and got to have fun."*

- Teamwork: *"I like to work with partners more."*
- Learning to cope/be resilient: "*I have benefitted by learning to never give up during projects no matter what."*
- Exploration/Creativity: "*It helped me learn more creative things and more science."*
- Building and Design: *"I will learn how to make a robot."*
- Future Engagement and Career: *"I am learning for my future."*
- Realizing the purpose and relevance of Science: *"It helped me see other things that happen in real life and different problems that occurred."*

In the Family Science post-survey, students (from Treatment Groups 1 and 2) and caregivers were asked to reflect upon students' dispositions after participating in the Family Science events. Table 6[6] shows the average ratings given by students and their caregivers. Both students and caregivers gave the program high ratings on the scale (1 being totally disagree and 5 being totally agree), suggesting that both students and caregivers perceived a positive impact upon students' dispositions towards science and engineering.

[6] These findings are based on a sample of 13 student and parent participants who completed the post-survey and should be interpreted with this limitation in mind.

Table 8. Family Science Student Reflections

Average **Caregiver** Score (n=13)	**After participating in the Curiosity Machine Family Science design challenges…** *Scale of 1 (totally disagree) to 5 (totally agree)*	Average **Student** Score (n=13)
4.3	I am (my child is) more interested in science	4.8
4.5	I am (my child is) more confident in science	4.7
4.6	I think (my child thinks) of myself (their self) more often as a person who likes to learn new things	4.7
4.5	I think of myself (my child thinks of their self) more often as a person who likes to learn science	4.7
4.6	I want to (my child wants to) take more science classes	4.8
4.6	I am (my child is) considering a career in science or engineering	4.9
4.3	I work harder now (my child works harder now) on difficult problems	4.7

Family Science Caregiver Outcomes

Pre- and post-surveys given to students' caregivers aimed to answer one research question: Is there an impact of participation on parents' understanding of their children's thinking about STEM? Of the 13 caregivers who provided post-survey responses, individuals gave particularly warm responses about their and their child's experience with Curiosity Machine's Family Science program. Their enthusiastic support for the program was reflected in both their survey rankings and their narrative responses.

Caregiver Satisfaction. Caregivers who participated in the Family Science events gave the Curiosity Machine program a net promoter score of 92 on a scale of -100 to 100, indicating a high level of satisfaction and a strong interest in participating again. Table 9 shows the average rating caregivers gave to questions about their satisfaction and interest in participating further.

Table 9. Average Family Science Caregiver Satisfaction Ratings

On a scale of 1 to 10, please rate…	*Average Score (n=13)*
… your overall satisfaction with the Curiosity Machine Design Challenges?	9.7
… how likely is it that you will complete additional design challenges on CuriosityMachine.org?	8.6
… how likely are you to recommend the program to a friend?	9.7

Caregiver's Perceptions of Student Benefits. In open-ended questions about their experience, caregivers were prompted to write about the way(s) in which their child benefited from Curiosity Machine Family Science events. Their responses were as follows.

In what way(s) do you think your child benefited from participating in the Curiosity Machine Design Family Science program?

- Learner Identity: *"My children benefitted from the Curiosity Machine family events by sharpening their creative thinking. They were challenged to work quickly, to use their own resources and to solve their own problems."*
- Social Skills: *"I think he benefitted by working as a team + seeing the many ideas & solutions to a problem."*
- Cognitive Engagement: *"She was eager to learn, seeing how to create things was very intriguing to her."*
- Engagement for Future/Career: *"These events will help him in the future as he explores the endless opportunities available to him in the world of science."*
- Confidence: *"He feels more confident working on challenges and getting results."*
- Building and Design: *"They liked figuring out how to make the projects."*
- Hands on Learning: *"Getting practically involves inspires him a lot."*

Table 10 shows the constructs and sample questions from pre- and post-surveys. Among the 13 available matched pre- and post-surveys collected from BOS, we found that the program created no changes in the caregivers' perspective of their children on the underlying scales, even as answers to open-ended questions provided positive results.

Table 10. Family Science Caregiver Survey and Sample Items

Construct	*Sample Items*
Identity	• My child likes to figure things out • My child has lots of new ideas
Future Engagement / Career	• I could imagine my child studying science or engineering in college • I could imagine my child wanting to be a scientist or engineer
Constructive Coping and Resilience	• When my child doesn't understand something s/he asks for help • If a problem is really difficult, my child just works harder
Cognitive Engagement	• My child wonders a lot about how things work • My child likes to talk about how things work with family and friends
Supporting Child's Learning	• I often help my child with their school work • I am confident in my ability to support my child's learning in • science and engineering at home
Competence and Self-efficacy	• My child is pretty good at math • With enough effort, my child could succeed in science/engineering

Benefits of Participation for Caregivers. Caregivers were also prompted to write about the way(s) in which they had personally benefited from Curiosity Machine Family Science events. Their responses were as follows:

In what way(s) do you think you personally benefited from participating in the Curiosity Machine Family Science program?

- Connecting with child: *"More time with my son doing something together."*
- Teaching/learning with child: *"We can work out challenges together bridging the gap in learning between the generations."*
- Personal learning: *"It gave me a chance to open my mind. I didn't know I could think of things in the way that I do when it comes to Engineering."*

- Supporting child's learning: *"I was able to show my child that I support his interest and willing to succeed or fail with him and make it a positive experience."*
- Witnessing child's learning: *"We got the opportunity to see how his mind worked when designing and redesigning. It also allowed us to see challenges in his learning."*
- Informing child's vision of future selves: *"It helped me to encourage him to think of a future in engineering."*

In the Family Science post-survey, caregivers were asked to reflect upon their confidence in supporting their child's learning and in understanding how their child thinks of science after participating in the Family Events. Table 11 shows the average ratings given by the caregivers. Caregivers gave high ratings on the scale (1 being totally disagree and 5 being totally agree) for both questions, suggesting that the caregivers sampled perceived a positive impact in their personal confidence and understanding of their child's thinking as a result of their participation.

Table 11. Family Science Caregiver Reflections

After participating in the Curiosity Machine Family Science design challenges… Scale of 1 (totally disagree) to 5 (totally agree)	*Average Score (n=13)*
… I feel more confident in supporting my child's learning of science and engineering at home	4.3
… I understand more about how my child thinks about science and engineering	4.5

Study Conclusions

The study was designed to understand the impact of Curiosity Machine engineering design challenges on students and their parents/caregivers. The study sought to understand how design challenges implemented in the classroom may impact students' STEM identities, possible selves, self-efficacy, interest in STEM learning, and academic performance. Overall, we found limited evidence of changes from pre- to post-surveys on these constructs after implementation; however, students' narrative responses showed some evidence of self-perceived changes, as did a careful interpretation of relative change scores between treatment and comparison groups on two of the measured constructs: coping and resilience, and purpose and relevance of science.

In our exploration of the effect of Family Science programming, we found limited evidence of impact upon caregivers' perspective of their children's thinking about STEM on close-ended survey items. And yet, in their narrative responses both caregivers and students who participated in Family Science events described perceived benefits for both their personal growth and their child's growth, while expressing enthusiastic support for the out-of-school program.

Fall 2017 Family Events Pre-Survey

What is your full name (first and last)? ________________________________

For each of the following questions, answer by placing an "x" in the box you agree the most with.

Example: "1" is "totally disagree" and "5" is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I understand how to answer these questions.	☐	☐	☐	☐	☒

Please ask if you have any questions.

How would you describe yourself? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am persistent	☐	☐	☐	☐	☐
I am curious	☐	☐	☐	☐	☐
I am creative	☐	☐	☐	☐	☐

Please Continue on the Next Page

To what extent do you agree or disagree with the following statements? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I have lots of new ideas	☐	☐	☐	☐	☐
I like to come up with different solutions to one problem	☐	☐	☐	☐	☐
If I don't understand something, I ask for help	☐	☐	☐	☐	☐
If a problem is really difficult, I work harder	☐	☐	☐	☐	☐
I am not afraid of failure	☐	☐	☐	☐	☐
I don't give up easily	☐	☐	☐	☐	☐
I enjoy solving problems	☐	☐	☐	☐	☐
I like figuring things out	☐	☐	☐	☐	☐
I'm pretty good at tackling challenges	☐	☐	☐	☐	☐
I wonder a lot about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
Science is fun	☐	☐	☐	☐	☐
I enjoy doing science in school	☐	☐	☐	☐	☐
Science and engineering helps solve problems	☐	☐	☐	☐	☐
I believe that science and engineering can help make the world better	☐	☐	☐	☐	☐

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
My teachers think of me as someone who likes science	☐	☐	☐	☐	☐
My family thinks of me as someone who likes science	☐	☐	☐	☐	☐
My friends think of me as someone who likes science	☐	☐	☐	☐	☐
I like to watch shows or documentaries about nature or science	☐	☐	☐	☐	☐
I like to read books or magazines about nature or science	☐	☐	☐	☐	☐
I like to go to science museums, zoos, or aquariums	☐	☐	☐	☐	☐
I like to talk about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am good at math	☐	☐	☐	☐	☐
I am good at science	☐	☐	☐	☐	☐
I want to take more science classes	☐	☐	☐	☐	☐
I could imagine studying science or engineering in college	☐	☐	☐	☐	☐
I want to be a scientist or engineer when I am older	☐	☐	☐	☐	☐

Thank you!

Fall 2017 Family Events Post-Survey

What is your full name (first and last)? ____

For each of the following questions, answer by placing an "x" in the box for your rating.

On a scale from 1 to 10, please rate your overall satisfaction with the *Curiosity Machine Family Events.*

Not at all satisfied ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 Very satisfied

On a scale from 1 to 10, how likely is it that you will complete additional design challenges on CuriosityMachine.org?

Not at all likely ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 Very likely

On a scale from 1 to 10, how likely are you to recommend the program to a friend(s)?

Not at all likely ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 Very likely

Please Continue on the Next Page

For each of the following questions, answer by placing an “x” in the box you agree the most with.

Example: “1” is “totally disagree” and “5” is “totally agree.”

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I understand how to answer these questions.	☐	☐	☐	☐	☒

Please ask if you have any questions.

How would you describe yourself? Please use a scale from 1 to 5 where 1 is “totally disagree” and 5 is “totally agree.”

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am persistent	☐	☐	☐	☐	☐
I am curious	☐	☐	☐	☐	☐
I am creative	☐	☐	☐	☐	☐

Please Continue on the Next Page

To what extent do you agree or disagree with the following statements? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I have lots of new ideas	☐	☐	☐	☐	☐
I like to come up with different solutions to one problem	☐	☐	☐	☐	☐
If I don't understand something, I ask for help	☐	☐	☐	☐	☐
If a problem is really difficult, I work harder	☐	☐	☐	☐	☐
I am not afraid of failure	☐	☐	☐	☐	☐
I don't give up easily	☐	☐	☐	☐	☐
I enjoy solving problems	☐	☐	☐	☐	☐
I like figuring things out	☐	☐	☐	☐	☐
I'm pretty good at tackling challenges	☐	☐	☐	☐	☐
I wonder a lot about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
Science is fun	☐	☐	☐	☐	☐
I enjoy doing science in school	☐	☐	☐	☐	☐
Science and engineering helps solve problems	☐	☐	☐	☐	☐
I believe that science and engineering can help make the world better	☐	☐	☐	☐	☐

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
My teachers think of me as someone who likes science	☐	☐	☐	☐	☐
My family thinks of me as someone who likes science	☐	☐	☐	☐	☐
My friends think of me as someone who likes science	☐	☐	☐	☐	☐
I like to watch shows or documentaries about nature or science	☐	☐	☐	☐	☐
I like to read books or magazines about nature or science	☐	☐	☐	☐	☐
I like to go to science museums, zoos, or aquariums	☐	☐	☐	☐	☐
I like to talk about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am good at math	☐	☐	☐	☐	☐
I am good at science	☐	☐	☐	☐	☐
I want to take more science classes	☐	☐	☐	☐	☐
I could imagine studying science or engineering in college	☐	☐	☐	☐	☐
I want to be a scientist or engineer when I am older	☐	☐	☐	☐	☐

After participating in the Curiosity Machine Family Events and Design Challenges…	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am more interested in science	☐	☐	☐	☐	☐
I am more confident in science	☐	☐	☐	☐	☐
I think of myself more often as a person who likes to learn new things	☐	☐	☐	☐	☐
I think of myself more often as a person who likes to learn science	☐	☐	☐	☐	☐
I want to take more science classes	☐	☐	☐	☐	☐
I am considering a career in science or engineering	☐	☐	☐	☐	☐
I work harder now on difficult problems	☐	☐	☐	☐	☐

Please Continue on the Next Page

What do you think is the most important thing you learned as a result of participating in the Curiosity Machine Family Events?

In what way(s) do you think you benefitted from participating in the Curiosity Machine Family Events?

Thank You!

Fall 2017 Family Events: Parent/Caregiver Pre-Survey

Part 1: Please fill in the questions with information about yourself

What is your name? ____

What is your child's name? ____

What is your ethnicity? (Please select all that apply)

☐ White or Caucasian
☐ Native Hawaiian or Pacific Islander
☐ Latino or Hispanic
☐ American Indian or Alaskan Native
☐ Black or African American
☐ Middle Eastern
☐ Asian
☐ Prefer not to answer
☐ Other (please specify): ______________

What is the primary language that you speak at home?

☐ English
☐ Spanish
☐ Prefer not to answer
☐ Other (please specify): ______________

Please continue to the next page

What is your relationship to the child participating in the Curiosity Machine program with you?

☐ Mother
☐ Father
☐ Grandmother
☐ Grandfather
☐ Other (please specify): ______________________
☐ Aunt
☐ Uncle
☐ Mentor

What is your age range?

☐ 18-24 years
☐ 25-34 years
☐ 35-44 years
☐ 45-54 years
☐ 55-64 years
☐ 65-74 years
☐ 75 years or older
☐ Prefer not to answer

Please continue to the next page

<u>Part 2</u>: For each of the following questions, answer by placing an “x” in the box you agree the most with.

To what extent do you believe that the following statements are true? Please use a scale from 1 to 5 where 1 is “not at all true” and 5 is “very true.”

	1 Not at all true	2 A little true	3 Not Sure	4 A Little True	5 Very true
My child has lots of new ideas	☐	☐	☐	☐	☐
When my child doesn’t understand something, s/he asks for help.	☐	☐	☐	☐	☐
If a problem is really difficult, my child just works harder	☐	☐	☐	☐	☐
My child doesn’t give up easily	☐	☐	☐	☐	☐
My child enjoys solving problems	☐	☐	☐	☐	☐
My child likes figuring things out	☐	☐	☐	☐	☐
My child likes to work on difficult problems	☐	☐	☐	☐	☐
My child wonders a lot about how things work	☐	☐	☐	☐	☐

Please continue to the next page

	1 Not at all true	2 A little true	3 Not Sure	4 A Little True	5 Very true
My child enjoys doing science in school	☐	☐	☐	☐	☐
I think of my child as someone who likes science related activities	☐	☐	☐	☐	☐
My child likes to look for more information about things s/he is interested in	☐	☐	☐	☐	☐
My child likes to watch shows or documentaries about nature or science	☐	☐	☐	☐	☐
My child likes to read books or magazines about nature or science	☐	☐	☐	☐	☐
My child likes to go to science museums, zoos, or aquariums	☐	☐	☐	☐	☐
My child likes to talk about how things work with me	☐	☐	☐	☐	☐

	1 Not at all true	2 A little true	3 Not Sure	4 A Little True	5 Very true
My child is good at math	☐	☐	☐	☐	☐
My child is good at science	☐	☐	☐	☐	☐
I could imagine my child studying science or engineering in college	☐	☐	☐	☐	☐
I could imagine my child wanting to be a scientist or engineer	☐	☐	☐	☐	☐
With enough effort my child could succeed in science/engineering	☐	☐	☐	☐	☐
I think my child could be a good scientist or engineer one day	☐	☐	☐	☐	☐

Please continue to the next page

	1 Not at all true	2 A little true	3 Not Sure	4 A Little True	5 Very true
I often help my child with their school work	☐	☐	☐	☐	☐
I often engage my child in educational activities at home	☐	☐	☐	☐	☐
I am confident in my ability to support my child's learning in science and engineering at home	☐	☐	☐	☐	☐
I put a lot of effort into helping my child learn to do things for himself/herself	☐	☐	☐	☐	☐

Thank you!

Fall 2017 Family Events: Parent/Caregiver Post-Survey

Part 1: Please fill in the questions with information about yourself

What is your name? ____

What is your child's name? ____

What is your ethnicity? (Please select all that apply)

☐ White or Caucasian
☐ Black or African American
☐ Native Hawaiian or Pacific Islander
☐ Latino or Hispanic
☐ Asian
☐ American Indian or Alaskan Native
☐ Middle Eastern
☐ Prefer not to answer

☐ Other (please specify): ______________________

What is the primary language you speak at home?

☐ English ☐ Spanish ☐ Other (please specify): __________________________

What is your relationship to the child participating in the Curiosity Machine program with you?

☐ Mother
☐ Father
☐ Grandmother
☐ Grandfather
☐ Aunt
☐ Uncle
☐ Mentor

☐ Other (please specify): _______________

Please continue to the next page

<u>Part 2</u>: For each of the following questions, place an "x" in the appropriate to indicate your rating.

Please rate your overall satisfaction with the *Curiosity Machine Family Events* using a scale from 1-10 where "1" is "not at all satisfied" and "10" is "very satisfied."

Not at all satisfied ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 Very satisfied

How likely will you and your child(ren) complete additional design challenges on CuriosityMachine.org? Please use a scale from 1 to 10 where 1 is "not at all likely" and 10 is "very likely."

Not at all likely ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 Very likely

How likely are you to recommend the program to another family? Please use a scale from 1-10 where "1" is "not likely" and "10" is "very likely."

Not at all likely ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 Very likely

To what extent do you believe that the following statements are true? Please use a scale from 1 to 5 where 1 is “not at all true” and 5 is “very true.”

	1 Not at all true	2 A little untrue	3 Not Sure	4 A Little True	5 Very true
My child has lots of new ideas	☐	☐	☐	☐	☐
When my child doesn’t understand something, s/he asks for help.	☐	☐	☐	☐	☐
If a problem is really difficult, my child just works harder	☐	☐	☐	☐	☐
My child doesn’t give up easily	☐	☐	☐	☐	☐
My child enjoys solving problems	☐	☐	☐	☐	☐
My child likes figuring things out	☐	☐	☐	☐	☐
My child likes to work on difficult problems	☐	☐	☐	☐	☐
My child wonders a lot about how things work	☐	☐	☐	☐	☐

	1 Not at all true	2 A little untrue	3 Not Sure	4 A Little True	5 Very true
My child enjoys doing science in school	☐	☐	☐	☐	☐
I think of my child as someone who likes science related activities	☐	☐	☐	☐	☐
My child likes to look for more information about things s/he is interested in	☐	☐	☐	☐	☐
My child likes to watch shows or documentaries about nature or science	☐	☐	☐	☐	☐
My child likes to read books or magazines about nature or science	☐	☐	☐	☐	☐
My child likes to go to science museums, zoos, or aquariums	☐	☐	☐	☐	☐
My child likes to talk about how things work with me	☐	☐	☐	☐	☐

Please continue to the next page

	1 Not at all true	2 A little untrue	3 Not Sure	4 A Little True	5 Very true
My child is good at math	☐	☐	☐	☐	☐
My child is good at science	☐	☐	☐	☐	☐
I could imagine my child studying science or engineering in college	☐	☐	☐	☐	☐
I could imagine my child wanting to be a scientist or engineer	☐	☐	☐	☐	☐
With enough effort my child could succeed in science/engineering	☐	☐	☐	☐	☐
I think my child could be a good scientist or engineer one day	☐	☐	☐	☐	☐

	1 Not at all true	2 A little untrue	3 Not Sure	4 A Little True	5 Very true
I often help my child with their school work	☐	☐	☐	☐	☐
I often engage my child in educational activities at home	☐	☐	☐	☐	☐
I am confident in my ability to support my child's learning in science and engineering at home	☐	☐	☐	☐	☐
I put a lot of effort into helping my child learn to do things for himself/herself	☐	☐	☐	☐	☐

Please continue to the next page

After participating in the Curiosity Machine Family Events…	1 Strongly Disagree	2 Disagree	3 Neither Agree nor Disagree	4 Agree	5 Strong ly Agree
…I feel more confident in supporting my child's learning of science and engineering at home	☐	☐	☐	☐	☐
…I understand more about how my child thinks about science and engineering	☐	☐	☐	☐	☐
… my child is more interested in science and engineering	☐	☐	☐	☐	☐
… my child is more confident in his/her abilities in science and engineering	☐	☐	☐	☐	☐
…. my child is interested in taking more science classes	☐	☐	☐	☐	☐
… my child is considering a career in science or engineering	☐	☐	☐	☐	☐
…my child is more persistent when solving difficult problems	☐	☐	☐	☐	☐

Please continue to the next page

<u>Part 3</u>: Last questions about your experience with the Curiosity Machine program.

In what way(s) do you think your child benefitted from participating in the Curiosity Machine Family Events?

In what way(s) do you think you personally benefitted from participating in the Curiosity Machine Family Events?

Thank You!

Fall 2017 Classroom Pre-Survey

What is your full name (first and last)? ____

For each of the following questions, answer by placing an "x" in the box you agree the most with.

Example: "1" is "totally disagree" and "5" is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I understand how to answer these questions.	☐	☐	☐	☐	☒

Please ask if you have any questions.

How would you describe yourself? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am persistent	☐	☐	☐	☐	☐
I am curious	☐	☐	☐	☐	☐
I am creative	☐	☐	☐	☐	☐

Please Continue on the Next Page

To what extent do you agree or disagree with the following statements? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I have lots of new ideas	☐	☐	☐	☐	☐
I like to come up with different solutions to one problem	☐	☐	☐	☐	☐
If I don't understand something, I ask for help	☐	☐	☐	☐	☐
If a problem is really difficult, I work harder	☐	☐	☐	☐	☐
I am not afraid of failure	☐	☐	☐	☐	☐
I don't give up easily	☐	☐	☐	☐	☐
I enjoy solving problems	☐	☐	☐	☐	☐
I like figuring things out	☐	☐	☐	☐	☐
I'm pretty good at tackling challenges	☐	☐	☐	☐	☐
I wonder a lot about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
Science is fun	☐	☐	☐	☐	☐
I enjoy doing science in school	☐	☐	☐	☐	☐
Science and engineering helps solve problems	☐	☐	☐	☐	☐
I believe that science and engineering can help make the world better	☐	☐	☐	☐	☐

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
My teachers think of me as someone who likes science	☐	☐	☐	☐	☐
My family thinks of me as someone who likes science	☐	☐	☐	☐	☐
My friends think of me as someone who likes science	☐	☐	☐	☐	☐
I like to watch shows or documentaries about nature or science	☐	☐	☐	☐	☐
I like to read books or magazines about nature or science	☐	☐	☐	☐	☐
I like to go to science museums, zoos, or aquariums	☐	☐	☐	☐	☐
I like to talk about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am good at math	☐	☐	☐	☐	☐
I am good at science	☐	☐	☐	☐	☐
I want to take more science classes	☐	☐	☐	☐	☐
I could imagine studying science or engineering in college	☐	☐	☐	☐	☐
I want to be a scientist or engineer when I am older	☐	☐	☐	☐	☐

Thank you!

Spring 2018 Classroom Implementation
Post-Survey (Treatment)

What is your full name (first and last)? ____

For each of the following questions, answer by placing an "x" in the box for your rating.

On a scale from 1 to 10, please rate your overall satisfaction with the *Curiosity Machine* Design Challenges that you completed in your class.

Not at all satisfied ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ Very satisfied

On a scale from 1 to 10, how likely is it that you will complete additional design challenges on CuriosityMachine.org?

Not at all likely ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ Very likely

On a scale from 1 to 10, how likely are you to recommend the program to a friend(s)?

Not at all likely ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ Very likely

Please Continue on the Next Page

EXAMPLE:

For each of the following questions, answer by placing an "x" in the box you agree the most with. Please use a scale from 1 to 5 where "1" is "totally disagree" and "5" is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I understand how to answer these questions.	☐	☐	☐	☐	☒

Please ask if you have any questions.

How would you describe yourself? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am persistent	☐	☐	☐	☐	☐
I am curious	☐	☐	☐	☐	☐
I am creative	☐	☐	☐	☐	☐

Please Continue on the Next Page

To what extent do you agree or disagree with the following statements? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I have lots of new ideas	☐	☐	☐	☐	☐
I like to come up with different solutions to one problem	☐	☐	☐	☐	☐
If I don't understand something, I ask for help	☐	☐	☐	☐	☐
If a problem is really difficult, I work harder	☐	☐	☐	☐	☐
I am not afraid of failure	☐	☐	☐	☐	☐
I don't give up easily	☐	☐	☐	☐	☐
I enjoy solving problems	☐	☐	☐	☐	☐
I like figuring things out	☐	☐	☐	☐	☐
I'm pretty good at tackling challenges	☐	☐	☐	☐	☐
I wonder a lot about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
Science is fun	☐	☐	☐	☐	☐
I enjoy doing science in school	☐	☐	☐	☐	☐
Science and engineering helps solve problems	☐	☐	☐	☐	☐
I believe that science and engineering can help make the world better	☐	☐	☐	☐	☐

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
My teachers think of me as someone who likes science	☐	☐	☐	☐	☐
My family thinks of me as someone who likes science	☐	☐	☐	☐	☐
My friends think of me as someone who likes science	☐	☐	☐	☐	☐
I like to watch shows or documentaries about nature or science	☐	☐	☐	☐	☐
I like to read books or magazines about nature or science	☐	☐	☐	☐	☐
I like to go to science museums, zoos, or aquariums	☐	☐	☐	☐	☐
I like to talk about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am good at math	☐	☐	☐	☐	☐
I am good at science	☐	☐	☐	☐	☐
I want to take more science classes	☐	☐	☐	☐	☐
I could imagine studying science or engineering in college	☐	☐	☐	☐	☐
I want to be a scientist or engineer when I am older	☐	☐	☐	☐	☐

After participating in the Curiosity Machine Design Challenges in your class…	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am more interested in science	☐	☐	☐	☐	☐
I am more confident in science	☐	☐	☐	☐	☐
I think of myself more often as a person who likes to learn new things	☐	☐	☐	☐	☐
I think of myself more often as a person who likes to learn science	☐	☐	☐	☐	☐
I want to take more science classes	☐	☐	☐	☐	☐
I am considering a career in science or engineering	☐	☐	☐	☐	☐
I work harder now on difficult problems	☐	☐	☐	☐	☐

Please Continue on the Next Page

What do you think is the most important thing you learned as a result of participating in the *Curiosity Machine* Design Challenges in your class?

In what way(s) do you think you benefitted from participating in the *Curiosity Machine* Design Challenges in your class?

Thank you for completing the survey!

Spring 2018 Post-Survey (Comparison)

What is your full name (first and last)? ____

EXAMPLE:

For each of the following questions, answer by placing an "x" in the box you agree the most with. Please use a scale from 1 to 5 where "1" is "totally disagree" and "5" is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I understand how to answer these questions.	☐	☐	☐	☐	☒

Please ask if you have any questions.

How would you describe yourself? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am persistent	☐	☐	☐	☐	☐
I am curious	☐	☐	☐	☐	☐
I am creative	☐	☐	☐	☐	☐

Please Continue on the Next Page

To what extent do you agree or disagree with the following statements? Please use a scale from 1 to 5 where 1 is "totally disagree" and 5 is "totally agree."

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I have lots of new ideas	☐	☐	☐	☐	☐
I like to come up with different solutions to one problem	☐	☐	☐	☐	☐
If I don't understand something, I ask for help	☐	☐	☐	☐	☐
If a problem is really difficult, I work harder	☐	☐	☐	☐	☐
I am not afraid of failure	☐	☐	☐	☐	☐
I don't give up easily	☐	☐	☐	☐	☐
I enjoy solving problems	☐	☐	☐	☐	☐
I like figuring things out	☐	☐	☐	☐	☐
I'm pretty good at tackling challenges	☐	☐	☐	☐	☐
I wonder a lot about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
Science is fun	☐	☐	☐	☐	☐
I enjoy doing science in school	☐	☐	☐	☐	☐
Science and engineering helps solve problems	☐	☐	☐	☐	☐
I believe that science and engineering can help make the world better	☐	☐	☐	☐	☐

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
My teachers think of me as someone who likes science	☐	☐	☐	☐	☐
My family thinks of me as someone who likes science	☐	☐	☐	☐	☐
My friends think of me as someone who likes science	☐	☐	☐	☐	☐
I like to watch shows or documentaries about nature or science	☐	☐	☐	☐	☐
I like to read books or magazines about nature or science	☐	☐	☐	☐	☐
I like to go to science museums, zoos, or aquariums	☐	☐	☐	☐	☐
I like to talk about how things work	☐	☐	☐	☐	☐

Please Continue on the Next Page

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am good at math	☐	☐	☐	☐	☐
I am good at science	☐	☐	☐	☐	☐
I want to take more science classes	☐	☐	☐	☐	☐
I could imagine studying science or engineering in college	☐	☐	☐	☐	☐
I want to be a scientist or engineer when I am older	☐	☐	☐	☐	☐

	1 ☹☹ Totally Disagree	2 ☹ Somewhat Disagree	3 😐 Not Sure	4 ☺ Somewhat Agree	5 ☺☺ Totally Agree
I am interested in science	☐	☐	☐	☐	☐
I am confident in science	☐	☐	☐	☐	☐
I think of myself as a person who likes to learn new things	☐	☐	☐	☐	☐
I think of myself as a person who likes to learn science	☐	☐	☐	☐	☐
I want to take more science classes	☐	☐	☐	☐	☐
I am considering a career in science or engineering	☐	☐	☐	☐	☐
I work hard on difficult problems	☐	☐	☐	☐	☐

Thank you for completing the survey!