# Learner Participation, Satisfaction, and Engagement with the Curiosity Machine, Camps, and Courses


**Daniel T. Hickey**

**Professor and Program Coordinator**

**Learning Sciences**

**Indiana University**


**October 2015**

iridescent

CRLT
Center for Research on Learning & Technology
Indiana University | School of Education

## Learner Participation, Satisfaction, and Engagement with the Curiosity Machine, Camps, and Courses

## EXECUTIVE SUMMARY

This report describes an evaluation of two educational programs that Iridescent offered with a grant from the National Science Foundation. These two programs were developed for youth and their families and were organized around open-ended *Engineering Design Challenges.* These are hands-on problem-solving activities supported by a web-based platform known as the *Curiosity Machine.* The Curiosity Machine and the Design Challenges were designed to work together to engage learners in fundamental physics and engineering concepts in fun and open-ended ways, while enhancing their curiosity, creativity, and persistence. One of these programs consisted of the three-week, full-day (7 hours per day) *Curiosity Camps* for youth ages 7-12. Two consecutive Curiosity Camps were offered during the summer of 2014 at Iridescent's Los Angeles studio. The other program was a five-week, ten-hour *Curiosity Course* for youth and their families. Eleven different Curiosity Courses were offered during 2014 and early 2015 around the country.

Data from program attendance logs, Design Challenge submissions, end-of-course surveys, and reflections were used to document: (1) who the participants were and how much they participated, (2) how often they completed Design Challenges from home or outside of class time, (3) which Design Challenges were most popular, (4) how satisfied participants were with the Curiosity Machine website, the Design Challenges, and web-enabled feedback from volunteer mentors, (5) the extent to which learners engaged meaningfully with creativity, curiosity, and persistence, (6) whether families completing their second Curiosity Course were more satisfied than those completing their first, and (7) the strategies that learners appear to use when producing solutions to the Design Challenges.

### Participants and Participation

A total of 38 children completed the summer Curiosity Camps for a total of 3990 contact hours, while 296 families (many with more than one child) participated in the Curiosity Courses and logged 1767 contact hours. Data from the self-report surveys showed that 42% of the summer campers were girls, while 58% of the Curiosity Course families included girls. Reflecting the goals of ethnic diversity, more than half of the campers came from homes where a language other than English was primary, and 23% of the Curiosity Course families primarily spoke a language other than English. These results confirm that the programs were very successful in achieving gender diversity and generally successful in achieving ethnic diversity.

Nearly all of the learners reported having access to the Internet outside of classes; 48% of the summer campers reported submitting Design Challenges from home, while 37% of Curiosity Course families reported submitting Design Challenges from home. This shows that the programs were partly successful in the goal of encouraging learners to work on and submit Design Challenges outside of the courses. Recommendations in this report are provided for increasing the level and amount of engagement and completion outside of the camps and courses and after the activities were completed.

One problematic aspect of participation was that roughly three quarters of the submitted Design Challenges did not provide a reflection on their work. For reasons elaborated in the report, it is possible that students completed a reflection and did not submit it. The modest number of reflections submitted was likely due to the delay between the time the learners uploaded their projects for the mentor to review and the time the mentor provided feedback and moved learners to the reflection phase. Specifically, it is likely that the majority of the times when learners were advanced to the reflection phase they were already engaged in another challenge. Several recommendations are provided for increasing the likelihood that learners will complete reflections and that the act of reflection will foster individual and social engagement with the specific disciplinary concepts targeted by each Design Challenge.

## Self-Reported Satisfaction

Generally speaking, the learners in the summer Curiosity Camps and the families in the Curiosity Courses reported being quite satisfied with the Curiosity Machine, the Design Challenges, and the mentors. The average means on most of the (positively worded) self-report items were around 4.0, which correspond with *Agree* on the five-point Likert scale (*Strongly Disagree* to *Strongly Agree*). Examining the means across the two consecutive summer camps confirmed that the substantial effort to fine-tune the three primary activities of the camp (completing Design Challenges, submitting Design Challenges, and working with mentors) was successful: average agreement for nine of eleven indicators was higher for the second camp, and two of these differences reached statistical significance.

It is worth noting that the Curiosity Camp and Curiosity Courses were two different programs serving two different types of learners. Furthermore, the summer camp self-report surveys were completed by children (with the assistance of the counselors as needed), while the Curiosity Course surveys were completed by the parents (with the input of the children). As such, the scores on similar items across the two programs cannot be directly compared to make strong claims about changes from one activity to the next. Nonetheless, the agreement that the parents reported for the Curiosity Courses was somewhat lower (roughly 0.25) for using the Curiosity Machine and working with mentors, and substantially lower (roughly 0.50) for completing Design Challenges, compared to the summer camps. However, an examination of the open-ended items that followed each of the three sets of Likert items revealed that the proportion of positive comments increased and/or the proportion of negative comments declined from the summer camps to the Curiosity Courses.

The most important finding from the self-report surveys was that the feedback from the mentors was not as useful or used in refining solutions to the Design Challenges as the designers had intended. While the results suggested that children liked getting feedback and found it motivating, there was little evidence it was used to refine solutions or to redesign. The fact that it took on average 48 hours for mentors to provide feedback certainly seems to be a factor here. It should be noted that the program is not alone in its struggles to make such feedback useful and used. While web-based mentoring is a tantalizing prospect for programs that have access to such expertise, such mentoring has proven consistently difficult to implement and sustain.[1] For example, when working with young learners, real-time interaction with adults presents non-trivial safety and privacy concerns. It is recommended that the project systematically consider a wide range of mentoring configurations and then systematically compare the most promising options in rapid cycles of "A/B testing" at the beginning of future implementations.

## Disciplinary Engagement

At the end of the camps and courses, learners were asked which Design Challenges best supported their curiosity, creativity, and persistence. Large proportions of these responses provided specific warrants that showed clear evidence of meaningful engagement with these disciplinary practices. A larger proportion of warranted responses (both specific and general) in the fall Curiosity Courses suggest that efforts to enhance engagement in those courses were successful. Several recommendations for further enhancing disciplinary engagement in these disciplinary practices are provided.

## Conclusion

This evaluation shows that the summer Curiosity Camp and the fall Curiosity Courses were worthwhile investments for the NSF, Iridescent, the children and families who participated, and the partner organizations that provided space and helped recruit participants. The Curiosity Machine is clearly a well-designed website that is easy to use and engaging; the Design Challenges are compelling activities both in concept and execution; the efforts to refine both across the period of the study were clearly effective. Iridescent's investment in a framework for finding and training volunteer mentors was very worthwhile. Online mentoring has proven challenging with adults; it seems particularly challenging with younger children. While further refinements to the mentoring system are called for, much progress was made.

Particularly in the 80+ Engineering Design Challenges, enormous potential for future engagement and learning resulted from this project. The activities are well designed and engaging. It seems likely that minor refinements could help to further enhance engagement with more specific disciplinary concepts in each challenge and more general disciplinary practices across challenges without making them feel like schoolwork.

---

[1] Ensher, E. A., Heun, C., & Blanchard, A. (2003). Online mentoring and computer-mediated communication: New directions in research. *Journal of Vocational Behavior*, *63*(2), 264-288; Miller, H., & Griffiths, M. (2005). E-mentoring. In D.L. DuBois & M.J. Karcher (Eds.), Handbook of youth mentoring. (pp. 300–313). Thousand Oaks, CA: Sage.

# 1. INTRODUCTION TO THE PROGRAMS AND THE STUDY

Iridescent is a non-profit organization dedicated to science and engineering education. As announced prominently on the www.iridescentlearning.org website, the organization *inspires and equips underserved children to imagine, invent, and engineer.* They embrace a three-pronged strategy of teaching cutting-edge science, engineering, and technology. This strategy is organized around fostering three dispositions:

*Curiosity* to understanding how things in the world around us work;
*Creativity* to try new ideas that solve the world's big problems;
*Persistence* to keep improving and developing one's ideas.

In order to foster these dispositions in young people, Iridescent created the *Curiosity Machine*, a web-based tool consisting of dozens of Engineering Design Challenges. The Curiosity Machine was designed for elementary students and their families to guide them through the engineering design process around fun and engaging Design Challenges carried out with everyday materials. The Curiosity Machine is part of a larger set of programs at Iridescent, including *Family Science*, where children ages 5-12 and their families learn to come up with solutions to Engineering Design Challenges with the help of engineers, and *Technovation*, a technology entrepreneurship program for young women in middle and secondary schools.

## Open-Ended Engineering Design Challenges

Curiosity Camps and Courses are organized around open-ended Engineering Design Challenges that engage young learners in the problem solving practices of engineering.[2] Engineering Design Challenges feature a clearly articulated design prompt that illustrates one or more fundamental physics or engineering concepts in an eye-opening way. The Design Challenges were developed by scientists and engineers based on the research or innovation work that they do at their jobs. Scientists and engineers went through a ten-hour online and in-person training course before developing sets of challenges in collaboration with Iridescent staff. The Curiosity Machine currently features 80 Design Challenges in 13 different categories ranging from aerospace engineering to computer science. Most feature an inspirational video of a scientist or engineer detailing their work, as well as a content video describing core science or engineering concepts. There is also an instructional video for each Design Challenge, which students can use as a starting point for designing their own prototype.

Engineering Design Challenges are intended to provide opportunities for families to build hands-on science and engineering projects and walk through the engineering design process, where they plan, build, test, and redesign. Each Design Challenge states a clear problem or a goal. What makes Design Challenges open-ended is that the problem or goal has more than one solution. That solution can be created using low-cost and easily accessible materials that are

[2]Introductory video located here: https://www.youtube.com/watch?v=XBAE46x2qio

readily available in the homes of many children. The Design Challenges are intended to be “age blind,” meaning that children (and adults) of all ages can address the challenge with their own version and level of scientific understanding. They are intended to require a third grader approximately one hour to complete their first design iteration with the support of an adult, while allowing older children to use various materials to complete the same challenge on their own without getting bored. Design Challenges are designed around a principle known as *low walls and high ceilings.* This principle means that a Design Challenge should scaffold and motivate a child to use the engineering design process to create a plausible solution to the challenge in an interesting and novel way, using methods and materials not explicitly shown or demonstrated. This is intended to give learners more opportunities to engage in creativity, curiosity, and persistence than are typically provided in school settings, where pressures of standards and accountability usually lead to more highly structured activities.

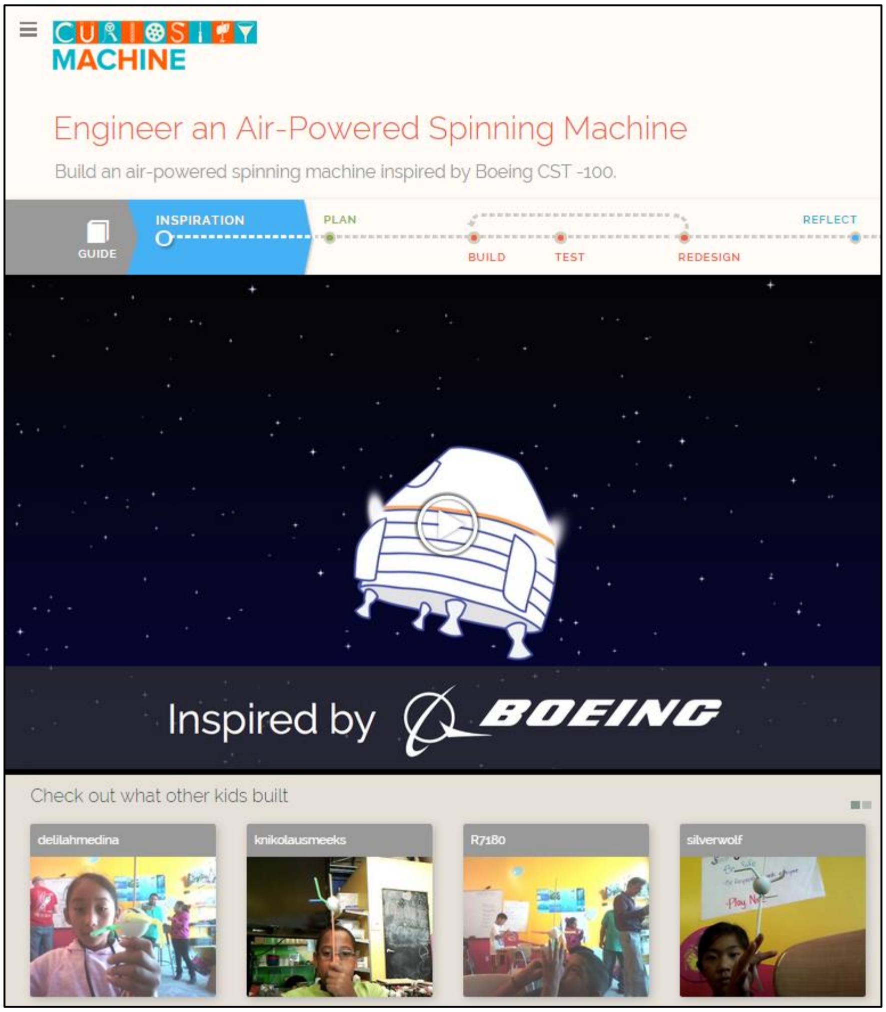


Figure 1.1 Example Design Challenge

For example, one of the popular Design Challenges was *Engineer an Air-Powered Spinning Machine*.[3] [4] The Design Challenge opens to show an "inspirational video" and images of solutions that other learners created (Figure 1.1). The three-minute video features a young Latino engineer who explains how a space capsule maneuvers and an animated cartoon that explains the concepts of thrust and friction (Figure 1.2).


Figure 1.2. Images from the Inspiration Video from Example Design Challenge

The *Plan* stage presents a suggested list of materials, encouraging learners to sketch a design and post it (Figure 1.3).

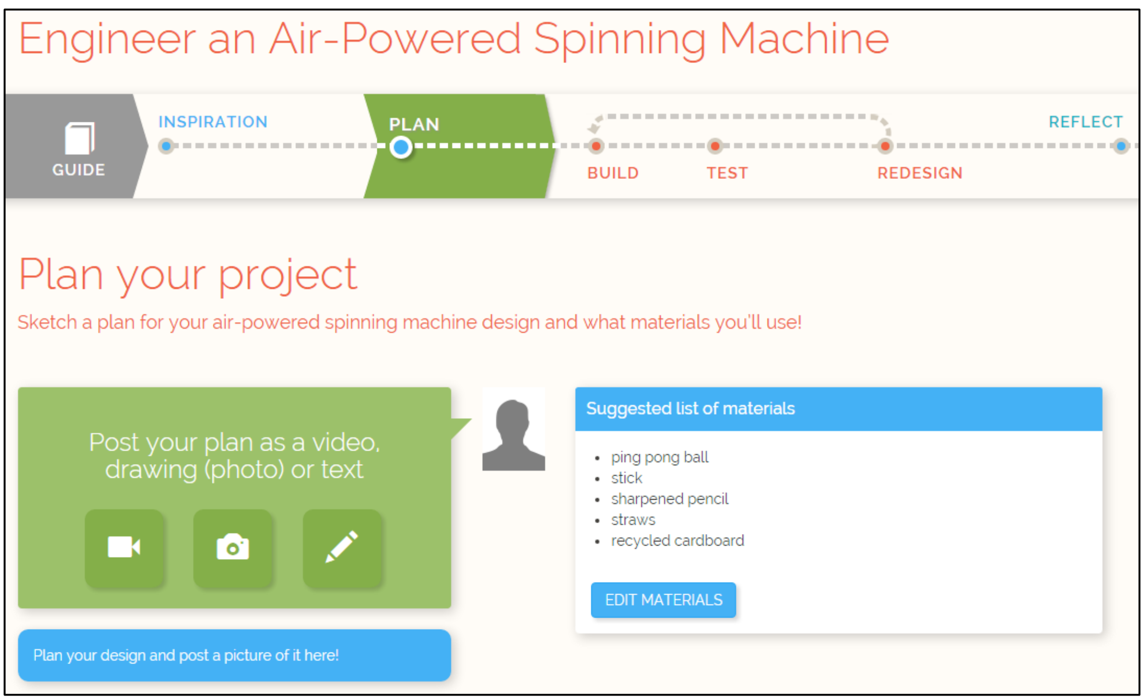



Figure 1.3. Planning Stage from Example Design Challenge

[3] https://www.curiositymachine.org/challenges/58/

[4] For a video of a complete solution visit https://www.youtube.com/watch?v=FWriO_zM0cw

The *Build*, *Test*, and *Redesign* stages present a crucial test and redesign process where learners are encouraged to redesign using the feedback provided by the mentors. In the case of the Air Powered Spinning Machine, learners are encouraged to consider the number of thrusters to include and the direction the air will be released from them (Figure 1.4). While doing so they document their design process in writing or by taking and uploading videos or photos on the website.

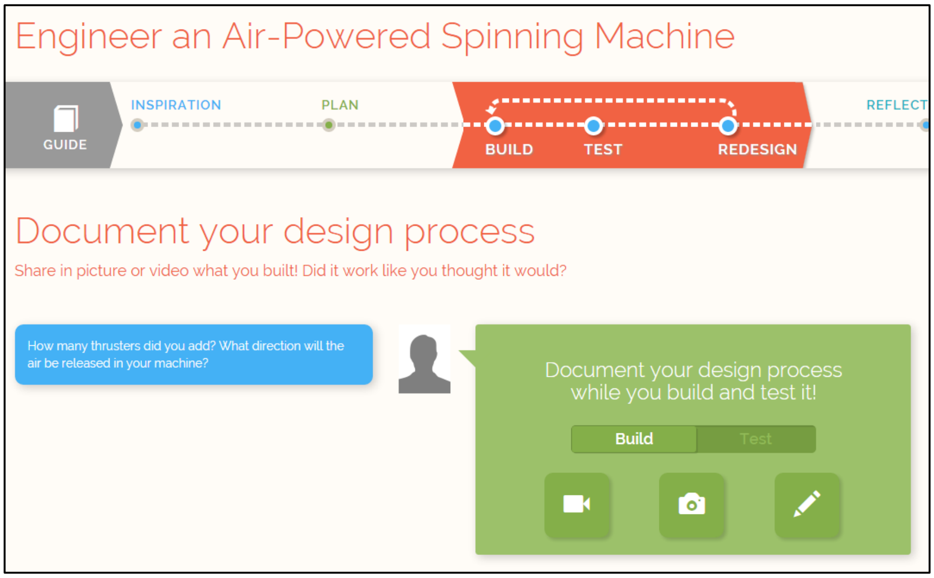


Figure 1.4. Build, Test, and Redesign Stages in Example Design Challenge

Once the learners have tested their solution and uploaded a photo, video, or typed explanation, the draft submission is displayed on the mentor interface, where the mentors can select which projects they wish to provide feedback for. Learners are encouraged to submit at every step in the process and can get feedback from mentors at any point. The mentors are trained specifically to provide feedback that includes suggestions for further redesign. Learners are encouraged to redesign using the feedback provided by the mentors and can go through as many build-test-redesign cycles as they wish. The mentors are responsible for advancing the submitted Design Challenge to the *Reflection* phase where learners are asked to respond to a question intended to prompt learners to consider the impact of their refinements (Figure 1.5).

Technically speaking, a Design Challenge is not considered "completed" until the learner responds to the reflection question (Figure 1.6). However, because the mentors do not provide feedback immediately, learners are likely to move on to a new Design Challenge before their mentor advances the prior Design Challenge to the Reflection phase.

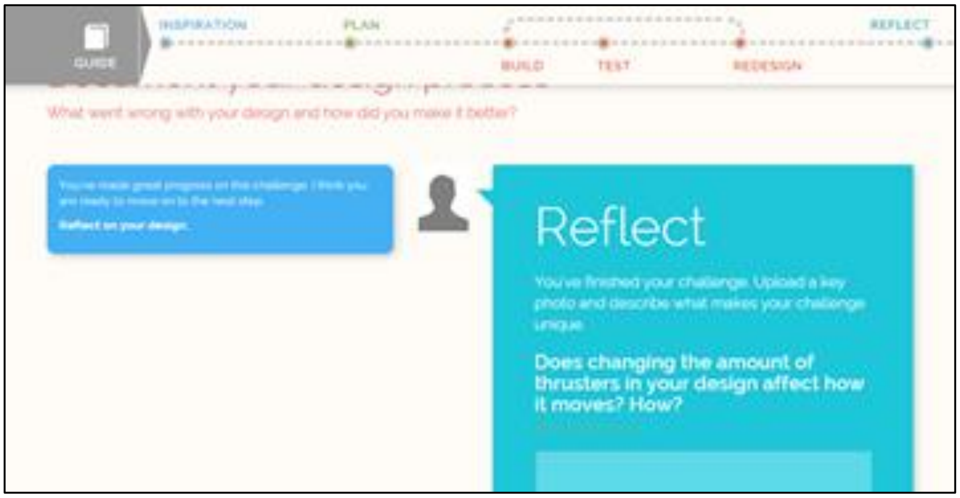



Figure 1.5. Final Reflection from another Example Design Challenge


Figure 1.6. Example Solution to an Engineering Design Challenge Including Reflection

This example nicely illustrates the six "crucial elements" that were central to training the scientists and engineers to create the Design Challenges. The first three "must-have" elements were considered crucial to ensure that children are building important strengths of curiosity, creativity, and persistence:

- *Have a clear purpose or goal.* It was crucial that the goal be *explicit* (e.g., “Make a machine that can lift a weight x-lbs at least y-inches high”, rather than “Make a design that can lift something”) and *reasonable* (i.e., children should be able to achieve the goal in the time allotted and with the available materials).
- *Illustrate and help children understand the engineering/physics concepts*. This means that it must help children understand the concept and that the most time-consuming aspect of the challenge must illuminate the concept(s).
- *Have multiple viable solutions or acceptable variations to the design*. This means that there must be multiple options for materials and multiple options for solutions using the same materials.

Most of the Design Challenges encompassed the following three elements in addition to the three must-have elements listed above:

- *Tangible outcome* (visual, audio, or physical indication of success).
- *Exciting story* (that relates to real-world work of engineers and scientists).
- *Creative and unique* (novel and different from other projects on the Internet).

## Program Description

This report presents an evaluation of two educational programs offered by Iridescent in 2014 and 2015. Both were highly engaging STEM experiences designed to (a) increase curiosity, creativity, and persistence, (b) develop conceptual understanding of STEM subjects, and (c) increase interest in STEM activities and careers. The experiences were designed to enrich a student’s understanding of science and engineering, while encouraging students to become strong problem solvers, creators, engineers, scientists, and designers. The open-ended Engineering Design Challenges are based on real scientists’ and engineers’ work. Learners completed Design Challenges on the Curiosity Machine online learning portal and engaged in meaningful interactions with remote mentors (who are real scientists and engineers).

The first program was a full-day summer camp called *Curiosity Camp* that was offered to learners in grades 3-8. Participants were recruited for the summer camps via the Internet and directly via the Family Science program based in Los Angeles, funded by the NSF “Be a Scientist!” project, with the aim of serving as many of the same children as possible. Two consecutive, three-week, full-day camps were offered during summer 2014 at Iridescent’s studio in Los Angeles. During the camps, roughly half of each day was committed to building physical prototypes that responded to their selected Design Challenges, which they then submitted on the Curiosity Machine website. Students completed one Design Challenge per day, for a total of 15 challenges. Particular attention was directed at the redesign process during the Curiosity Camp. The remainder of the day was spent on *Biobots*, another educational program developed by Iridescent. Biobots was a project-based curriculum where learners built a mechanical robot inspired by nature.[5]

The second educational program considered in this evaluation consisted of after-school activities called *Curiosity Courses.* Curiosity Courses were first offered in spring 2014 with the previous version of the Curiosity Machine and Design Challenges. (These initial courses are not included in this study.) The Curiosity Machine was refined before and during the 2014 summer Curiosity Camps in advance of the second round of Curiosity Courses starting in fall 2014. Families were recruited for the fall 2015 Curiosity Courses in the partner schools and libraries where the courses were delivered. Curiosity Courses were offered to families at 11 different school or library sites around the country in 2014 and early 2015. These after-school programs lasted two hours. Families completed one Design Challenge each week for five weeks. A significant proportion of these families (22, 32% of the participating families) had participated in the previous Curiosity Courses offered in 2013-2014. Continued participation was one of the goals of this project, because project leaders predicted that extended engagement with additional Design Challenges would support more learning, and that families and learners would see themselves develop together over time as the children developed. As such, one of the research questions concerned whether the repeat families reported different levels of satisfaction and participation than the first-time families.

[5] http://iridescentlearning.org/biobots_workbook/

# 2. RESEARCH QUESTIONS AND METHODS

This report represents a second phase in the Curiosity Machine evaluation that began in mid-2014. This new evaluation effort was intended to both generate summative evidence of engagement and learning among participants while also generating useful insight for formative improvement.

## Research Questions

The original research questions were revised somewhat in the new evaluation effort. The final set of questions and the methods used to answer them were as follows:

**1. Who are the participants in the Curiosity Camps and Curiosity Courses?** The first page of the survey that all participants completed after their experience included background demographic questions, including gender, home language, home access to computers, and home access to the Internet. For the Curiosity Course survey, an additional question was asked regarding whether participants had completed a prior course. The Curiosity Camp surveys were completed by the campers, with the assistance of the staff; the Curiosity Course surveys were completed by parents with input from their child(ren). The questions on the surveys were revised slightly to accommodate this difference.

**2. How often do participants in the Curiosity Camps and Curiosity Courses complete Design Challenges from home?** Design Challenges and the Curiosity Machine were designed so that participants could complete challenges from outside of the programs and to allow continued learning. To this end, questions on the survey completed on the last day of the camp or course asked whether Design Challenges were completed from home, whether they were submitted, and how they were submitted.

**3. How many Design Challenges were completed by participants in the Curiosity Camps and Courses, and which were the most popular?** This question concerns the amount of engagement with Engineering Design Challenges that was supported by the Curiosity Machine. This question was answered by examining log files on the Curiosity Machine website that documented the number of Design Challenges submitted across these two courses.

**4. How satisfied are participants with various aspects of the Curiosity Machine and the Design Challenges**? The post-activity survey included three sets of questions regarding the Curiosity Machine website, the completion of Design Challenges, and working with mentors. Each set included a 3-5 Likert scale (*Strongly Disagree* to *Strongly Agree* on a five-point scale) about their success in using specific aspects of each of the three resources. These scores were analyzed as means, and statistical comparisons were carried out to determine whether differences across question within groups or differences across groups were statistically significant.

Each of the three sets of Likert items was followed by an open-ended prompt asking for additional information about each resource:

> *Please tell us what you/your child liked and did not like about the Curiosity Machine/completing projects/working with mentors and anything else we should know*

*about it. If you/your child did not use the Curiosity Machine/complete projects/work with mentors, please tell us why.*

The responses to the open-ended questions were coded thematically and are presented along with the mean scores for the Likert-scale items.

**5. Do participants engage in the Design Challenges in ways that demonstrate curiosity, creativity, and persistence, and do they demonstrate more disciplinary knowledge of those dispositions?** It was beyond the scope of the project to evaluate whether completing Design Challenges increased curiosity, creativity, and persistence; doing so would have required asking participants to complete structured performance assessments at the beginning and end of the activities, and two such activities would have needed to be counterbalanced. In response, a new set of questions was drafted that asked students to articulate how the activities together fostered each of the dispositions and whether any challenges were particularly effective at fostering those dispositions:

*The Curiosity Machine and the Design Challenges were intended to encourage* ***Curiosity/Creativity/Persistence.*** *How did the Design Challenges you/your child completed help you/your child practice being curious? Were any challenges particularly good for helping you/your child become more curious?*

These questions were included in the paper survey in the summer courses; they were presented to learners and parents on the online platform during the fall Curiosity Courses. In the Curiosity Course, participants had the option of answering by typing answers into the box or recording a video.[6] The inclusion of these questions was part of a broader effort to foster disciplinary engagement around these dispositions as the students were choosing, completing, and submitting Design Challenges.

**6. Are levels of satisfaction different for repeat participants?** This was answered by searching for systematic differences in the responses to the satisfaction survey between the two groups and testing any differences to see if they were unlikely to have occurred by chance.

## New Focus on Disciplinary Engagement

An important goal of the evaluation was examining whether significant new efforts to foster disciplinary engagement that were introduced after the summer Curiosity Camps were reflected in the survey response for the fall Curiosity Courses. This goal is reflected in the sixth research question above. Current theories of learning and expertise insist that useful disciplinary learning must involve both the declarative *knowledge* of the discipline as well as the contextual and cultural *practices* that disciplinary experts engage in when the opportunity presents itself.[7]

---

[6] https://www.curiositymachine.org/tsl/

[7] Greeno, J. G. (1998). The situativity of knowing, learning, and research. *American Psychologist*, *53*(1), 5-26.

The practical implication of this assumption is that declarative knowledge by itself, when developed independent of disciplinary practice, is not particularly useful. Rather than treating curiosity, creativity, and persistence as static declarative knowledge to be memorized and recalled on an assessment, disciplinary practices are really "ways of knowing" or "dispositions" that take on specific meaning in specific scientific and engineering contexts. The Design Challenges were designed to give learners extended practice being curious, creative, and persistent in ways that impact the way learners solve problems to help define a "trajectory" towards being a practicing engineer or a great problem solver. Specifically, the Design Challenges were organized to introduce students to the concepts of creativity, curiosity, and persistence by giving them practice enlisting those dispositions in engineering contexts.

One advantage of focusing on disciplinary practices is that the declarative knowledge that gets left behind is more genuine and will be more useful in subsequent settings that call for its use. Another advantage is that the curriculum and programs, and supervisors and mentors, can focus directly on fostering engagement in disciplinary practices, without fear of undermining the evidence in the assessments used for the program evaluation. This made it possible for the evaluation effort to safely introduce guidelines for fostering productive ways of being creative, curious, and persistent without fear or "teaching to the test." Specifically, this allowed the interventions to incorporate widely cited principles for fostering productive disciplinary engagement.[8] These principles are as follows:

- *"Problematize" knowledge from learners' perspective*
    - Let contexts give meaning to concepts.
    - Encourage questions, proposals, challenges.
- *Give learners authority over disciplinary engagement*
    - Avoid known answer questions.
    - Position learners as "local experts," etc.,
- *Hold learners' accountable for their disciplinary engagement*
    - Have them defend their position respectfully.
    - Model appropriate kinds of interaction, etc.
- *Provide relevant resources*
    - Give enough time, information, scaffolding, etc.
    - Connect with learners' prior interests and future aspirations.

These more general guidelines for fostering disciplinary engagement were translated into three more specific principles and strategies for the Curiosity Courses:

- *Introduce the disciplinary knowledge gently and concretely.*

[8] Engle, R. A., & Conant, F. R. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction*, *20*(4), 399-483.

    - Do not let more knowledgeable students confuse others with abstract characterization of curiosity, creativity, and persistence early on.
    - Do not provide abstract characterizations of those dispositions to be memorized.
- *Contextualize disciplinary knowledge when choosing challenges for students or letting them choose them for themselves*
    - Use the videos to make the point that some challenges are particularly well suited for supporting particular dispositions.
    - Many learners won't be able to initially articulate how a particular Design Challenge will support creativity, curiosity, or persistence.
    - Some learners will have enough experience to initially connect dispositions with Design Challenges. The other students can learn from them, but be careful not to let conversation get too abstract or confusing before the others gain enough experience to participate in the conversation.
    - As learners gain more experience, encourage additional discussion of how challenges support dispositions.
- *Help students articulate knowledge in speaking and writing*
    - Push them to articulate curiosity, creativity, and persistence *in context.*
    - Do not encourage them in a way that would lead them to overstate this knowledge on the end-of-course survey.

These principles were shared with the Iridescent leadership team, who in turn shared them with staff and discussed ways that they might be implemented. In the beginning of the sessions of all fall Curiosity Courses, an Iridescent team member provided an introduction to curiosity, creativity, and persistence that was consistent with this perspective and then lead an informal discussion about these aspects of engineering design and problem solving.

## Survey Administration

The surveys were administered to the children in the summer camps on the last day of the camp. Counselors and some parents helped the students complete the surveys. In the Curiosity Courses, the paper surveys were handed to each parent at the end of the course and parents were asked to complete the survey with their children.

## Analysis

The surveys were gathered by program staff at the various sites and scanned. The scans were transcribed and that numerical and text data was entered into a spreadsheet for coding and analysis.

# 3. PROGRAM PARTICIPANTS AND PARTICIPATION

## Curiosity Camps

The two Curiosity Camps served two cohorts of students in Los Angeles, as shown in Table 3.1. Significant enhancements were put in place between the two camps. The counselors were more experienced with the Curiosity Machine platform that was launched during the first week of camp for session 1. There was a lower student to counselor ratio, the website was improved, and new Design Challenges (e.g., circuitry) were introduced. Most importantly, the facilitators were very conscious about allowing and encouraging students to redesign. The facilitators took time every day in the second session to help students redesign, and they allowed the students to repost their redesigned prototypes to the website so they could get feedback from their mentors. The guidelines for supporting disciplinary engagement were more fully introduced for the second cohort. As such, one goal of the evaluation was finding out if those enhancements were reflected in the outcomes. As shown below, the results were compared across the first and second camp to explore whether these enhancements were indeed reflected in the outcomes.

Table 3.1. Summer Camp Participants

| Site | Characteristics | Number Participants | Study Participants | Total Contact Hours+ |
|---|---|---|---|---|
| Los Angeles 1 | First Implementation | 20 | 18 | 2100 |
| Los Angeles 2 | Enhanced Implementation | 18 | 13 | 1890 |
| TOTAL | | 38 | 32 | 3990 |

+Based on seven hours per day for 15 days.

## Curiosity Courses

The Curiosity Courses were offered at 11 locations. Table 3.2 shows the approximate number of participants and the number of families who completed the survey. The Florida summer 2014 course was the first course to be offered, and it took place before the Curiosity Camps. The site presented significant challenges in terms of Internet access, and the Curiosity Machine website and the various Engineering Design Challenges were still being refined. However, the remainder of the courses that took place in fall 2014 was able to benefit from the refinement that occurred during the summer 2014 Curiosity Camps, and the guidelines for fostering productive engagement were introduced above. With the exception of the summer 2014 course, the remainder of the courses was relatively stable across offerings. Given this and the relatively small number of surveys completed at each site, no effort was made to compare the experience or satisfaction from one course to the next.

Table 3.2. Curiosity Course Participants

| Site | City or State | Approximate Number of Participants** | Study Participants | Total # Contact Hours++ |
|---|---|---|---|---|
| Florida summer 2014 | FL | 24 | 7 | 54 |
| Bronx Arts Enhanced Family Science | NY | 10 | 0 | 122 |
| Wilmington Public Library | CA | 14 | 5 | 120 |
| Betty Placencia's Elementary School | CA | 12 | 3 | 54 |
| Van Deane Fall Elementary School | CA | 24 | 8 | 114 |
| Girls Prep Enhanced Family Science | NY | 10 | 12 | 98 |
| St. Athanasius Enhanced Family Science | NY | 54 | 12 | 396 |
| Westport Heights Elementary School | CA | 18 | 11 | 144 |
| MS 304 Enhanced Family Science | NY | 55 | 14 | 462 |
| Felipe De Neve Public Library | CA | 12 | 3 | 67 |
| Seminole County Public Library (Oviedo) | FL | 87 | 0 | 189 |
| TOTAL | | 296 | 68 | 1767 |

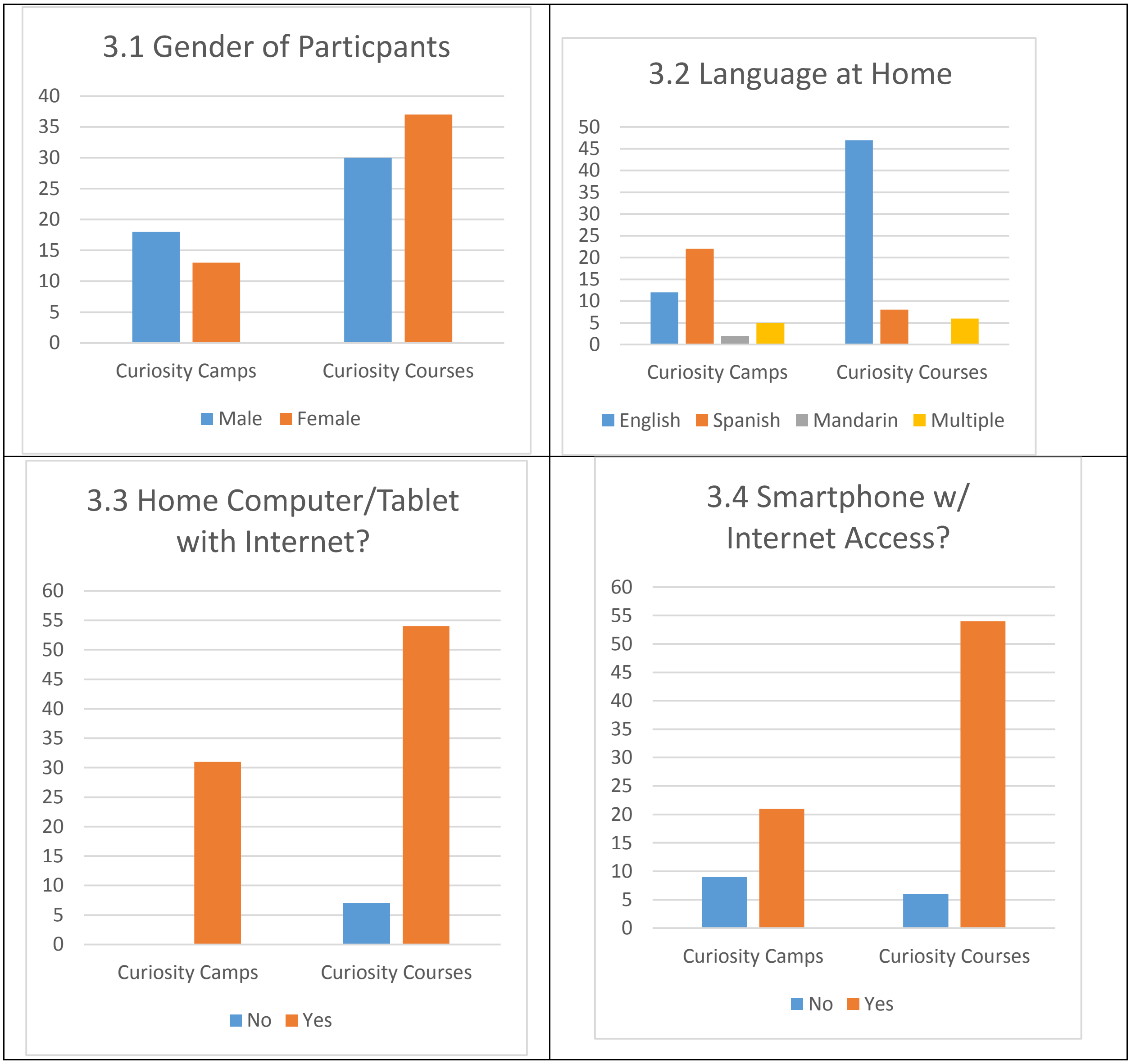
**Includes parents and students

++Information gathered from attendance logs

## Demographics Across Camps and Courses

Figures 3.1-3.4 display the demographics for the Curiosity Camps and Curiosity Courses for the participants who completed the survey administered at the end of the program. Figure 3.1 shows that both programs served roughly similar numbers of boys and girls. Reflecting the goal of reaching diverse learners. Figure 3.2 shows that more than half of the participants in the Curiosity Camps came from homes where a language other than English was primarily spoken. In contrast, the majority of the participants in the Curiosity Courses (77%) reported coming from a primarily English-speaking home.

Notably, nearly all of the respondents indicated that they had a home computer or tablet that had Internet access. This is significant, as a major goal of the program was to get students to work on and submit Design Challenges from home, either in the evening while the camp was in session or after the program was concluded (Figures 3.3 and 3.4).




Figures 3.1-3.4. Demographics and Participation in Curiosity Camps and Courses

## Submitting Challenges from Home

A series of questions on the survey asked about the crucial question of whether participants reported working on Design Challenges from home. In the Curiosity Camps, 15 students reported not working on Design Challenges at home, while 14 students (48%) reported that they did work on Design Challenges at home (Figure 3.5). Six of 14 students working from home reported that they did submit them to the Curiosity Machine; the participants who did report submitting from home indicated that they submitted using a range of methods (some reported multiple methods so the numbers add up to more than the total).

In the fall Curiosity Courses, 38 participants reported not working on Design Challenges from home, while 25 (37%) reported working on Design Challenges from home (Figure 3.5). In this regard, the fall courses were not as successful as the summer camps (where 48% reported submitting from home). Given the differences in learners and programming between the summer camps and the fall courses, there are a number of factors that may explain this. One likely explanation is the much more pronounced focus on redesign in the summer camps and the emphasis on reflecting on the designs based on mentor feedback.[9]

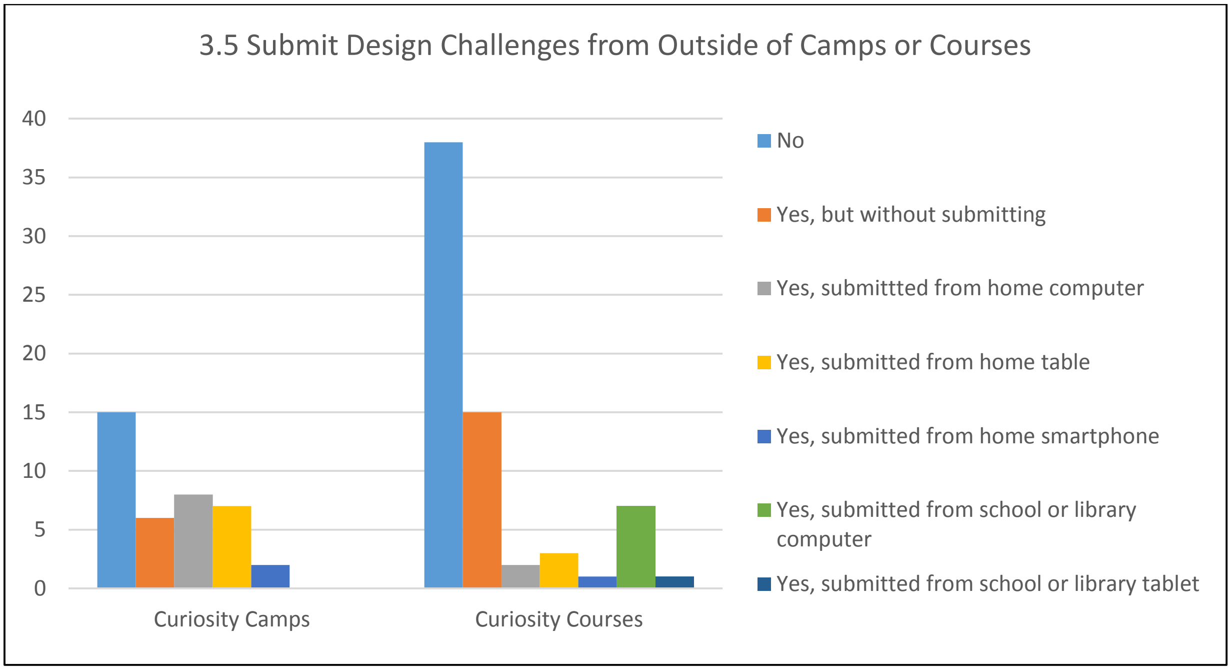



Figure 3.5. Number of Participants Completing Design Challenges at Home

## Design Challenges Completed

Table 3.3 presents the most often used Design Challenges in terms of overall submissions and submissions with completed reflection questions. This shows that approximately three-fourths of the submissions were completed without including a reflection. Given that this is a required step to "complete" the Design Challenges and an obvious place to foster more disciplinary engagement, this seems worthy of further consideration.

Table 3.3. Most Popular Design Challenges

| Most Popular Design Challenges | | Most Popular Completed Design Challenges (including complete reflection question) | |
|---|---|---|---|
| Design Challenge | Number | Design Challenge | Number |
| Build a Suspension Bridge | 108 | Build a Suspension Bridge | 24 |
| Engineer a Skyscraper for the Wind | 72 | Engineer a Skyscraper for the Wind | 14 |

[9] It is worth noting that examination of backend data from the website suggests that these numbers of reported submissions from home were likely inflated (presumably due to social desirability bias).

| | | | |
|---|---|---|---|
| Build a Glider | 69 | Build a Glider | 14 |
| Build a Cam Mechanism | 52 | Build a Wind Powered Sailboat | 9 |
| Engineer an Aeolipile | 49 | Build a Belt Mechanism | 8 |

## Summary and Recommendations for Participants and Participation

In summary, these two programs were successful in attracting diverse participants and engaging them in extended practice in the engineering design and problem solving processes. In this regard, the programs clearly met their overarching goal.

One notable finding was the modest level of submissions from outside of the class for the Curiosity Courses. Given that the courses only met for two hours each week, nearly all participants had access to home computers and the Internet, and this was a central goal of the program, this looks like a worthwhile area for further refinement. One possibility is that the families relied heavily on the Iridescent staff in the courses—the parents deferred to the staff when their child(ren) had questions or needed guidance. An alternative measure here is that the staff could insistently direct questions back to parents, direct all of their guidance to the parents, and have the parents communicate that information to the children. Another possibility is to have a separate FAQ for the parents. The existing FAQ[10] includes a very general overview, and the guidelines for the parents do not seem like they were designed to help parents help their children at home. It seems possible that providing a FAQ specifically designed to help parents help their children, and help parents use that FAQ during the class, could substantially increase the amount and quality of home engagement during the class and continued engagement after the class is over. Similar actions with parents during pick-up and drop-off at the Curiosity Camps might also enhance the amount and quality of outside engagement.[11]

Another notable finding was that just one-fourth of the completed Design Challenges included reflection. Given that we know from research that reflection is a key component in disciplinary engagement and learning, this seems like an aspect worthy of significant attention. One open question is that the current prompts do not explicitly ask students to enlist the disciplinary concepts that they engaged with. This was presumably done to keep the activities from being too much like school. Returning to points made above, contemporary theories of learning suggest that this is a missed opportunity. Of course, school assignments often ask students to learn specific disciplinary concepts like force and friction, but such assignments typically have students learn such concepts in highly structured routines that have little meaning. The Design Challenges succeed in connecting hands-on problem solving activity with the work of practicing professionals. It is very possible that the learners will be quite happy and proud to display their newly developed disciplinary knowledge in the context of their submissions for the Design Challenges. Building on the notions of contextualized disciplinary engagement outlined

[10] https://www.curiositymachine.org/faq/
[11] It is worth noting that since the completion of this program, efforts have been initiated in response to these concerns. Iridescent has created some of these resources in their parent portal and throughout the submission process on the Curiosity Machine and have added new FAQs to help provide this information. These and other changes are not elaborated in this report.

in the introduction, it is recommended that learners be asked to reflect on which aspects of the Design Challenges helped them understand the disciplinary concepts (e.g., tension, torque, etc.). Because the reflections are not formally reviewed or graded, learners who did not make these connections or did not care to articulate them simply would not do so. But it seems likely that many would and that some particularly productive disciplinary discourses would take place both in and around the process with individuals, peers, parents, and staff. Additionally, doing so promises to "proleptically" shape the way learners engage with the challenges.[12] Specifically, after completing the first challenge, the act of completing such a reflection would lead the learner to pay closer attention to the disciplinary concepts during the challenge and how they related to features of the challenge—in order to facilitate the process of reflection. In addition to readily increasing the level of disciplinary engagement, this would leave behind compelling evidence of that engagement. Such evidence will be ideal once the planned digital badges are introduced to the Curiosity Machine. More specifically, such reflections would allow the program to issue digital badges that make claims about disciplinary engagement and learning, and provide clear evidence to support those claims. These badges themselves should provide compelling evidence of engagement and learning.

It is recommended that options for encouraging learners to complete and submit reflections be explored and systematically tested in A/B rapid prototyping in the future, both within and without the context of open digital badges. Certainly, the step of getting mentor approval before continuing to the reflection stage is a factor, since learners have likely moved on to the next Design Challenge. One possibility is to begin issuing digital badges only once a reflection is posted, and then feature that reflection prominently in the badge.

[12] This phenomenon of *prolepsis* is a central concept in anthropology and cultural psychology, and it refers to the way that anticipation of something in the future shapes the way individuals engage in the present. However, this is a highly contextual phenomenon that can only be examined using interpretive methods and therefore was beyond the scope of this evaluation.

# 4. PARTICIPANT SATISFACTION

The second set of questions on the survey asked participants about their use and satisfaction with the Curiosity Machine online platform itself, the process of completing Design Challenges, and working with mentors. A number of five-point Likert-scale items (i.e., *agree-disagree*) asked about use and satisfaction. These were followed by open-ended items requesting opinions. This design reflected a common pairing of numerical Likert items with open-ended responses. This design helped prompt respondents to provide open-ended rationale for relatively strongly positive or negative responses on the Likert items.

Regarding the Curiosity Camps, the main goal was comparing the two Los Angeles camps to determine whether the improvements to the second LA camp were reflected in the respondents' reports. The summer Curiosity Camp surveys were completed by the young participants, but the fall Curiosity Course surveys were completed by parents; no statistical comparison was carried out.

## Curiosity Machine

**Likert-scale items.** Figure 4.1 presents the mean agreement with five open-ended items regarding the Curiosity Machine for the two LA Curiosity Camps. Respondents agreed strongly with all five items concerning the use and usefulness of the Curiosity Machine and agreed more strongly with all of the items for the second Summer Camp. Statistical testing revealed that the difference between LA1 and LA2 for 9b was very unlikely to have occurred by chance ($p <$ 0.02), and none of the other differences were unlikely to have occurred by chance ($p >$ 0.05). This suggests that the improvements between the first and second camp led to improved use and satisfaction among campers.

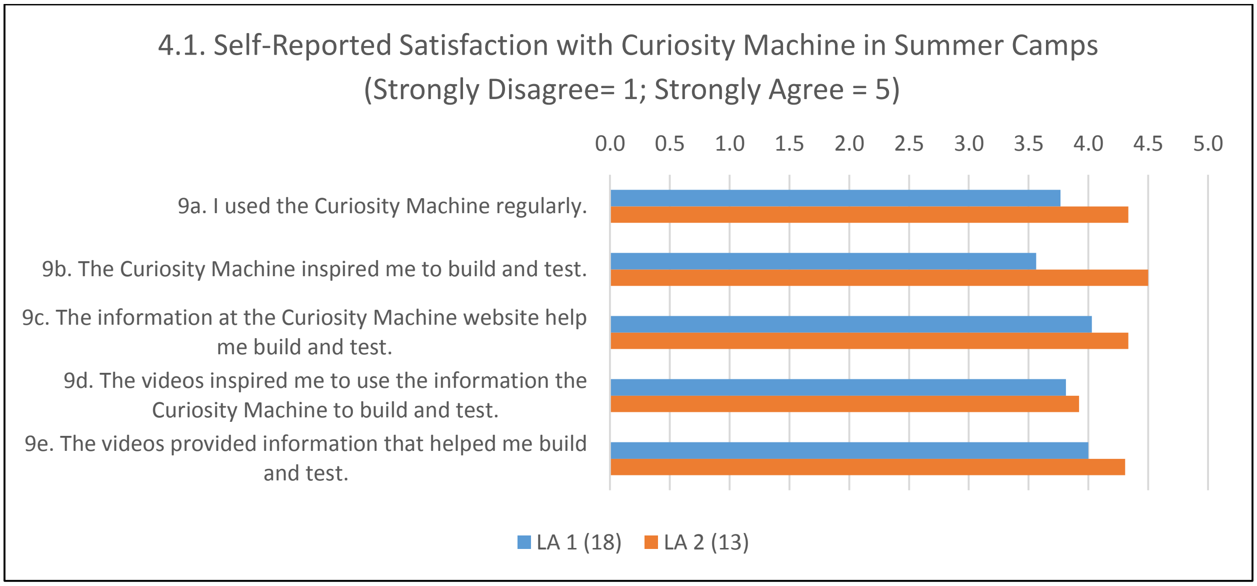



Figure 4.1. Self-Reported Satisfaction with Curiosity Machine in Summer Camps

Figure 4.2 displays both the summer Curiosity Course reporting for the self-report items for the Curiosity Camps (9a-9e) alongside the responses for similar items for the Curiosity Courses (10a-10d). A difference observed between 9c and 9d suggests that students found the information on the website to be more useful than the inspirational videos. However, this difference did not reach statistical significance ($p = 0.22$). To reiterate, the Curiosity Camp survey was completed by learners, while the Curiosity Course survey was completed by parents. The means for the camps and courses were comparable, and both sets of satisfaction scores with the Curiosity Machine were overwhelmingly positive.

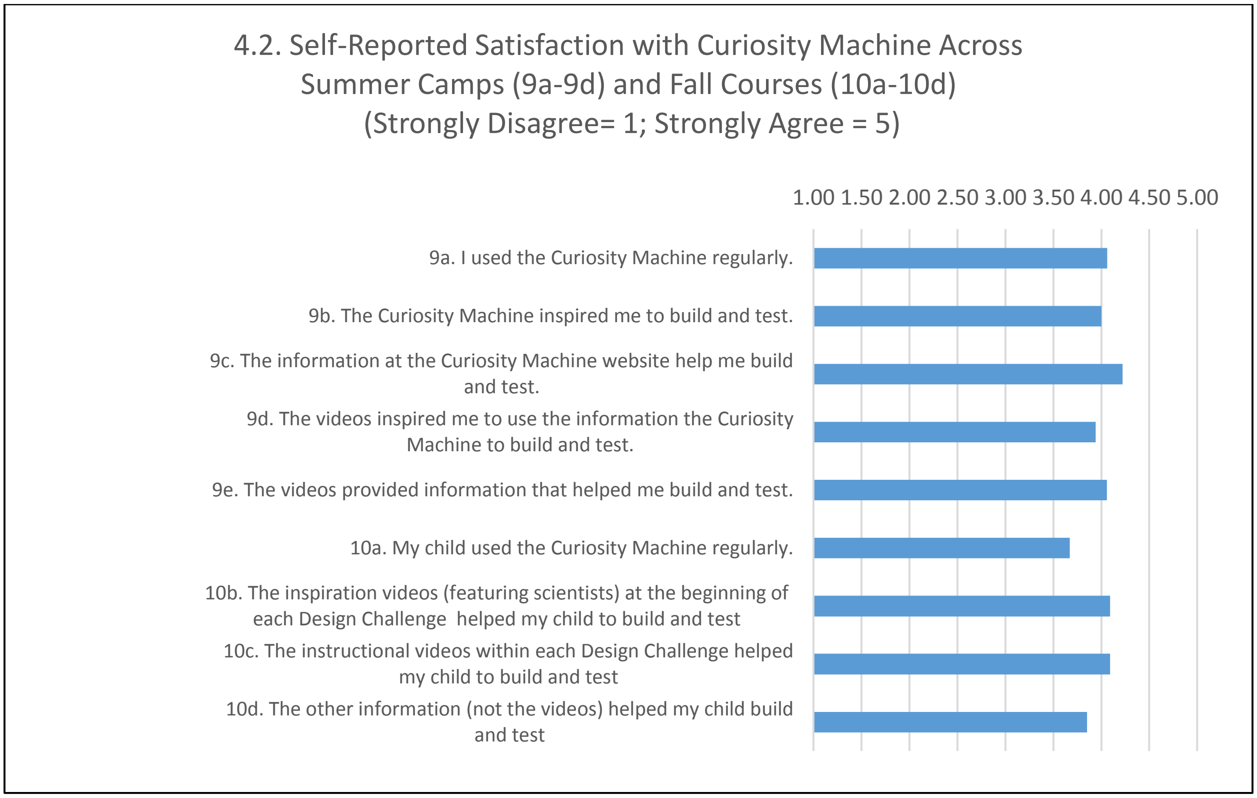



Figure 4.2. Self-Reported Satisfaction with Curiosity Machine across Summer Camps (9a-9d) and Fall Courses (10a-10d)

**Open-ended items.** Each of the Likert items was followed by an open-ended question: *Please tell us about your opinions about the **Curiosity Machine** and anything else we should know about it. If you did not use it regularly please tell us why.* Table 4.1 shows examples of the transcribed responses broken down by valence and nature. The most important notable observation, looking across the first and second cohort in LA summer camps, is that the number of negative comments went from nine to one, providing additional evidence that the improvements to the Curiosity Machine website were indeed recognized by participants.

Table 4.1. Open-Ended Responses Regarding the Curiosity Machine

- Curiosity Camp 1 (11 responses, 5 positive, 9 negative)
    - 4 positive-general (e.g., *I like it because it helped me improve my skills*.)
    - 1 positive-learn engineering (*I like the curiosity machine because it teaches us hot to learn engineering*)
    - 2 negative-general (*It is not that fun but it is ok; I don't know how It supose to help us*)
    - 3 negative-mentor (e.g., *And sometimes people don't reply to me.*)
    - 2 negative-website (e.g., *It glitched*)
    - 2 negative-other
- Curiosity Camp 2 (12 responses, 10 positive, 1 neutral, 1 negative)
    - 6 positive-general (e.g., *I liked using the Curiosity Machine because there are many cool and interesting projects/challenges*)
    - 3 positive-mentors (e.g., *Curiostiy Machine is great, I think that it is really cool that I got to talk to real-life engineers*)
    - 1 positive-website (*I think the curiosity machine is cool because you can costumize your profile and learn new things*)
    - 1 negative-general (*the explain should tell you how to do it*)
    - 1 neutral (*It's okay but I don't use it after camp*)
- All Curiosity Courses (49 responses, 26 positive, 7 neutral, 10 negative, 3 unknown)
    - 12 positive-general (e.g., *She liked it because it helped her be more creative*)
    - 6 positive-Design Challenges (e.g., *She liked everything-loves the challenges*)
    - 3 positive-videos (e.g., *My child liked the ideas that she gets from watching the videos*)
    - 5 positive-other (e.g., *She enjoyed the science aspect and building things. The videos helped her as well*)
    - 7 neutral (e.g. *Didn't use it because we were too busy but plan to use it in the near future*)
    - 5 negative-website (e.g., *At first the site was hard to navigate. It wasn't until we saw someone else to the challenge that we were able to do as well*)
    - 5 negative-other (e.g., *we only did activities in class, not at home. The directions and examples given were often too vague.*)
    - 3 unknown or suggestions (e.g., *He did not use it outside class due to time. Also thinking about materials to use. There should be age (suggested) categories for the projects.*)

One particularly notable finding was the sharp decline in negative comments after the first Curiosity Camp. In particular, there were three negative comments about mentors, two negative comments about the website in the first camp, and only one negative comment about the Curiosity Course after the second summer camp.

Figures 4.3a and 4.3b show a summary of the proportion of open-ended comments from the Curiosity Camps and Curiosity Courses. It shows that the proportion of positive comments was similar across the Curiosity Camps to the Curiosity Courses, while the proportion of negative comments was substantially lower. One-fifth of the responses across the Curiosity Course survey (which was completed by parents) was coded as negative (including five regarding the website). The ten negative comments for the Curiosity Courses provide some useful pointers for further areas of potential refinements. Five of the negative comments concerned the website (e.g., "It was very difficult sometimes to log on," "It was hard to edit comments," "At first the site was hard to navigate," "trouble uploading to the site"). Three of the negative comments concerned the instructions on the website ("Sometimes the directions or examples were too vague," "It is difficult to follow," and "The directions and examples given were often too vague."). These comments concern a central issue for this program and are revisited below. One of the negative comments concerned the lack of time ("She did not like that she felt that she did not have enough time to finish…she felt rushed"), and one of the negative comments concerned the projects ("She found some of the projects frustrating" is also addressed below).

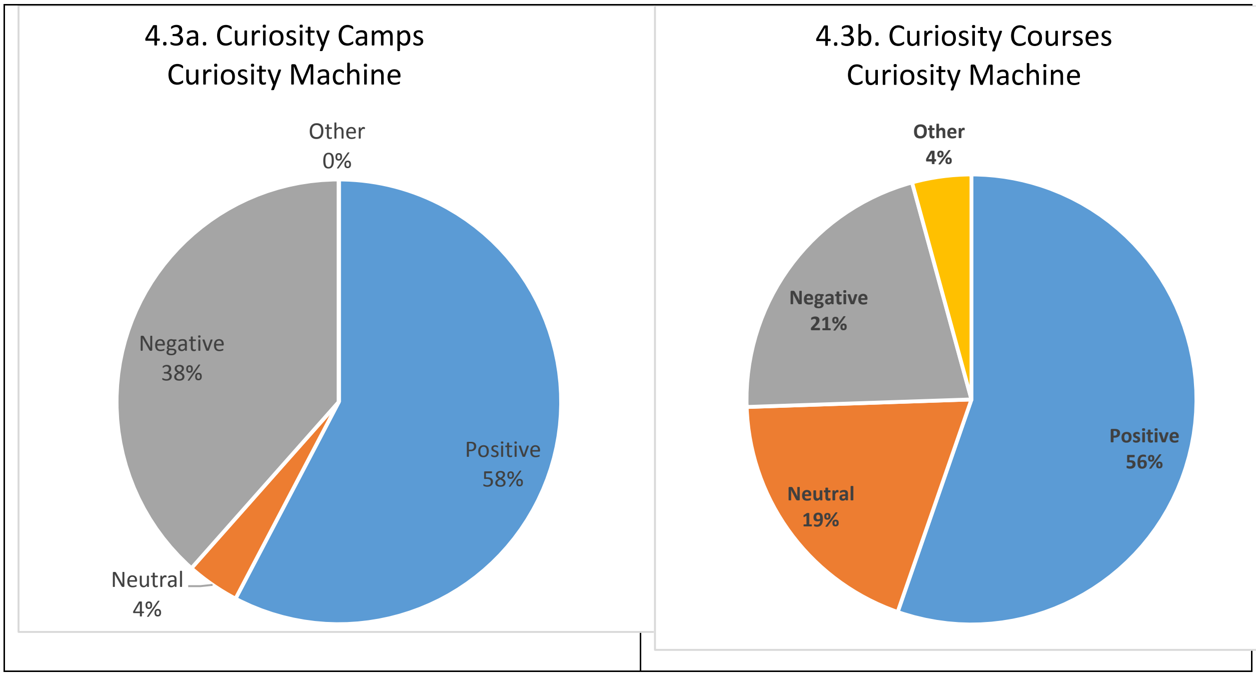



Figure 4.3. Open-Ended Comments Regarding Curiosity Machine

**A common issue with inquiry learning.** One notable observation is that a substantial number of the negative comments concerned the instructions being vague. This highlights a central challenge when supporting open-ended inquiry in educational contexts. School science experiments in particular are often presented as a very specific set of steps to follow, typically on worksheets. These two programs using the Curiosity Machine were specifically designed to give learners supported practice in open-ended investigation. Nonetheless, given that some of these comments about vague instruction were presented as examples of why participants did not complete challenges at home, this may be a point worth reconsidering. If this is simply an expectation that the process be as structured as school activities, then these concerns likely can just be ignored. But it might be worth investigating to see where some of the learners, particularly the younger ones, were unsure on what to do next. A think-aloud study with a range of learners might be helpful to explore this further. For example, some of the text might be written at a more advanced level than appropriate.

## Completing Design Challenges

The second set of survey items asked about completing and submitting Design Challenges. Figure 4.4 shows the mean agreement with the three Likert-scale items for completing projects for the first and second summer Curiosity Camps. The responses were generally favorable—the first and third questions were somewhat higher for the second camp, providing additional evidence of improvement from the first to the second camp.

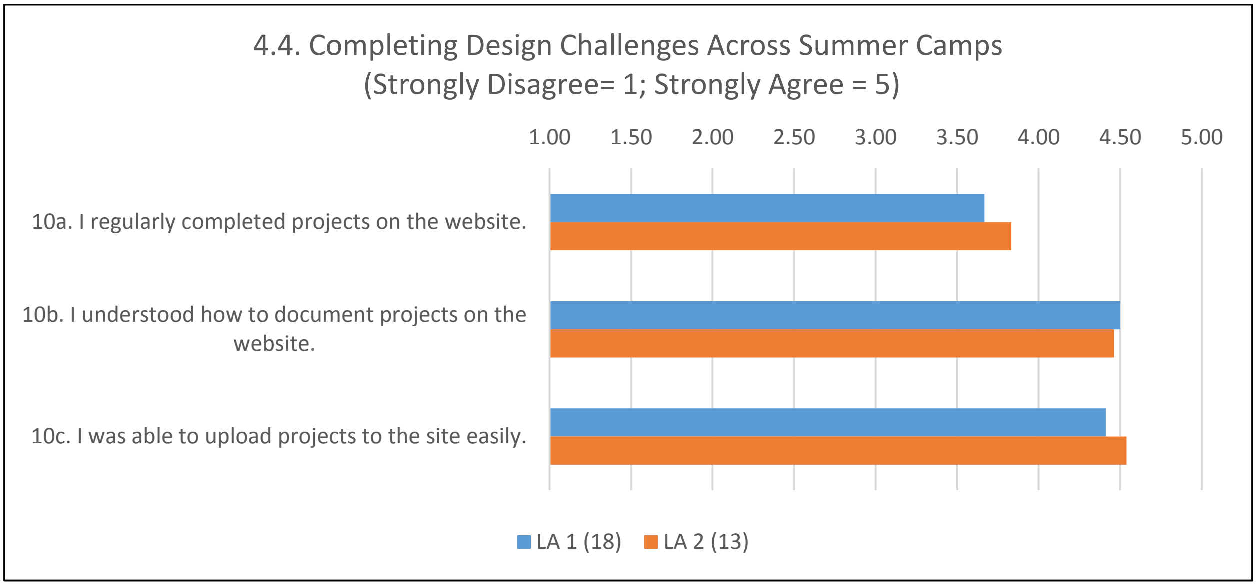
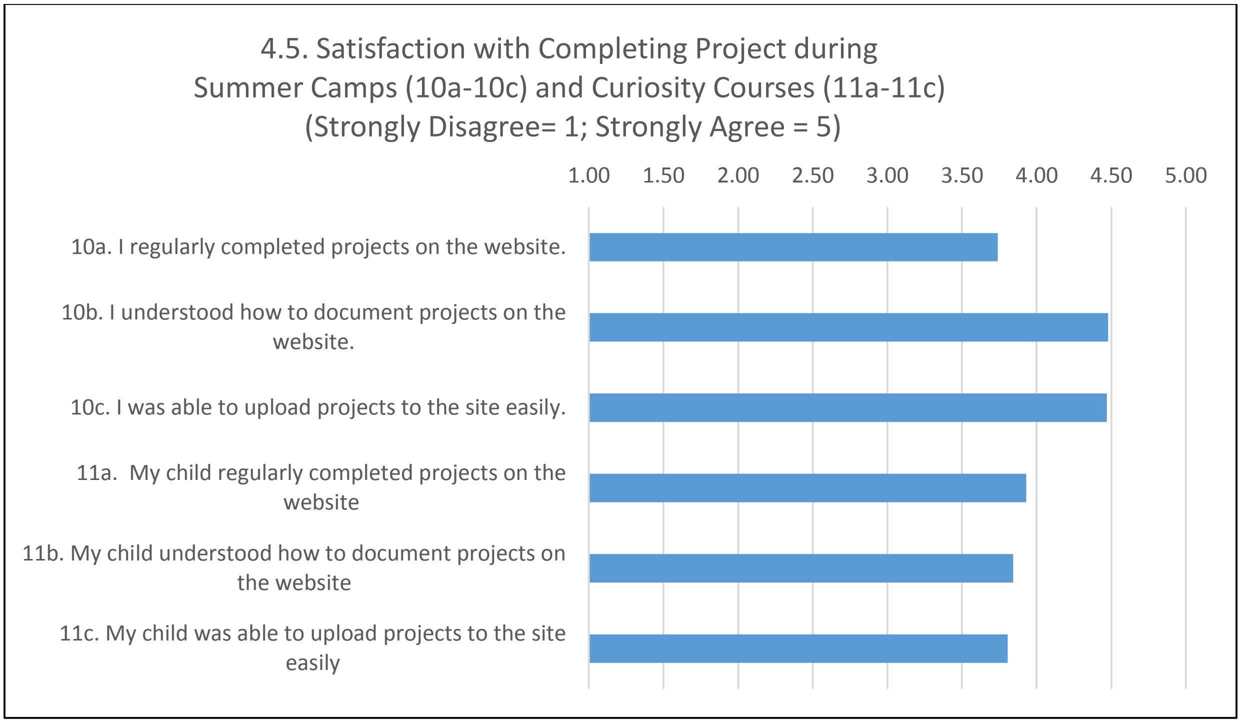



Figure 4.4. Satisfaction with Design Challenges across Two Summer Camps

Figure 4.5 collapses the summer Curiosity Camps' means for the first and second summer Curiosity Camp (10a-10c). Presumably reflecting early problems with submitting Design Challenges during both Curiosity Camps, the means for item 10a was significantly lower than 10b and 10c ($p < 0.01$). While the means for the fall Curiosity Courses (11a-11c) declined relative to the summer, these items were completed by parents rather than children. Notably, the significantly lower response for the first question (11a) regarding completing projects was actually slightly higher for the fall Curiosity Courses. Compared with the very large difference between 10a and 10b in the other direction, this suggests that the resolution of the challenges with the websites from the summer camps was reflected in satisfaction in the fall courses. (To reiterate, the summer camp surveys were completed by the participants, while the fall course surveys were completed by the parents. This means that the most meaningful comparisons can be carried out within those sets of responses.)

**Open-ended items.** On the open-ended items regarding completing projects (Table 4.2), the proportion of negative comments was quite low, and they concerned not having enough time to finish projects or reflect. For the fall Curiosity Courses, there were eight negative comments concerning the website and not having enough time.




4.5. Satisfaction with Completing Projects during Summer Camps (10a-10c) and Curiosity Courses (11a-11c)

Table 4.2. Open-Ended Responses for Completing Projects

- *10e. Please tell us about your answers about* ***Completing Projects*** *and anything else we should know about that. If you did not complete projects on the website, please tell us why.*
    - Curiosity Camp 1 (11 responses, 6 positive, 2 neutral, 1 negative, 2 suggestions)
        - 1 positive-general (*It was very fun completing the progect*)
        - 3 positive-mentors (e.g., *It was 27retty cool to talk with all our mentors*)
        - 1 positive-inventing (*I felt the completing projects was a great experience being able to learn more and inventing new objects*)
        - 1 positive-video (*I like to take video and pictures*)
        - 2 suggestions (*I didn't know there were digital badges* and *Peers sometimes make it more difficult to upload*)
        - 2 Neutral (*I didn't finish the curiosity machine* and *I don't always because sometimes I forget*)
        - 1 Negative (*I didn't have enough time*)
    - Curiosity Camp 2 (9 responses, 3 positive, 4 neutral, 2 negative, 1 suggestion)
        - 1 positive-general (*The projects were really, really fun and I hope I can go back next year. This is the best camp that I've been to*)
        - 2 positive-specific (*I think completing projects is great because it makes you feel proud or what you have engineered*)
        - 1 suggestion (*we should post video*)
        - 4 neutral (e.g., *I did projects like a speedboat, redwood tree, glider, and many more*)
        - 2 negative-reflection (*Well completing project was a little bit harder because I was able to post my plan and build but I wasn't able to reflect* and *I completed 1 project and I went to reflect. But I still completed every project but they all didn't go to reflect*)

- All Curiosity Courses (42 responses, 26 positive, 9 neutral, 8 negative, 2 other)
  - 18 positive-general (*He liked that it was fun and they were challenging*)
  - 7 positive-specific (*My child loved completing projects, he would take them home and play with them. These designs inspired him to create more projects at home*.)
  - 9 neutral (*She completed both projects. We started toward the end of the week.*)
  - 3 negative-website (*we had trouble logging into the website, and mom couldn't enter project details for all 3 kids (2nd grader))*
  - 2 negative-time (*when we have more free time, we will definitely use the website more. With the regular daily homework assignments, it was a little too much to start additional projects and complete them*)
  - 3 negative-other (*Not every project was exciting. Some of the materials did not meet the project's needs*)
  - 2 other (*Its hard to motivate him in a non classroom setting. I think if you incorporate teamwork with his friends online it would motivate him and his friends. Sort of a online gaming setup*).

Figures 4.6a and 4.6b show the proportion of open-ended responses for the summer camps compared to the fall courses. The proportion of positive comments increased in the fall, providing additional potential evidence of increased disciplinary engagement in the fall courses.

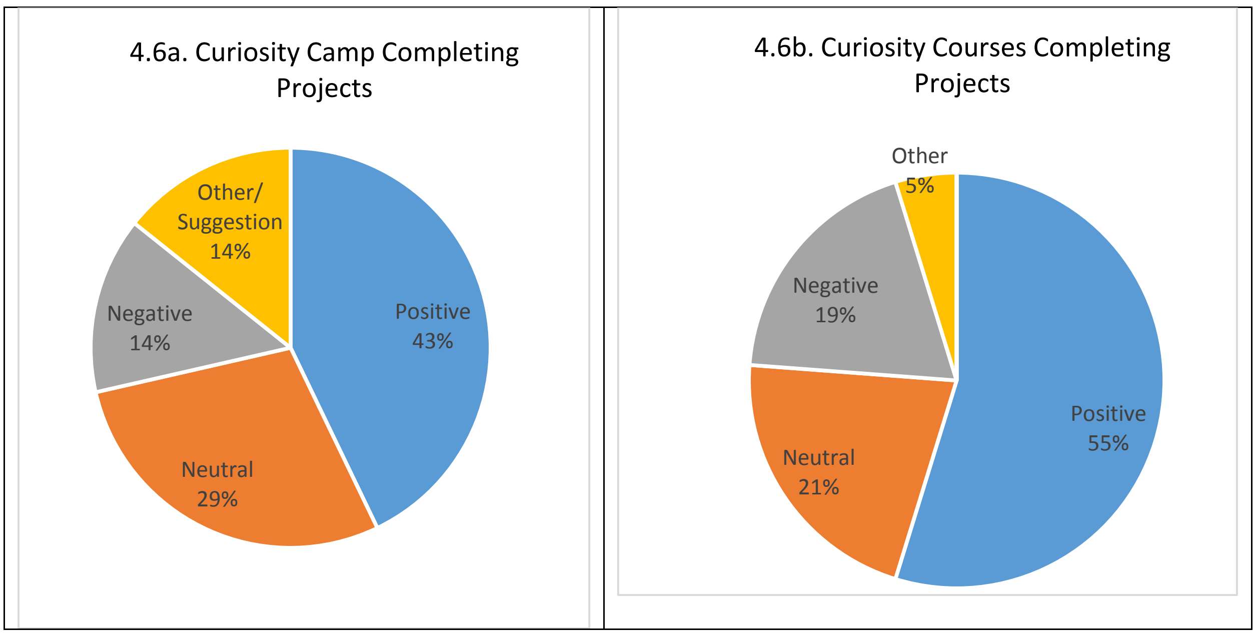



Figure 4.6. Open-Ended Responses for Completing Projects

## Working with Mentors

The third set of satisfaction items on the survey concerned working with mentors. Figure 4.7 shows means responses from the Likert-scale items for working with mentors for the summer Curiosity Camps. The means suggest an increase in use of feedback by learners from the first to the second camp (11a); the other two items were quite similar across the two camps.

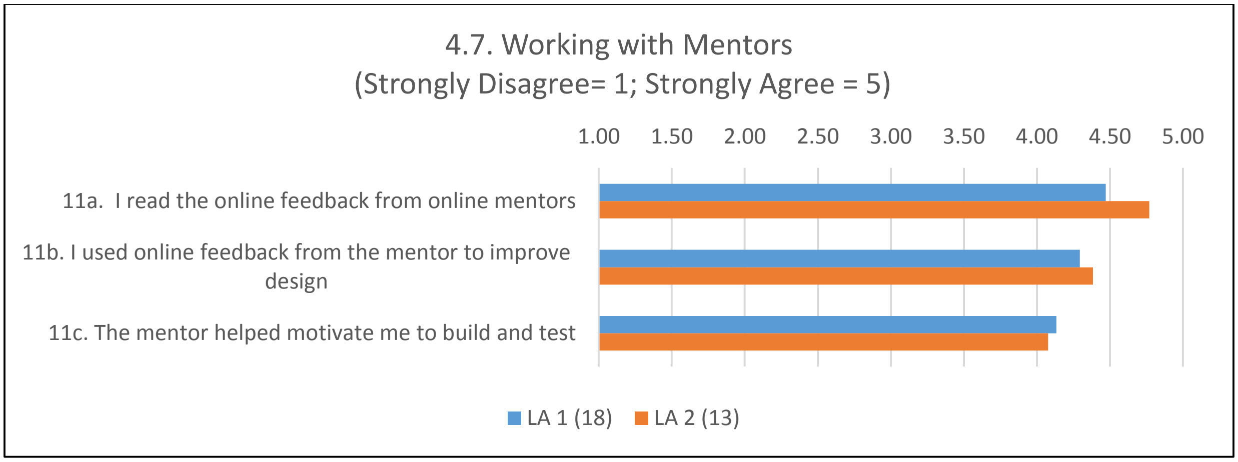



Figure 4.7. Satisfaction with Mentors across Two Summer Camps

Figure 4.8 collapses the summer Curiosity Camp means across the summer camps (11a-11c) and places them alongside the means for the fall Curiosity Courses (12a-12c). Most notably, the means for the two directly comparable items for the fall Curiosity Courses (12b and 12c) were significantly different ($p < 0.002$). When coupled with the (non-significantly) higher satisfaction on item 12a, this suggests that learners read the feedback from mentors, they enjoyed getting this feedback, and were motivated by it, but they were less inclined to use that feedback to refine their Design Challenges. This difference was very likely due to the fact that the Curiosity Courses did not designate specific time for redesigning the way that the longer summer Curiosity Camps were able to.

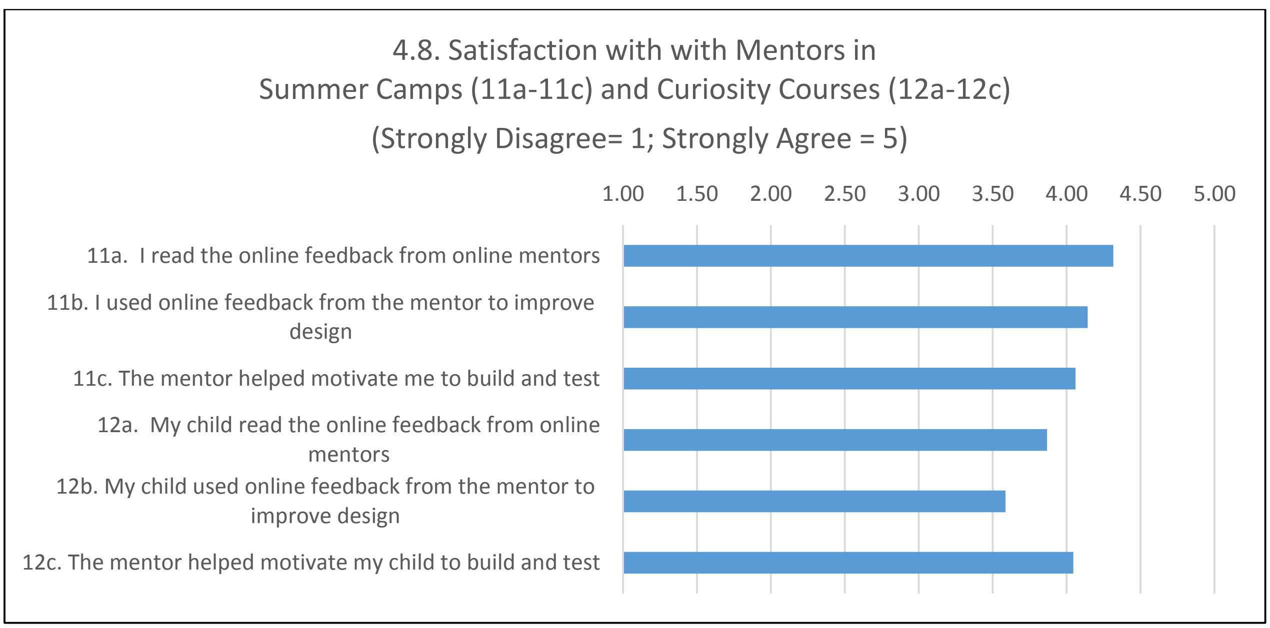



Figure 4.8. Satisfaction with Mentors in summer Curiosity Camps (11a-11c) and Curiosity Courses (12a-12c)

**Open-ended items.** In contrast to the findings on the satisfaction survey, the open-ended items for working with mentors (Table 4.3) reveal that the proportion of negative comments decreased from the first to the second summer Curiosity Course. Taken by itself, this suggests that the significant efforts to improve the engagement of the mentors between the first and second summer camp were indeed successful. It is unclear how to interpret these responses in light of the responses to the satisfaction items. However, the open-ended nature of these sorts of items makes responses much more random and potentially volatile; traditionally, open-ended items are paired with Likert items to provide clues as to what might have created the (more readily interpreted) mean differences on the Likert items.

For the fall Curiosity Courses, the majority of the comments were positive, however, just two of the positive comments mentioned using the feedback to refine the designs. Many of the neutral and negative comments indicated that the feedback was delayed or was not useful. While there were only four negative open-ended responses regarding feedback, they all pointed to the difficulties students had in using the feedback.

Given that helping learners use mentor feedback to redesign was a primary goal for this project, Iridescent researchers examined the data collected on the Curiosity Machine backend for insights regarding mentor feedback and interactions. This revealed that the number of back and forth exchanges between mentors and learners was just 1.13 per submission. This reveals that, just 13% of the comments consisted of threaded exchanges between the mentors and the learners. Perhaps more significantly, the average time that transpired in learner-mentor interactions (the time it took for mentors to provide feedback on submitted Design Challenges) was 49.7 hours. On average, two full days transpired between the time a Design Challenge was submitted and the mentor provided feedback. This delay presumably worked against the central goal of getting learners to use the feedback to help redesign.

Together, the findings from the Likert-scale items, open-ended items, and log files argue that, while most learners liked getting feedback and that it was motivating, the feedback was not particularly *useful* or *used* to refine Design Challenges or other aspects of student work. This is not entirely surprising given how ambitious it was to get useful feedback from volunteer mentors in time and in a fashion that it was directly useful for learners. Further examination of the content of the mentor feedback might shed additional light on the challenges encountered in accomplishing this important goal. In the meantime, practices and systems for getting feedback from mentors in a timely fashion seems like a worthwhile goal.

Table 4.3. Responses to Open-Ended Questions about Mentors.

- *11d. Please tell us about your answers about* ***mentors*** *and anything else you think we should know about mentors. If you did not read or use the mentor feedback please tell us why.*
    - Los Angeles 1 (11 responses, 3 positive, 1 neutral, 5 negative, 2 other/suggestions)
        - 2 positive-general (*My mentor was cool and wise* and *The mentors help me*)
        - 1 positive-specific (*The mentors were a source of help in terms of my projects; they encouraged me and assisted me when needed to reflect on my designs*)

    - 5 negative-response (e.g., *I didn't get much feedback from the mentors* and *The need to reply more*)
    - 2 suggestions (*I think what we should know about mentors is what they build and how the build* and *I think we should know where they live*)
    - 1 neutral
- Los Angeles 2 (12 responses, 11 positive, 1 negative)
    - 3 positive-general (*Andrew is nice* and *I have five mentors help me with my projects*)
    - 8 positive-specific (e.g., *The mentor bobby taught me something new* and *the mentors helped me improve my designs)*
    - 1 negative (*The mentors are very good. But they don't Respoined usuly*)
- All Curiosity Camps (20 positive, 12 neutral, 4 negative, 2 other)
    - 11 positive-general (*My child liked mentors very helpful* and *I read the comments to my children and they were excited about the comments.*)
    - 7 positive-interaction (*My child liked the mentors' advice and the fact that they could exchange about her work*)
    - 2 positive-specific (*My child had a lot of support while coming up with designs. They gave us tips and helped us to make our designs work.*)
    - 12 neutral (*We did not have a chance to go over the mentors feedback; He said he was still working on it; Only because we have been really busy. Have saved each email for when we can work. We just didn't have time*)
    - 4 negative-feedback (*She did not use the mentor because she didn't find it useful*; *The older/mature mentors did not click and have the same views as a child does; sometimes the feedback was a bit delayed*; and *We didn't like the feedback of the mentors*.)
    - 2 other (*we have not*)

Qualitatively, these responses suggest that further refinements to the mentoring practices and efforts to make the mentors more personable and "human" are warranted. Figures 4.9a and 4.9b display the distribution of open-ended responses across the two summer Curiosity Camps with the distribution of the responses across the fall Curiosity Courses. The proportion of negative comments dropped substantially in the fall courses.

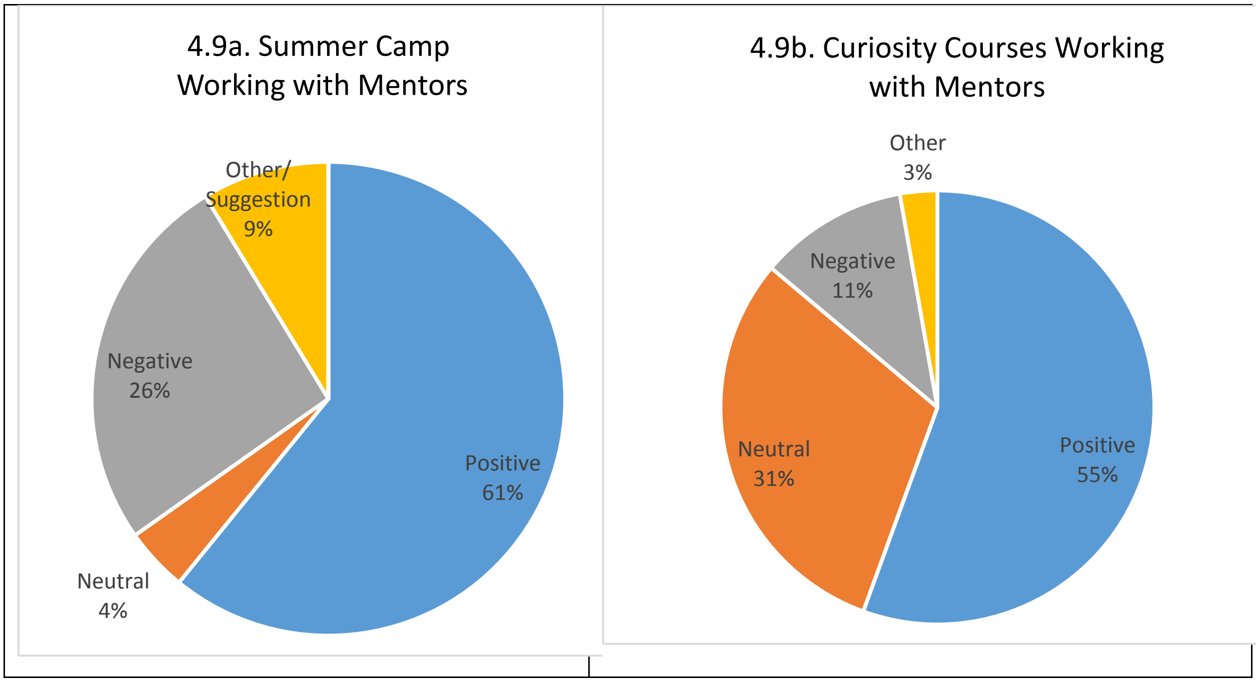


Figure 4.9. Open-Ended Response about Working with Mentors

**Completing Multiple Courses**

One additional question on the survey asked the Curiosity Course participants whether they had participated previously. Of the families, 22 (32%) reported that they had participated in the prior Curiosity Course. Figure 4.10 displays the mean satisfaction scores for the 47 families who reported that they were completing the Curiosity Course for the first time with the 22 families who reported that they had participated in the previous Curiosity Course. Two patterns emerged in comparing the scores. First, mean satisfaction scores for all of the questions about the Curiosity Machine (10a-10d) were higher for the families who were completing their second Curiosity Course. One of these differences (10c) was statistically unlikely to have occurred by chance, given the amount of variance within the two groups of scores. In contrast, the mean satisfaction for the three questions about completing projects (11a-11c) was very similar. The differences that did exist went in both directions, while the averages for the three questions involving mentors (12a-12c) were all higher for the first timers, none of these differences even approached statistical significance given the high levels of variance within the two sets of scores.

Analysis of the responses to the open-ended items was searched for additional insights regarding the experiences of repeating families. Nine of the 26 positive responses to the open-ended question about the Curiosity Machine came from the repeating families:

- *Challenge his creativity and understanding*
- *I like that we had to float the boat and create propellors. That was really fun*
- *I liked it because the challenges were fun to make. Also we learned new things.*
- *Help her think about how to design and how things worked*
- *My child like everything about curiosity machine*

- *He believes sometimes it doesn't work you can try different ideas with it. Its also very interesting.*
- *Les gusto mucho*
- *Yes we did use the curiosity machine. I lie how we could upload our designs and being able to refer to the videos in the website.*
- *He like the awesome challenge curiosity machine offers on their website and I have to say he loves curiosity machine*

Conversely, four of the ten negative responses to the open-ended comments about the Curiosity Machine were submitted by repeating families:

- *We only did activities in class, not at home. The directions and examples given were often too vague.*
- *My daughter liked it. But it was very difficult sometimes to log on.*
- *we only did activities in class not at home. Sometimes the directions or examples were too vague.*
- *It was hard to edit our comments once we entered them.*

These comments did not provide any insight as to why repeating families were more satisfied with the Curiosity Machine. Other potentially relevant factors in understanding these patterns include that the Curiosity Machine and interaction with mentors was substantially improved in the second Curiosity Course.

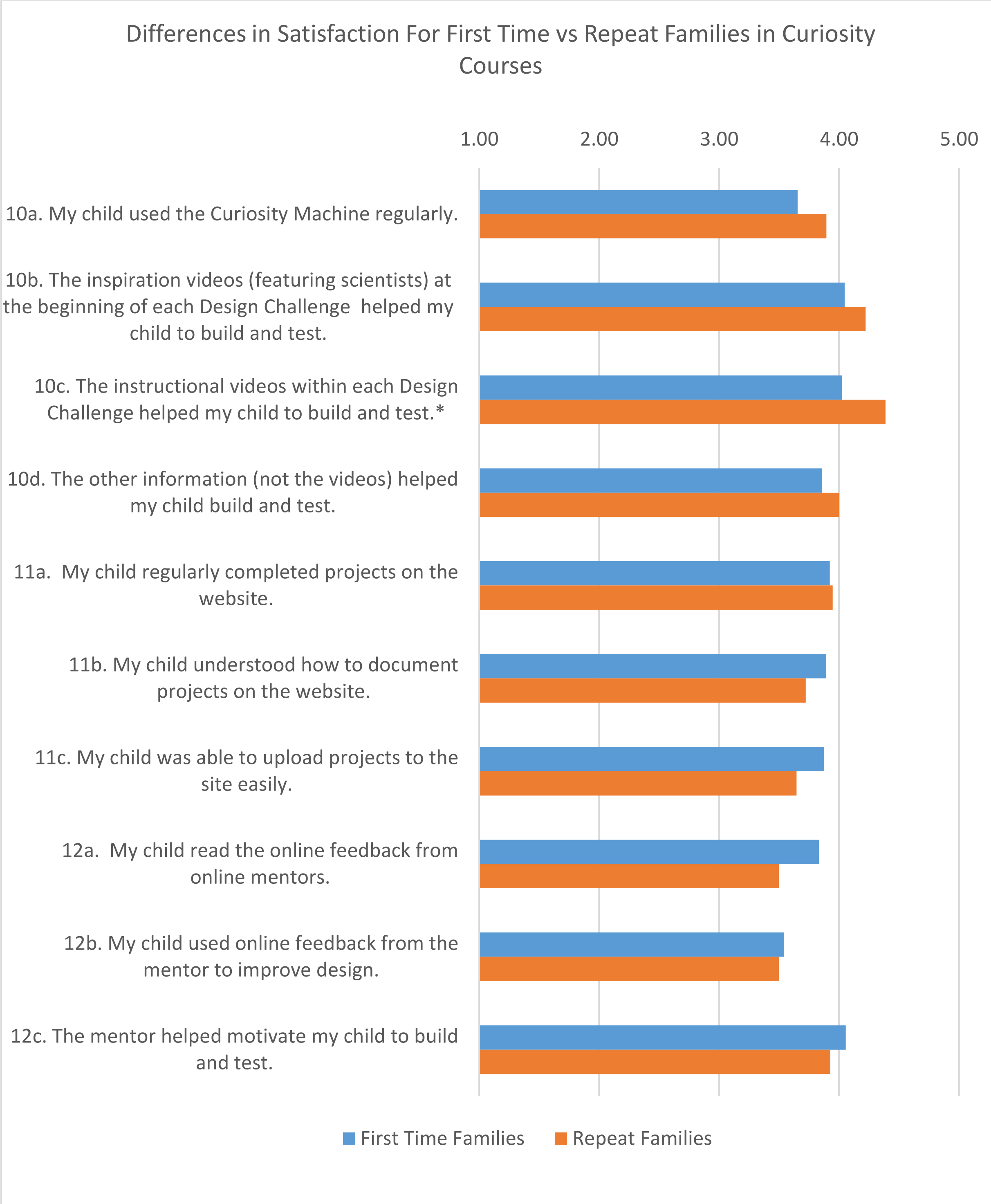



Figure 4.10. Satisfaction of Repeat Families Compared to First-Time Families in Fall Courses

## Summary of Satisfaction Survey Responses and Recommendations

Generally speaking, both the Likert-scale and open-ended responses on the end-of-camp/course survey were very positive and became more positive across events. Specifically, these results provide strong evidence that the efforts to improve the Curiosity Machine website, the process of completing projects, and the act of working with mentors were improved between the first and second summer Curiosity Camp, and again before the fall Curiosity Courses.

One important finding is that the survey results show that, while learners enjoyed getting feedback from mentors and were motivated by it, they did not appear to use this feedback to redesign. This is likely due to the average two-day delay in getting feedback and may be due to the nature of the feedback. Additionally, the satisfaction of the families who were completing their second Curiosity Course was consistently and significantly higher for questions concerning the Curiosity Machine. It seems possible that this was the result of familiarity with the Curiosity Machine in repeating families.

Consistent with the previous section, it is recommended that various options for organizing the mentor feedback be considered and that the most promising alternatives be explored in rapid prototyping A/B testing cycles. While the evaluation did not examine the content of the learner-mentor interactions, it seems inevitably that iterative refinements could increase usefulness of that feedback for encouraging and facilitating redesign, supporting additional disciplinary engagement, and learning targeted engineering and science concepts. The obvious concern with all such feedback is that it is overly general. It seems that very specific task-driven feedback from mentors, such as refining the suspension bridge to support more weight, would be useful. Ideally, such feedback would make strong connections between the relevant disciplinary concepts and the embodiment provided by the hands-on redesign. Put differently, this seems like an ideal opportunity to help learners use disciplinary concepts in a concrete way and become fluent with both the concepts and the way experts talk about them.

# 5. FINDINGS FOR DISCIPLINARY ENGAGEMENT

As introduced above, the new evaluation included three questions asking learners to articulate how the summer Curiosity Camps or fall Curiosity Courses enhanced their curiosity, creativity, or persistence, and specifically which Design Challenges best supported those dispositions. The reasoning here is that a learner who can explain how a particular Design Challenge supported a particular disposition has likely experienced something that shaped both their knowledge of the disposition as well as the likelihood that their engagement will be shaped by that in the future.

These questions were answered on the paper survey by the learners on the last day during the summer Curiosity Camps and were completed on the computer by parents with their children on the last session of the fall Curiosity Course. However, more than half of the responses to the fall Curiosity Course (60 of 120) were written in the first person in the voice of the learner (*I* and *me*); 33 used *we* or *us*, 11 used *he*, *she*, or *they*, 16 could not be coded in this regard (because the wording did not convey person).

The particular focus here is a search for evidence that learners were able to articulate why a particular Design Challenge supported a particular disposition (coded as *Warranted: Specific*; nonetheless, the more general statements that the aspect of the program enhanced a particular disposition were also perceived as positive findings). A particular goal of the evaluation was to find out whether the efforts to better articulate disciplinary engagement after the summer camps were reflected in the learner survey responses. Specifically, new introductions to the three constructs and guidelines for instructors were introduced in the fall Curiosity Courses in a way that was expected to result in increased learner engagement during the Design Challenges, and this was expected to yield valid evidence of that increased engagement.

**Engagement in Curiosity.**

The open-ended question for engagement in Curiosity was as follows:

*The Curiosity Machine and the Design Challenges were intended to encourage* ***Curiosity.*** *How did the Design Challenges help you become curious? Were any challenges better or worse for helping you become more curious?*

Figure 5.1a displays the distribution of the 35 responses across the two summer Curiosity Camps. The distribution and examples were as follows, with the specific warrant for the coding category in italics:

- Just four of the responses were coded as evidence of *Warranted Curiosity* that referenced a *Specific* Design Challenge (e.g., “The stomp rocket made me curiosity *cause it was a little hard* but I stilled did it” and “I want to *Learn abiut Rodetes* [presumably Rockets] *and how they fly and the movent.*”

- Fifteen of the responses were *Warranted Curiosity* that referenced the course in *General* (e.g., "the design challenges helped me become more curious *about engineering, science and programing with aArduino.* [Even if some didn't work that well]" and "They help you be curios *because they make you want to find how things work and how they function*.).
- Four were characterized as *Unwarranted Curiosity* because they did not provide a warrant for the claim that the activity supported their curiosity (e.g., "The stomp rocket made me more curious of all the projects that were done").
- Six of the answers were coded as *General Affirmation* but did not reference curiosity (e.g., "The curiosity machine really did help me complete me desighns. The curiosity machine is awesome.")
- Four of the responses expressed dissatisfaction or disagreement (e.g., "Well I'm not sure about that. I don't know how curiosity machine would enable my curiosity."
- Two of the responses were incomprehensible or uncodable.

It is notable that the few specifically warranted references to curiosity were imprecise or conflated curiosity with other constructs, and that one third of the responses comprised general affirmation, disagreement, or other, meaning that they did not provide evidence of engagement in curiosity.

Figure 5.1b displays the distributions for the 38 responses to the curiosity question for the fall Curiosity Courses. The distribution and examples are as follows:

- Ten comments (over one-fourth) were coded as *Warranted Curiosity: Specific* (e.g., "The *edible skyscraper made me wonder* how real skyscrapers are built" and "When we did the airplane. *Making the guidelines to make the actual plane made we want to know more about the plane*. What's in it? I've been in a plane before I looked around there's lots of windows. Made me want to know how to make it. How to get the seats inside a plane that connect to the rest of the plane. Thinking of the machines think of how to make movement. Like a giant bird. How do you make wings move up and down.")
- Seventeen comments were coded as *Warranted Curiosity: General* (e.g., "The challenges that make me curious is that I learn something that I don't know" and ""'It helped us use our imagination. Some were challenging and helped us work in a team").
- Eleven comments were coded as *Unwarranted Curiosity* (e.g., "The projects made both myself and my daughter more curious to figure out how things work" and "They made us wonder how things worked and how we could make our challenges work.")

Notably, the proportion of warranted references to curiosity increased substantially in the fall Curiosity Courses and appeared much more precise than the summer Curiosity Camps. Likewise, all of the remaining comments referenced engagement with curiosity. This provides evidence that the effort to increase disciplinary engagement with curiosity in the fall Curiosity Courses were indeed reflected in the responses.

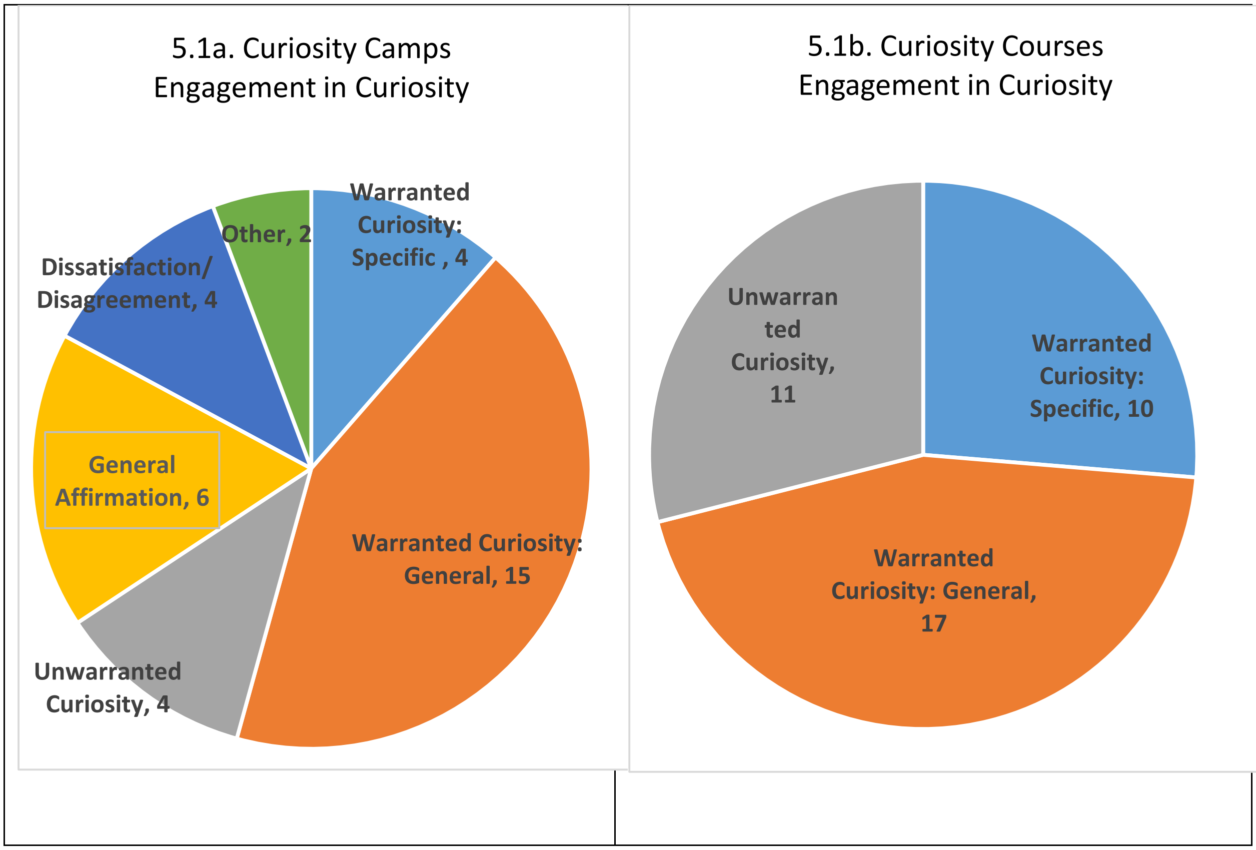



Figure 5.1. Disciplinary Engagement in Curiosity

Only a handful of students elected to respond to these questions by recording videos, but those who did provided particularly compelling examples of disciplinary engagement in curiosity. For example, one if the young participants responded:

> *There were many design challenges in this session. I thought that the one that helped me become the most curious was the shadowbox because I had to play with the shapes to try to decide where to put each one of them and whether I had to put one high and one low and things like that. I also thought that another one that made me curious was making the balloon helicopter because I had to see if I could put the stake and tape it and stuff so that I could make it spin and stay at least three feet off the ground. Those were the two Design Challenges that made me most curious.*

## Engagement in Creativity

The creativity question read as follows:

*The Curiosity Machine and the Design Challenges were intended to encourage* ***Creativity.*** *How did the Design Challenges you completed help you practice being creative? Were any challenges better or worse for you become more creative?*

Figure 5.2a displays the distribution of the 35 responses to this question from the summer camps. The distribution and examples were as follows:

- Six responses were coded as *Warranted Creativity: Specific* (e.g., "The glider is the creativity *because I use different and colorful paper*" and "They helped me be creative, *like when we made circuits, I could make my circuit be any way I want it*").
- Nine responses were coded as *Warranted Creativity: General* (e.g., "The design challenges actually made me think outside the box to make master projects" and "I was able to use direffent materials").
- Seven responses were coded as *Unwarranted Creativity* (e.g., "It helped me be more creative like 2 friends that were here" and "The mentor help me be more creativity").
- Nine responses were coded as *General Affirmation* (e.g., "The encourage me to have more fun").
- One response was coded as *Dissatisfaction/Disagreement.*
- Three responses were coded as *Other* because they did not fall into any of these categories.

Figure 5.2b displays the distribution of the 40 responses to this question across the fall Curiosity Courses. The distributions and examples were as follows:

- Twelve responses (almost one-third) were coded as *Warranted Creativity: Specific* (e.g., "The skyscraper challenge helped me become more creative *because i want to build it like a skyscraper but it came out like a house*" and "The Rube Goldberg made me *want to create lots of different machines* to get a marble from one place to another").
- Seventeen responses were coded as *Warranted Creativity: General* (e.g., "The challenges made me want to make my model one of a kind. and to see if mine worked in a different way than the others" and "The challanges helped me become more creative by making me do more challenges at home. All challanges helped me become equaly more creative.")
- Six responses were coded as *Unwarranted Creativity* (e.g. "The design challenges unlocked my iner creativity" and "The boat required more creativity but he liked the stomp rocket best").

- One response was coded as *General Affirmation* ("The food challenge was the best because we were able to make something out of food.")
- Four responses were coded as *Other* because they did not belong to any of the above categories.

For creativity, as with curiosity, we see a substantial increase from the summer camps to the fall courses in the responses that provide a warranted evidence of engagement in creativity and a decrease in the general affirmations that suggest an unclear understanding of the question and (therefore) the disposition of curiosity. This difference suggests that the additional efforts to engage participants more deeply in considering how each challenge supported creativity in the fall Curiosity Courses had an impact.

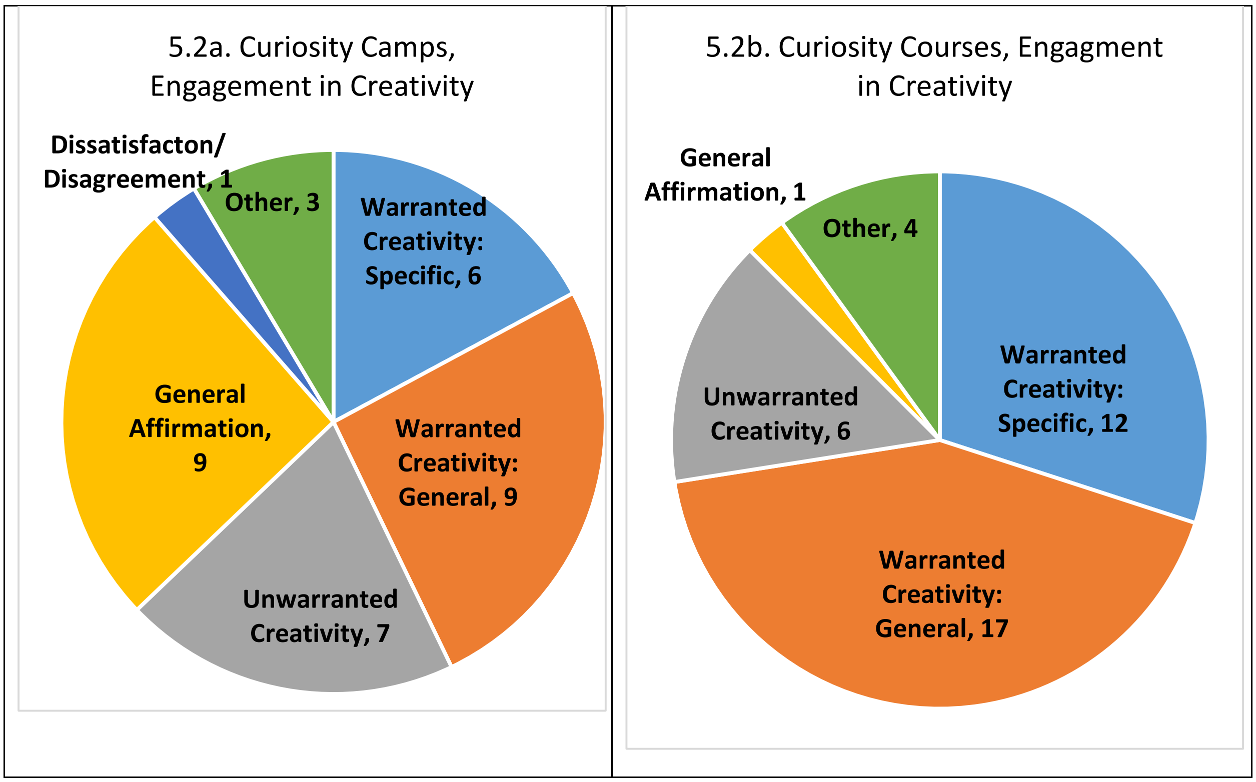



Figure 5.2. Disciplinary Engagement in Creativity

## Engagement in Persistence

The persistence question read:

*The Curiosity Machine and the Design Challenges were intended to encourage **Persistence**. How did the Design Challenges you completed help you practice being **persistent**? Were any challenges better or worse for becoming more persistent?*

Figure 5.3a shows the proportions of the 33 responses from the summer camp. Distributions and examples are as follows:

- Four responses were coded as *Warranted Persistence: Specific* (e.g., "Aeolipile (?) it was hard but I still complete it" and "The sailboat helped my Persistence because I had to make many changes").
- Fifteen responses were coded as *Warranted Persistence: General* (e.g., "It help me me be more persestan bt trying more they I should" and "My challenges helped me become more persistent, because not all of my projects worked, so I had to re design.)
- Four responses were coded as *Unwarranted Persistence* (e.g., "The candy brige is the most persistence projet" and "My robot helped my increase my persistence").
- Four responses were coded *General Affirmation* (e.g., "Because when I first started I loved doing the experiments now" and "it heleped my child ollout").
- Four responses were coded as *Dissatisfaction/Disagreement* (e.g., "I'm not sure how CM was intended to encourage persistance because the website didn't say messed up on a project").
- Two responses were coded as *Other* because they did not fit in any of the above categories.

Figure 5.3b shows the proportions of the 40 responses to the persistence question from the fall Curiosity Courses. The distributions and examples are as follows:

- Ten responses (one-fourth) were coded as *Warranted Persistence: Specific* (e.g., "The bird beak beacuse *I had to try to do the over and over because the beak didn't close too much*" and "the challenges helped me become more persistent because i did not give p an when I was building the *edible skyscraper it collasped but i tried again and i did not give up*").
- Fifteen responses (about one-third) were coded as *Warranted Persistence: General* (e.g., "It made me want to try harder and try different options because I wanted to get the job done" and "It made us not stop until we got it right. We could not quit because we had to try our hardest").
- Nine responses were coded as *Unwarranted Persistence* (e.g., "He feels the aeliopile made him more persistant" and "Keep trying some more other things").
- One response was coded as *General Affirmation* ("I liked it all but the questions at the end.")
- Five responses were coded as *Other* because they did not fit into any of the above categories.

Yet again, compared to the summer camps, more of the fall responses were coded as warranted examples of engagement in persistence, and those responses were generally much more articulated. There were also fewer responses that suggested that the respondents did not understand the question.

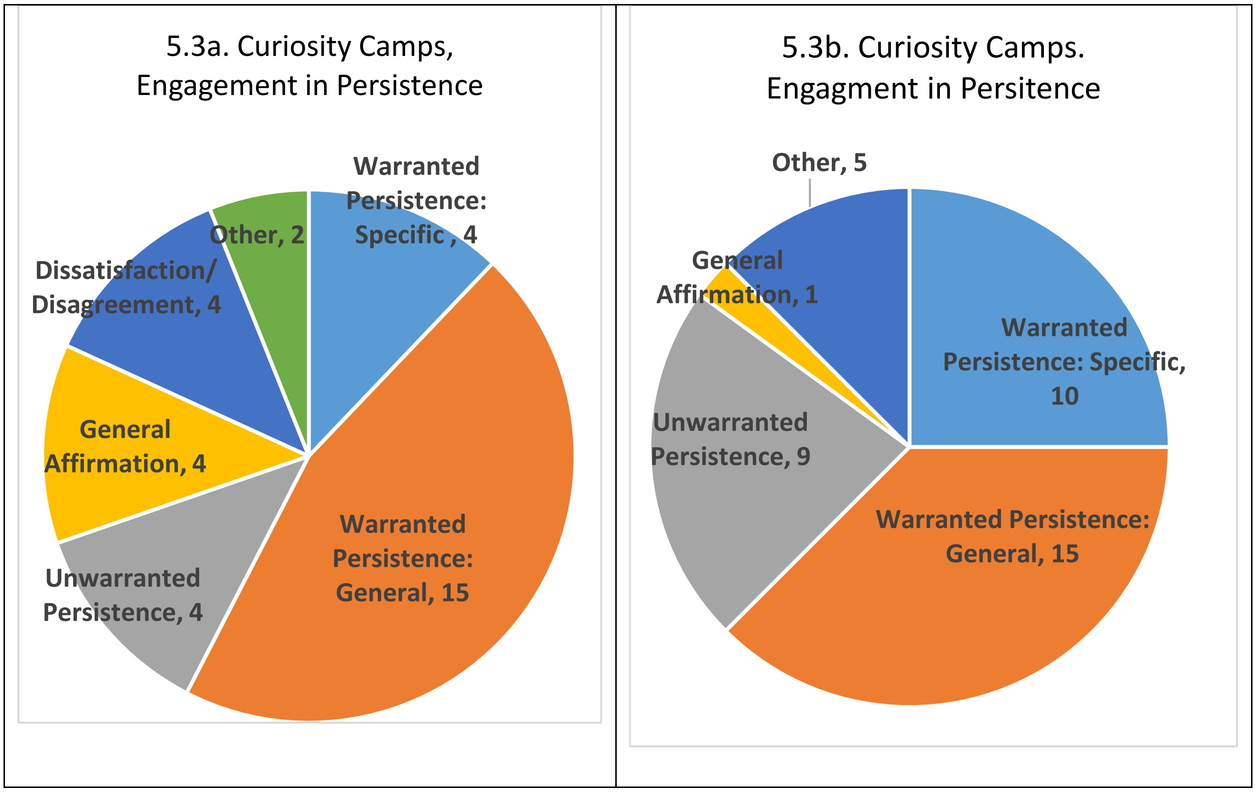



Figure 5.3. Disciplinary Engagement in Persistence

## Summary of Disciplinary Engagement and Recommendations

The above findings for creativity, curiosity, and persistence show clear evidence of engagement with "higher order" disciplinary practices among a significant proportion of respondents. This difference between the summer camps and fall courses suggests that the additional focus on disciplinary engagement resulted in the enhanced engagement and learning. Such a conclusion is tempered by the fact that parents and children crafted responses to the questions in the fall Curiosity Courses together. This is significant because the parents were presumably more able to understand the nature of the question and therefore prompt the children to provide both specific and general warrants characterizing their engagement.

One recommendation for further supporting engagement with higher order disciplinary practices is encouraging the mentors to engage with those practices while giving feedback to children. Specifically the mentors should be encouraged to reference these three practices in their feedback and work to link them to specific aspects of the submitted solution. For example, they could frame their encouragement to redesign as a chance to "practice being persistent, curious, and/or creative." They could also link specific aspects of each solution to each of the three concepts (e.g., "Your second redesign was particularly creative because…").

Another recommendation for enhancing engagement and evidence of engagement with these disciplinary practices is embedding the end-of-course reflection into some sort of recognition of accomplishment across the course. A digital badge would be ideal for this, particularly if the learners were able to stack badges for the individual Design Challenges that they completed in such a badge, and if those individual badges also feature reflections that show clear evidence of engagement with more specific disciplinary concepts. This would allow the collection of evidence of engagement without requiring a survey and encourage learners to craft more detailed reflections (because they presumably would be public and seen by others).

# 6. SUMMARY

## Summary of Findings

The Curiosity Camps and Courses provided hundreds of learners and families with high-quality opportunities to engage engineering design practices and practice being curious, creative, and persistent. In particular, the programs were successful in recruiting many female participants and members of linguistic and racial minorities. Reflecting success on a central goal, roughly half of the summer campers and a third of the families in the Curiosity Courses reported completing Design Challenges from home while the activities were running. It is presumed that some of them continued completing Design Challenges after the activities were over, but this cannot be confirmed with the available data. One problematic aspect of the activities was that roughly three quarters of the submitted Design Challenges did not include a reflection. This appears to have partly been due to delays in mentors approving the submission and moving learners to the reflection phase, and partly due to the difficulty of communicating the importance of reflection state in the Engineering Design Process. However, this may be an inevitable consequence of working with minors and the way that programs must be structured to keep learners engaged.

Generally speaking, the learners in the summer Curiosity Camps and the families in the fall Curiosity Courses reported being quite satisfied with the Curiosity Machine, the Design Challenges, and the mentors. Examining the means across the two consecutive summer camps confirmed that the substantial effort to fine-tune all three aspects of the camp was successful: average agreement for nine of 11 indicators was higher for the second camp, and two of these differences reached statistical significance. The most important finding from the self-report survey was that the feedback from the mentors was not particularly useful or used in refining solutions to the Design Challenges. Presumably, this is due to delays in mentors advancing designs to the reflection stage, so that learners were already engaged in a new Design Challenge.

The end-of-course survey provided clear evidence of meaningful engagement with the three disciplinary practices of curiosity, creativity, and persistence. A larger proportion of warranted responses (both specific and general) in the fall Curiosity Courses suggests that efforts to enhance engagement in those courses were successful. Several recommendations for further enhancing disciplinary engagement in these disciplinary practices is provided.

Taken as a whole, these findings suggest that this was a worthwhile investment for all parties: the Curiosity Machine is clearly a well-designed website that is easy to use and is engaging, the Design Challenges are compelling activities both in concept and execution, and the efforts to refine both across the period of the study were clearly effective. In particular, these efforts led to a website, over 80 Engineering Design Challenges, and a framework for recruiting and engaging mentors that appears to have enormous future potential.

## Summary of Recommendations

In order to increase the amount and quality of activity outside of the camps and classes, and after the programs are completed, it is recommended that a separate FAQ be prepared to help parents support their children, and that this FAQ be used in the classes so that parents get experience supporting their children's engagement. In order to increase the number of submitted challenges that include a reflection, it is recommended that additional strategies be explored for getting feedback quicker from mentors and to somehow encourage reflections to be submitted. In order to increase engagement in the specific disciplinary concepts targeted by each Design Challenge, it is recommended that the reflection prompts learners to reflect on which aspects of the challenge helped them practice using those concepts to design and redesign, and that the feedback from the mentors reinforces this.

It seems likely that continued effort to explore micro-credentials could be quite a promising direction. It may be possible that with minor further refinements, and efforts to refine digital badges, the Curiosity Machine, Design Challenges, and mentors could together provide compelling evidence of out-of-school engagement in the specific disciplinary concepts and more general disciplinary practices outlined in the Next Generation Science Standards. Such information might be sufficiently convincing evidence of engagement and learning that classroom teachers would be willing to accept towards course credit. If so, this would represent a significant leap forward towards the goal of "seamless cyberlearning" advanced by the National Science Foundation in 2008.

# 7. APPENDICES

## Summer 2014 Curiosity Course Survey

Curiosity Course Experience Survey

Please take a few minutes and complete this survey so we can better serve you.

- Parents can complete Page 1, but parents should discuss the questions on Page 2 and Page 3 with their child before answering.
- If you feel uncomfortable or would prefer not to answer any of the following questions, you are welcome to leave them blank.
- If you have more than one child participating, please complete one survey for each child.

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 own a computer/tablet in your house? __No __Yes

5. Do you have a computer/tablet with Internet access in your home? __No __Yes

6. Do you or members of your family own a smartphone that has Internet Access? __No __Yes

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

8. Did your child work on Design Challenges outside of the Curiosity Course? (check all that apply)
No ____
Yes, but without submitting it on the Curiosity Machine _____
Yes, submitted from a home computer ______ tablet _______ or smart phone ______
Yes, submitted from school or library computer ___ or tablet____

Please discuss these statements with your child. Check one box for each statement to indicate how strongly your child agrees or disagrees with the statement. If your child does not have an opinion check *don't know.* Please explain your responses or tell us anything else you would like us to know about.

| 9. The Curiosity Machine | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Don't Know |
|---|---|---|---|---|---|---|
| 9a. My child used the Curiosity Machine regularly. | | | | | | |
| 9a. The Curiosity Machine inspired my child to build and test. | | | | | | |
| 9b. The information at the Curiosity Machine website help my child build and test | | | | | | |
| 9c. The videos inspired my child to use the information the Curiosity Machine to build and test | | | | | | |
| 9d. The videos provided information that helped my child build and test | | | | | | |

9e. Please tell us about your opinions about the Curiosity Machine and anything else we should know about it. If your child did not use the Curiosity Machine, please tell us why.

| 10. Completing Projects | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Don't Know |
|---|---|---|---|---|---|---|
| 10a. My child regularly completed projects on the website | | | | | | |
| 10a. My child understood how to document projects on the website | | | | | | |
| 10b. My child was able to upload projects to the site easily | | | | | | |
| 10c. My child enjoyed earning digital badges | | | | | | |

10e. Please tell us about your answers about Completing Projects and anything else we should know about that. If your child did not complete projects on the website, please tell us why.

| 11. Working with Mentors | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Don't Know |
|---|---|---|---|---|---|---|
| 11a. My child read the online feedback from online mentors | | | | | | |
| 11b. My child used online feedback from the mentor to improve design | | | | | | |
| 11c. The mentor helped motivate my child to build and test | | | | | | |

11d. Please tell us about your answers about mentors and anything else you think we should know about mentors. If your child did not read or use the mentor feedback please tell us why.

Please discuss these questions with your child before answering them. You may want to explain the difference between curiosity, creativity, and perseverance with them.

12. The Curiosity Machine and the Design Challenges were intended to encourage Curiosity. How did the Design Challenges your child completed help your child practice being curious? Were any challenges better or worse for helping your child become more curious?

13. The Curiosity Machine and the Design Challenges were intended to encourage Creativity. How did the Design Challenges your child completed help your child practice being creative? Were any challenges better or worse for helping your child become more creative?

14. The Curiosity Machine and the Design Challenges were intended to encourage Persistence. How did the Design Challenges your child completed help your child practice being persistent? Were any challenges better or worse for helping your child become more persistent?

## Fall 2014 Curiosity Course Survey

**Please complete this survey so we can better serve you.**

- **Parents can complete Page 1, but parents should discuss the questions on Page 2 with their child before answering.**
- **If families have more than one child participating, please complete one survey for each child.**
- **It should take about 5-10 minutes to complete both sides of the survey**

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

2. What is the parent's gender: __ Male __Female

3. What is the child's gender: __ Male __ Female

4. Do you own a computer/tablet in your house? __No __Yes

5. Do you have a computer/tablet with Internet access in your home? __No __Yes

6. Do you or members of your family own a smartphone that has Internet Access? __No __Yes

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

8. Did your child work on Design Challenges outside of the Curiosity Course? (check all that apply)
No ____
Yes, but without submitting it on the Curiosity Machine _____
Yes, submitted from a **home** computer ______ tablet _______ or smart phone ______
Yes, submitted from **school** or **library** computer ___ or tablet____

9. Has your child attended a Curiosity Course before attending this one? ____No ____ Yes

**Please discuss these statements with your child. Check one box for each statement to indicate how strongly your child agrees or disagrees with the statement. If your child does not have an opinion check *don't know.* Please explain your responses or tell us anything else you would like us to know about.**

| **10. The Curiosity Machine** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Don't Know |
|---|---|---|---|---|---|---|
| 10a. My child **used** the Curiosity Machine regularly. | | | | | | |
| 10b. The **inspiration videos** (featuring scientists) at the beginning of each Design Challenge helped my child to build and test | | | | | | |
| 10c. The **instructional videos** within each Design Challenge helped my child to build and test | | | | | | |
| 10d. The **other information** (not the videos) helped my child build and test | | | | | | |

10e. Please tell us what your child liked and what you did not like about the **Curiosity Machine** and anything else we should know about it. If your child did not use the Curiosity Machine, please tell us why.

| **10. Completing Projects** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Don't Know |
|---|---|---|---|---|---|---|
| 10a. My child regularly completed projects on the website | | | | | | |
| 10b. My child understood how to **document** projects on the website | | | | | | |
| 10c. My child was able to **upload** projects to the site easily | | | | | | |

10e. Please tell us what your child liked and did not like about **Completing Projects** and anything else we should know about that. If your child did not complete projects on the website, please tell us why.

| **11. Working with Mentors** | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | Don't Know |
|---|---|---|---|---|---|---|
| 11a. My child **read** the online feedback from online mentors | | | | | | |
| 11b. My child used online **feedback** from the mentor to improve design | | | | | | |
| 11c. The mentor helped **motivate** my child to build and test | | | | | | |

11d. Please tell us what your child did or did not like about **mentors** and anything else you think we should know about mentors. If your child did not read or use the mentor feedback please tell us why.

**Online Question**

**1.** The Curiosity Machine and the Design Challenges were intended to encourage **Curiosity.** How did the Design Challenges your child completed help your child practice being curious? Were any challenges particularly good for helping your child become more curious?

**2.** The Curiosity Machine and the Design Challenges were intended to encourage **Creativity.** How did the Design Challenges your child completed help your child practice being creative? Were any challenges better or worse for helping your child become more creative?

**3.** The Curiosity Machine and the Design Challenges were intended to encourage **Persistence.** How did the Design Challenges your child completed help your child practice being persistent? Were any challenges better or worse for helping your child become more persistent?