# Investigating the Impact of Curiosity Machine Classroom Implementation:

# Year 2 Study Findings

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# Executive Summary

This summary 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). 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 understand outcomes of participating in the design challenges. The survey data was also complemented by classroom observations. In our analysis, we also made comparisons by dosage (i.e., how many CM design challenges students completed/contact hours and participation in the fall family events) and by variables such as attendance, GPA, test scores, and grades from school records provided by the district.

After analyzing the classroom implementation data, we noted the following key study findings:

- **STEM Identities:** There were no significant changes on STEM identity or learner identity from pre- to post- or from treatment to comparison as a result of the classroom implementation. We made comparisons by dosage and found evidence that those who completed eight or more design challenges had significantly greater changes as compared to those who completed only one.

- **Possible Selves:** There were no significant changes on this construct from pre- to post- or from treatment to comparison as a result of classroom implementation. However, we did find a difference due to dosage. Students who completed three or more design challenges had significantly greater changes on this construct as compared to students who completed only one.
- **Self-Efficacy:** To understand self-efficacy, we tested students' constructive coping and resilience as well as their perceived competence in STEM. While there were no statistically significant changes on self-efficacy, we did find a statistically significant difference in treatment students' constructive coping and resilience as compared to the comparison group. We also found some statistically significant differences due to dosage. Specifically, students who completed at least six design challenges had significantly greater changes as compared to students who only completed one.
- **Interest in STEM Learning:** There were no significant changes in students' interest in STEM learning from pre- and post- or treatment and comparison as a result of the classroom implementation. There was, however a statistically significant difference for students who completed at least six design challenges as compared to those who only completed one.
- **Beliefs about STEM:** There were no significant changes in students' beliefs about STEM learning from pre- and post- or treatment and comparison as a result of the classroom

implementation. We did note some significant differences by dosage for students who completed six design challenges as compared to those who only completed one.

- **Academic Performance:** When we compared changes in students' academic performance (e.g., GPA, test scores, grades, attendance) to changes in the comparison group, we found no significant difference. We did find that student who participated in eight or more design challenges showed statistically significant increases on PARCC ELA scores, GPA, and absences as compared to students who only complete one challenge.

After analyzing the Family Science implementation data, we noted the following key study findings:

- **Caregiver's perspective of their children's thinking:** Overall, we found no statistically significant changes in the caregivers' perspective of their children's thinking about STEM from pre- to post-survey on the underlying scales, even as answers to open-ended questions provided positive results.

While the overall findings suggest that there were limited changes from the pre- to post-survey on the constructs of interest, especially when analyzed against the comparison group, there were some notable findings related to dosage. Our analysis suggests that many of the constructs (e.g., identity, self-efficacy, beliefs) require ongoing and repeat engagement of roughly 6-8 design challenges (12-16 contact hours) before the intervention has a measurable impact.

## 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 platform. The Curiosity Machine program is designed 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 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.

## Study Context

The research study examined Curiosity Machine programming as an intervention in grades 4-8 classrooms in BOS and MOS schools in Illinois. The intervention included the implementation of 5 Family Science after-school sessions and 3 in-class design challenges, estimated to be anywhere from 2-16 contact hours for students.

[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; nor were design portfolios received. 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. Instead, we used the participation in fall Family Events as a variable to understand how dosage influences outcomes for the students.

## Research Questions

Our research study focused on measuring outcomes for students, especially related to academic achievement, and 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 affective outcomes for students  and their academic performance. Additionally, we 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. To explore these hypotheses, 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)?
2. Is there an impact of participation on parents' understanding of their children's thinking about STEM?

## Research Design and Data Collection Methods

Our overall study uses a complementary, mixed methods design to gain insight related to our research questions. Using this methodological approach, complementary data are collected using both quantitative and qualitative data collection strategies that occur in parallel and are interpreted to provide a comprehensive understanding of the Curiosity Machine intervention (Creswell, 2013). The quantitative data are used to test the stated hypotheses while the qualitative data will provide a more detailed, nuanced account of students' experiences in the program and resulting outcomes.

The implementation study described in this report used a pre-post design with both a treatment and comparison group. Students in the treatment group were those who completed Curiosity Machine design challenges in their classrooms and/or in Family Science events. As appropriate, we used information from the Fall 2016 and Fall 2017 Family Science events to analyze and interpret the data, specifically in terms of how dosage (i.e., number of design challenges completed and contact hours) influenced outcomes on the survey. Our 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: control 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);

The study also included a sample group of parent/caregivers (n=13) 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 1* | Participation in Fall 2017 Family *Curiosity Machine Events*<br>Participation in Spring 2018 Classroom *Curiosity Machine* programming |
| *Treatment Group 2* | Participation in Fall 2017 Family *Curiosity Machine Events*<br>No participation in Spring 2018 Classroom *Curiosity Machine* programming |
| *Treatment Group 3* | No participation in Fall 2017 Family *Curiosity Machine Events*<br>Participation in Spring 2018 Classroom *Curiosity Machine* programming |
| *Comparison Group* | No participation in Fall 2017 Family *Curiosity Machine Events*<br>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<br>I am curious |
| **STEM Learner Identity** | My friends think of me as someone who likes science related things.<br>My teacher thinks of me as someone who likes science related things. |
| **Future Engagement/Career** | I could imagine studying science or engineering in college<br>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<br>If a problem is really difficult, I just work harder |
| **Cognitive Engagement** | I wonder a lot about how things work<br>I like to talk about how things work with family and friends |
| **Purpose and Relevance of Science** | Science and engineering helps solve problems<br>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<br>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 SPSS to generate inferential statistics.

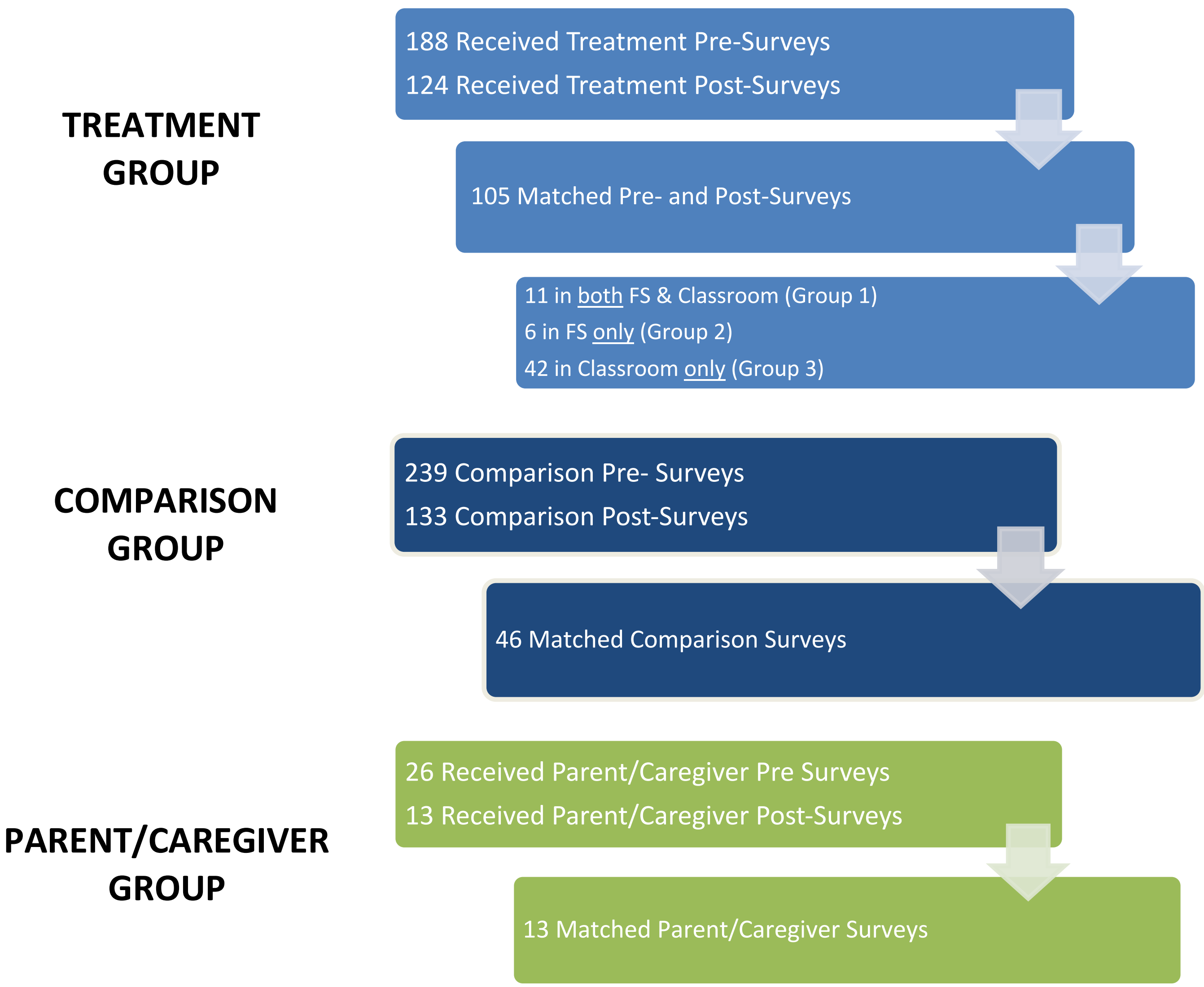
When calculating dosage, we incorporated prior encounters students had in Year 1 of Curiosity Machine implementation, giving students a combined dosage score from Years 1 and 2.

## Study Implementation Challenges

It is important to note that the findings reported here are synthesized from a small sample of data: 59 matched pre- and post-treatment, 46 matched pre-and post-comparison, and 13 matched pre- and post- caregivers. Figure 1 shows how the sample sizes were narrowed down for each group prior to analysis. OSU and Curiosity Machine team met at the end of year 1 to identify strategies to promote 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 project portfolios in-person, and both teams created a document with step-by-step guidance for teachers to collect survey data. Although these strategies were implemented, there were still substantial challenges in gathering a full set of matched pre-post data from the schools.

A sample size of over 20 was acceptable and 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.

**Figure 1. Narrowing of Sample Sizes Prior to Analysis**

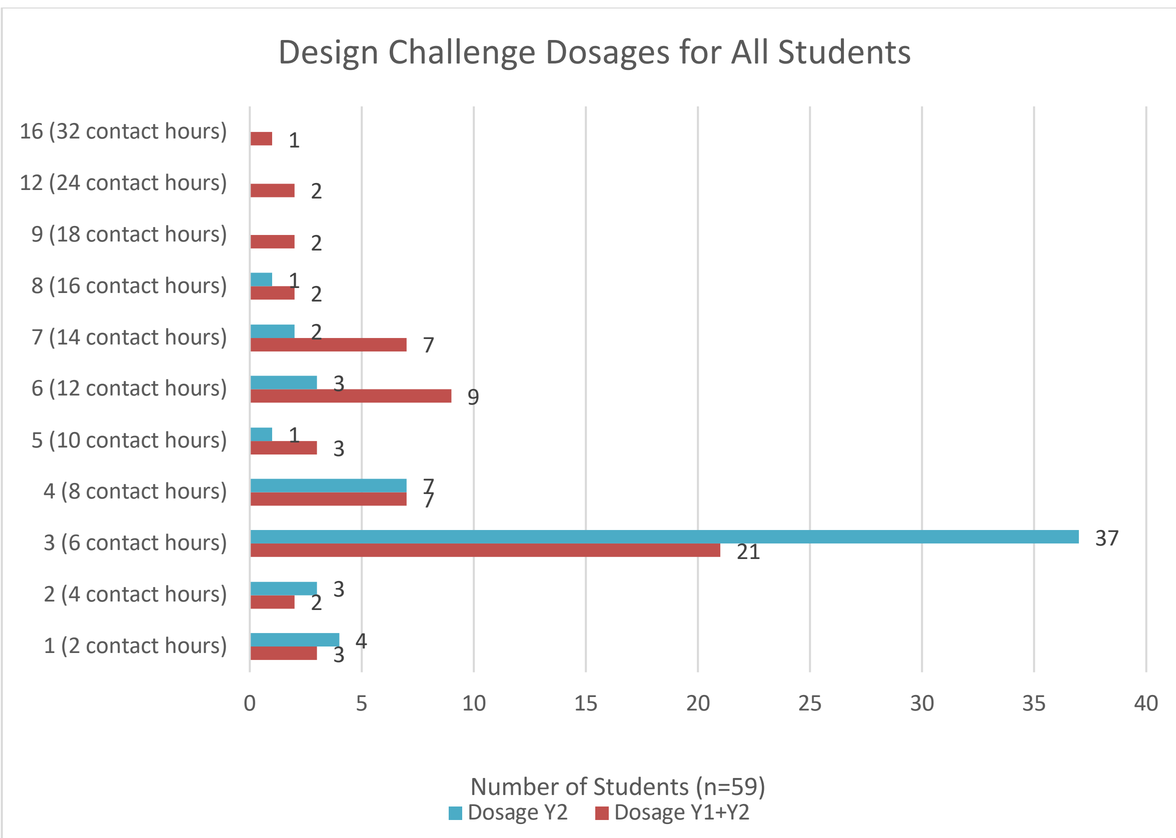



## Key Findings

### Design Challenge Dosage

We used Excel to generate descriptive statistics of the participation and attendance data to understand dosage for students in the treatment group. 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). As displayed in Table 1, 3 Design Challenges (6 contact hours) was the most common number completed among students in the treatment group. 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.

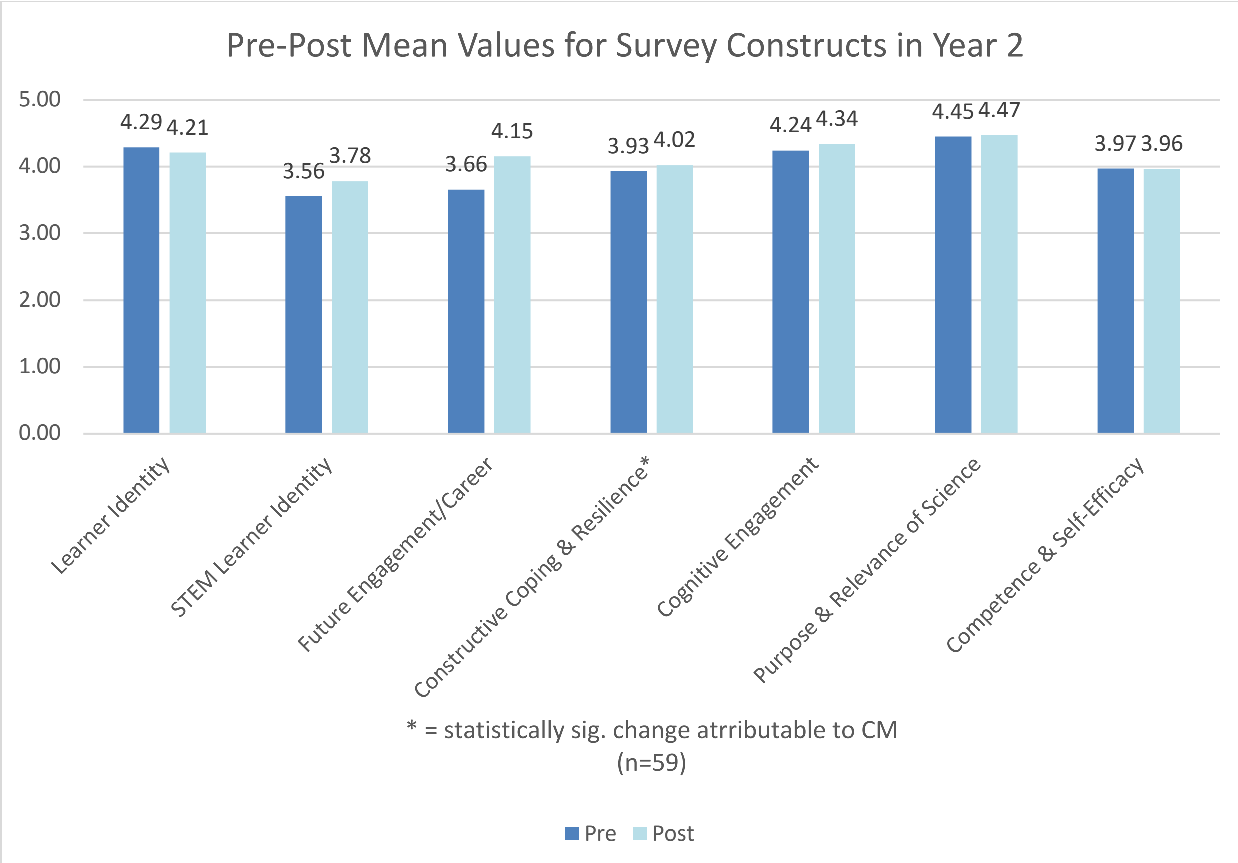
**Figure 2. Design Challenge Dosage for Students in the Treatment Group**



## Overall Survey Findings

Figure 3 displays the mean values from the pre- and post-survey for each of the survey constructs. 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 control 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. Across all constructs we found that there were significant improvements for students who participated in more than eight design challenges (16 contact hours); moreover, for two constructs, *cognitive coping and resilience* and *cognitive engagement*, the significant improvements began to show after participation in six design challenges (12 contact hours).

**Figure 3. Pre-Post Mean Values for Each Survey Construct**




We further explore each construct and related findings from our analysis in the next section.

**STEM Identities.** Two constructs on the survey, learner identity and STEM learner identity, aimed to understand how student's identities as learners and STEM learners were influenced by Curiosity Machine's design challenges. We found a statistically significant difference from pre- to post- in student's response about their STEM learner identities, but when compared to the results of the comparison group, this difference was not statistically significant. However, across both constructs there were statistically significant increases for students who had completed eight or more design challenges (16 contact hours).

**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 this difference was not significant when analyzed against the comparison group. However, there were significantly differences for students who participated in more than two design challenges as compared to those who only completed one.

**Self-Efficacy.** Constructive coping and resilience as well as competence were used to understand students' 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 suggesting participation in Curiosity Machine had a positive effect on students' constructive coping and resilience. We also found differences in self-efficacy based upon dosage. Specifically, students who participated in more than six design challenges (12 contact hours) showed a significant increase from pre- to post- in their coping and resilience, while students who participated in more than eight design challenges (16 contact hours) showed significantly greater increases in competence.

**Interest in STEM.** Overall, there was no difference in pre- to post-survey or treatment and comparison for the construct used to understand students' interest in STEM—cognitive engagement. We did, however, find that students who participated in more than six design challenges (12 contact hours) showed greater improvements in their interest in STEM as compared to students who only completed one.

**Beliefs about STEM.** There were no differences in pre- to post-survey or treatment and control for in students' understanding of purpose and relevance of STEM, but we did identify some differences by dosage. Students who participated in more than six design challenges (12 contact hours) showed statistically significant improvements on beliefs about STEM as compared to students who only completed one.

**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, standardized test scores, and grades. We found that there were some statistically significant changes from the beginning to end of the school year for students in the treatment group (increase GPA, math and ELA grades). However, when we compared these to changes in the comparison students' data, we did not find any statistically significant differences in students' academic performance. Therefore, we were not able to conclude that the changes in academic performance were a result of the Curiosity Machine program.

We also explored any potential differences that might emerge as a result of dosage, using the number of design challenges as a co-variate. Here, we found that students who participated in eight or more design challenges (16 contact hours) statistically significant increases on PARCC ELA scores, GPA and absences.

**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. Unfortunately, students did not provide further explainations for why. Table 3 shows the average responses given to the classroom student questions about satisfaction.

**Table 3. 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, 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."*

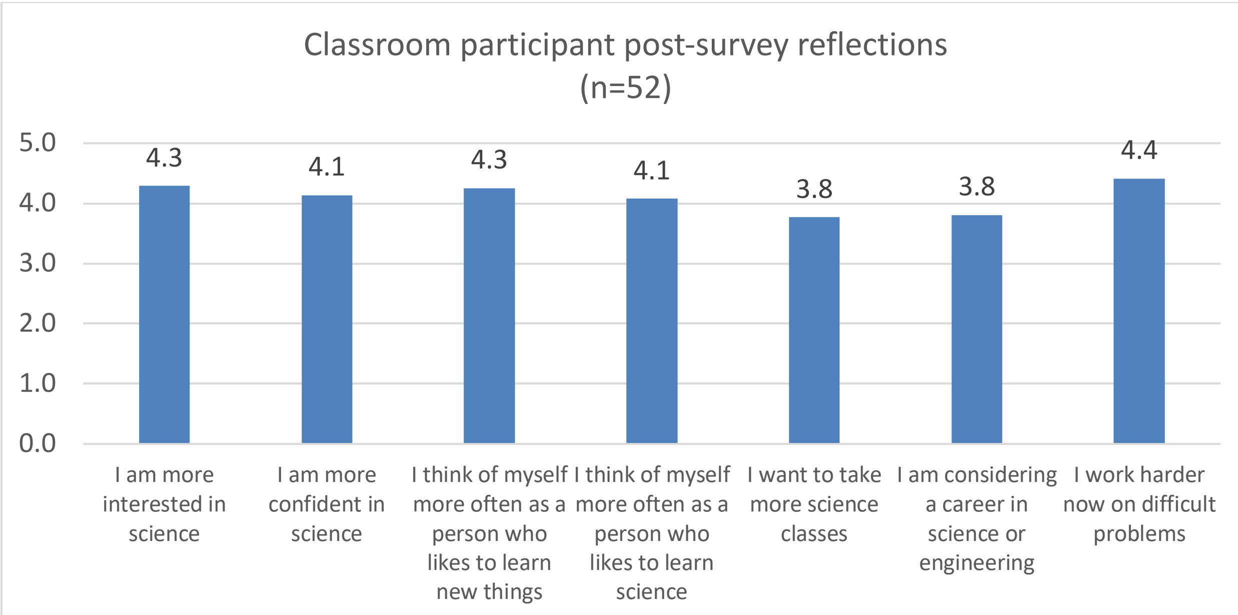
- Building & Design: *"I learned how to make a crossbow"*
- Teamwork: *"The most important thing I learned in the design challenge is to work with your teammates and try to tackle down big challenges."*

**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 Events Student Outcomes

**Student Satisfaction and Impressions.** Students who participated in the family events (Treatment Groups 1[3] and 2) gave the Curiosity Machine program a net promoter score of 54 on a scale of -100 to 100, indicating overall satisfaction and a moderate interest in promotion or father participation. Table 4 shows the average responses given to the classroom student questions about satisfaction.

[3] 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 4. 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 5[4] 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.

**Table 5. 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 |

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

**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?

**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 strong interest in participating again. Table 6 shows the average ratings caregivers gave to questions about their satisfaction and interest in participating further.

**Table 6. 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 7 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 7. Family Science Caregiver Survey and Sample Items**

| Construct | Sample Items |
|---|---|
| Identity | My child likes to figure things out<br>My child has lots of new ideas |
| Future Engagement/Career | I could imagine my child studying science or engineering in college<br>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<br>If a problem is really difficult, my child just works harder |
| Cognitive Engagement | My child wonders a lot about how things work<br>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<br>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<br>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?**

- <u>Connecting with child</u>: *"More time with my son doing something together."*
- <u>Teaching/learning with child</u>: *"We can work out challenges together bridging the gap in learning between the generations."*
- <u>Personal learning</u>: *"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."*
- <u>Supporting child's learning</u>: *"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."*
- <u>Witnessing child's learning</u>: *"We got the opportunity to see how his mind worked when designing and redesigning. It also allowed us to see challenges in his learning."*
- <u>Informing child's vision of future selves</u>: *"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 8 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 8. Family Science Caregiver Reflections**

| **After participating in the Curiosity Machine Family Science design challenges…**<br>*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, we found that dosage contributed to the impact upon students across all constructs with more significant changes noted for students who completed six to eight design challenges as compared to students who only completed one. We found limited evidence of impact upon caregivers' perspective of their children's thinking about STEM.

We suspect dosage is an important variable to consider in future implementation efforts and research studies of CM design challenges. In years one and two of the study, changes to student outcomes were generally not significantly different to the comparison group. However, we did note in both years changes resulting from dosage, suggesting that repeat engagement is likely important for influencing constructs such as identity, possible selves, interest, beliefs, and self-efficacy.

## Appendix A: Data Collection Instruments

# 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<br>☹☹<br>Totally Disagree | 2<br>☹<br>Somewhat Disagree | 3<br>😐<br>Not Sure | 4<br>☺<br>Somewhat Agree | 5<br>☺☺<br>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 | ☐ | ☐ | ☐ | ☐ | ☐ |

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| | 1<br>☹☹<br>Totally Disagree | 2<br>☹<br>Somewhat Disagree | 3<br>😐<br>Not Sure | 4<br>☺<br>Somewhat Agree | 5<br>☺☺<br>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 | ☐ Aunt |
| ☐ Father | ☐ Uncle |
| ☐ Grandmother | ☐ Mentor |
| ☐ Grandfather | |
| ☐ Other (please specify): ______________________ | |

What is your age range?

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

## Please continue to the next page

Part 2: 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<br>Not at all true | 2<br>A little true | 3<br>Not Sure | 4<br>A Little True | 5<br>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<br>Not at all true | 2<br>A little true | 3<br>Not Sure | 4<br>A Little True | 5<br>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<br>Not at all true | 2<br>A little true | 3<br>Not Sure | 4<br>A Little True | 5<br>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<br>Not at all true | 2<br>A little true | 3<br>Not Sure | 4<br>A Little True | 5<br>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<br>Not at all true | 2<br>A little untrue | 3<br>Not Sure | 4<br>A Little True | 5<br>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<br>Not at all true | 2<br>A little untrue | 3<br>Not Sure | 4<br>A Little True | 5<br>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<br>Not at all true | 2<br>A little untrue | 3<br>Not Sure | 4<br>A Little True | 5<br>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<br>Not at all true | 2<br>A little untrue | 3<br>Not Sure | 4<br>A Little True | 5<br>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<br>Strongly Disagree | 2<br>Disagree | 3<br>Neither Agree nor Disagree | 4<br>Agree | 5<br>Strongly 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<br>☹☹<br>Totally Disagree | 2<br>☹<br>Somewhat Disagree | 3<br>😐<br>Not Sure | 4<br>☺<br>Somewhat Agree | 5<br>☺☺<br>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<br>☹☹<br>Totally Disagree | 2<br>☹<br>Somewhat Disagree | 3<br>😐<br>Not Sure | 4<br>☺<br>Somewhat Agree | 5<br>☺☺<br>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 | ☐ | ☐ | ☐ | ☐ | ☐ |

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| | 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 | ☐ | ☐ | ☐ | ☐ | ☐ |

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| | 1<br>☹☹<br>Totally Disagree | 2<br>☹<br>Somewhat Disagree | 3<br>😐<br>Not Sure | 4<br>☺<br>Somewhat Agree | 5<br>☺☺<br>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 | ☐ | ☐ | ☐ | ☐ | ☐ |

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| | 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 | ☐ | ☐ | ☐ | ☐ | ☐ |

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| | 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 | ☐ | ☐ | ☐ | ☐ | ☐ |

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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 | ☐ | ☐ | ☐ | ☐ | ☐ |

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| | 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 | ☐ | ☐ | ☐ | ☐ | ☐ |

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| | 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!***