THE CURIOSITY MACHINE EVALUATION

Final Report

Prepared by Ashley Lewis Presser, Ph.D.
Education Development Center, Inc.
Center for Children and Technology
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EXECUTIVE SUMMARY

The Curiosity Machine (CM) project seeks to develop a set of online and in-person learning experiences for underserved families to engage deeply and increasingly independently in STEM projects that involve designing, building, creating, engineering, and inventing. The Curiosity Machine itself is an online system that consists of easily accessible learning experiences, including videos of scientists and design challenges. A key aspect of the design challenges is that students upload pictures and videos, along with textual responses about their learning, and receive individualized feedback from Iridescent-trained mentors. The mentors are engineers and scientists who volunteer their time to provide feedback on projects, including suggestions for the design and questions to challenge children to think more deeply about both the project design and the underlying science concepts.

There are many ways in which the Curiosity Machine has been successful. The program is positively impacting parents and children. Parents and children enjoy participating in this fun and enriching program, which maintains children’s attention and parents view as valuable. One of the students’ described the program: “It’s like school but more fun.” The program is also reaching a much larger population through the online Curiosity Machine portal compared to in-person Sessions.

Learning outcomes for teaching discreet concepts and doing so by persisting through failure seems effective. The majority of projects were effective in terms of the structure and design strength of the projects, aesthetics, creativity, and performance. In addition, the majority of participants followed directions and used the recommended materials, recorded observations about process and design outcomes, maintained the design requirements throughout the process, and demonstrated knowledge using specific vocabulary.

Iridescent has outstanding staff, facilitators, instructors, and volunteers and they provide quality programing. One element of this is the successful mentor training program, which was well rated by mentor. In general, mentor feedback was helpful and guided students in the right direction. In addition, the feedback loop between mentors and students is clearly beneficial, however, the CM system does not allow mentors to respond multiple times to entries or send reminder messages to students. Finally, the project successfully established a number of quality partnerships with a variety of stakeholders, especially schools and libraries.
Program challenges included getting families and children to engage with the website at home, particularly when families lack technology at home and have limited access to computers and the internet at schools and libraries. Another challenge was that students struggled to evaluate their own work, suggest possible modifications, and respond to mentors feedback.

Recommendations for the Curiosity Machine website and organization include:

- Translate the videos, design directions, and website text into other languages (i.e. Spanish).
- Provide easier design challenges for younger children and those just starting out to build confidence.
- Include the entire curriculum online.
- Make mentor training more widely available, perhaps even offering it to teachers and parents, and evaluate the impact of that training on mentor ability/knowledge.
- Incorporate additional user-friendly features to encourage more participation and engagement, such as improved log-ins for families with multiple children, expand user profiles, and improve access by mobile device.
- Increase the connection between mentors and students, both online and in-person. For the websites, allow mentors to (1) send multiple responses to a submission, (2) send responses to students not related to specific projects, and (3) indicate whether or not a student has viewed mentors feedback. Incorporate in-person experiences with mentors (i.e. at in-person session or skype).
- Add a support within the Curiosity Machine website to help students evaluate their own work and suggest modifications.

Recommendations for the in-person Curious Sessions include:

- Improve the program for teacher use. For example, paying the teachers (teachers are student volunteers) or make it a course in which students receive credit for their participation as a way to hold them accountable ‘because it’s really, really difficult to not have that in place.”
- Hold Family Science sessions in the schools in order to get students, parents, and school staff more involved in the program.
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INTRODUCTION

The Curiosity Machine (CM) project seeks to develop a set of online and in-person learning experiences for underserved families to engage deeply and increasingly independently in STEM projects that involve designing, building, creating, engineering, and inventing. The Curiosity Machine itself is an online system that consists of easily accessible learning experiences, including videos of scientists and design challenges. A key aspect of the design challenges is that students upload pictures and videos, along with textual responses about their learning, and receive individualized feedback from Iridescent-trained mentors. The mentors are engineers and scientists who volunteer their time to provide feedback on projects, including suggestions for the design and questions to challenge children to think more deeply about both the project design and the underlying science concepts.

The Curiosity Machine evaluation focuses on the program’s impact on participants’ technology literacy skills, their rate of tinkering and building, and their persistence in troubleshooting and redesign in project work. Participants include families employing the Curiosity Machine with elementary-aged children. The family is the primary unit of analysis for the evaluation, as the interactions between parents and children is critical to the program’s implementation.

Specifically, the project seeks to investigate the following questions.

1. Do parents and students use the Curiosity Machine to complete science projects?
2. Do parents and students achieve adequate technology literacy skills?
3. Do parents and students increase their engagement in science projects that include tinkering and building?
4. What strategies do parents and students use to troubleshoot and redesign science projects?

CURIOSITY MACHINE LOGIC MODEL

The purpose of a logic model is to provide a pictorial display of how the daily activities of the program link to the program’s goals, including both content and process (Coffman, 1999). Logic models are created through an analytic process that explicitly states the connection between program activities and outcomes by showing the causal relationships between factors, which “is essential in both
planning and evaluation” (Renger & Titcomb, 2002, p. 494). Logic models can be used to plan programming activities, sometimes scaling back to make the intervention feasible, and can help evaluators understand the intervention itself (Mulroy & Lauber, 2004). The process can help evaluators understand the underlying causes of the problem that the intervention is meant to solve (Renger & Titcomb, 2002).

Embedded in the evaluation was a process of reviewing the Curiosity Machine’s logic model, in order to clarify the necessary elements of the program and serve as a framework for the program’s further refinement. Specifically, the logic model identifies the participants, key program elements, participant supports, activities, short-term outcomes, and long-term outcomes. The short-term and long-term outcomes were selected as indicators of the program’s success for this evaluation. Some of the outcomes were not selected for study, either because they were not a priority at this stage of the evaluation or it was not feasible within the time constraints of the project.

The first logic model was created by the evaluation team, with subsequent feedback from the Curiosity Machine staff; the model then was revised and divided into four separate logic models in order to best represent the unique elements of different programs using the Curiosity Machine across the country. These logic models laid the foundation for the theory behind how using the Curiosity Machine affects students and informs future work. In particular, the logic model, along with evaluation findings in this report, helps to focus on

1. the aspects of the program that have to be maintained during the next project,
2. the aspects of the program that require revision, and
3. the research questions for future work.

Overall, the logic model revision process helped to clarify how the daily activities of the program were linked to the hypothesized outcomes.
The Curious Course sessions took place in Los Angeles and Florida, and incorporated both written direction and kits with project materials with the in-person Curious Sessions, in order to improve participants’ ease of access. This model also was used for the Family Science Sessions conducted in New York City.
The Curious Sessions in Los Angeles took place both in schools and libraries and consisted of in-person Curious Sessions.

The Curiosity Machine Summer Camp was the most comprehensive version of the program, with components that individually targeted both parents and students.
Parents of enrolled students were invited to attend a parent technology session at the beginning of the summer, in an effort to aid parents in helping their children with projects over the summer. The Summer Camp consisted of intensive in-person Curious Sessions that allowed time to build things and practice skills, receive help from an “explainer mentor,” present work, and engage in field trips.

Overall, this logic model process helped the team clarify the elements of each program and show how the Curiosity Machine’s online system fit into each implementation model.

ORGANIZATION OF REPORT
The remainder of this report is organized into three sections: Overview of Evaluation Methods, Findings, and Conclusions and Recommendations.
OVERVIEW OF EVALUATION METHODS

In order to address the research questions, the evaluation team collected the following data:

- Website Data,
- Session Observations,
- Family Surveys,
- Family Interviews,
- Mentor Interviews, and
- Staff Interviews.

Curiosity Machine Website Data
As students work on projects, the Curiosity Machine prompts them to submit photographs, videos, and textual responses to questions about the learning and design process. Some 150 projects were selected and coded for features both of the projects themselves and of the mentors’ responses to the submissions.

Each participant’s project entry was coded on four main criteria, including:

1. Structure and strength of design. Does the material allow the structure to perform its function?
2. Aesthetics. Is the design attractive and easy-to-use?
3. Creativity. Did student come up with new ideas and insights to move ahead?
4. Performance. How well does the design perform its function? (Checked only if there was a video to see how the design worked.)

In addition, projects were further rated on the degree to which they demonstrated the following criteria effectively.

- Student created and completed design.
- Student uploaded a visual representation (picture or video) of finished project.
- Student used mentor feedback to improve design.
- Student evaluated own work and suggested possible modifications to the designing and making task.
- Student recorded observations about process and design outcome.
- Student demonstrated understanding/knowledge of subject by using specific vocabulary to describe design process.
• Student demonstrated learning by reflecting on mentor feedback and coming up with better answers.
• Student followed instructions to create (product).
• Student maintained design ideas and requirements throughout the process.
• Student responded to mentor feedback.

Mentors’ responses were coded based on the following questions.

• Did the mentor provide any feedback?
• Was the mentor helpful, attentive, and friendly?
• Did the mentor provide details of how to improve the design?
• Did the mentor provide hints/cues/prompts that guided the student in the right direction?
• Did the mentor highlight errors without giving the correct answer?
• Did the mentor’s feedback inform the student about incorrect response and allow the student one or more attempts to improve the design?

In addition, the number of mentors and the overall percentage of projects on which each mentor provided feedback were assessed. Then projects were coded by the frequency of Curiosity Machine use—as defined by the number of projects submitted by a student—and by child’s age in order to conduct subgroup analyses.

Session Observations
In-person Family Science Sessions conducted in the New York City metropolitan area were observed five times in order to understand the format of the sessions and to observe parents’ and children’s behavior during the sessions.

Family Surveys and Interviews
Using family surveys and phone interviews, we collected data on participants’ technology literacy skills and their experience with the Curiosity Machine website. The data from the surveys and interviews will inform project activities and help project staff improve the services and materials that they provide.

Family surveys. The surveys consisted of a number of open-ended questions and quantitative items, designed to gather information about parents’ and children’s technology literacy skills and use of technology. Also, the surveys helped us understand participants’ experiences with the CM website—parents and students were asked a set of questions about the rate of tinkering and building, and the
persistence in troubleshooting and redesign in project work. The survey was available in both English and Spanish.

The first round of parent and student surveys was conducted in New York and Los Angeles in fall 2013 (46 surveys—13 parents and 33 students). After consultations with Iridescent staff, the research team made the following revisions to the survey tool: (1) combined the parent and student surveys to create a family survey, since parents were filling out both surveys, and (2) shortened the survey so that parents’ questions were on the first page and questions for parents to ask their children were on the second page. A second round of parent surveys was conducted in three states (New York, Florida, and California) in spring 2014 (63 surveys), and resulted in an increasing wealth of data to better understand participants’ experiences with the in-person programs and the Curiosity Machine website.

**Family interviews.** The interview questionnaires complemented the surveys by providing additional information on parents and students’ use of technology and engagement on the CM website. The sample comprised data collected from eight families who participated in the Curiosity Machine summer programs and the Family Science programs in New York and the Bay Area. Participants were solicited through Iridescent and during in-person sessions. Of the four families who were interviewed by phone, three families had elementary-aged children and two families had preschool-aged children, with one family having both elementary- and preschool-aged children. Of the four families who were interviewed in person, all four families had elementary-aged children and one family also had preschool-aged children. All families who participated in the interviews consented to participate in the study.

**Mentor and Staff Interviews**
Three mentors and four staff members were interviewed by phone about the training process, program successes and challenges, and possible program improvements.
FINDINGS
This section describes the different implementation models and summarizes the results from each of the following sources in order to triangulate findings.

- Website Data
- Session Observations
- Family Surveys
- Family Interviews
- Mentor Interviews
- Staff Interviews

Description of Implementation Models

Summer Camps
In 2013, two summer camps were held in New York and the Bay Area. The Bay Area camp was a four-week camp for young, pre-K students, and was based heavily on the Curiosity Machine. Each week had different content, and children could register week by week, rather than for the camp as a whole. Some children registered for all four weeks, and some registered only for alternate weeks.

All curricula used in the camp were also available on the website (except for the Week 4 curriculum, which did not get uploaded on time). There was a parent coordinator who worked with children to share their designs on the website. The parent coordinator was responsible for asking children questions and typing out their answers, and also for taking pictures of their projects. The parent coordinator helped students only with their initial upload to the first one or two questions, not with responding to mentor feedback or responding to later questions. Parents were asked to work with their children at home to complete these remaining tasks, but this did not happen in some cases. In Week 1, the Curiosity Machine was used as an initial tool to capture student progress, but this seemed to interrupt students’ cycle of building and testing. In later weeks, the Curiosity Machine was used more as a reflective tool for students to talk about what they did after they finished their design, and this worked much better.

In New York, a Curiosity Machine-driven summer camp was run as well, with similar content to the Bay Area program, but adjusted for older children. The two sessions each ran for three weeks at a time, with a different group of students at each session. The sessions had identical content. An orientation session with parents was held before the camp began; parents were introduced to the website and encouraged to work on it with their children.
**Libraries**

Los Angeles presented Curiosity Courses in three different library branches during June and July, 2013. A total of 80 participants took part in these sessions. The sessions also were based around the Curiosity Machine. An Iridescent part-time staff member was at each library session running these events. The sessions started with a Curiosity Machine video, and then students were given a chance to start building. The staff provided direct support to ensure that students uploaded projects to the website. Due to staff support, participants registered the most submissions to the website at this location (Los Angeles Library Sessions).

However, this also meant that the families relied on the staff at the library sessions for uploading, and did not continue to work on their projects at home or after the session, nor did they respond to much of the mentor feedback that was provided. In short, Los Angeles generated the highest participation numbers, but the least follow-through. There were also some technology issues (difficulty using the website, internet connectivity, computer shortages) that prevented projects from being uploaded on all days of the program.

The Curiosity Machine provides professional development opportunities for approximately 40 librarians who come to the studio to learn about the program’s methodology and interface. Libraries in the area are trying to position themselves as a place of learning beyond just books, are embracing technology, and are positioning themselves to act as a hub for the community.

**Family Science Sessions**

In New York, the Family Science sessions were run at two sites simultaneously in spring 2013—one site, the school of St. Athanasius, reached over 80 people, and the other, the Iridescent studio recruited from the Bronx Charter School for the Arts, reached about 20 people. In fall 2013, they ran enhanced family science courses at the same two sites. During the spring 2014 sessions, four new school sites were added—PS 304, Girls Prep, Hyde Leadership Charter School, and PS 48—to make a total of six sites and 130 families reached. Iridescent continued running enhanced family science courses, and integrated a new at-home night session into the program. The sessions ran once a week for five consecutive weeks, either at the schools or at the Iridescent studio; each session lasted two hours. Researchers conducted five observations of Family Science sessions and interviewed four families during the course of the year.

During the Family Science sessions, parents and elementary school children explored a variety of STEM activities and design challenges to help them learn new science concepts and interact with the materials. The instructors presented the
content, outlined a challenge, introduced the materials, and let the families build and test various solutions. The instructors also provided some scaffolding and used various methods to teach the content, which made it simple and easy to understand, especially for the younger children. Each session began with a mini design challenge to get their creative juices flowing. The challenge typically led to a lesson where staff asked open-ended questions to elicit student participation. The lesson would often lead to a circle activity to give children and parents an opportunity to think about the connections between the science terms and concepts being learned and to visualize them. The children also were provided with a notebook or folder to take notes and reflect on the lesson and their designs, and to keep their handouts, pictures, and drawings. However, they were not allowed to take their notebooks home until the last day of the program. During the design challenge, staff circulated the room, provided feedback, and guided the families through the process. Some were armed with cameras and took instant pictures of the children with their designs. The families worked together—parents were encouraged to play, explore, observe, and support their children during the group activities and design challenges.

Each family was its own independent learning unit, with parents and children—especially the older children—engaged in the process together. The younger children were engaged for a while, but eventually became disengaged. They all worked diligently on their designs, building, and putting materials together. There was a good deal of interaction among parents, children, and staff, who circulated around the room to answer questions and to make sure families were on task. This posed a small problem, as families relied on the instructors and not themselves to stay on-task with the activities. Also, because each family received personal feedback at these sessions, it was hard to bring them back to the Curiosity Machine website—they felt as if they were done when they finished building, rather than being done when the project was uploaded online.

In Los Angeles, program staff took a different approach and were more hands-off, forcing families to engage with the website. The objective was that, at the end of the five weeks, families would feel empowered to do informal science at home. A staff member provided the following reflection:

“When you are working in a blended environment with parents and children [a challenge] is that one of the two parties might be more interested than the other. So I see my role as to constantly engage the families to ensure that they understand what they are doing and are also motivated to interact both with the actual building part and interacting with the website. Children have
little to no problem understanding the website, how to log in, how to post; often parents have a much greater challenge orienting themselves to a website and that’s why we offer the five-week program where we literally go step-by-step to teach the families how to register, log in, post, and how to respond to feedback.”

Also, in Los Angeles, the Curiosity Courses were conducted at two sites, Eastman and Foshay, in spring 2013. These courses were identical to the Family Science sessions in New York. Each course was a five-week session, in which families worked primarily on the website, in local schools. Some submissions on the website occurred as part of the program, but no families continued the interaction at home. In fall 2013, two Curiosity club programs were conducted at the same two sites. Eastman reached 30 participants with a typical Curiosity Machine Course, run with families. Foshay reached 24 participants with a high-school program, run without parents, but parents came on the last day for a showcase event.

The Los Angeles programs also ran several one-day events, some of which led to Curiosity Machine submissions. All these events had the same format. These were primarily teaser events to get partners interested, including the two libraries that participated. They continued running Curiosity Courses and Curiosity Clubs in spring 2014. The clubs were run entirely by the partner organization, whereas the courses were led by program staff with support from the partner organization’s staff. The Bay Area program was replaced by a new program in Orlando, Florida. These were also Curiosity Courses that were run by Iridescent staff.

Challenges
Following the design instructions was a significant challenge for families in New York, especially the Spanish-speaking parents who needed extra help with translation. Also, the New York team has had significant recruiting/retention difficulties, with many new families and turnover in all of their programs. According to staff, the standardized testing, which is now a two-week event in New York State, is a significant challenge for successful program implementations. They have had many families cancel attendance at sessions because their children were in after-school test prep, or they wanted their children well-rested for testing. The team has never had to plan programs around standardized testing before, but they hope to be better prepared for future series. Another challenge with the schools is scheduling and matching Curiosity Machine programing with their existing activities and calendar. For example, the Family Science program was not
implemented in a few schools this year because staff could not make the scheduling work around other programs and overall timing issues.

In Los Angeles, families did not like that the videos on the website were in English. About 80% of the families the program served—especially parents—do not speak English, so translating the website into Spanish would be helpful. Parents also felt that the design challenges were too hard and wanted more help completing the project. They reported that they were not getting enough attention from staff at the Curiosity Courses. The general feeling was that the use of this tool in an in-person program feels disingenuous, and that the experience might be quite different for an experiment done at home, where the website (rather than the staff) becomes their main avenue for information and interaction. This feedback reflected what staff saw in New York—parents expected more interaction from the staff than the website alone provided. There also were some technical difficulties at one of the sites in Los Angeles, in getting the computers wired and online, and so families did not really have a chance to submit projects until later sessions. A real challenge with the current Curiosity Machine website is that it is not optimized for smartphone use, so program staff have to rely on technology that is accessible to libraries and schools, which often is very limited.

Curiosity Machine Website Data

**Overall Project Features**
The Curiosity Machine portal produces website data based on the entries of participants. Each participant is expected to enter specific information as they complete each project, including uploading visual information (i.e., pictures and video) and written responses to questions. Mentors then review each submission and provide written feedback. This Web data was coded and summarized by the evaluation team. Overall, the analysis of the Curiosity Machine’s Web data is promising and sheds light on both the strengths and challenges of the program, as well as informs our suggestions about ways in which the program could further support participants.

The projects were well-rated on most of these criteria.

- All participants who submitted a photograph or video were rated on the *structure and strength of design* of their project, and all were at least somewhat effective in this domain (43% effective, and 57% somewhat effective).
• The aesthetics of the projects was the domain that received the highest ratings, with 59% achieving the full aesthetic rating, 40% achieving a partial aesthetic rating, and 1% with no meaningful aesthetics.

• The creativity of the projects was moderate (24% creative, 69% somewhat creative, and 7% not creative), which was expected given that many participants were focused on following the directions and achieving the overall goals of each project.

• All participants who submitted a photograph or video were rated on performance. The projects’ performance was rated as somewhat effective in most cases (93% somewhat effective, 7% effective).

Other findings about projects were as follows.

• Sixty-five percent of the participants’ entries included a visual representation (i.e., photo or video) of the finished project, whereas 35% did not include a visual representation. In some cases, this was due to technical problems with uploading pictures and video.

• The majority of participants used one or more of the recommended materials to complete the project. Specifically, 73% of participants used the recommended materials effectively, 16% used non-recommended materials without impeding project success, and 11% used non-recommended materials that did impede project success.

• Participants frequently engaged in recording observations about both the process and design outcome (55% effectively, 6% somewhat effectively, and 39% did not do).

• The majority of participants followed the instructions to create the designs, 74% of participants did so effectively, while 16% did so somewhat effectively, and 11% did not do so.

• The majority of the participants maintained the design ideas and requirements throughout the process (65% effectively, 19% somewhat effectively, and 15% did not do).

• Participants’ entries frequently demonstrated knowledge of the subject by using specific vocabulary (51% effectively, 9% somewhat effectively, and 40% did not do).

• Students frequently did not succeed in evaluating their own work and suggesting possible modifications (30% effectively, 15% effectively, and 55% did not do). The skill of evaluating one’s own work might have to be taught in a more explicit way than the way in which the Curiosity Machine is typically organized, and may depend heavily on the age of the participant.
One consistent challenge for the Curiosity Machine is the low response rate elicited by participants. The majority of students did not respond to mentors’ feedback (84%), whereas 16% did respond to mentors’ feedback in some way. For those participants who responded to mentors’ feedback, the majority of them demonstrated learning by reflecting on mentor feedback and coming up with better answers (75% effectively, 17% somewhat effectively, and 8% did not do), and used mentor feedback to improve design (71% effectively, 12% somewhat effectively, and 17% did not do).

Project learning as evidenced by the number of projects uploaded to the Curiosity Machine also demonstrate positive learning outcomes. The majority of projects were effective in terms of the structure and design strength of the projects, aesthetics, creativity, and performance. In addition, the majority of participants followed directions and used the recommended materials, recorded observations about process and design outcomes, maintained the design requirements throughout the process, and demonstrated knowledge using specific vocabulary. However, participants frequently did not evaluate their own work, suggest possible modifications, and respond to mentors’ feedback. Overall, these behaviors demonstrate evidence of engagement in the learning process and design process, and lend support to the idea that the Curiosity Machine is helping participants practice and master skills related to the engineering design process specifically and to scientific practices generally.

Mentors

Number of Mentors and Projects
There are 21 mentors who responded to the sample of participants entries. However, 59% of all coded entries were mentored by one mentor, 22% of coded entries were mentored by a second mentor, and 18% of coded entries were mentored by a third mentor. This means that 99% percent of all the coded responses (a sample of the overall projects) came from three specific mentors, making it difficult to generalize to the impact of the mentors as a group. More reasonably, these findings generalize to mentors who respond to a high number of projects.

Features of Mentors’ Feedback
After participants submitted projects, they received feedback from a mentor, although the mentor may have changed throughout the participants’ use of the Curiosity Machine. The ratings of the mentors’ feedback revealed the following.
Almost all of the mentors’ feedback was rated as helpful, attentive, and friendly (99% yes, 1% no).

The majority of these responses from mentors provided hints/cues/prompts that guide student in the right direction (85% effective, 7% somewhat effective, and 7% did not do).

Half of the mentor responses provided details of how to improve the design of the project (35% effective, 15% somewhat effective, and 50% did not do). It is possible that mentors including more of these details on how to improve the design could facilitate more frequent responses from students.

About half of the mentor responses highlighted errors without giving correct answer (49% effective, 11% somewhat effective, 40% did not do).

More than half of the mentor responses informed student about incorrect response and allow student one or more attempts to improve design (46% effective, 13% somewhat effective, and 41% did not do).

Examples of Mentors’ Feedback
The most common feedback that participants received from mentors was praise, and it ran the gamut from simple “Great design and picture!” statements to much more elaborate, encouraging, and positive references to participants process and designs (i.e informative praise; Corpus & Lepper, 2007). Some examples of this feedback include the following.

“I can tell you worked hard to make a bird that can fly that far! I would love to see a photo or video of your bird if you can upload one!”

“Very cool design! I like how [you] put together the graham crackers in different ways on the top and bottom.”

Love the concept and the picture! I bet you were able to store quite a bit of energy in those big rubber bands! Way to explore and build!

Fantastic! I’m impressed with your effort! Can you explain how your bird design works? It would also be great if you could share a picture or video of your design!

Mentors also asked follow-up questions or made statements designed to inform participants about the quality and accuracy of their designs. The following are some examples of these follow-up questions or statements.
“Good documentation, with your picture and description.”

“Cool design, lots of rubber bands used to make your joints!”

“I see the sticks that you used, but where did you attach the rubber bands?”

Very cool! I like how you were able to get the suction working on your design. Can you explain more how this works?

Wow this photo looks like you have built a very powerful machine! I bet that it really flies! I can’t wait to see what you build next!

In terms of the quality of the feedback and amount of information provided, the comments were usually brief and pointed. These follow-up statements helped mentors verify whether a participant’s answer was right or wrong, and provided facilitative information to the participant.

Mentors provided hints, clues, or prompts to guide participants in the right direction. Some highlighted errors and encouraged participants to keep working on projects. Some examples of hints/clues/prompts include the following.

“Great job showing your design! It looks like you were close to a solution, but had some problems scooping the rice. That’s ok! The best designs never work on the first try; I think you have a good starting beak that you can redesign to make it work”

This design looks like it would really fly! Is there anything you are thinking about doing to make it shoot further or more accurately? Great work - can’t wait to see what you think of next!

This design sounds very interesting! I would love to see a picture or video of it! Can you help me understand how the tape, rubber bands and spoons work together to pick up tennis balls? This is a complicated problem - way to work through to a solution that is effective! I would love to know more about your idea!

Ok! Great work building your design, I know this is a tough one to get flying very high. What might you be able to change about the hot air source that would help it fly higher? I wonder if changing the materials would help at all too. What do you think?
I couldn’t see the video, but love the photograph! So cool that you did three different shapes of birds! What inspired you to do these three? Which one flew 11 feet? What do you think made it fly so much further than the last one? Excellent exploration and documentation my friend!

The feedback messages containing praise were meant to elicit motivation and keep participants on task. The following are some examples of feedback messages.

“Very cool design! I don’t think I’ve seen one yet with such long sticks, that’s a very interesting way to build it. And it’s great that you found a way to incorporate the paper clip as a latch. I’d love to hear your answers to the other questions, great start on this project!”

What a unique design! I like your thought process in creating a wide base to support the main tower. How did the insulation help against the earthquakes?

“Great work! I’m impressed by your effort and creativity in building a redesign that worked better! How high did your structure jump?”

Wow! I like your creativity and effort here building such an interesting design! Could you explain a little more how it works as a catapult?

Awesome job!! That’s great that you redesigned and got it to go so much farther! I see that you put the same number of paperclips on each side. Having symmetrical weight like that is very important.

Mentor Feedback Loop
Overall, the written responses and interactions between mentors and participants were similar across time in content, however, the interactions between mentors and participants created feedback loop that made the learning process more productive in terms of motivation and continued engagement with the projects. Unfortunately, a majority of the participants did not respond directly to their mentor’s follow-up questions.

Curiosity Machine Projects by User Frequency
The frequency of CM use analysis was conducted by assigning projects a code indicating how many projects were submitted, and analyzing projects based on the
participant’s frequency of use. Specifically, “novice users” completed one project using the CM, “moderate users” completed two projects, and “expert users” completed three or more projects.

**Project Structure and Design Strength.** All projects were rated effective in some manner; however, moderate users had the highest percentage of “effective” ratings.

**Project Aesthetics.** Novice and moderate users had an overall higher percentage of projects that rated as “effective” in demonstrating project aesthetics. This could reflect expert users’ focus on other aspects of the design, such as overall functionality or scientific element of the work.
**Project Creativity.** On average, moderate and expert users were more effective in completing projects in a creative way.

![Curiosity Machine Web Data: Project Creativity](chart1.png)

**Project Performance.** On average, user groups were very similar on project performance.

![Curiosity Machine Web Data: Project Performance](chart2.png)

**Uploaded Visual Evidence (photograph or video).** A much larger percentage of novice users uploaded visual evidence for projects. It’s possible that moderate and expert users relied more heavily on textual descriptions, had more difficulty providing visual evidence, or felt less motivated to include such information.
**Utilized Recommended Materials.** Moderate and novice users were most likely to have used the recommended materials in the design of their projects. Perhaps expert users were more flexible in their use of materials because they felt better able to understand the features of materials that would lead to success, and selected alternative materials as a result.

**Demonstrated Observations about Process and Design.** On average, a greater percentage of expert users demonstrated observations about the process and design. This may be due to repeatedly practicing the skill of observation across several projects.
Following Instructions. A greater percentage of novice and moderate users followed project design directions as they were written. It is possible that expert users felt more comfortable deviating from the directions after completing several projects. Not following directions may be a good outcome that indicates growing cognitive flexibility and engagement with the design process.

Maintaining Design Ideas Throughout the Process. Moderate users were, on average, more effective in maintaining the design idea throughout the process.
**Demonstrated Knowledge with Specific Vocabulary.** A greater percentage of expert and moderate users effectively demonstrated knowledge using specific vocabulary. This may indicate that engaging in the design process repeatedly improves fluency in the vocabulary related to STEM and design content.

**Evaluating Own Work and Suggesting Modifications.** A greater percentage of expert and moderate users effectively evaluated their own work and were able to suggest design modifications. This may indicate that engaging in the design process repeatedly improves children’s ability to evaluate and revise their own designs.
Responding to Mentors’ Feedback. A small percentage in each group responded to mentors’ feedback; however, expert and moderate users did so much more frequently compared to novice users. This skill may improve as children engage in more and more projects.

Reflecting on Mentor Feedback. Of those who did respond to mentors’ feedback, a greater percentage of expert and moderate users were effective in this reflection. Completing multiple projects may improve children’s ability to engage in meaningful reflection.
Using Mentor Feedback to Improve Design. Of those who did respond to mentors’ feedback, a greater percentage of expert and moderate users were effective in using this to improve the overall design of the project. Completing multiple projects may improve children’s ability to use mentors’ feedback effectively.

Overall, there are multiple indicators that children who complete at least two projects—and, ideally, three or more—benefitted in their ability to design with creativity, use novel materials, improvise on the design process based on directions, reflect on design elements, evaluate their own work, and respond to mentor feedback.
Curiosity Machine User Ages
The mean age of the participants was 9 years old, but ages ranged from 4 years old to 17 years old.

A subgroup analysis of web data codes was conducted by grouping a sample of projects for which a child’s age was known. Original coding criteria were then examined by age band. Specifically, “older users” were 9 or older (range 9 to 17 years of age) and “young users” were 8 or younger (range 4 to 8 years of age). The young user group likely received a significant amount of assistance from a parent or other adult during the design and submission of that design. This analysis attempts to better understand the added benefit of parental or other adult involvement in the design process.

Project Structure and Design Strength. All projects were rated effective in some manner; however, a much greater percentage of younger users were rated as effective compared to older users. If we assume that younger users received guidance from a parent or other adult, this may indicate that guided support improves the overall project structure and design strength.

Project Aesthetics. Younger users had an overall higher percentage of projects that rated as “effective” in demonstrating project aesthetics. Again, this could reflect the benefit of structured support from parents or other adults.
Project Creativity. On average, older users were more effective overall compared to younger users in completing projects in a creative way. It is possible that the structured support provided to younger users may have hindered project creativity in subtle ways.

Project Performance. On average, user groups were very similar on project performance, with slightly higher ratings for older users.
Uploaded Visual Evidence (photograph or video). A much larger percentage of older users uploaded visual evidence for projects. Older users may have been more familiar and comfortable with collecting and uploading this information to the Curiosity Machine website.

Utilized Recommended Materials. A much higher percentage of younger users used the recommended materials in the design of their projects. Perhaps older users were more flexible in their use of materials or had differential access to materials.
Demonstrated Observations about Process and Design. On average, a greater percentage of younger users demonstrated observations about the process and design. This may reflect the inclusion of parents and other adults in the design process for younger users.

Following Instructions. A greater percentage of younger users followed project design directions as they were written. It is possible that older users felt more comfortable deviating from the directions after completing several projects. Not following directions may be a good outcome that indicates growing cognitive flexibility and engagement with the design process.
Maintaining Design Ideas Throughout the Process. Younger users were, on average, very slightly more effective in maintaining the design idea throughout the process. This may reflect the inclusion of parents and other adults in the design process for younger users.

Demonstrated Knowledge with Specific Vocabulary. A greater percentage of younger users effectively demonstrated knowledge using specific vocabulary. This may reflect the inclusion of parents and other adults in the design process for younger users.
Evaluating Own Work and Suggesting Modifications. A slightly greater percentage of older users effectively evaluated their own work and were able to suggest design modifications. This may indicate that older children have an increased ability to evaluate and revise their own designs. It could also be heavily influenced by the inclusion of parents and other adults in the design process for younger users.

Responding to Mentor’s Feedback. A small percentage in each group responded to mentor’s feedback; however, older users did so much more frequently compared to younger users. This skill may improve as children age.
Reflecting on Mentor Feedback. Of those who did respond to mentor’s feedback, a greater percentage of older users were effective in this reflection. Again, age may improve children’s ability to engage in meaningful reflection. However, if we continue to assume that parents or other adults are providing guidance to younger children, these adults may need additional help learning how to reflect on mentor feedback.

Using Mentor Feedback to Improve Design. Of those who did respond to mentor feedback, a greater percentage of older users were effective in using this to improve the overall design of the project. Again, age may improve children’s ability to use mentor’s feedback effectively. However, if we continue to assume that parents or
other adults are providing guidance to younger children, these adults may need additional help learning how to help facilitate the use of mentor feedback.

Overall, there are multiple indicators that younger children, with the help of parents or other adults, are scoring higher on multiple indicators, such as project structure and design structure, aesthetics, using recommended materials, following instructions, and demonstrating knowledge with specific vocabulary. Conversely, older users achieved higher creativity and project performance scores. In addition, older users were more effective in responding to, reflecting on, and using mentor feedback.

Family Interviews
Interviews with families were conducted both in-person and by phone.

In-Person Interviews
In New York, the evaluation team interviewed four parents—two male and two female—from two different sites about their experiences with the Family Science program. Two of the parents were returning participants—both have been part of the program for over two years and have participated in multiple Iridescent programs in previous years. The other two parents were new to the program. They were all recruited through their child’s school; either by a teacher or by the school principal. Despite their varying experiences, they all praised the program, as their total experience with the Family Science program has certainly been positive.
Parents enjoyed participating in the Family Science program and believed that the program had a positive impact on their children’s learning. As one parent stated:

“It is a great opportunity to keep our kids away from the community and television. A lot of kids don’t have this opportunity, but our kids are here to learn.”

They were particularly fond of the hands-on activities and described them as fun and enriching. Parents also liked the fact that their children were learning from expert engineers and scientists, and were getting first-hand experience building things with them and getting feedback from them. Parents said:

“Children need encouragement to become confident and motivated, and the mentors provide just that.”

“As a mother, I like that my children enjoy the sessions. My children love science and doing creative stuff and building things. I think it’s a great partnership with the school—bringing the children and their families together after school to do fun science activities. I also like the content [topics and concepts] covered, and the fact that my children are exposed to things that they wouldn’t normally do in the classroom.”

Among parents who used the Curiosity Machine website, they logged in to help their children and supervise them when they were on the website and working on activities. However, they all admitted that their children were the more frequent users, especially the older children who can easily navigate the website and work on activities with their younger siblings.

When asked how the website has affected their families, they said that it had affected the family in many ways. A father stated that his son “is more open about his academics and more comfortable and open talking to him about his designs,” which he attributes to the teamwork structure and approach of the program. Another parent mentioned that she has noticed that her sons “are more comfortable talking and engaging with science projects. Whether it is building or designing things around the house, or working on school projects.” In general, parents reported that their children were “totally into the program” and often recruited and invited their friends to the sessions.

Parents also liked the staff because they were dedicated and helpful. The quotes below demonstrate the respect and appreciation that parents have for staff.

“They make it so easy and simple. You see the love.”
“It’s different from what you see around. The staffs are smart, patient, and always willing to help.”

“The Iridescent staffs are awesome. They care so much for our children and are there for them.”

*Family telephone interviews*

The evaluation team conducted interviews with parents and elementary school students to inform project activities and to document their experiences. The interviews lasted approximately 20 minutes, and were conducted over the phone at a time of their convenience. The interview questionnaires complemented the surveys by providing additional information on parents’ and students’ use of technology and their engagement with and participation in Curiosity Machine.

*STEM Background.* All parents said that they were comfortable engaging in science projects with their children at home. They all reported doing some form of activity with their children. Parents talked about allowing their children to play science games and watch educational videos. Other common activities included microscope study, learning about gravity, observing a celery stalk absorb water, building with Legos, and building things from materials around the home.

*Technology Background.* In general, families have at least one working computer with Internet access at home. The more affluent children have their own laptop computers or tablets to access games and videos. Other technologies present in homes include TV, DVD, smart phones, Wii, Nintendo DS, and tablets. Parents reported using the computers, but the general consensus was that they make a great effort to monitor screen time on school days.

In terms of how families are using technology at home, parents with younger children used the computers or tablets to watch fun, educational videos on YouTube. The older children were allowed to use their computers for learning and leisure at least once a week, but could spend more time on the computer to work on specific assignments that required the Internet. Television and games were generally reserved for weekends. Parents said that they used their computers for conducting business, downloading music, movies, and games, chatting, and so on. Both parents and students could access the CM website from home.

*Use of Curiosity Machine Site.* In general, the older children used the website more than the younger children did. Among those who used it, they followed instructions on the website, answered questions about their projects, and uploaded pictures and
videos of their projects. A typical user uploaded around four projects and received feedback from program mentors to revise and improve projects. It should be noted that this is a very high number of projects when compared to the web use data set, thus the interview responses may represent expert users more than novice or moderate users.

Children reported zero use of the website after the end of the summer program. School demands—homework and accompanying activities—were some of the reasons that were cited by both students and parents. Although a majority of parents were familiar with the website, they did not use it as much. Almost all parents who participated in the interview stated that they did not use it as much as they would have liked.

Program Impact. Both parents and students have been overwhelmingly positive about the program. Students are thrilled to have access to the website, create fun science projects, and get feedback to improve projects. The website is a tool to help them solve problems. For parents, fostering their child’s interest in science is top priority and they feel that a project like Curiosity Machine helps children learn new ways to understand the world. In the words of one mother,

“Having access helped him to get instructions on how to build things. The samples and instructions on how to get started reinforces interest because kids know that it is there as a reference.”

However, parents of younger children would like to see more content geared for preschool-aged children on the website. One parent wishes the website would suggest activities by age. That way, she could quickly see where to start for an appropriate preschool level of discovery. There is very little to be found for younger children trying to get this exposure.

Barriers to Use. Overall, parents and students like the content and messaging of the website. They think it is a great and useful tool. The barriers most frequently reported by parents and students were (1) the website’s technical glitches and (2) lack of time in the schedule for parents and students to work on projects, especially during the school year.

Family Surveys
To assess parents’ and students’ comfort levels and attitudes toward technology and engagement with the Curiosity Machine website, the evaluation team administered
a family survey and asked parents to complete a survey with their children. The surveys consisted of a number of open-ended questions and quantitative items, designed to gather information about participants’ technology literacy skills and use of technology.

**Pilot Session Survey Findings (Fall 2013)**
The results reported in this section are based on the analysis of post surveys of the thirteen parents surveyed during the pilot semester in Fall 2013. Three parents (23%) were male, and nine (69%) were female.

**Curiosity Machine Recruitment.** Parents found out about the Curiosity Machine program from multiple sources. Ninety-two percent (92%) first learned about the program from their child’s school, and 8% each reported that they heard about it through a teacher, a friend, or Iridescent staff.

![Bar chart showing how parents heard about the program](image)

**Parents’ use of Curiosity Machine Website.** Thirty-eight percent (38%) of the parents have a Curiosity Machine account and have either uploaded projects or browsed activities and videos on the website. Of the sixty-two percent (62%) who reported that they have never accessed the website, 15% had never heard of the website, and 31% reported that they were too busy and did not have time to visit the website. Another fifteen percent (15%) have not had the opportunity to create an account but plan to do so in the near future.
Parents’ Interests and Engagement with Website. The survey asked parents to talk about their experiences using the website and to rate the extent to which the website contributed to their interests. The survey used a five-point scale, with 1 signifying ease of use or interest in design of the website, 2 signifying fairly easy or interesting to use, 3 signifying no interest or use of website, 4 signifying quite a bit more difficulty or lack of interest, and 5 signifying a lot more difficulty or lack of interest. Overall, parents’ responses indicated that the objectives of the website were easy to understand. Parents also reported that the design of the website was interesting/fairly interesting and easy/fairly easy to navigate.
Parents’ Comfort Levels with Technology. As shown in the next two charts, seventy-seven percent (77%) of parents feel very comfortable using technology, while ninety-two percent (92%) feel very comfortable engaging in science projects with their children.
Students also were surveyed in Los Angeles and New York City about their overall experience with the Curiosity Machine Project. Of the 33 students who responded to the survey, 44% were male and 56% female.

Curiosity Machine Recruitment. Students found out about the Curiosity Machine from multiple sources. Sixty-four percent (64%) of the students reported that they heard about it through their school, sixty-seven percent (67%) through their teacher, whereas six percent (6%) each reported that they first learned about it through a friend or from a flyer. Thirty-six percent (36%) indicated that they have accessed the website at home, and sixty-four (64%) percent at school.
Below, we report the findings from the surveys in four sections: student comfort levels with technology, student engagement with the website, student experience with Curiosity Machine, and student interests in science and engineering.

**Students’ Comfort Levels with Technology.** Overall, students indicated that their parents/guardian felt comfortable helping them with their science projects.

In the same vein, students reported feeling comfortable using technology.
**Students’ Engagement with Website.** Asked to assess the quality of the website and their engagement with it, fifty-two percent (52%) reported that it was easy to understand and thirty-five percent (35%) reported that it was fairly easy to understand.

![Bar graph showing students' assessment of website objectives](chart1.png)

A large percentage indicated that the design of the website was easy/fairly easy to navigate.

![Bar graph showing students' assessment of website design](chart2.png)
A majority of the students reported that the design of the website was interesting/fairly interesting.

**Student’s Experience with Curiosity Machine Project.** Students were asked to describe their experience with the Curiosity Machine. Forty-two percent (42\%) indicated that they have not used the Curiosity Machine, whereas fifty-eight percent (58\%) reported that they have used it. Asked to explain why they have not used it, students had a variety of responses. Some reported that they could not log in to the website or their teammates were in charge of the accounts. Other students reported that they were either busy with schoolwork or completely forgot to do it.
A greater percentage of students reported that they did not have access to online mentors or did not receive regular online support and encouragement from mentors (see Charts below).

An even greater percentage reported that they did not have online mentors who inspired them, and that they did not receive online support and encouragement from the Iridescent team (see Charts below).
However, a majority indicated that they received useful feedback and clear guidance from the Iridescent team and that they understood the instructions provided on the Curiosity Machine website.
Fifty-four percent (54%) reported that they experienced difficulties on the website when they uploaded their projects; whereas forty-six percent (46%) reported that they did not encounter problems when uploading their projects.
More than half indicated that they reworked their projects based on feedback from their mentor.

An overwhelming number reported that they did not resubmit revised projects for online review.
Students’ Interest in Science and Engineering. Both before and after their participation in the program, students were asked a set of questions to rate their interest in tinkering and building, and their persistence in troubleshooting and redesign in project work (see charts below).
I would rather find out why something happens by doing an experiment than by being told how it works

Strongly Disagree Disagree Not sure Agree Strongly Agree

Percent of Students

I am likely to keep trying if I don't figure something out after that first attempt

Strongly Disagree Disagree Not sure Agree Strongly Agree

Percent of Students
I like doing experiments and testing things more than I did before

I like trying things out as I go
I understand science and engineering better

I am better at solving complex problems and challenges
Full Curiosity Machine Session Survey Findings (Spring 2014)
The current family survey builds on findings from the 2013 parent and student surveys. Of the 61 parents who responded to the survey, 82% were female and 18% male. Ninety-seven percent (97%) of the parents responding to the survey reported that they had Internet access at home; forty-four percent (44%) reported that they had at least one computer at home, and fifty-three percent (53%) reported owning multiple computers. Only three percent (3%) reported not having a computer at home. Parents were asked on the survey if they or their family members owned a smartphone that has access to the internet. Ninety-three percent (93%) reported that they did.

Curiosity Machine Recruitment. Parents found out about the Curiosity Machine project through a variety of sources. Among the parents who completed the survey, sixty percent (60%) learned of the program through their child’s school, twenty-four percent (24%) heard about the program from a teacher, eighteen percent (18%) from a flyer, and nine percent (9%) each reported that they heard about it through a friend, or via the internet/email. Sixteen percent (16%) were returning participants and indicated that they had participated in another Iridescent program. The majority of parents reported having accessed the website either at home or at the Iridescent program/studio.
Parents’ Use of Curiosity Machine Website. Parents were asked on the survey to indicate whether or not they have used the Curiosity Machine website. Fifty-seven percent (57%) of the parents reported that they have not used the Curiosity Machine, whereas forty-three percent (43%) reported that they have used it. Of the fifty-seven percent (57%) who reported that they have never accessed the website, six percent (6%) reported that they were too busy and did not have the time to visit the website, and two percent (2%) did not know about the website. Another four percent (4%) were new to the program and have not had the opportunity to create an account but plan to do so in the near future.

Parents’ Comfort Levels with Technology. In general, parents feel very comfortable using technology and engaging in science projects with their children. Fifty-seven
percent (57%) indicated that they felt very comfortable engaging in science projects, while thirty-nine percent (39%) felt somewhat comfortable.

Additionally, sixty-four percent (64%) reported feeling very comfortable using technology, and thirty-three percent (33%) reported feeling somewhat comfortable with technology.

**Parents’ Engagement with Website.** Overall, parents’ responses indicated that the objectives of the website were easy to understand.
An overwhelming number of parents reported that the website is appealing, and showed agreement on the design of the website.

Parents also indicated that the website was easy to navigate.
Child’s Experience with Curiosity Machine Project. Parents were asked on the survey to describe their child’s experience with the Curiosity Machine project (see charts below).
I have access to an online mentor to answer my questions and provide feedback

![Bar Chart](image1)

I receive regular online support and encouragement from my mentor

![Bar Chart](image2)

I have an online mentor who inspires me

![Bar Chart](image3)
I receive online support and encouragement from the Iridescent team

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<th>No</th>
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<td>54</td>
<td>46</td>
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I receive useful feedback and clear guidance from the Iridescent team

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<tr>
<td>70</td>
<td>30</td>
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I understand the instructions provided on the Curiosity Machine site

Percent of Students

Yes  No

I upload my project on the site without difficulties

Percent of Students

Yes  No

I rework my project based on feedback received from my mentor

Percent of Students

Yes  No
Child’s Interests in Science and Engineering. Both before and after their participation in the program, parents and students were asked a set of questions to rate their interest in tinkering and building, and their persistence in troubleshooting and redesign in project work (see charts below).

I resubmit my revised project for online review

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<th>Percent of Students</th>
<th>Yes</th>
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In science experiments, I like to use methods which I haven’t tried before

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<th>Percent of Students</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
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I would rather find out why something happens by doing an experiment than by being told how it works

I am likely to keep trying if I don't figure something out after the first attempt

I like doing experiments and testing things more than I did before
I like trying things out as I go

I understand science and engineering better

I am better at solving complex problems and challenges
Mentor Interviews

*Mentorship Training Program*

**Recruitment**
The program usually reaches out to professional science teachers or graduate students, or to people who are obviously trained scientists or engineers who might have the free time or interest in mentoring. There is also a volunteering form online where people can submit their contact information if they wish—and the program does get a lot of responses that way. Otherwise, the program works with local universities to recruit graduate students or students who have completed teaching courses.

**Mentor Training**
All mentors who participated in the Curiosity Machine completed a five-part course in mentorship training prior to the beginning of activities. The program was offered to volunteer mentors through Google communities; each course lasted about 2–3 hours and was spread out over two weeks. This course was a quick refresher on how to interact with children to guide them through an open-ended design challenge and evaluate completed projects on the Curiosity Machine website. In general, mentors go through several practice tasks to learn how to provide feedback before getting approval from the lead mentor to become “active mentors” on the Curiosity Machine website. This is a critical component because the mentors provide useful tips and feedback as children work on their individual projects at home.
Most mentors came to the training with at least some prior experience with teaching or working with students, and often were motivated to serve as mentors in order to gain more experience in a digital setting. The trainers rated the training as very good, and appreciated that it was organized and succinct, yet comprehensive, and allowed mentors to gain skill in an efficient way. For example, one mentor said, “really comprehensive but really accessible at the same time.” Mentors reported that the training tasks took the right amount of time and made the mentors think more deeply about how to help students progress. They also felt that conducting the training in an online environment was a excellent preparation for working with students online.

Beyond familiarizing mentors with the Curiosity Machine projects and website, the mentor training focused on how to praise what students had done thus far (i.e. praise focused on the process) and then prod them to think more deeply or to try something additional. One mentor said that training helped her to provide praise in “an open-ended way that focused on their process.” The most beneficial activity during training involved explaining science using only the 100 most common words. One mentor explained that this activity “was an interesting challenge for me ... it really put it tangible form for me ... how is it that you could simplify, simplify, simplify as much as possible and still get the meaning across.”

There were two suggestions for improving the training. First, the training activity that provided mentors with scenarios of student responses and asking them to provide sample responses could be expanded to provide mentors with more practice in giving feedback. The second suggestion was to improve interaction between mentors, both during the training with explicit activities that require interaction between them and after training so that mentors could develop a support system.

Overall, the mentor training was highly successful. Iridescent may wish to consider expanding this training to teachers and parents in order to facilitate the mentoring experiences students receive from multiple sources.

The Experience of Mentoring

The number of projects for which mentors provided feedback ranged from between 12–45 projects. Mentors reported that the process of providing feedback was simple, with specific questions for students to answer and mentors to respond to. In general, mentors attempted to give feedback that would help the students think
more deeply. The first time mentors responded to student submissions they felt nervous, but gained confidence quickly over subsequent submissions. Mentors typically approached the task of providing feedback by looking at the lesson first, reading through all of the students’ submitted work, and writing feedback that focused on asking students to think more deeply or to try different conditions. Mentors noted that the Gravity Design Challenge was particularly effective, as the competitive element helped lead to a quick response feedback loop between mentors and students. Overall, the program provides a good balance of projects that are achievable for students with a process that provides guidance, yet also allows them to explore on their own.

The quality of student submission varied greatly; sometimes projects were described as “dazzling” while others were incomplete, but the average project was of acceptable quality. Mentors often felt that the highest quality projects were the ones completed at home, likely because students attending an in-person program may have run out of time to finalize the online submission, despite having a very good experience during the session.

The main concern expressed by mentors was the low response rate, and this was disappointing and frustrating for them. The mentors wanted students to continue toward completing projects, and attempted to leverage their feedback to provide positive, encouraging guidance. At times, mentors struggled with not having an option to encourage students to do more after their initial response. Mentors suggested adding additional communication features to the website, so that they could send reminders and additional comments in an effort to continually engage students.

**Impact on Mentor**

The experience of mentoring for the Curiosity Machine was overwhelmingly positive. The mentors enjoyed the training, the online process, engaging in meaningful interactions with students, and learning about how to capitalize on the affordances of the online learning environment, such as responding to student projects at convenient times. One mentor summarized the impact:

“I loved it. Like I said, it was a super easy way to give back ... and feel like I was actually making a difference in someone’s life and actually helping to get them involved and interested in science ... in this incredibly low-commitment sort of way. It was super rewarding! And it was really great to teach you how to mentor! Like I said, I really value
teaching, and the experience of learning how to be better at that and getting practice at that is really valuable to me.”

**Impact on Students**
The mentors felt the impact on students was very positive, and that the most valuable aspect of the program was the ability of mentors to help students think through the design process and to push students to learn more during the “feedback loop.” Specifically, mentors summarized the impact on students in the following ways.

- “Pretty incredible that kids were making projects and posting videos and posting pictures. From what I saw they were very enthusiastic about what they were doing. The projects themselves seemed to work well.”

- “They [students] seemed pretty inspired, which was great. I think that it’s a different environment than they are used to in learning science, it’s not reading a dry textbook and learning facts, it’s playing, which is a great way to learn. In general, they all seemed pleasantly surprised as to how much fun they were having. Which is a great impact; it’s a great thing to tie science to fun in their minds.”

- “I thought that I got the most out of the experience and I felt like my kids got the most out of the experience when we were really able to build a back-and-forth dialogue on some of the questions ... because of having that back-and-forth part, you get to have a relationship with the students and they get to go through this thinking process a little bit more, and it became really enjoyable for both the student as well as the mentor. That was something that wasn’t able to happen for every one of the students’ projects. It becomes part of logistical issues ... . (Some of the students don’t have computer access regularly.) ”

**Mentor Recommendations for the Future**
There were three main recommendations that mentors had for the Curiosity Machine project. The first was to find a way for greater interaction between mentor and student—especially early in the process—and they suggested allowing mentors to send additional messages to students to check in with them or to add additional thoughts on a student’s submission, as the current system does not allow for more
than one response from the mentor to the student. Mentors also would like the ability to see online whether a student has read a mentor’s comment.

The second suggestion was to require students to list their age in their profile, in order to allow mentors to personalize their feedback to the students’ age and improve the likelihood that students will find the feedback encouraging and will continue working on the project.

The third suggestion was to create a trajectory of projects that begins with simpler projects, for younger students or those less experienced with science, and then build in difficulty over time. This strategy might allow students to achieve success early on and might motivate engagement in more projects.

Staff Interviews
The evaluation team interviewed four Iridescent staff from the New York and Los Angeles offices. They asked staff to share information about their backgrounds and experiences running the various programs for the Transformative STEM Learning (TSL) grant.

Overall, the staff members are excited and happy to work on the programs—they think the programs are strong, and are what they thought they would be. The Curiosity Machine, however, has been a struggle, especially in getting families to work on it. The team understands the weaknesses of the platform, and they are working hard to fix those problems. One thing they are learning along the way is that it is very difficult to ask families to go from an in-person experience to a totally online guided experience. They have had very positive interactions with families so far, and very positive moments in which parents voice their appreciation for the program. One staff member described the experience in the following way.

“The children like it, they understand interacting with the website, they appreciate being able to share, and they love getting feedback. For parents, the Curiosity Machine is really great because they get intimidated by science, and having that sort of mentorship possibility relieves some of the pressure on them.”

Despite the positive impact of the program on families, staff members mentioned technology problems that hampered implementation. Technical aspects have been challenging, particularly having to work in underserved communities that do not
have computers and other necessary hardware. Staff have found out that most of the school computers do not have webcams for the activities; often, the schools disable their webcams for security reasons. The libraries and computer labs usually have limited numbers of computers, which consequently limits participation. But staff are confident that they will be able to make the necessary adjustments to the website, and they hope it will improve the online experience of the families and students they work with.

Other challenges identified by staff arose largely as a result of the difficulties involved with collaborations and partnerships. All participating schools were recruited via parents who have participated in previous programs, or through building partnerships with local schools. Iridescent also is working with various higher education institutions (e.g., University of California, Berkeley) and technology corporations (e.g., Google).

**More enthusiastic and committed partners/staff at the schools.** An important role for program staff is to cultivate new partnerships and to maintain the relationships that they have with schools, universities, museums, and other organizations. Program staffers also are responsible for finding the contacts at the schools and recruiting people who are willing to work with them to implement the programs. The partnership between schools and libraries and Iridescent staff has improved for several reasons, including more involvement of key stakeholders in setting goals and a clear understanding of the respective roles and responsibilities in the implementation of programs. They want families to participate in the programs and engage with the materials, but it all hinges on the full participation of their partners to recruit those families, reserve the space for sessions, and get families to attend the sessions.

**Greater involvement of partners.** While the program is reaching a much larger population, there remains room for expansion; that is why Iridescent staff are interested in involving more partners and training partners. They are actively and constantly reaching out to afterschool programs and local schools to establish ongoing professional development sessions for partners—not just the initial introduction to the Curiosity Machine website, which they always offer, but training on how to share that knowledge and get more people engaged with it. In addition, staff offer educators the opportunity to come to their studios, participate in new challenges, and provide feedback on the materials so that partners are engaged much more in the process and can learn the skills to implement the activities.
In recent months, staff have had success at some libraries and schools, and have been able to motivate the teachers and administrators to lead the sessions on their own. For example, in Los Angeles, they have asked school principals to assign one teacher to attend sessions so they can see how the courses are executed and how to use the website and the computer lab. The ultimate goal is to have more teachers leading the sessions and transitioning into a science club. This has not worked in other cities, but staff have had some success in Los Angeles with the Curiosity Courses.
CONCLUSIONS AND RECOMMENDATIONS

Revising the Evaluation Questions

1. Do parents and students use the Curiosity Machine to complete science projects?
   In general, parents did not use the Curiosity Machine to complete projects, for various reasons. All of the parents responding to interview questions admitted that they did not use the Curiosity Machine as much as they would like. Although some working and single parents may be unable to engage with the website because of work commitments and time constraints, some parents are committed and readily volunteer their time for the program. Students, on the other hand, are more active users, especially the older students who often are either moderate or expert users of the website. To effect change, parents must find time to participate both in the in-person sessions and at home with their children. (sources: family interviews, website data)

2. Do parents and students achieve adequate technology literacy skills?
   As part of the in-person sessions, staff teach families how to work with the technology they have onsite and show them what they have to do. The objective is that, at the end of the five weeks, the families will feel empowered to do informal science at home and to continue using the Curiosity Machine at home. In LA, the program also works with schools to do afterschool activities at their sites to prepare students for informal science, and encourages educators to consider using the Curiosity Machine in class as a way to enhance different ways of learning through hands-on building. Finally, the summer program explicitly targets parents’ technology literacy by holding parent technology sessions at the beginning of the summer.

   Overall, parents and students were able to access the Curiosity Machine site, engage in design challenges, and submit projects. (sources: session observations, staff interviews)

3. Do parents and students increase their engagement in science projects that include tinkering and building?
   Parents were asked on the surveys and interviews to state what impact the program had on their child’s interest and engagement in science projects. A large percentage of parents and students indicated that they understand science and
engineering better, are better at solving complex problems and challenges, and are better at figuring out how things work. Parents also reported that the program helped to get their children excited about science and to engage in hands-on science activities in school and at home. (sources: family surveys, family interviews)

4. What strategies do parents and students use to troubleshoot and redesign science projects?
Both parents and students find the mentor feedback very exciting and motivating. It means a good deal for them to see the mentor responses, even if it does not seem like the most meaningful interaction due to how little the students are posting responses to that feedback. Asked to describe his family’s experience with the Curiosity Machine, one parent responded, “Children need encouragement to become confident and motivated, and the mentors provide just that.” (sources: mentor interviews, family interviews)

Program Successes
There are many ways in which the Curiosity Machine has been successful.

The first success is in positively affecting parents and children. Parents and children enjoy participating in the program. They describe it as fun and enriching, and parents do not have to worry about keeping children interested. Parents understand the value of the program, and the children feel that there is a purpose for it. One of the students described the program as, “It’s like school, but more fun.” The program also is reaching a much larger population through the online Curiosity Machine portal compared to in-person sessions. In fact, two staff members mentioned that the spring 2014 session has been their most successful session in comparison to last fall.

Learning outcomes for teaching discreet concepts and for encouraging students to persist through failure seem positive. Session observations revealed that children are attempting five to six variations of the same design without getting discouraged or upset. Children would come up to a staff member after their second try to ask what they were doing wrong, and would get the help they needed, but did not seem unhappy or embarrassed. If their designs did not work, they understood that it is part of the process of learning; they understood that they are learning through doing.
Project learning as evidenced by uploads to the Curiosity Machine also demonstrate positive learning outcomes. The majority of projects were effective in terms of the structure and design strength of the projects, aesthetics, creativity, and performance. In addition, the majority of participants followed directions and used the recommended materials, recorded observations about process and design outcomes, maintained the design requirements throughout the process, and demonstrated knowledge using specific vocabulary.

The second set of successes relates to program staff. Iridescent has outstanding staff, facilitators, instructors, and volunteers, and they provide quality programing. The in-person sessions are very well done. Enthusiasm among students, staff, and instructors also is very high.

Perhaps an element of that success is the quality of the mentor training—which was well rated by mentors—and the mentoring component of the CM program. In general, mentor feedback was helpful and guided students in the right direction. However, mentor feedback could improve in the amount and quality that provides details on how to improve project designs, and by highlighting errors without providing the correct answer. In addition, although the feedback loop between mentors and students is clearly beneficial, the CM system does not allow mentors to respond multiple times to entries or to send reminder messages to students.

The third set of successes relates to the number and quality of partnerships. More external partners were engaged as collaborators by the end of the grant. The Curiosity Machine has strong partnerships with a variety of stakeholders, especially schools and libraries. They are working with a number of school partners who have established connections with the organization, but are also reaching out to new partners and a few schools in the LA area. In New York, the Curiosity Machine staff have good relationships with the schools. One staff member mentioned that the relationships have been on a much improved trajectory since the program began. For example, school staff members are recruiting families, making the reminder calls, and ordering food for the sessions. Additionally, the principals and teachers are much more interested and excited about the program and the possibility of incorporating CM programs into their existing instruction/classroom work.

Program Challenges
One of the biggest challenges was getting families and children to engage with the website at home. According to staff, the students really enjoy building at the in-person sessions, but building at home with their families was more difficult in
terms of completing and uploading projects. However, mentors noticed that the overall quality of submitted projects was better for projects completed at home. This may be due to the fact that participants at in-person sessions felt less compelled to submit full answers and frequently did not follow up with mentor feedback. In addition, projects conducted by younger students were generally of higher quality, probably due to increased parent participation in the process. The CM was created with the idea of getting students to build at home—in particular, with their parents—and to have parents encourage those behaviors. For younger students, this seems quite effective. Overall, though, it remains a challenge for families to engage in and complete design projects on a consistent basis.

A second challenge is the lack of technology and Internet access in schools and libraries. However, the new features of the website and librarian training should help lesson this challenge.

A third major challenge was that students struggled to evaluate their own work, suggest possible modifications, and respond to mentors’ feedback.

Recommendations for the Future
There are a number of recommendations based on the evaluation findings. These include the following.

- Make mentor training more widely available, and evaluate the impact of that training on mentor ability and knowledge. These mentor trainings also might be useful to teachers and parents, or could be integrated into other models of implementation. (sources: mentor interviews, evaluation team)
- Incorporate additional user-friendly features to encourage more participation and engagement with the website. Program staff agree that the new website will reflect some of these changes and will allow students to interact more with the site. Some of the new features mentioned were:
  - the new website will be much friendlier to smartphones and tablets
  - developers have included better profiles (personal touch) to make the interaction more fun, inviting, and engaging (sources: staff interviews)
- Whenever possible, allow for more interaction, both online and in-person, between mentors and students.
The current website does not allow mentors to send reminders and additional comments to students who have submitted projects. It would be helpful if mentors could (1) send multiple responses to a submission, both to add additional feedback and as a method to increase communication with students and establish a deeper feedback loop, (2) send responses to students not related to specific projects, and (3) see whether or not a student has viewed their mentor’s feedback.

In-person experiences with mentors might be useful, whenever possible. For example, mentors could be introduced at in-person sessions or by free video calls (i.e., Skype). Families do appreciate the in-person interaction, and an initial introduction might facilitate engagement between students and mentors in the online environment. (sources: website data, mentor interviews)

- Improve the program for teacher use, for example, paying the teachers (teachers are student volunteers), or structuring the program as a course in which students receive credit for participation as a way to hold them accountable. (sources: staff interview)
- Add a support within the Curiosity Machine website to help students evaluate their own work and suggest modifications. (This did improve as students completed more projects.) (sources: website data, evaluation team)
- Hold Family Science sessions in the schools in order to get students, parents, and school staff more involved in the program. (sources: staff interviews)
- Translate the videos, design directions, and website text into other languages (e.g., Spanish). (sources: family interviews, staff interviews)
- Provide easier design challenges for younger children and those just starting out, to build confidence. (sources: family interviews, staff interviews)
- Include the entire curriculum online. According to staff, Iridescent has some high-quality resources that are not currently online. (sources: staff interviews)
- Improve the login to allow for families with multiple children. (source: staff interviews, family interviews)
REFERENCES


APPENDICES

List of Surveys and Interview Protocols:

- Appendix A: Curiosity Machine Family Survey (English)
- Appendix B: Curiosity Machine Family Survey (Spanish)
- Appendix C: Parent Phone Interview Protocol
- Appendix D: Student Phone Interview Protocol
- Appendix E: Curiosity Mentor Interview Protocol
- Appendix F: Iridescent Staff Interview Protocol
- Appendix G: Curiosity Machine Project Review Criteria
Appendix A: Curiosity Machine Family Survey (English)

1. What is your username for the Curiosity Machine website:_________________

2. Are you: __ Male __Female

3. What is your child’s gender: __ Male __Female

4. Do you have internet access in your home? __No __Yes

5. Do you own a computer in your house? __No __1 computer __Multiple computers

6. Do you or members of your family own a smartphone that has access to the internet?
   __No __Yes

7. What is the primary language spoken in your home?
   __English __Spanish __Other (specify):_________________

8. How did you and/or your child hear about this program? (Select all that apply)
   __ Participation in another Iridescent program
   __ Child’s school
   __ Teacher
   __ The internet, email
   __ A flyer
   __ A friend
   __ Walk by the Iridescent studio
   __ Science Festival
   __ Iridescent staff member
   __ Child mentioned it to me
9. Please indicate your level of comfort below.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Very Comfortable</th>
<th>Somewhat Comfortable</th>
<th>Somewhat Uncomfortable</th>
<th>Very Uncomfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>How <strong>comfortable</strong> do you feel engaging in science projects with your child(ren)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How <strong>comfortable</strong> do you feel using technology?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I understand the site objectives.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The design of this site is easy to navigate.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The site is appealing to use.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

10. Have you **used** the Curiosity Machine yet?

   ___ No (respond question 8) ___ Yes (skip to question 9)

11. If you have **not** used the Curiosity Machine, please describe why not?
Please answer the next few questions from your child’s perspective.

12. Where have you and/or your child accessed the Curiosity Machine website? (circle all that apply)

___ Home  ___ School
___ Friend’s House  ___ Iridescent Program
___ Other (please describe): _________________________

13. Please select the statements that best describe your child’s experience with the Curiosity Machine Project?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have used the Curiosity Machine.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have access to an online mentor to answer my questions and provide feedback on my project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I receive regular online support and encouragement from my mentor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have an online mentor who inspires me.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I receive online support and encouragement from the Iridescent team.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I receive useful feedback and clear guidance from the Iridescent team.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I understand the instructions provided on the Curiosity Machine site.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I upload my project on the site without difficulties.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I rework my project based on feedback received from my mentor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I resubmit my revised project for online review.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14. Please ask your child to indicate their level of agreement with each of the following statements.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Not sure</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>In science experiments, I like to use methods, which I haven't tried before.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would rather find out why something happens by doing an experiment than by being told how it works.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am likely to keep trying if I don’t figure something out after the first attempt.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like doing experiments and testing things more than I did before.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like trying things out as I go.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Since participating in this program, ...</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Not sure</td>
<td>Agree</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>I understand science and engineering better.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am better at solving complex problems and challenges.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am better at figuring out how things work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you for completing this survey!

Appendix B: Curiosity Machine Family Survey (Spanish)

1. Cuál es su nombre de usuario para el sitio web de la Curiosity:_________________
2. Usted es: __ Hombre __ Mujer
3. Sexo de su hijo(a): __ Hombre __Mujer
4. ¿Cuenta con acceso a Internet en su hogar? __No __Sí
5. ¿Cuenta con una computadora en su hogar? __No ___1 computadora ___Varias computadoras
6. ¿Usted o sus familiares tienen un smartphone con acceso a Internet? __No ___Sí
7. ¿Cuál es el idioma principal de su hogar?
   ___Inglés ___Español ___Otro (especifique):_________
8. ¿Cómo se enteró de este programa? (Seleccione todas las respuestas que correspondan).
   ___Mediante la participación en otro programa de Iridescent
   ___En la escuela de mi hijo
   ___Por la maestra
   ___Por Internet, correo electrónico
   ___Por un folleto
   ___Por un amigo
   ___Pasé por el estudio de Iridescent
   ___En el Festival de Ciencias
   ___Por un miembro del personal de Iridescent
   ___Me lo comentó mi hijo
9. Por favor indique su nivel de la comodidad abajo.

<table>
<thead>
<tr>
<th>Afirmaciones</th>
<th>Muy cómodo</th>
<th>Algo cómodo</th>
<th>Algo INCómodo</th>
<th>MuyINCómodo</th>
</tr>
</thead>
<tbody>
<tr>
<td>¿Que tan cómodo se siente al involucrarse en proyectos de ciencias con su(s) hijo(s)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>¿Cuán cómodo se siente al usar tecnología?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprendo los objetivos de este sitio.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>El diseño de este sitio es fácil para navegar.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>El diseño de este sitio es interesante.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. ¿En dónde ingresó al sitio?(marque con un círculo todas las respuestas que correspondan).

   ___ En el hogar
   ___ En la escuela
   ___ En la casa de un amigo
   ___ En el programa Iridescent
   ___ Otro (describa): ________________________________
11. Seleccione las afirmaciones que mejor describan la experiencia de su hijo en el proyecto sobre Curiosity Machine.

<table>
<thead>
<tr>
<th>afirmación</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>He utilizado la Curiosity Machine.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puedo comunicarme con un tutor en línea para que responda mis preguntas y me brinde comentarios sobre mi proyecto.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recibo soporte y ayuda en línea constante de mi tutor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tengo un tutor en línea que me inspira.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recibo soporte y ayuda en línea constante del equipo de Iridescent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recibo comentarios útiles y ayuda clara del equipo de Iridescent.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprendo las instrucciones proporcionadas en el sitio de Curiosity Machine.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puedo cargar mi proyecto en el sitio web sin dificultades.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modifico mi proyecto en base a los comentarios que recibo de mi tutor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vuelvo a subir mi proyecto revisado para su revisión en línea.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
12. Pídale a su hijo que indique su nivel de acuerdo con cada una de las siguientes afirmaciones.

<table>
<thead>
<tr>
<th>Afirmaciones</th>
<th>Muy en desacuerdo</th>
<th>En desacuerdo</th>
<th>No estoy seguro</th>
<th>De acuerdo</th>
<th>Muy de acuerdo</th>
</tr>
</thead>
<tbody>
<tr>
<td>En experimentos de ciencias me gusta utilizar métodos que no he utilizado antes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preferiría descubrir, por medio de un experimento, por qué algo sucede, en lugar de que me lo digan.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Por lo general, si no logro algo en el primer intento, vuelvo a intentarlo.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Me gusta más que antes hacer experimentos y probar cosas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Me gusta probar cosas todo el tiempo.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Después de participar en este programa:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprendo mejor ciencia e ingeniería.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resuelvo mejor problemas complejos y enfrento mejor los desafíos.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprendo mejor cómo descubrir algo.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Thank you for completing this survey!
Appendix C: Parent Phone Interview Protocol

Date of Visit: __________       Time of Visit: ___ am / ___ pm
Researcher: _______________________________

**Background Information**
1. How many people live in your house?
2. What do members of your family do for a living?
3. What is your ethnic background?
4. What is the primary language spoken in your home?

**Family Science Background**
5. How long have you been involved with the Family Science program?
6. How did you hear about the Curiosity Machine project?

**STEM Background -- Before getting involved in family science, ...**
7. Did you do science activities at home with your child(ren)? If yes, which types of activities? If not, why not?
8. How comfortable did you feel engaging in science projects with your child(ren) at home?
9. Did you take objects apart and put them back together with your child(ren) at home?
10. Did you create (design and build) new objects with your child(ren) at home?

**Technology Background**
11. Do you own a computer? If so, how many and how long have you had them?
12. Do you have an Internet connection in your home? If so, how long have you had them? Probes: Where else do you have access to computers and the Internet? What other technology do you own (TV, radio, MP3, Smart Phones, tablet computer)?
13. How often do you use these technologies with your child(ren)?
14. What do you use the technologies for? Probes: Look for information on the Internet, communicate with friends or family, participate in social networking activities, etc.
15. How do you feel about using technology?

**Family Science Experience (Spring 2013)**
16. What did you see your role(s) as during family science?
17. What did you do the most during Family Science? Probes: Did you work with your child(ren)? Did you work with other children/adults? Did you design and build something?
18. Did you design work? Did your child(ren)’s design work?
19. What did you feel worked well during Family Science? Probes: what did you like about the project activities?
20. Did you experience any challenges during Family Science?
21. Is there anything you would recommend changing for the next session?

22. Did you assist your child(ren) on her/his(their) projects at home? If yes, please describe your activities? If no, why not?

**Use of Curiosity Machine Site**

23. How familiar are you with the Curiosity Machine site?
24. Where do you use the site?
25. What do you use the site for?
26. How frequently do you use the site?
27. What motivates you to use the site?
28. What do you like most about the site?
29. Whom do you encourage to use the site?

31. Who is the primary user of the site in your household? Where do they access the site?
32. Who else in your home uses the site? Where do they access the site?
33. What do people in your household use the site for?
34. How frequently do people in your household use the site for?
35. Did you and/or your child(ren) post projects on the site? If yes, did you receive feedback? Did you revise your projects based on the feedback you received?

36. Do you have rules for your child/children’s use of the site? If yes, what are they?

37. Is there anything you think would help you and/or your child(ren) finish your/his/her projects at home and upload them to the site?

**Barriers to Use**

38. What are some challenges to using the site?
39. Have you had any technical problems with the site? If so, how did you resolve them?
40. What do you like least about using the device?

42. What would you need to take full advantage of the site?
43. If you could make improvements to the site, what would you do?

**Impact on you and your child(ren)**

45. Has having access to the site helped you do anything you couldn’t do before?
46. What did you learn from making your design and/or helping your child(ren) make their design?
47. What did your child(ren) learn from making their design at home?
48. Have you noticed any changes or differences in your child/children since you have had access to the site?
49. Has having access to the site made any difference for you and your family?
Appendix D: Student Phone Interview Protocol

Date of Visit: __________       Time of Visit: ___ am / ___ pm
Researcher: _______________________________

Background Information
1. How old are you?
2. What grade are you in?

Family Science Background
3. How long have you been involved with the Family Science program?
4. How did you hear about the Curiosity Machine project?
5. Why did you decide to participate in the Curiosity Machine project?

STEM Background – Before getting involved in family science...
6. Did you do science activities at home with your parents/siblings? If yes, which types of activities? If not, why not?
7. Did you take objects apart and put them back together with your parents/siblings at home?
8. Did you create (design and build) new objects with your parents/siblings at home?

Technology Background
9. Do you have access to a computer with Internet access at home? If so, how long have you had it? Probes: Where else do you have access to computers and the Internet? What other technology do you own (TV, radio, MP3, Smart Phones, tablet computer)?
10. How often do you use these technologies?
11. What do you use the technologies for? Probes: Look for information on the Internet, communicate with friends or family, participate in social networking activities, etc.
12. How do you feel about using technology?

Family Science Experience
13. What did you do the most during Family Science? Probes: Did you work with your parents/siblings, other children/adults? Did you design and build something?
14. How did you design work?
15. What did you feel worked well during Family Science? Probes: what did you like about the project activities?
16. Did you experience any challenges during Family Science?
17. Did you work on your projects at home? If yes, please describe your activities? If no, why not?
Use of Curiosity Machine Site
18. How familiar are you with the Curiosity Machine site?
19. Where do you use the site?
20. What do you use the site for?
21. How frequently do you use the site?
22. Did you post projects on the site? If yes, did you receive feedback? Did you revise your project based on the feedback you received?
23. What motivates you to use the site?
24. What do you like most about the site?
25. Who else in your home uses the site? Where do they access the site?
26. What do people in your household use the site for?
27. How frequently do people in your household use the site?
28. Is there anything you think would help you finish your projects at home and upload them to the site?

Barriers to Use
29. What are some challenges to using the site?
30. Have you had any technical problems with the site? If so, how did you resolve them?
31. What do you like least about using the site?
32. What would you need to take full advantage of the site?
33. If you could make improvements to the site, what would you do?

Impact on child
34. Has having access to the site helped you do anything you couldn’t do before?
35. What did you learn from the process of making your design during Family Science?
36. What did you learn from making your design at home?
37. Has having access to the site made any difference for you and your family?
Appendix E: Curiosity Mentor Interview Protocol

Background
- What is your past experience with Iridescent?
- What is your education and work experience?
- What is your STEM experience?
- What is your mentoring experience?
- What is your experience working with underserved families and students?
- How did you hear about the program?
- Why did you decide to participate in the CM project?
- Please describe the goals of the CM project based on your experience with the project?

Online CM Training
- Can you tell me what worked well during the training?
- Can you tell me what was challenging about the training?
- What would you recommend Iridescent change in order to improve the training program?

Mentoring Experience in CM Project
- How many projects did you review?
- How long on average does it take you to respond to a student’s project?
- How many projects did you review more than once? (Probe: How many times per project?)
- What was your experience providing feedback to the students online?
- What kinds of support did you receive from Iridescent during your mentoring?
- Did you encounter any challenges reviewing the students’ projects?
- What would you recommend Iridescent change in order to improve your mentoring experience?

Impact on Self
- What did you gain personally as a result of participating in the CM project? (Probe: mentoring, STEM, social relations)
- Did you improve your communication skills?
- Did the project meet your expectations?
- Would you recommend the project to someone interested in STEM mentoring?

Impact on Students
- Can you describe how students integrated your feedback into their final design?
- What is your assessment of the quality of the students’ projects?
- What do you think the students learned from this project? (Probe: about STEM content and skills?)
- Would you recommend the project to students interested in or curious about STEM?
• Is there anything else you want to share with us that you think would be beneficial for Iridescent to know about its online mentoring program and impact?
Appendix F: Iridescent Staff Interview Protocol

Background
1. What is your name?
2. Tell me about your role at [organization] in general. How long have you been with the organization?
3. What are the major responsibilities of your current position? What is your role with respect to Family Science/Curiosity Machine in particular?

Program and Services
1. What activities does your school/program offer for children as part of Family Science? *Probe on: goals of the offerings and how they meet participants’ needs, kinds of experiences the children and parents are having, learning/outcomes intended.*
2. How successful has this round of Family Science outreach been so far? What have been the greatest successes? Have there been any areas in which the current Family Science work did not match your expectations?

Key Partnerships and Collaborations (for senior staff)
3. We’d like to know more about how you are working with community partners. Let’s start with [PARTNER SCHOOL]. Tell me more about that partnership. *Probe on the history of the partnership, the current Family Science and non-Family Science activities with the partner, how working with that partner fits with their target audience for Family Science/Curiosity Machine, any challenges with the partnership.*

Final Thoughts
1. Is there anything that you would do differently if you were doing this Family Session in the future (i.e. next fall or on another grant)?
2. Have your expectations for Family Science/Curiosity Machine changed over the past year? If so, how?
3. Anything else you’d like to tell us?
Appendix G: Curiosity Machine Project Review Criteria

Project Coding Criteria

- **Structure and strength of design.** (Does the material allow the structure to perform its function?)
- **Aesthetics.** (Is the design attractive and easy-to-use?)
- **Creativity.** (Did student come up with new ideas and insights to move ahead?)
- **Performance.** (How well does the design perform its function?) Check only if there is a video to see how the design works.
- Student uploaded a visual representation (picture and/or video) of finished project.
- Student created and completed design using 1 or more recommended materials?
- Student recorded observations about process and design outcome.
- Student followed instructions to create design.
- Student maintained design ideas and requirements throughout the process.
- Student demonstrated understanding/knowledge of subject by using specific vocabulary to describe design process.
- Student evaluated own work and suggested possible modifications to the designing and making task.
- Student responded to mentor feedback.
- Student demonstrated learning by reflecting on mentor feedback and coming up with better answers.
- Student used mentor feedback to improve design.

Mentor Response Coding Criteria

- Did the mentor provide any feedback?
- Was the mentor helpful, attentive and friendly?
- Does mentor provide hints/cues/prompts that guide student in the right direction?
- Does the mentor provide details of how to improve the design?
- Does mentor highlight errors without giving correct answer?
- Does mentor feedback inform student about incorrect response and allow student one or more attempts to improve design?