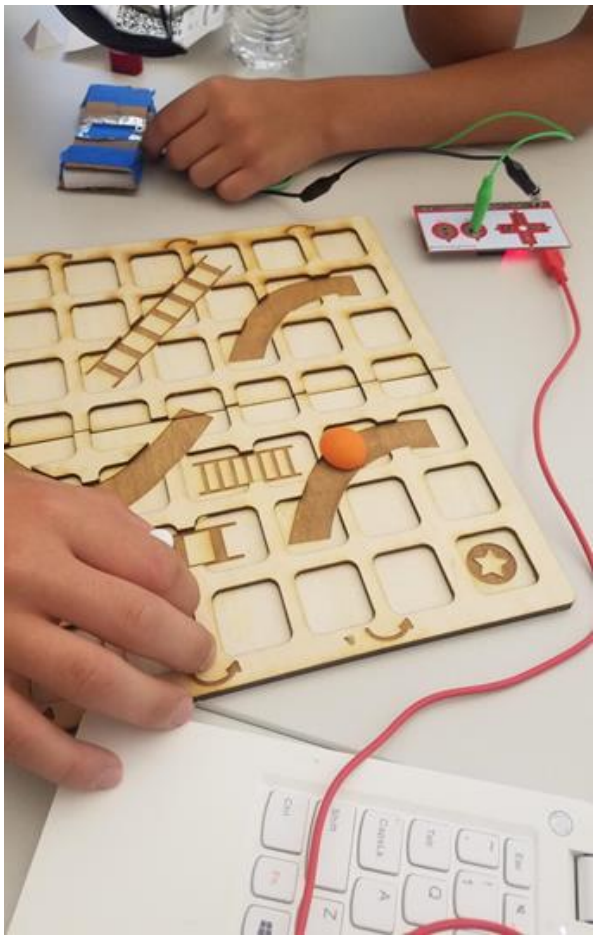

EXTERNAL EVALUATION OF THE BUILD A BETTER BOOK PROGRAM

UNIVERSITY OF COLORADO, BOULDER
NSF ITEST PROGRAM

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Executive Summary

The Build a Better Book program seeks to "iteratively develop, test, and refine a Tactile Picture Books curriculum suitable for makerspaces." In the past year, the program continued to be implemented in a variety of formats and contexts, including schools, libraries, university summer programs, and museums. Program formats ranged from integration of BBB content into school courses or enrichment sessions to multi-week library programs to an extended multi-week museum internship. Build a Better Book also offered a teacher and librarian training to scale the program to other sites nationally. Most of the workshop participants implemented the program in their own schools and libraries in spring and summer 2019, or plan to do so in fall 2019.

The external evaluation in year 3 of the grant used multiple methods, including observations, pre-post student surveys, post-only survey, student individual and focus group interviews/embedded assessments, a librarian/educator workshop survey, and librarian/educator interviews to evaluate outcomes from the extended format programs offered by the Build a Better Book program in 2018-19. In particular, the evaluation focused on students' engagement in the design process, changes in their technological and design-based skills and self-efficacy, STEM interest, and perceptions of accessibility and disability.

The main findings from the evaluation are as follows:

The Build a Better Book Learning Environment:

- The Build a Better Book program expanded to 15 sites with several more that will implement in fall 2019. Expansion programs were offered in-school and out-of-school in library and makerspace settings. In-school offerings were incorporated into technology, art, and science classes and as stand-alone enrichment or electives. Out-of-school offerings were implemented as multi-day or multi-week, extended programs. In-school offerings generally provided more contact time than out-of-school programs.
- The Build a Better Book program showed strong evidence of "authentic making" in program observations at local sites and in interviews with expansion site facilitators. The program scored the maximum scores for attention to audience on the observation rubric.
- Students used a variety of technologies, including 3-d modeling and printing, Scratch, Makey Makey, swell machines, lasercutters, among others. Programs varied in their use of technology with some that incorporated multiple technologies and others that primarily used textiles, braille, and crafting materials.
- The BBB program—both at local and expansion sites—engaged students deeply in the design process and project-based learning. Students had the opportunity to design, create, and iterate a product for youth with visual impairment in all programs, including all of the expansion sites.

- Programs displayed varying levels of collaboration. In-school programs tended to foster more collaboration because facilitators' learning goals for students often focused on teamwork and because of more limited access to tools and resources which necessitated sharing and collaboration.
- At observed program sites, the BBB program scored highly in teacher feedback to students. Peer-to-peer feedback was present but observed less frequently. One program used a structured reflection sheet.
- All observed programs showed strong teacher-student rapport, inclusion of all students, and a learning environment that fostered creativity, learning, and risk-taking.
- Similar to previous years, the pacing of student projects is challenging. However, more students were able to complete projects in a timely manner in this past year. Balancing the depth and scope of the project with time to iterate is a challenge for facilitators, but many implementation sites seemed to capture the right balance by structuring the project to be completed in the allotted time.
- 100% of observed programs and 100% of facilitators at expansion sites demonstrated high levels of student engagement. All Build a Better Book programs offered multiple opportunities for student choice and engagement. Students chose their projects, designs, and materials. Students took great care with their projects and were motivated by the real-world purpose of their products. The majority of expansion site facilitators also noted that the program attracted a different audience of students than their typical makerspace offerings.

Student Outcomes:

Understanding the Design Process

- In interviews, almost all (89%) facilitators at expansion sites observed student growth in understanding the design process in general. Facilitators observed that students tested, iterated, and re-tested their prototypes until they were appropriate and useful for youth with visual impairments. Students also had to problem-solve challenges in the design process, such as pieces that did not 3-d print or laser cut as expected. One facilitator did not observe iteration in a program that was primarily crafts-based. These students engaged in a creative design process but the facilitator did not observe iteration to the extent of other programs.
- 80% of students described growth in their understanding of the design process in general. Students in programs with multiple modes of technology reported more iteration on their design than students in lower-tech programs.
- 100% of expansion site facilitators and 95% of students described gains in understanding universal design. Students developed an awareness of the need for and benefits of universal design. They also developed greater capacity to create and modify objects to be accessible, especially for people with visual impairments.

Develop of Empathy and Awareness of People with Visual Impairment

- Throughout the life of the program, one of the most important outcomes for students has been the ability to understand how visually impaired or blind people experience the world and the development of empathy that comes with this increased awareness of inclusion and ability.
- 100% of students found it meaningful to talk with someone with a disability.
- 100% of students found it meaningful to learn about how people with disabilities accomplish certain tasks.
- 91% of students increased their understanding of how design helps people with disabilities.
- 86% of students increased their ability to make a difference for people by using technology.
- 100% of facilitators from expansion sites observed gains in empathy and altruism in their students.
- In an open-ended question, students reported that they learned from the BBB program that they can help people with disabilities, they gained a better understanding of the experiences of people with disabilities and they learned to take a strengths-based approach to disability.

Interest in Engineering and Design

- Student attitudes toward and interest in technology, engineering, or design was sustained over the course of the program, remaining steady between the pre- and post-surveys.
- On the post-only survey, 2/3 of students reported increased interest in learning new technologies and 60% were more interested in learning about engineering.
- When asked about the influence of the BBB program on their interest, the most common response was that students gained insight into the broad range of applications of engineering. Students also gained a better understanding of how engineering can be used to help people. About half of students stated that they were more interested in STEM from their participation in the BBB program, while the remainder reported that they had gained more confidence in their technological and design skills.
- In the post-only survey, 94% of students expressed interest in continuing with the Build a Better Book program. And 83% were interested in designing or creating things in their free time. Additionally, 71% were likely to apply the skills they learned in BBB to another project.

Gains in technological skills

- 100% of students reported that they increased their ability to adapt common objects for a new purpose, on the post-only survey.
- 90% of students increased their ability to create new things.
- 69% of students increased their ability to use Tinkercad and a 3-d printer.

Librarian and Educator Outcomes from BBB Training

Participants' prior experience with makerspace technologies

- BBB workshop participants had extensive experience in developing and implementing STEM programming for youth, though less experience with universal design, specifically. Almost all participants had prior experience in facilitating makerspaces, but only about half had prior experience with 3-d modeling and printing.

- A fair number of attendees had prior experience in working with youth disabilities (18% in past years yet 45% of this year's cohort had some or a lot experience).

- Teachers and librarians had similar prior experience in facilitating STEM programming for youth, though teachers had significantly more experience in engineering/design thinking and electronics/circuits than librarians or school librarians.

- Classroom teachers had less experience than pubic librarians or school librarians in integrating specific makerspace technologies (e.g., 3-d printing and modeling, Scratch computer programming) into youth programming.

Gains in knowledge of how to facilitate inclusive makerspace programming

- After the workshop, almost all participants (97%) reported that they knew how to facilitate inclusive makerspace activities and how to implement a tactile book activity.

- After the workshop, almost all participants (94%) felt confident that they could facilitate a makerspace.

- The 2019 cohort generally had the capacity within their organization to implement makerspaces, but there were a few key differences. Classroom teachers were more likely than librarians to cite a lack of expertise as an obstacle to implementing a makerspace. Across all participants, lack of time was the biggest obstacle to implementing a makerspace.

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- In an open-ended question, training participants cited that the most important ideas they gained from the workshop were how to facilitate universal design programming and the importance of partnerships in doing so. There were no differences in responses between teachers or librarians.

- The most common resources still needed to implement a BBB program were access to technology and access to partnerships. Additionally, public librarians were concerned about student recruitment and K-12 school personnel were concerned about financial resources.

Networking and partnerships

- 91% of participants planned to engage with the national BBB network. In interviews, 50% of expansion site facilitators were actively engaged in the network through Twitter and other means. The remainder were engaged through the listserv.

- 70% of participants had partnerships they could rely on to facilitate a Build a Better Book program. Most of the rest of the cohort had plans to develop partnerships with community organizations or schools that serve people with disabilities.

- Partnerships, especially with community organizations or schools serving people with disabilities, were cited as integral to the success of the BBB program by expansion site facilitators.

Recommendations

The BBB program continued to provide authentic making experiences for students that engaged them in universal design and increased their understanding of the way that people with visual impairments experience the world. Expansion sites replicated the BBB model and the program's mission and activities seem to transfer well to new contexts and sites. Expansion site facilitators noted that partnerships, especially with the visually impaired community, were integral in making the project task "real" for students and to develop their empathy and awareness. The pacing of the projects and program continued to be challenging, though less so. Some sites adjusted to the pacing issue by limiting the scope of designs (e.g. have all students work on a letter of the alphabet) and this seemed to be an effective way to attend to timing and pacing for programs with a limited number of contact hours. While the program scored highly on most markers of authentic making in the observation rubric, there was less observed peer-to-peer feedback or facilitator summative feedback on student work. If BBB would like to incorporate more structured feedback, programs may consider using a structured feedback or reflection form similar to that used by the Museum of Boulder program. While all local and expansion sites fostered design, development and iteration, sites that used more technology fostered higher levels of iteration and re-design. As much as possible, expansion sites may consider how to incorporate more technology within the limited

time frame and resources for BBB programming. In all, the BBB program appeared to transfer well to a variety of environments, both in- and out-of-school and integrated with differing academic disciplines. In the future, it would be beneficial to systematically capture the program implementation and context at expansion sites in a form or short survey. This would allow some of the program implementation variables to be quantified (e.g., extent of technology, program duration, etc.) and used to assess whether there are different outcomes for various program types and formats. Additionally, the evaluation may be well-served to implement a post-survey only as there was difficulty in collecting matched pre- and post-survey data from some of the expansion sites. Moreover, students seem better able to reflect on their learning and growth when asked to deliberately evaluate their gains from the program upon the completion of their project.

Introduction

The Build a Better Book project funded through the ITEST program of the National Science Foundation aims to "iteratively develop, test, and refine a Tactile Picture Books curriculum suitable for library Makerspaces." This curriculum engages youth in designing and building multimodal, tactile books for blind and visually impaired youth using textiles, 3-d printing and other technologies and materials. The Build a Better Book program is offered in several different formats. In the past year, the program was offered through extended, drop-in workshops at Golden Public Library and other library locations, extended camps and multi-day workshops at a variety of scale-up national sites, an internship at the Boulder Museum, extended, a school-based program at Northglenn High School and other national locations, and extended summer multi-week, outreach programs for diverse middle and high school youth at the University of Colorado, Boulder. Additionally, a multi-day training was held for teams of librarians and educators from around the country in spring 2019. This report will focus on student outcomes from the extended, multi-day or multi-week programs, national expansion sites, and participant outcomes from the librarian and educator training.

Evaluation Design and Methodology

Similar to previous years, the primary goals of the evaluation are to: 1) evaluate outcomes related to different extended program formats, 2) provide formative feedback to guide future implementation, and to 3) evaluate outcomes from Build a Better Book trainings, including identifying librarians' and educators' resources, challenges, and needs in implementing STEM programming in libraries and afterschool programs. This past year, more of the program implementation occurred from expansion sites and was led by program facilitators trained during the spring 2019 workshop. Thus, the evaluation questions have been slightly adapted to focus less on the implementation of different program formats and more on the scalability of the program in general (i.e., whether it achieved the same or similar results in different contexts and with different staff/leadership implementing the program). The evaluation addresses the following questions:

- Has the Build a Better Book program achieved its goals to broaden participation in STEM and to increase student interest and engagement in STEM?
- Has the Build a Better Book program achieved its goals to broaden students' conceptions of STEM, especially the use of STEM tools and concepts to help people or society?
- What are the outcomes and challenges for the Build a Better Book program at scale?
- How might the program be modified to better serve youth and achieve its goals?

Evaluation Instruments

In the first year of the grant, the external evaluator and project co-PI identified several relevant survey scales by searching the STELAR resource center for ITEST projects and the research literature on informal STEM learning. Survey scales are a group of items that are clustered to measure student outcomes in a specific area, granting the array of items greater statistical power than a single item. The project leadership and evaluator also modified these survey scales with items related specifically to the Build a Better Book program to gauge students' interest in accessible design, blending art and technology, and their interest in specific technologies that are used in the program. These survey items and scales were assembled into a survey that could be delivered in a pre-post format. In the past year, the survey was further modified to focus less on STEM career interest and more on general STEM interest because of the age of the youth served by Build a Better Book and the program focus did not align with career interest as an outcome variable. In the past year, the student survey measured the following domains:

- Technological self-efficacy,
- STEM aspirations,
- Belief that technological skills will help in the future,
- Interest in engineering and design, and
- Belief that technology can be used to contribute to society

Additionally, the survey collected demographic information about participants, such as gender, race/ethnicity, parental education level, and grade level. The survey was administered at the beginning and end of program sessions. Students completed the survey on laptops or phones through an anonymous web link but had the choice whether to participate in the evaluation of not.

To assess the extent to which the Build a Better Book program engaged in principles of engineering design and authentic STEM making experiences, an observational rubric was used at a sample of sessions. The rubric was created by one of the project co-PIs from the School of Education. A modified version of the observational rubric was used to include only sections that are relevant for the Build a Better Book program. The rubric sections include "Authentic Making," "Collaboration," "Feedback and Revision," "Multiple Means of Engagement" "General Teacher Items," and "Reflection." Each section of the rubric contains several items that are observed and rated on 4-point scales, such as: 0=not observed, 1=observed minimal attempts, 2=partially observed and 3=observed. The rubric was used for seven observations of five different programs: Golden Library, Lafayette Library, Boulder Museum internship, CU-Boulder Pre-Collegiate program, and CU-Boulder ACCESS program.

To capture student learning outcomes and understanding of the design process, an embedded assessment /student interview was used in a sample of the same sample of five

programs that were offered in Colorado during the 2018-19 year (Golden Library, Boulder museum internship Boulder Pre-Collegiate program, ACCESS program, and Lafayette Library). In the past, the embedded assessment was recorded by video through the Recap app. Because the Recap app is no longer available, the evaluator recorded student responses to the embedded assessment/interview questions with a phone or digital recorder. The recordings were transcribed. Students responded to four questions:

1. What was your vision for your project and what features did you add to make it more accessible?
2. What challenges did you encounter and how did you overcome them?
3. What features are you most proud of and why?
4. What is your biggest take away from this experience? If you looked back on this 5 years from now, what will you remember?

This year the embedded assessment questions were collapsed into student interviews that were conducted during the observations of the five Colorado programs. In all 22 interviews were conducted with students from the five programs. Almost all of the interviews were focus group interviews, but a few were conducted individually. Approximately 50 students were interviewed in the five programs. Students were asked about their project, how they designed it to be accessible, what they learned about designing for accessibility, their favorite aspects of the program, challenges they encountered in the design process and how they overcame them, and their advice for improving the program.

Librarian and educator outcomes were documented in two ways, through interviews with facilitators who had implemented the program and through a post-workshop survey for participants in the spring training. The survey documented outcomes from the training, elicited feedback about the workshop, and also gathered data on librarians' and educators' needs, challenges, and preferences in delivering inclusive STEM programming to youth. The survey link was sent to all librarian and educator participants of the training and 33 completed the survey. The survey also addressed librarians' and educators' knowledge of youth programming and programming for people with disabilities. All librarians and educators who implemented the program after the training were invited to participate in an interview to document student outcomes and program implementation models. Fifteen sites reported that they had implemented BBB programs in the fall, spring or summer of 2018-19. All of these facilitators were invited to participate in an evaluation interview to gain information about their implementation model, student outcomes, and lessons learned. Eleven facilitators agreed to an interview, while the remainder did not respond to interview requests. Interviews typically lasted about 30 minutes and addressed participants' interest in the BBB program, student outcomes, implementation models and challenges, and support received from the BBB training workshop and team.

Data Analysis

In the past, survey data were cleaned and merged for analysis, and pre-post analyses were only conducted on matched student data (i.e., the same student completed both a pre- and post-survey). However, with the expansion of the Build a Better Book program in the past year, this approach was not as fruitful. For instance, some programs completed the pre-survey but not the post-survey and two programs completed the post-survey but not the pre-survey. Additionally, the number of students completing the pre- and post-survey varied quite substantially in many programs. For instance, one program had 53 students complete the pre-survey, but only 19 students completed the post-survey. Thus, the matched survey set was not very robust and a matched data set of pre-post survey responses greatly limited the number of responses that could be included in the analysis (e.g., even within a program, some students completed a pre-survey and not a post-survey or vice versa). Consequently, analyses were conducted on the entire pre-survey and entire post-survey data set combined. This does not allow for the statistical power of paired samples analysis, but outcomes could still be compared across the entire group. This type of analysis also does not allow for comparison of individual programs, but does allow for broader comparison across demographic variables, such as gender.

Therefore, survey data were cleaned and merged into SPPS statistical software package. Descriptive and inferential statistics were conducted. Inferential statistics, such as chi-square, t-tests, and ANOVA were performed as appropriate to test for statistically significant differences in outcomes according to program format or students' background characteristics. The variables that were tested were gender, program format, and grade level. Significant results are reported. Qualitative data, including interviews, embedded assessment question responses, and open-ended survey questions, were analyzed using content analysis methods. Open-ended survey comments and transcriptions of student interviews/embedded assessments were searched for units of meaning, called codes, and organized into taxonomies. Codes reflected patterns in librarians' or students' responses related to issues such as learning gains, motivation, or other aspects of their experience in the Build a Better Book programs.

Evaluation Findings

The findings section is organized according to outcomes for each participant group. First, student outcomes are described and reported. Next, outcomes from the librarian training workshop are reported, and finally, implementation outcomes as reported by librarian and educator program leaders.

Student Participation and Demographics

Student Participation

All program offerings in the past year consisted of extended Build a Better Book programs, rather than one-time workshops or outreach events. Offerings included

programming provided in Colorado through the University of Colorado, Boulder and the BBB team, and programming provided by expansion sites whose facilitators attended BBB trainings. Because so many of the programs are expansion sites, exact numbers of student participants are not recorded. Librarians/teachers reported on their target audience rather than actual participation numbers, so this report estimates the number of BBB offerings in spring and summer 2019 and their implementation context, rather than the actual number of student participants in each program. Several expansion sites did not offer BBB programs in the spring or summer and intend to implement their first program in fall 2019.

Overall student and librarian/teacher workshop participation rates for expansion sites in the various program formats for spring/summer 2019 are as follows:

- 8 library or out-of-school extended programs, consisting of 6 summer programs and 2 academic year programs; most programs served middle school/high school, but three included elementary students
- 7 in-school programs; 6 of these were academic year and one was a summer enrichment program; All but one served middle school but two also served elementary students and one served high school students.

Additionally, seven expansion sites plan to implement BBB in fall 2019. Five of these are library programs and two are in-school programs. Four will serve middle school students, including both of the in-school programs. While one will serve high school students and two of the library programs will serve elementary students.

Demographics for Student Survey

This section will report demographic results from student surveys administered to program participants. This section provides more detail on the participation in BBB expansion programs. In all 196 students completed a pre-survey and 125 students completed a post-survey. Not all students who completed a post-survey also completed a pre-survey so the matched data set comprised fewer than half of overall student responses. Some programs administered the pre-survey but not the post-survey which accounted for most of the discrepancy between the survey response rates. Additionally, one program administered the post-survey as both the pre- and post-survey. For the most part, this did not impact the results as many items were matched, but it did have a slight impact. Not every student answered every demographic question; however, students also were allowed to mark multiple races so the percentages total more than 100%. Students were relatively diverse, especially Latino/Hispanic. Nearly half were first-generation college students. BBB program participants were primarily middle school students with a fair number of high school students.

Following is a table of pre-survey and post-survey student demographics.

Table 1. Demographics, Pre- and Post-survey Student Respondents

Demographic Category	Pre-survey (n=196)		Post-survey	
	Overall #	%	Overall #	%
Has a parent in STEM	124	67%	68	63%
Female	87	47%	50	46%
Male	98/185	53%	58	54%
Black/African-American	35	19%	8	7%
American Indian/Alaska Native	8	4%	5	5%
Asian/Pacific Islander	12	6%	6	6%
Latino/Hispanic	64	35%	52	49%
White/Caucasian	75	41%	35	33%
Parents have graduated college	99	61%	57	59%
Parents did not attend college	63	39%	40	41%
3rd grade	1	<1%	1	1%
4th grade	2	1%	3	3%
5th grade	0	0%	1	1%
6th grade	3	2%	2	2%
7th grade	60	33%	34	32%
8th grade	44	24%	24	23%
9th grade	6	3%	4	4%
10th grade	20	11%	20	19%
11th grade	41	23%	13	12%
12th grade	3	2%	3	3%

Below is a table that outlines the response rates for each program. Some programs were unable to complete the survey at all because of privacy concerns within their school district or library. The table outlines the number of respondents for the programs that were able to administer the survey. As discussed previously, the number of pre- and post-surveys was not well aligned for many programs.

Table 2. Pre- and post-survey responses for individual programs

Program	# of pre-survey responses	# of post-survey responses
University of Wyoming	7	0
Yonkers	2	9
Maryland State Library for the Blind	19	0
Southeast Junior High	10	5
Westchester Middle School	17	11
Westtown	14	9
Central Michigan University	16	0
Tulare City	28	25
Lafayette Library	6	2

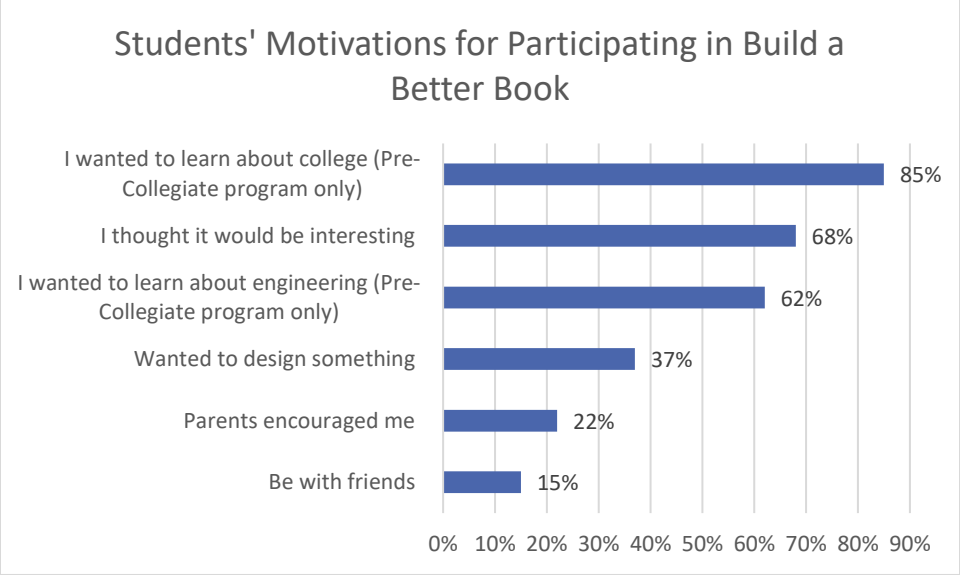
Golden Library	0	3
Northglenn High School	0	21
ACCESS program	15	10
Pre-Collegiate program	53	19
Museum of Boulder internship	9	11

Students in two out-of-school programs in fall 2018 took a post-only survey which comprised part of the analysis presented in the report. Twenty-one students completed the post-only survey and their demographics were relatively similar to the pre-post students who completed the survey in the spring and summer. For instance, 53% of students were female and 47% were male. Students were 80% white/Caucasian, 10% Latino, 5% African-American and 5% Asian/Pacific Islander. Students ranged in age from 6th to 10th grade, although most were 7th and 8th graders.

Students' Motivations to Participate in Build a Better Book Programs

For the most part, students in opt-in programs wanted to participate in Build a Better Book because they thought it would be an interesting experience. To a lesser extent, students wanted to design something. A smaller number of students were encouraged by their parents to enroll in the program. Very few students participated in the program to be with friends. This latter finding was confirmed by observations of opt-in BBB programs as most students did not seem to know each other prior to their participation in the program. Pre-Collegiate students were also asked whether they were motivated by wanting to learn about college and engineering. Because the nature of the program and the age group served were different from the typical Build a Better Book program, these were relevant motivations. By and large, Pre-collegiate program students were highly motivated by wanting to learn about college. A majority also wanted to learn more about engineering. The following figure illustrates students' motivations for participating in the program.

Figure 1. Students' Motivations for Participating in Build a Better Book



The Build a Better Book Learning Environment

This section describes the learning environments fostered by the Build a Better Book program. Learning environments were evaluated using a rubric that scored the program sites (five separate programs) on key markers of authentic making. Interviews with facilitators from expansion sites also provided insight into the program formats and learning environments of expansion sites and in their use of activities and resources. While these programs were not observed and scored on the rubric, facilitators' descriptions of their implementation provide insight into the program formats and learning environments of adopting sites.

Program Format and Structure at Expansion Sites

In interviews, the 11 expansion site facilitators described a wide variety of program implementation formats and contexts. Four of the sites offered the program in libraries or other out-of-school contexts, while seven of the sites offered it in-school. Three of the out-of-school offerings were summer camps or classes while one was an afterschool offering during the academic year. The out-of-school offerings ranged in their duration: Two met for a week-long summer camp, while two of the programs met once-a-week for three or four weeks in a row. Thus, the out-of-school offerings ranged from a minimum of 5 hours of program time in a weekly program to 15 hours of programming in a week-long summer camp. Two of the out-of-school programs served middle school students exclusively, while two of them served upper elementary and middle school students.

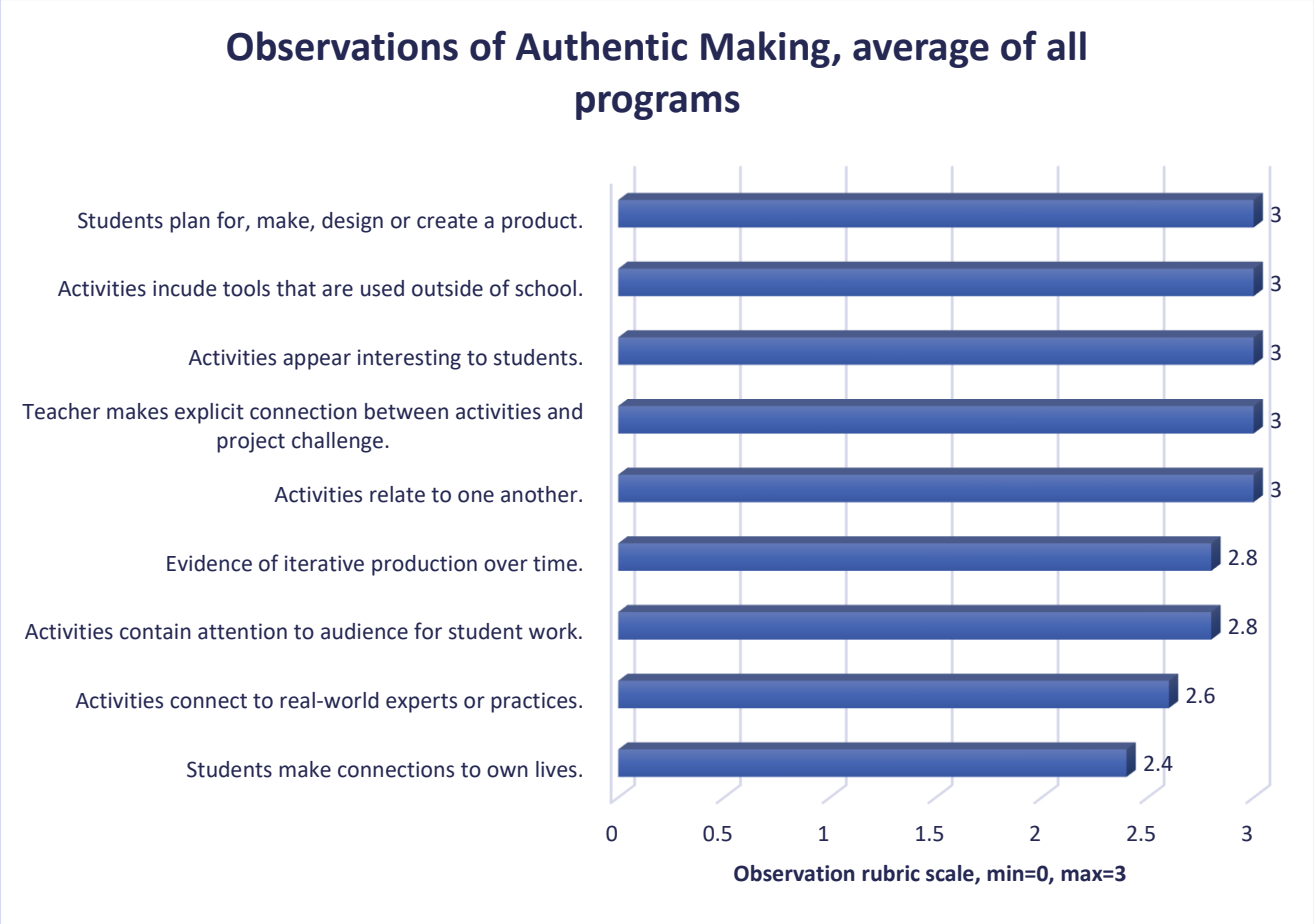
In-school offerings also varied in their format and duration. Six of the in-school expansion programs served middle school students, while one served high school students. Two of the in-school programs were offered in technology classes, one in an art class, one in

a science class, and three as enrichment blocks or elective courses. Thus, in-school programs varied as to whether they were opt-in for participation. In-school programs generally offered more hours of contact time, but they varied by program format as well. For instance, they ranged from a minimum of meeting twice a week for 45 minutes over a 6-week period (9 hours contact time) to a maximum of meeting daily for 50 minutes over a 10-week period (about 40 hours of contact time).

Authentic Making

The Build a Better Book program continued to provide a robust learning environment that fostered authentic making experiences for students. In observations of five separate programs, all of the observed programs provided the opportunity for students to plan, design, and create a product for visually impaired people (see figure 2). Therefore, attention to audience is embedded in the project activity and four out of the five sites scored the maximum for attention to audience. Nevertheless, one site displayed slightly less attention to audience as a few students designed elements in their books that were not readily accessible to a visually impaired audience (e.g., writing with a sharpie rather than braille, 3-d print, or some other form of raised texture and relief). All of the observed programs incorporated tools that are used outside of school, such as 3-d printing, Scratch, Makey Makey, and textiles and other crafts. All programs displayed evidence of iteration and therefore received the maximum score on the rubric for iteration within design. Students were observed, or were able to articulate, iterating on their designs as they revised, improvised, and corrected designs that did not work appropriately for the visually impaired community. Students were highly engaged in the process of iteration. Most programs also made explicit connections to real-world experts or practices. One program even had a member of the visually impaired community serve as a mentor to students who helped to test their designs and provide feedback. While the projects served a real-world purpose, the connection to students' own lives was not always as apparent as the connection of the projects to the broader community.

Figure 2. Authentic Making, average of all programs



As demonstrated in figure 2, the BBB program scored consistently high marks across all observed programs in evidence of authentic making activities. The Museum of Boulder internship scored the maximum in all areas (see table 3). All programs displayed abundant evidence of student engagement in the design process within authentic making experiences. The library programs displayed slightly less evidence of real-world connections and connections to students' lives. Still, the implementation of the BBB programs in Colorado (three led by BBB staff and two expansion sites) was very consistent and all programs engaged students in a creative design process with an end product intended for youth with visual impairments.

Table 3. Authentic Making Scores, by program

Observation item	Pre-Collegiate	ACCESS	Lafayette Library	Golden Library	Museum of Boulder
Activities are connected to project challenge or final product.	3	3	3	3	3
Activities in lesson relate to one another.	3	3	3	3	3
Teacher makes explicit connection between activities and project challenge.	3	3	3	3	3
Students make connections to their own lives.	2	3	2	2	3
Activities appear interesting to students.	3	3	3	3	3
Activities contains attention to audience for student work.	3	3	2	3	3
Activities include tools that are used outside of school.	3	3	3	3	3
Activities connect to real world experts or practices.	3	3	2	2	3
Students plan for, make, design, or create a product.	3	3	3	3	3
Evidence of iterative production over time.	3	3	3	2	3

Authentic Making and the Design Process: Interview Findings

In interviews, almost all (89%) facilitators at expansion sites observed student growth in understanding the design process in general. Facilitators observed that students tested, iterated, and re-tested their protoypes until they were appropriate and useful for youth with visual impairments. Students also had to problem-solve challenges in the design process, such as pieces that did not 3-d print or laser cut as expected. One facilitator did not observe iteration in a program that was primarily crafts-based. Students in that program chose not to use the available technologies and many chose to use textiles and crafting materials for texture in

their book designs. Although these students engaged in a creative design process, the facilitator did not observe iteration to the extent of other programs. The use of technologies, especially 3-d printing and laser cutting, seemed to prompt more iteration and design development than crafts and textiles alone.

The following comments were representative of facilitators' observations of student engagement in the design process. Many facilitators introduced students to the design process by keeping the end user in mind. Facilitators encouraged students to plan for their intended audience from the beginning and then to test their prototype book page or game to determine whether it can be used as intended by a person with visual impairment.

> *So they had to start thinking about how they'd design it… So it made them think a lot about how things actually work. And they had to think about, okay, we have all these different parts. How do we make it work? And it was really cool, on their own they got other people test it out, which was good. So I think once they get into the project is when they start to understand design thinking and how iteration works and that entire design process. And I think that's the number one thing….they naturally start to go through design process elements in the program. (Teacher, in-school program, Computer Science class)*

> *What I really liked was the opportunity for the kids to make something that had a purpose. They definitely had to go through that design process because they had to prototype it first. They had some fails in the sense that we would look at them and ask them some questions, and then they would figure out, "Ooh. Okay. This isn't going to work right. So okay, we're going to try it this other way." They made their prototype. They had to come up with a plan. They worked cooperatively so they had to work together. They had to use those empathy-building skills to try to put themselves in somebody else's spot. (Teacher, in-school program)*

> *And then we started with our users. … to ask, "What do your [visually impaired] kids need?" So I think that was powerful. And we used the blindfold, and we had our kids check as they were making their projects... Some of the projects were visually-based still, and we said, "Okay I want you all to put your blindfolds back on and feel this. And what do you actually think this is by what it feels like?" And a couple of students scrapped their projects at that point and started over. So that was great for them to learn the iteration phase. (Teacher, In-school program in an art class)*

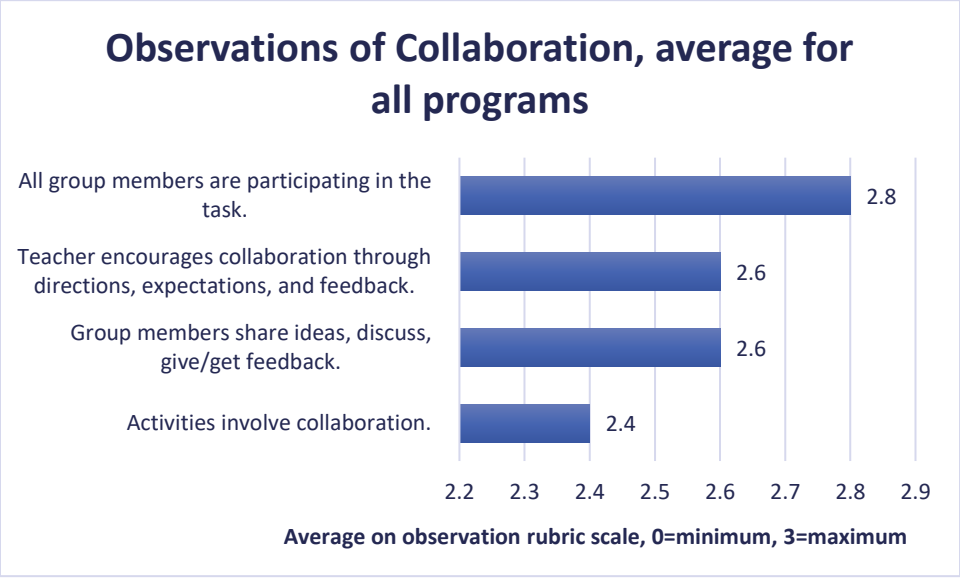
Likewise, in interviews, 80% of student interviewees described gains in understanding the design process in general. The few students who did not experience design testing and iteration in their projects made primarily crafts-based projects or created simpler designs that did not involve extensive problem-solving or iteration to make them accessible. Additionally, 65% of students described actively problem-solving during their design process. Most of these

problems involved 3-d prints or laser cuts that did not come out as students intended, prompting students to re-design their prototype. In some cases, there was not time to re-do a 3-d print or laser cut, so students had to problem solve in other creative ways (e.g., using wiki stiks for relief and definition on a game board since the board had not been cut as intended).

Collaboration

Similar to previous iterations of the program, the BBB program displayed varying levels of student collaboration across sites. The project can be undertaken as a group or individual task, and sites differ as to whether they require students to work in groups or whether students can choose to work individually or with a partner or group. In the past year, three of the sites required students to work in teams, while two sites let students choose whether to work individually or in teams. Therefore, varying levels of collaboration were observed across programs. For the most part, almost all students were observed to participate in the project and students interacted with each other to share ideas or solicit feedback. In interviews, the 11 expansion site facilitators also described varying levels of collaboration among their programs. For instance, almost all of the school programs required teamwork because of project learning goals as well as access to resources and materials for an entire class of students. Out-of-school programs generally offered student choice of working individually or in teams. Students often, though not always, opted to work individually.

Figure 3. Collaboration, Average for all programs



Because sites differed on whether students worked individually or in groups, they demonstrated varying amounts of collaboration according to the observation rubric. Pre-Collegiate, ACCESS, and Museum of Boulder had high levels of collaboration because teamwork was a part of those programs. On the other hand, many students in the library

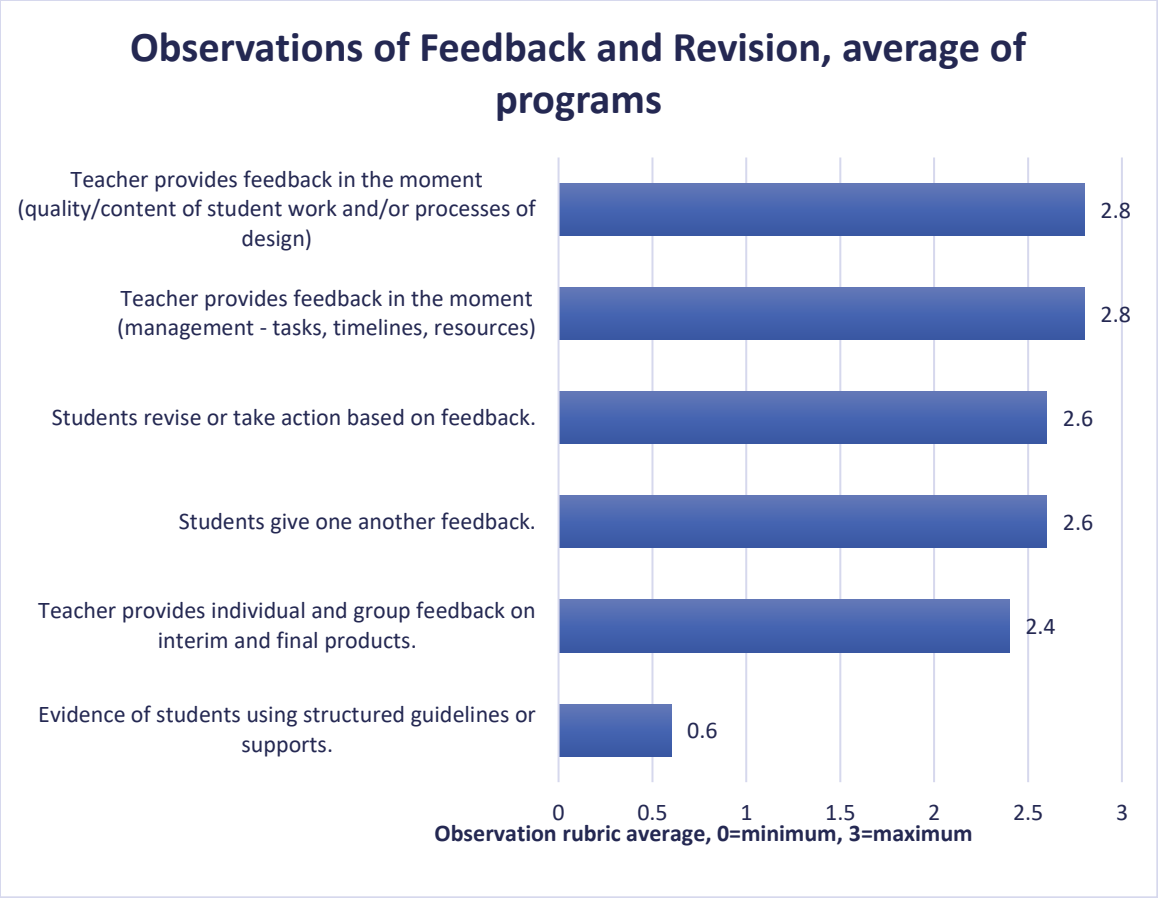
programs chose to work on individual. Nevertheless, collaboration was still observed at those sites as students shared their work with one another and sought feedback.

Table 4. Collaboration items, Observation rubric

Observation item	Pre-Collegiate	ACCESS	Lafayette Library	Golden Library	Museum of Boulder
All group members are participating in the task.	2	3	3	3	3
Activities involve collaboration.	2	3	2	2	3
Group members share ideas, discuss, give/get feedback.	2	3	3	2	3
Teacher encourages collaboration through directions, expectations, and feedback.	2	3	2	2	3

In the past year, programs improved on the practice of incorporating feedback and revision. The feedback and revision process was observed to some extent at all five sites. Most often, teachers provided informal feedback to students in several areas. Teachers provided feedback about the quality of design (e.g. how well it may work for visually impaired students) or encouraged students to provide feedback to one another. Teachers also helped students to troubleshoot design challenges, if they needed extra support to overcome setbacks. Teachers also provided feedback on the use of resources and time management, helping students to manage and plan their time to complete their task within the given period. Students often revised their work based on the feedback of teachers or peers. Students often gave each other feedback in the moment, usually on one aspect of the project, rather than the overall design or use of materials. Therefore, informal feedback in the moment was the most common type of support provided. Less often, programs incorporated formal feedback mechanisms. Only one program provided a structured reflection for students.

Figure 4. Feedback and Revision, Average for all programs



Observation sites also differed in the amount of feedback provided to students. While few of the sites offered formal feedback mechanisms, one of the sites did implement a feedback and reflection sheet (Museum of Boulder). Several other sites provided informal feedback mechanisms as facilitators offered guidance to students or students informally provided feedback to one another.

Table 5. Feedback and Revision, by program

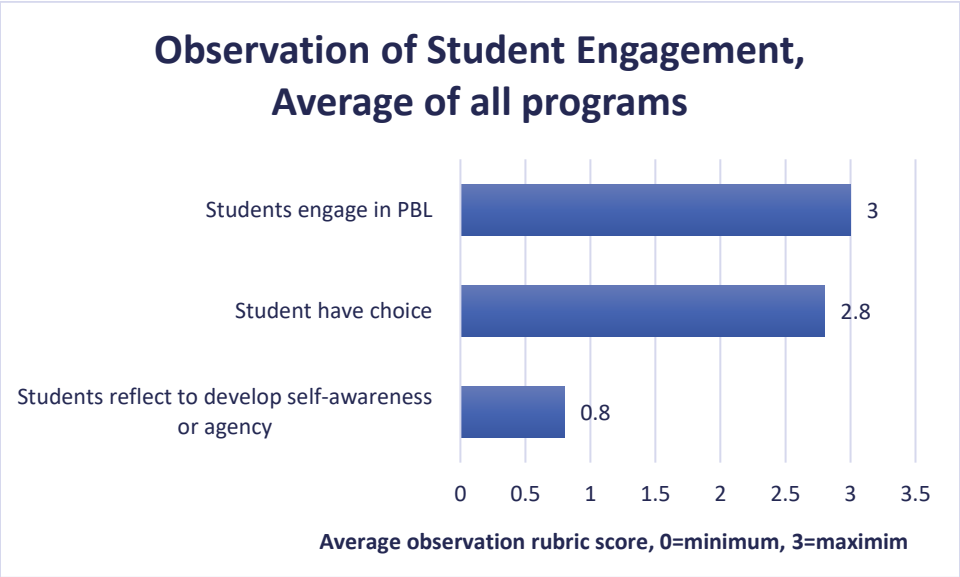
Observation Item	Pre-Collegiate	ACCESS	Lafayette Library	Golden Library	Museum of Boulder
Teacher provides feedback in the moment (quality/content of student work and/or processes of design)	2	3	3	3	3
Teacher provides feedback in the moment (management - tasks, timelines, resources)	3	3	3	2	3
Teacher provides individual and group feedback on interim and final products.	2	3	2	2	3

Students revise or take action based on feedback.	2	3	3	2	3
Students give one another feedback.	2	3	3	2	3
Evidence of students using structured guidelines or supports.	0	0	0	0	3

Engagement

All Build a Better Book programs offered multiple opportunities for student choice and engagement. Students chose their projects, designs, and materials. In fact, students at one observed site decided to exclusively use craft and textile materials, even though technological tools were available. Therefore, student choice in the BBB programs was quite extensive. The BBB program often provided the end product for students to create (e.g. a book or game), but students had full autonomy within that parameter to choose their desired book, game, materials, and design. All sites also actively engaged students in the design process through project-based learning design elements. Similar to previous years, students rarely, if at all, reflected to develop self-awareness or agency. All sites scored quite highly in project-based learning and student choice which are also important indicators of authentic making experiences.

Figure 5. Multiple means of engagement, average of all programs



As noted, all programs had evidence of authentic project-based learning along with student choice of design and materials. There was less evidence of student reflection for self-awareness, although this is not an explicit goal of the BBB program. On the other hand, there is a strong evidence of student choice and authentic making which are explicit goals of the BBB program. These elements were evident in programs run by BBB staff and in expansion sites as well (Lafayette and Golden libraries).

Table 6. Engagement items, Observation rubric

Observation Item	Pre-Collegiate	ACCESS	Lafayette Library	Golden Library	Museum of Boulder
Students engage in PBL	3	3	3	3	3
Students have choice	3	2	3	2	3
Students engage in reflection to develop self-awareness and agency	0	2	0	0	2

In interviews, 100% of facilitators observed high levels of student engagement throughout the Build a Better Book program. In fact, nearly 2/3 of interviewees positively compared the BBB program to other makerspace offerings, noting that BBB students were more engaged than in typical programs and that the BBB program reached a broader audience of students than their typical STEM or makerspace offerings (e.g., not typical STEM students, but art students, girls, etc.). About 1/3 of expansion site facilitators also stated that it was the best or one of the best programs that they have ever run. Facilitators noted that the real-world

aspect of helping people led to increased students' engagement. Partnerships, particularly with community organizations for the blind or with blind community members, helped to make the real-world element more concrete for students. Facilitators also noted that there were no behavioral issues during the implementation of the BBB program because students were so highly engaged. Following are representative comments from the expansion site facilitators about the level and depth of student engagement during the BBB program:

> *The kids were so engaged. We had zero behavior challenges. It was just one of those experiences where they were all-in, even when their parents came to pick them up, they were still working. We didn't have a lot who came with a friend and it didn't matter. We had two homeschool kids who had never been in our space before, they were brother and sister. Didn't matter. The whole group just worked together really nicely. (Librarian, after-school library program)*

> *And they kept bringing me more information on the life of somebody visually impaired. Then I got this student who is legally blind to be a consultant for us. I brought her down and she taught them how she walks with a cane, how she types braille. And they were glued. We started to do the initial product, we did some prototyping. And I had her check the items out, touch them, read the braille. And that's when all of a sudden I saw the switch get hit and they became very, very engrossed in getting things right, that somebody was going to experience this and potentially enjoy the game or to read the book differently from what they normally would. And that's the empathy part I started to see coming out because the serious nature of the project got amped right up, the bar went up. And their working together and things like that. (Teacher, in-school program)*

> *To see the authenticity of the project didn't just hit the kids. It also hit the teacher. And then the authenticity of the project, I really did feel like the kids put extra care into what they were doing because they knew that it wasn't just something they were making and it was going to sit in their school. It was literally going to somebody else. And it was made with more love and care I think because of the authenticity of it. (Collaborator with teacher, in-school program)*

> *I was just so impressed with the kids and it was the best week of my summer. Definitely a good experience I think for all of us. Because of how engaged the kids were. It was just a really good atmosphere as they were working. (Librarian, summer program)*

> *It was one of the most thoughtful programs we've ever done. The students in the program were really, really thoughtful about their product, about their prototype, and the decisions they were making. It was great…. I think the students were very invested in completing their prototype, but not so much for themselves. They really wanted it done well. Probably about half the students are continuing to come into the maker space periodically this fall to work on either the prototype they started in camp or to start a new project to making*

a game. I think there's been follow-through, but not because they want a complete project for themselves, because they really would like to see a student who is visually impaired interact with the prototype or the product. We don't have that during our other camps. That was really refreshing. (Other makerspace, summer program)

I had a lot of kids who came who had never done it before. It definitely drew a different crowd and they took it much more seriously. They had more really thoughtful discussions about what they were doing than we'd really had in other big projects that we've done in the makerspace. (School librarian, school makerspace, enrichment program)

These were students, they signed up for computer tech. Super boy-heavy. We were thinking, "Oh, no. These boys are not going to want to do this." But surprisingly, a lot of them did and a lot of them that were in there had some special needs of their own. There's a little boy in there who is deaf and has hearing aids, and he's sharp as he can be. He's a major behavior problem. When he started working on his little book, he wanted to do it by himself and not work with somebody else. But he was so engaged in that and so focused. And I've been in that classroom many times and witnessed him causing multiple interruptions all the time. When he was working on that, I forgot he was even in there. (Teacher, in-school program, elective class)

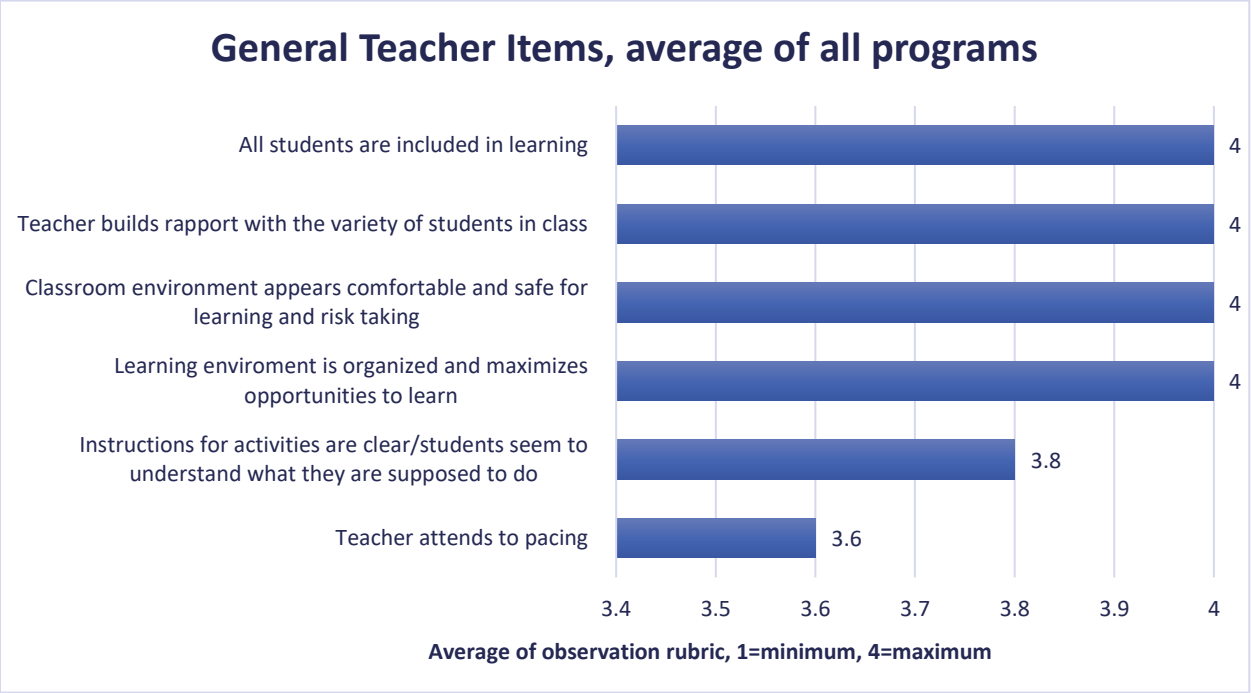
Therefore, observations of five programs and interviews with 11 expansion site facilitators all documented very high student engagement throughout the program. Students were invested in their projects and took great care in planning and developing their prototypes. Students were motivated by the potential use of their books and games by other children with visual impairments. Several expansion site facilitators reported that students in the BBB were much more invested and engaged in their designs than students in their other programs or makerspace offerings. The real-world element of the program and the plentiful opportunities for creativity were highly motivating and engaging for students.

General Teacher Items

While the Build a Better Book programs have scored highly on teaching items in the observation rubric, teacher support has increased in the past year. In the 2018-19 academic year and summer, all programs displayed inclusion, support, and safe, creative learning environments. Teachers were more attendant to the pacing of student projects (e.g., average increased from 3.3 to 3.6 out of 4.0). Teachers also improved on the clarity of instructions for project activities. (e.g. increased from 3.5 to 3.8 out of 4.0). Therefore, programs run by both BBB staff and expansion sites were focused on creating inclusive, supportive, robust learning environments for students. Finally, all sites were well-organized and included access to a variety of technological and crafting materials for students to use in their designs (e.g., 3-d printers, Makey Makey, 3-d pens, laser cutting machines, glue guns, swell machines, and crafting materials). Teachers also clearly communicated instructions and expectations for the

session, including attention to pacing and reminders to students of the time available to complete their tasks.

Figure 6. General Teacher Items, Average of all programs



Student Outcomes

Students made multiple gains from their participation in the Build a Better Book program. This section will report on student outcomes as measured through student surveys, student interview, and facilitator interviews. Students' strongest outcomes were in their understanding and use of universal design, including a shift in their understanding of accessibility and how to design or modify products for accessibility. Student also gained an awareness of the everyday experiences of people with visual impairments. Students appreciated the opportunity to work on a meaningful product that could help people.

Student Learning Outcomes

Authentic Making and the Design Process: Interview Findings

In interviews, almost all (89%) facilitators at expansion sites observed student gains in understanding the design process. Facilitators observed that students tested, iterated, and re-tested their protoypes until they were appropriate and useful for youth with visual impairments. Students also had to problem-solve challenges in the design process, such as

pieces that did not 3-d print or laser cut as expected. One facilitator did not observe iteration in a program that was primarily crafts-based. Students in that program chose not to use the available technologies and many chose to use textiles and crafting materials for texture in their book designs. Although these students engaged in a creative design process, the facilitator did not observe iteration to the extent of other programs. The use of technologies, especially 3-d printing and laser cutting, seemed to prompt more iteration and design development than crafts alone.

The following comments were representative of facilitators' observations of student engagement in the design process. Many facilitators engaged students in the design with the end user in mind. Facilitators encouraged students to plan for their intended audience from the beginning and then to test their prototype book page or game to determine whether it can be used as intended by a person with visual impairment.

> *So they had to start thinking about that and how they'd design it… So it definitely really invoked, it made them think a lot about how things actually work. And they had to think about, okay, we have all these different parts. How do we like make it work? And it was really cool, on their own they got other people test it out, which was good. So I just think once you get into the project is when you start to understand design thinking and how iteration works and that entire design process. And I think that's the number one thing….they naturally start to go through design process elements in the program. (Teacher, in-school program, Computer Science class)*

> *What I really liked was the opportunity for the kids to make something that had a purpose. They definitely had to go through that design process because they had to prototype it first. They had some fails in the sense that we would look at them and ask them some questions, and then they would figure out, "Ooh. Okay. This isn't going to work right. So okay, we're going to try it this other way." They made their prototype. They had to come up with a plan. They worked cooperatively so they had to work together. They had to use those empathy-building skills to try to put themselves in somebody else's spot. (Teacher, in-school program)*

> *And then we started with our users. … to ask, "What do your [visually impaired] kids need?" So I think that was powerful. And we used the blindfold, and we had our kids check as they were making their projects... Some of them were visually based still, and we said, "Okay I want you all to put your blindfolds back on and feel this. And do you actually think this is by what it feels like?" And a couple of students scrapped their projects at that point and started over. So that was great for them to learn the iteration phase. (Teacher, In-school program in an art class)*

Likewise, in interviews, 80% of student interviewees described gains in understanding the design process in general. The few students who did not experience design testing and

iteration in their projects made primarily crafts-based projects or created simpler designs that did not involve extensive problem-solving or iteration to make them accessible. Additionally, 65% of students described actively problem-solving during their design process. Most of these problems involved 3-d prints or laser cuts that did not come out as students intended. Students had to re-design their prototype. In some cases, there was not time to re-do a 3-d print or laser cut, so students had to problem solve in other creative ways (e.g., using wiki stiks for relief and definition on a game board since the board had not been cut as intended).

Students worked with a variety of technologies and tools in their designs. Four out of five sites in which students were interviewed used extensive technology in their book and game designs. For instance, students used lasercutters, 3-d printers and Tinkercad, Makey Makey, and Scratch in their designs. Students at the other site relied primarily on craft materials and textures, although that site had other technologies available. The students did not choose to use the technologies and preferred the crafting materials. Nonetheless, students at all of the observed sites used technologies and other materials to provide texture and relief to their projects so they could be used by students with visual impairments. Students at all sites also added braille, whether for books or game boards. Most students added craft materials or elements, especially students who worked on children's books. In interviews, students described their use of technology and many students noted that the Build a Better Book program was the first time that they had used certain technologies, such as Tinkercad or Makey Makey.

Understanding Universal Design

Facilitators also discussed students' gains in understanding the universal design process, in particular. In fact, 100% of facilitators observed increases in students' understanding of universal design. Although some students had prior experience with project-based learning and design, few, if any, had prior experience with universal design projects. The real-world aspect of the design project was highly appealing to students. Subsequently, facilitators observed students take great care in designing their products for the visually impaired community. During the testing of their prototypes, students shifted their perspective from sight-based judgment to touch- and sound-based. Facilitators often noticed that students paid great attention to their audience and put a lot of thought and effort to creating designs that were suitably tactile. The very process of creating and testing the tactile design helped to develop empathy in students as they took care to make it functional for their audience. A facilitator described this process in the quote below which is representative of the observations of the facilitators overall.

> *And then it was interesting too, especially because we were in an art classroom, and I think it was the first time they ever made art that wasn't visual. Instead it was all tactile and not visual. I mean, it ends up being a little visual because they are, but we're asking them to design for a completely different purpose which is feel instead of sight. And also void of color. We had them do it in black and white. So that was a really*

interesting thing for our students to experience too, besides the fact that it was a real world experience for them. They were designing for actual students and they were somewhat empathizing. I'm not going to say that they understand what it's like to be blind. They don't. But at least it made them aware that that's something that we have to look out for and that not everyone is experiencing the world in the same way. So that was really powerful for our kids. (Teacher, in-school, art program)

Students also described their burgeoning understanding of the important aspects of universal design. In fact, in interviews, 95% of students described gains in understanding universal design and in their ability to produce objects that are accessible to people with visual impairments or other disabilities.

Students approached the design project with the end user in mind and considered how their creations may work for people with visual impairments. Students described the planning process and the iteration process of deciding which elements will work best to create functional and tactile designs. Some students displayed a nuanced understanding of designing for the range of visual impairments, recognizing that blindness is only aspect of the continuum. The following comments were typical of students' descriptions of their design planning and process:

I think we spent more time on how the animals were supposed to feel and actually what the story is. Because I think it's just very difficult to explain to your child the story itself if you can't even understand how the objects feel. And so we spent a lot of time understanding whether the feet should be smaller or bigger, and just thinking about those bigger attributes of an animal or a think that you want to project for someone who has a different perspective than yourself. (Pre-Collegiate program)

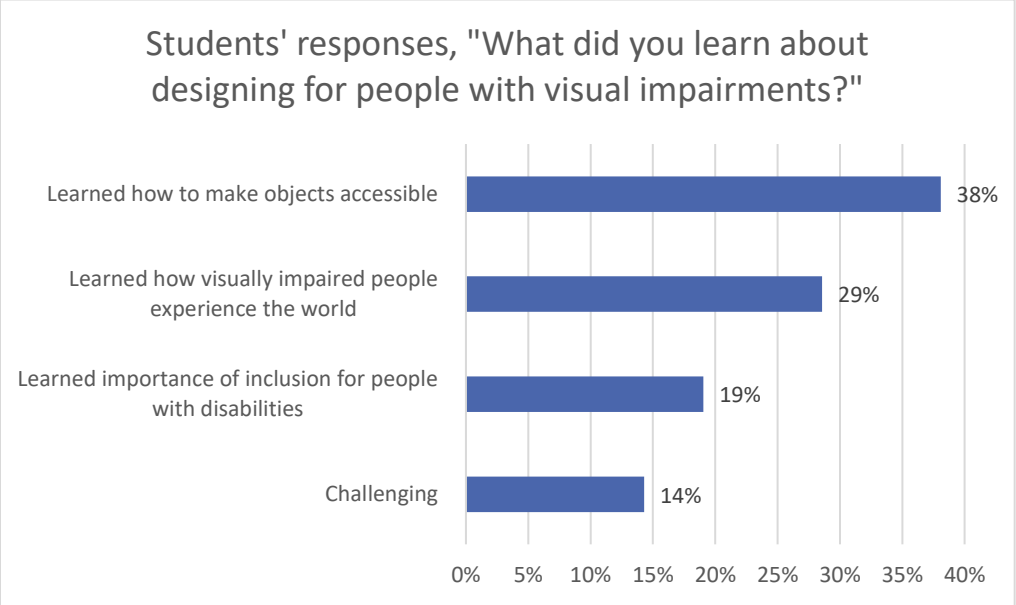
You have to consider everything, and from a lot of different materials. And everyone's situation is different, so you have to figure it out for everyone. You have to consider everyone's situation. Like some people can't see anything, some people can have tunnel vision, where they can only see some things. And different ages want different things, too. (Museum of Boulder intern)

We had to think about how the children would be able to tell like "Oh this is a candy cane or this is a hat or this is a lollypop." And we had to use the swell paper in order to do that and it might work, it also could not work. But you know, we'll figure it out. (Access students)

In an open-ended question about what students learned about designing for disability, students wrote about learning the importance of universal design and broadening their conceptions of STEM. In contrast, the most common response in previous years was that it is hard/challenging. This past year, "challenging" was the least common response. Instead, the most common response was that students learned how to modify objects for disability

(e.g., use of touch and texture, must be precise, etc.). Students also described empathy in their responses, stating that they had learned more about how people with visual impairments experience the world. Other students noted that they learned it is important to include and consider people with disabilities.

Figure 7. Students' responses, "What did you learn about designing for people with visual impairments?"



Representative comments from student surveys were:

Learned how to make objects accessible:

- *Texture is key. It doesn't matter if it looks good, just make it feel correct.*
- *I learned that textures really matter, trying to guess what a picture is with indents is hard and sometimes too much detail is confusing.*
- *I learned that the things you make have to be pretty precise but understandable like high contrast colors.*
- *I learned that it is very important to utilize other functioning senses, so that they can get a good idea about what the thing being designed is.*

Learned how visually impaired people experience the world:

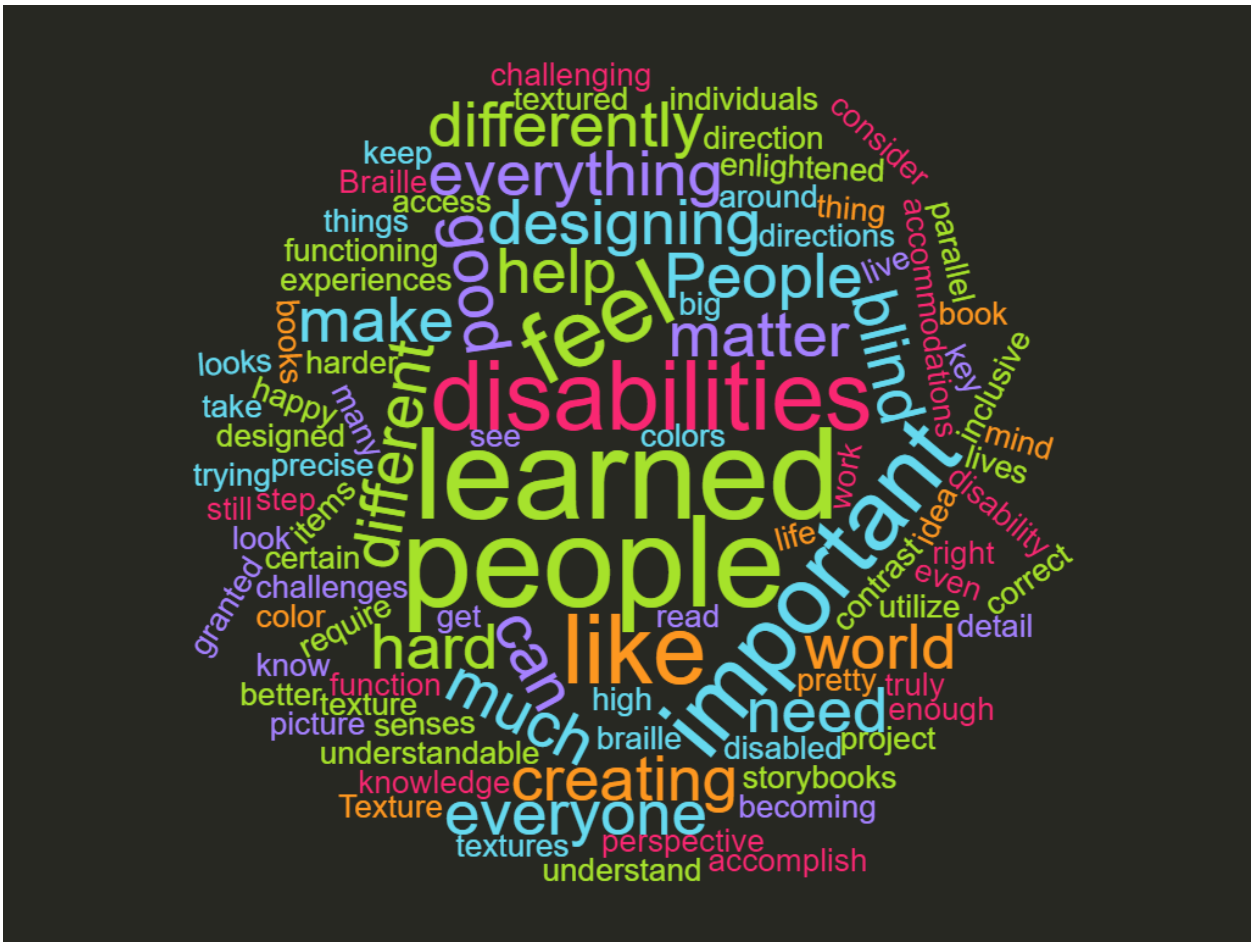
- *I've learned how to 'read' braille whilst creating the storybooks. It also enlightened my knowledge on what it's like being in the shoes or from the perspective of people with these disabilities.*
- *I learned that, even though people have these disabilities, it doesn't stop them from having a happy life.*
- *We need to consider everything that we take for granted. People with disabilities live parallel lives to our own, but must accomplish everything differently.*

Learned the importance of inclusion

- *I can never truly understand what it is like to have a disability, however creating things to help people with disabilities is a step in the right direction to becoming for inclusive for those individuals.*
- *It is important to do this because not everyone can have access like everyone else.*

Following is a word cloud that illustrates students' responses to the survey question about universal design.

Figure 8. Word cloud, Student responses to open-ended question about universal design



Interest in STEM, Design and Making

Student attitudes toward and interest in careers that involved technology, engineering, or design remained consistent over the course of the program, for the most part. Interest in STEM and design was measured in four ways: facilitator interviews, student interviews, pre-

post survey with spring and summer expansion sites, and post-only survey with fall expansion sites. For instance, 49% of students were interested in a job that involves technology on the pre-survey, while 51% were at the end of the program. The overall mean (out of 5.0) on the group of interest items (interest scale) declined slightly from 3.61 to 3.44, although this difference was not significant and in practical terms represented sustained interest, rather than a decrease. Thus, students maintained their interest in technology and design throughout the program.

STEM interest and design outcomes were also consistent across groups of students and across difference program models. There were no meaningful differences on the pre-post survey by program model, program site, or by demographic group. It was difficult to discern statistically significant differences because of the unbalanced pre- and post-survey responses. Nevertheless, there were slight, though not statistically significant differences among program models. Overall, students' interest in technology and design seemed to decline, but these differences were not statistically significant and actually represented sustained interest over the course of the BBB program. As noted previously, the survey responses were not matched pairs so it is difficult to discern if the survey results were an accurate representation of student outcomes. It should also be noted that many students marked "not sure" on the survey, and few students marked "disagree" on the interest items.

Table 7. STEM Interest items, by program type

Item.	PRE	PRE	PRE	PRE	POST	POST	POST	POST
	Out of school	Internship	In school	ALL	Out of School	Internship	In school	ALL
I am interested in a job someday that uses technology	55%	56%	38%	**51%**	53%	44%	46%	**49%**
I would like to learn more about technology or design	80%	78%	48%	**72%**	65%	45%	49%	**56%**
I like to combine art and technology	54%	89%	52%	**56%**	55%	80%	50%	**55%**

Likewise, on the post-only survey that was administered to two out-of-school programs, a slim majority of students reported that the program had increased their interest in certain areas:

- 66% were more likely to learn about new technologies

- 62% were more likely to learn about design concepts
- 60% were more likely to learn about engineering topics
- 55% were more likely to explore accessible design in the future
- 48% were more likely to learn about STEM careers

Interview data provided more insight into student interest. For instance, facilitators commented that there was strong interest in BBB programs. Several of the school programs were conducted within existing classes, but two school programs were voluntary—one offered as an enrichment block and one as an elective. Student interest in the enrichment and elective offerings was high and the elective course (set to be implemented in the fall) filled its roster quickly. Student interest was high, for the most part, among out-of-school programs as well. Facilitators commented that the programs generally drew a different type of student than typical makerspace activities. Students were more design-oriented and artistic and less traditionally interested in STEM. Nearly 50% of facilitators noted that the BBB program served to broaden participation in STEM/STEAM programming to "different" kinds of students. Thus, the program served to sustain students' STEM interest, but not necessarily increase their interest in STEM activities or engineering. A facilitator commented on the student audience that was attracted to the BBB program:

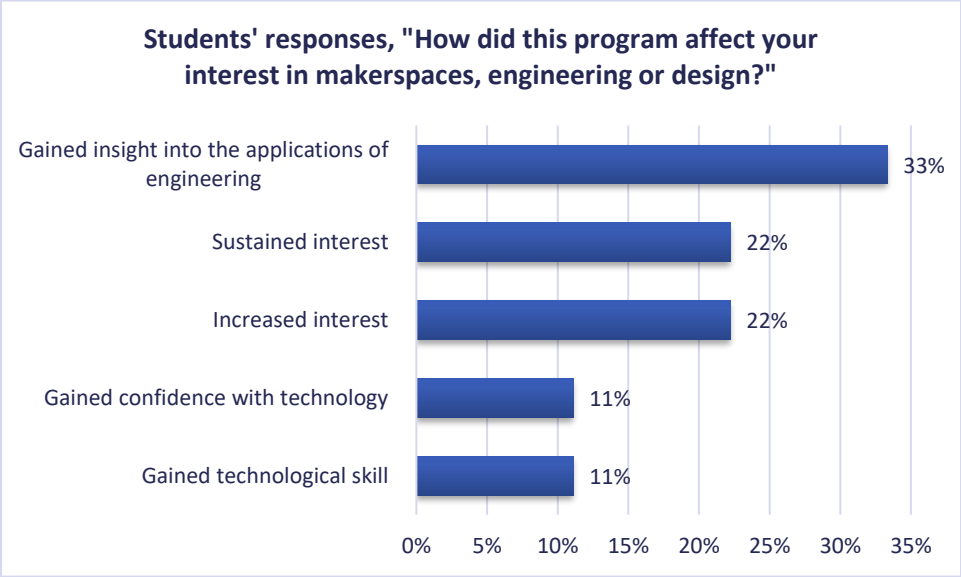
> *I had a few kids, mostly seventh grade boys actually, who had stopped coming to the makerspace because they were no longer just allowed to play with Legos. Then, I had a lot of other kids who came who had never done it before. It definitely drew a different crowd and they took it much more seriously. They had a lot more really thoughtful discussions about what they were doing than we'd really had in other big projects that we've done in the makerspace. (School librarian, school makerspace)*

Students generally affirmed these observations in interviews as well. Three of the five programs that participated in interviews were opt-in while two were outreach programs and BBB was a part of broader programming within those outreach summer programs. For the most part, students in the opt-in programs maintained their same level of STEM interest throughout the program. Many of the opt-in students were not always motivated by the opportunity to work with technology (students in one of the programs opted out of using technology entirely) but were motivated more by the opportunity to design something and help people. Thus, the STEAM aspect of the program was very important to many students. Nevertheless, about half of interviewees stated that program had increased their interest in technology and STEM (similar rates as the survey).

In an open-ended survey question about interest, the most common response (33%) was that the BBB program had provided insight into the wide range of applications of engineering and design. Students were split as to whether the program had sustained or

increased their interest in makerspaces and engineering. A smaller number of students stated that they had gained confidence in their ability to create or gained skill with new technologies.

Figure 9. Student responses to open-ended survey question about interest

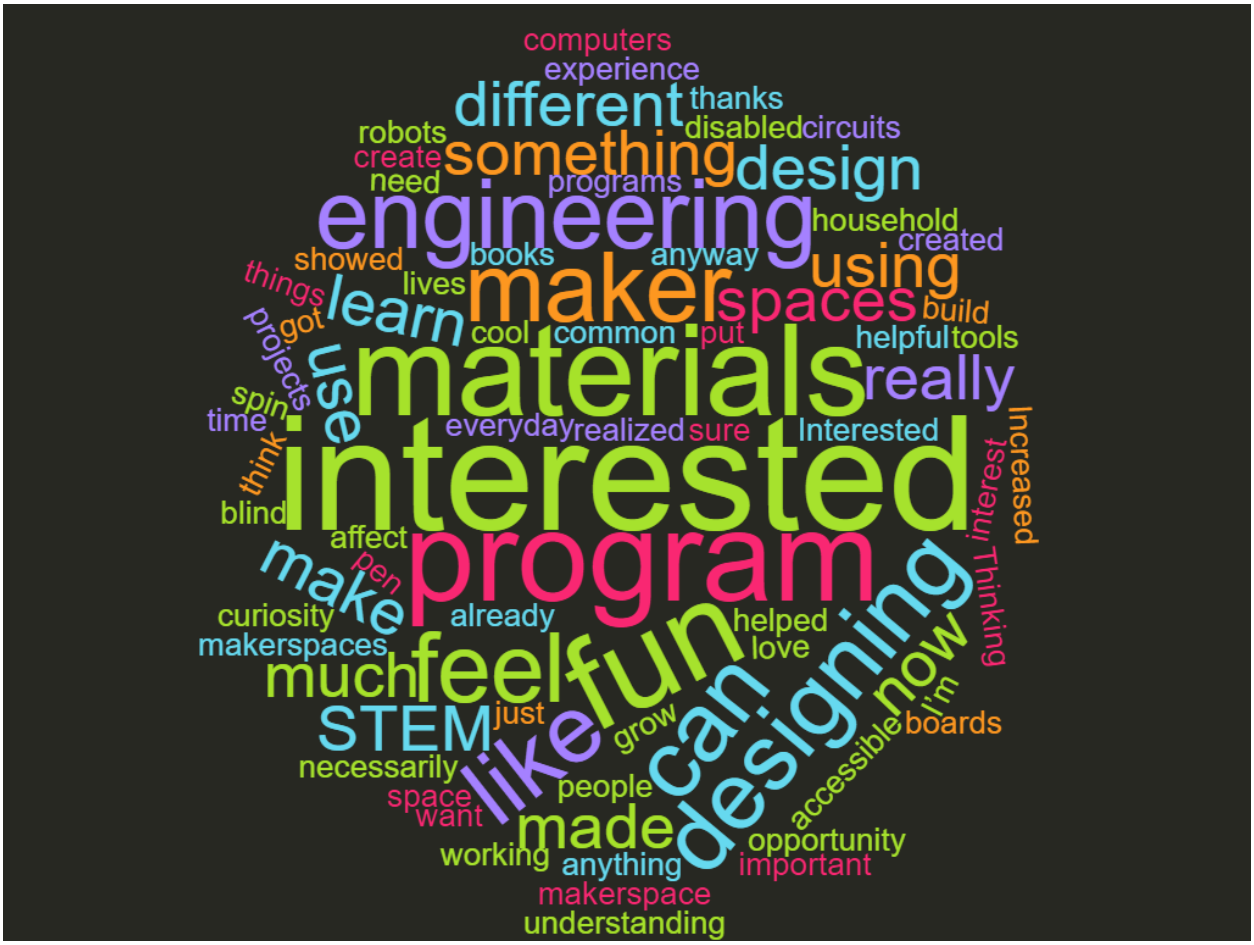


Following are some of the typical survey written responses:

- *I feel like I can create anything after this*
- *It put a spin on my typical maker space experience. Typically I am working with robots and computers. However this time I created a technology that had nothing to do with motherboards or circuits. My technology is just as important!*
- *Increased my understanding of the applicability of STEM projects.*
- *I really now want to do it more thanks to all the cool materials*
- *After this program, I am very interested in makerspaces, engineering, and designing.*
- *I feel like if I had the opportunity to, I would go to a makerspace. I was already in to engineering and design.*
- *This program did somewhat affect my interest in maker spaces, engineering, and designing, although I was already interested in them anyway.*

Below is a word cloud of students' responses to the open-ended question about interest.

Figure 10. Word cloud, students' responses to open-ended question about influence of BBB program on interest



In interviews, many students commented that they had also found the integration of engineering, art, and empathy to be interesting and fun, as described by one of the typical comments from student interviewees. These elements sustained students' interest in makerspaces and design. Students derived enjoyment, fun, and engagement from the BBB activities which, in turn, served to sustain their interest in design activities.

> *I think it was just fun how it integrated art into it because it wasn't just all "oh I do this to fill a purpose" it was like make it make sense in an artistic sense. I just enjoyed that aspect that you were adding back in the humanism into engineering and 3D design. I liked that a lot. (Pre-Collegiate program)*

Similar to their responses on the open-ended survey item, students expanded their conceptions of the field of engineering. In interviews, students commented on broadened

conceptions of engineering at the same rate as students on the survey (about 30%). Students realized that engineering takes more planning, time and creativity than they expected. In particular, Pre-Collegiate students compared the BBB program with the other engineering activities in their summer program which were much more structured than the BBB project. Following are typical student comments about how the BBB program changed their conception of engineering as contrasted to the other engineering programming they experienced.

> *I took other [engineering] classes too, there's a specific way of doing things, while this one there's many different ways. Either we could have just done it on a flat platform, we could have done it 3D way, or maybe just words, or you know, now we're using sound. We had no idea of approaching it, but we tried. And I guess that's what engineering should be, is being able to come out of nothing to make something. (Pre-Collegiate program)*

Some students realized that engineering can be used to help people and improve society.

> *Student 1: It takes out, it doesn't take out but it adds on to engineering isn't just the technical side, there is the humanity side of things. Like you can do something with it to help the world in more ways than just technology-*
>
> *Speaker 2: I found that it was interesting that engineering could be used to teach kids and help them … with the books that we're doing, it's teaching them how to read and it can also help with their creativity so if maybe they wanna be an engineer. (Pre-Collegiate program)*

Students also realized that engineering took more planning, iteration, time and effort than they had thought.

> *Interviewer: Did your ideas about engineering change at all?*
>
> *Student 1: Yeah, actually. I thought it was just this little plan and you do it and then it's kind of done. But it takes a lot of effort and hard work, it's not going to get done in one day. It's going to take multiple days to get it done. It's time consuming, but it's also fulfilling when it's finished.*
>
> *Interviewer: Did you have to change and revise things too along the way?*
>
> *Student 1: Yes, a lot. (ACCESS program)*

In conclusion, the BBB program generally served to sustain students' interest in STEM or to increase their interest in engineering and design. Additionally, students expanded their conceptions of engineering, realizing that it can be used to benefit people and that it requires creativity and iteration.

STEM Educational and Career Pathways

Students varied in their interest and intention to continue with the BBB program or to pursue STEM or engineering in the future. Similar to other results in the past year, students' responses also varied between the pre-post survey and the post-only survey. On the pre-post survey, students mostly remained steady in their intentions to continue with BBB, STEM, or art. However, there are several caveats. For one, many of the in-school program students and several out-of-school program students (e.g., Pre-Collegiate, ACCESS) may not have had the opportunity to engage in another BBB program and this may have shaped their responses on the survey. Second, the samples were quite mismatched from pre- to post-survey, as noted previously, so it is difficult to determine whether this is an accurate representation because it the post-survey sample was quite a bit smaller and because the analysis was not conducted on a perfectly matched set of students who responded to both the pre- and post-survey.

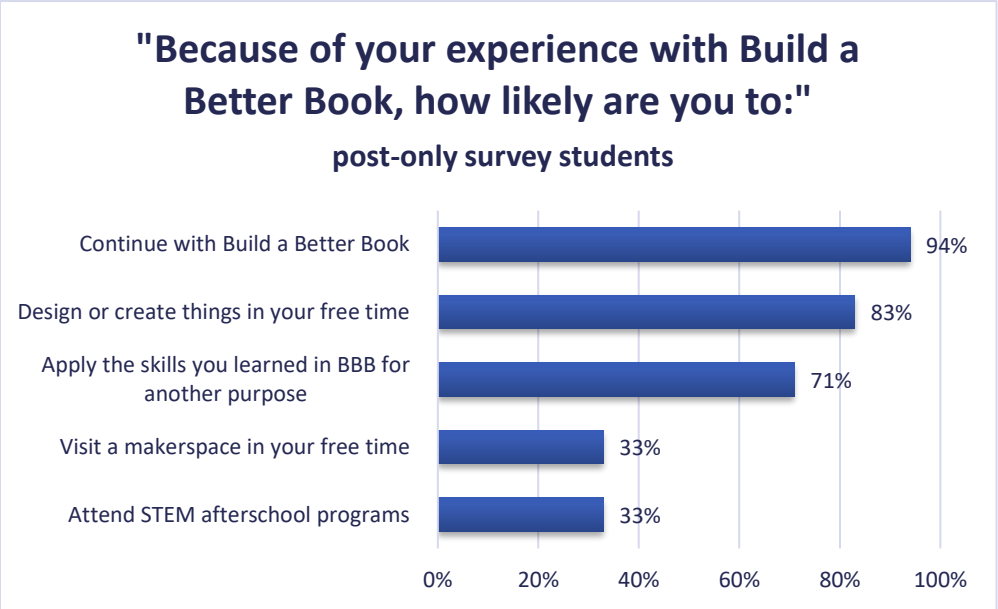
Table 8. Students' likelihood of continuing with BBB or STEM programs, pre-post survey

Column1	PRE	PRE 2	PRE 3	PRE 4	POST	POST 5	POST 6	POST 7
	Out of school	Internship	In school	ALL	Out of School	Internship	In school	ALL
Continue working on a project for BBB	37%	11%	25%	**39%**	26%	50%	23%	**27%**
Attend another BBB program or event	36%	33%	17%	**31%**	30%	70%	15%	**27%**
Work in a Makerspace	36%	56%	21%	**33%**	17%	60%	24%	**24%**
Attend a different STEM program or event	68%	67%	25%	**57%**	55%	90%	29%	**37%**
Take engineering classes	58%	78%	34%	**53%**	50%	80%	37%	**47%**
Take technology/CS classes	64%	56%	38%	**53%**	55%	60%	35%	**44%**
Take art classes in school	66%	89%	56%	**65%**	60%	60%	35%	**44%**

On the other hand, when students were asked to explicitly reflect on their experience in the BBB program and its influence on their future intentions, they were much more likely to express interest in continuing with BBB and other STEM-related activities. In contrast, the pre-post survey simply asked for students' likelihood of engaging in certain future activities and did not connect those activities to their actual experience in the BBB program. In pre-post survey fashion, the items were the same on the pre- and the post-survey. Instead, the post-only survey asked students to reflect and specifically respond to their experience in the BB

program. When prompted to connect their BBB experience to future engagement in STEM, students expressed a much greater desire to continue with BBB and to explore more STEM-oriented programming.

Figure 11. "How likely are you to:" – post-only survey students



On an open-ended survey item, students stated that the broader conception of engineering and design that they gained from the BBB program had influenced their interest in making and STEM. Influence on career interest was primarily observed in the Pre-Collegiate program as that program served older students who may be more actively considering college major and career options. In fact, 75% of Pre-Collegiate students were more actively considering an engineering career because of their experience in the BBB program and overall Pre-Collegiate program, although many were still uncertain about career direction. Following are comments from Pre-Collegiate students about how the BBB program had opened their mind to the possibility of an engineering career.

> *Before the program I never saw myself as an engineer or ever studying it, but taking the classes, I thought they were really fun and interesting. And I can see myself being an engineer if I don't have anything else. (Pre-Collegiate program)*

> *For me it did [increase my interest] just because I thought that it was interesting having to rearrange stuff and learning how to write the braille and learning how to do the Tinkercad stuff because I've never used Tinkercad before, so even though engineering is not what I wanna do, it did change my idea of well maybe I do wanna do engineering. But I haven't decided. (Pre-Collegiate program)*

For me I got two big things from it. One, in the future whatever I do, I hope I can somehow help out communities that are blind or deaf because learning from this you do simple stuff, and you, like, make a change. And the other thing it brought me back to the idea of maybe engineering as one of the fields I might go into. (Pre-Collegiate program)

Self-Efficacy

Students sustained their self-efficacy in STEM, technology, and design throughout the program. There were not significant pre-post differences across program types or significant changes from pre-survey to post-survey on the self-efficacy items. For the most part, students' self-efficacy stayed constant or declined slightly (though not significantly). For instance, the average rating on the self-efficacy scale (all self-efficacy items grouped together into one construct) was 3.46 on the pre-survey and 3.42 on the post-survey, suggesting that students' self-efficacy remained steady over the program. When considering individual items on the self-efficacy scale, students' perceptions that they were good at designing or creating things increased, while their perceptions that they were good at learning new technology decreased slightly. This latter finding may be complicated by the fact that programs used technology to varying extents, with a few using little to no technology. The inconsistency across pre- and post-survey response rates did not allow for a program-by-program analysis to better understand the impact of technology use (or lack of) within the program on student outcomes. Nevertheless, students stayed consistent in their technological self-efficacy and slightly increased their self-efficacy in design.

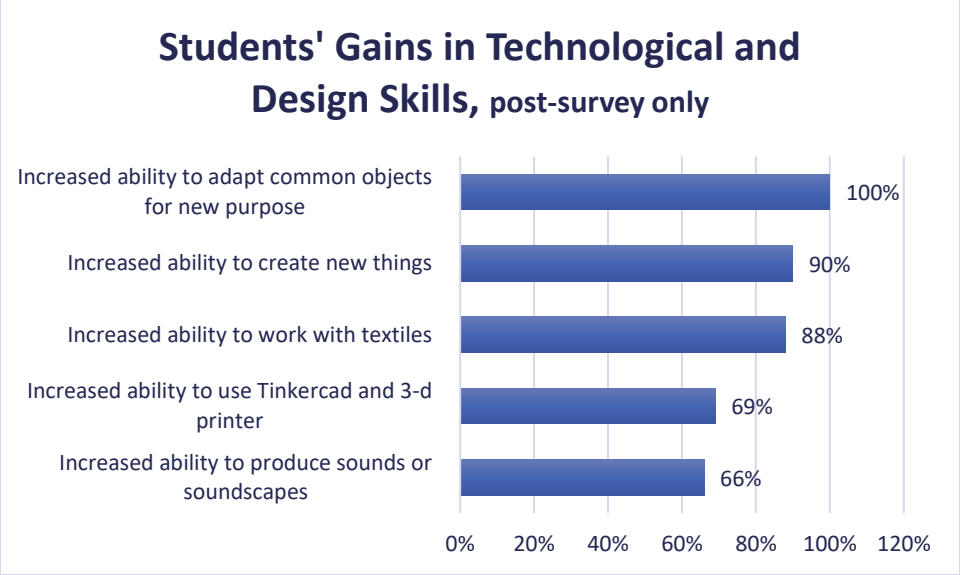
Table 9. Student responses on self-efficacy items, by program type

Item	PRE	PRE	PRE	PRE	POST	POST	POST	POST
	Out of school	Internship	In school	ALL	Out of School	Internship	In school	ALL
I am good at creating and designing things	48%	67%	48%	**48%**	55%	73%	46%	**59%**
I am sure I can be successful in technology	50%	56%	27%	**45%**	38%	27%	47%	**41%**
I can get good grades in technology	68%	67%	57%	**65%**	69%	45%	50%	**58%**
I am good at learning new technology	67%	89%	53%	**65%**	61%	73%	38%	**54%**

Gains in Technological and Design Skills

While students remained steady in their self-efficacy in technology and design, they reported strong gains in technological and design skills, perhaps a precursor to enhanced self-efficacy in these areas. Skills gains were measured through the post-only survey in which students were asked to evaluate their gains in skills based on their experience in the BBB program. Skills gains were also evaluated through interviews with students and facilitators. Students reported the strongest gains in design and creativity. Students also reported quite strong gains in working with crafts and textiles, and lesser gains in using Tinkercad or Makey Makey. Students were asked to evaluate their skills gains only if they had used the particular technology, so the findings reflect students who actually used those technologies in the program.

Figure 12. Students' Gains in Technological and Design Skills



In interviews, as described previously, 100% of facilitators observed gains in design skills among their students. However, gains in technological skills were more varied. For instance, about 1/3 of expansion site programs were low-tech or no tech. Because the programs were very open-ended and involved extensive student choice, students in some programs chose to use little to no technology in their designs. Most of these programs were in libraries or art classes. On the other hand, about 1/3 of programs were much more high-tech and these were often administered in school. The remainder of programs were in the middle and the use of technology varied by student project. Nevertheless, almost all facilitators who ran programs utilizing more technology observed extensive gains in technological skills among their students. Several facilitators noted that 3-d printing and Tinkercad were new skills for their students.

I grabbed SketchUp from Google. And so they learned that. So 3D printing was big because that was new for these guys at this age. But especially the 3D was definitely new for an eighth grade group of people. (Facilitator, in-school program)

Other facilitators commented on why their students did not use as much technology as they had expected. Out-of-school programs were often constrained by time and it was more expeditious for students to use a 3-d pen, for instance, than to create or download a design in Tinkercad and have it 3-d printed. Thus, time constraints to learn and use the new technologies impacted the use of technology in some programs.

We did use the bare conductive board. Not every student used that, but some students used the bare conductive boards. We had Makey Makeys available. I don't think any student chose to use a Makey Makey. We did use the 3D pen to a certain extent. I can't think of any other technology that we used. We have 3D printers, they could have 3D printed, but I don't think anyone did. We have a laser cutter, but in that short amount of time, the learning curve for some of those tools, like it's easier to hold a 3D pen then to learn Tinkercad to 3D print. I feel like in the amount of time we had, we went more for the easier technology. We certainly used computers, but not really for the prototype. (Facilitator, out-of- school program)

Other facilitators reported that their students created a range of high-tech and low-tech designs, depending on students' design plans and interest. Students who undertook high-tech designs were exposed to new technologies and gained skill in their use, as observed by the facilitator of an in-school program.

We said, "Okay, we want to have a prototype that eventually could be made into something better assuming that we had feedback from the visually-impaired community that said how to improve it." And then the idea is to take that a step further. Projects ranged from low to high tech. And some definitely used 3D design and printing well because they went on their own to do multiple iterations of what the game board would look like and multiple iterations for what the pieces would look like and how they would actually work. I was really proud of them because they did go back to the drawing board a bunch of times on the design and also came to understand the 3D printing settings a lot more so they could print finer, quicker, just however they wanted to fine tune it which is a really good skill to have. (Facilitator in-school technology class)

In interviews, 100% of students in focus groups commented on learning and gaining skill in new technologies. Because one of the programs was more crafts-oriented, students in that particular program discussed using and mastering the Brailler. Nevertheless, students in all groups described learning new technologies and gaining skills in new areas, including 3-d printing, Scratch, Makey Makey, laser cutting, and brailling. Students also described going through multiple iterations and prototypes until they had mastered the technology and

corrected any issues with their previous design. Students mentioned that they spent a lot of time learning the new technologies. Some students commented that the rewards of learning the new technology were their favorite aspect of the program:

> *I guess for me [my favorite part] was when we received our 3D printings, because we spent so much time trying to perfect and everything. And so when we get it back we're like oh, either it's good or bad, or, you know, it's kind of rewarding to see that it turned out well. (Pre-Collegiate program)*

Students also viewed their technological skills as transferable skills that could be applied to other projects and would be useful in the future.

> *Now that we have a good idea of how Tinkercad works and how QR works, now we can apply it to other types of projects if we wanted to. And that's what we've been doing, I bet at least in some small way that all of us as students have used what we have learned in other classes besides just one. (Pre-Collegiate program)*

As in previous years, students greatly enjoyed learning Braille.

> *I learned a little braille. I have to read a little braille. So yeah. I think later in life I'll be like oh that's a C. (ACCESS program)*

> *Student 1: I learned a lot of things. I learned how to use the laser cutter, TinkerCAD... I pretty much never used anything before we used it, especially the Braille stuff, but it was really fun. It was really fun learning how to do that but I've never really used any of that stuff before this.*

> *Student 2: Yeah. I learned swell machine, laser cutter... I didn't know what Illustrator is and TinkerCAD, and I learned Braille but yeah, now I understand how it works. (Museum of Boulder students)*

Students in several of the programs, including the Museum of Boulder internship program and Lafayette library program, created their own designs in Tinkercad when they could not find suitable representations in existing designs. Students found it challenging but were satisfied with the results and the skills they gained.

> *The greatest challenge was probably just the 3D designing of all the little things. It was pretty difficult because I used this thing where people have design stuff and I can take some of that. Some of the things I wanted to design on my own. So I designed a penny bike and that was really difficult, because I had to put together all the pieces and figure out how to make it feel like a penny bike. (Museum of Boulder intern)*

In conclusion, students in most BBB programs, including expansion sites, were introduced to a variety of new technologies. Students took pride in mastering the new tools and viewed them as important, transferable skills that they may use later in life.

Empathy and Contributing to Society

Throughout the life of the program, one of the most important outcomes for students has been the ability to understand how visually impaired or blind people experience the world and the development of empathy that comes with this increased awareness of inclusion and disability. The opportunity to create objects with purpose in the makerspace and to foster empathy in students was a primary motivation to become involved with the BBB program for expansion site facilitators. In fact, 82% of facilitators stated that they became involved with the program because of the mission of the program to design materials for youth with visual impairments. Multiple facilitators commented that they had a 3-d printer and were not sure what to do with it until they discovered the Build a Better Book program. The prospect of using the 3-d printer for a social purpose with students was highly appealing to many of the facilitators.

Students and facilitators alike reported that one of the strongest program outcomes was students' understanding of the experiences of people with visual impairments and the importance of inclusion for all abilities. The development of empathy and understanding of disability was evaluated through five measures: likert scale items on post-only survey, likert scale items on pre-post survey, open-ended question on post-survey, facilitator interviews, and student interviews. As seen on other pre-post survey constructs, students remained steady on the empathy items over the course of the program (e.g., mean of 3.64 for both the pre- and the post-survey for the scale—meaning the average of the group of items related to empathy stayed constant). There were no significant differences or changes between the pre- and the post-survey, nor were there meaningful differences among program types. The internship students were the only ones who consistently showed gains on the empathy items, but these differences were not statistically significant because there was such a small number of internship students compared to other program types. For reasons described previously, the survey this year may not be a reliable measure of this construct because of the differences in response rates from pre- to post-survey and the inconsistency across programs in completing the pre- and post-survey.

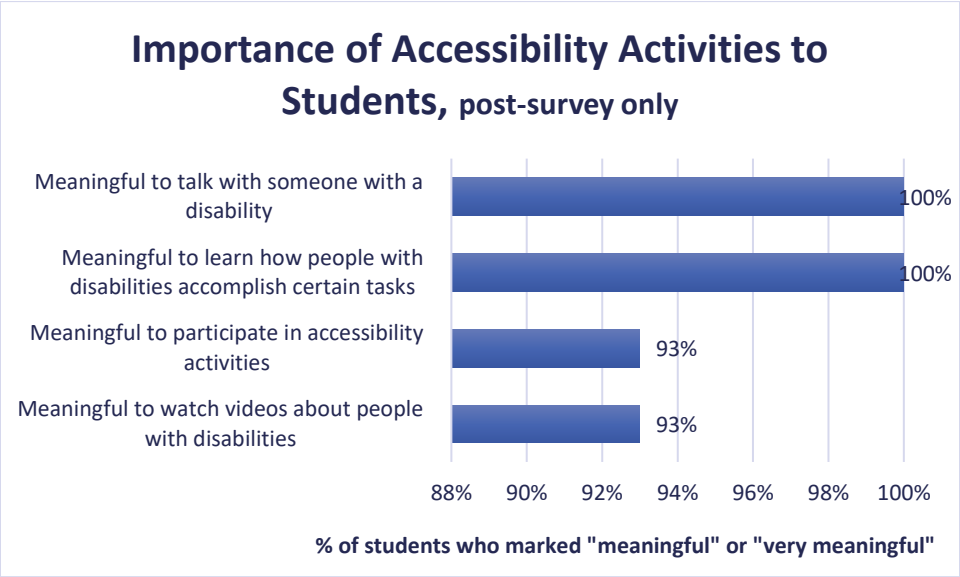
Table 10. Empathy scale items, by program type

Item	PRE Out of school	PRE Internship	PRE In school	PRE ALL	POST Out of School	POST Internship	POST In school	POST ALL
I would like to use technology and design to help people	73%	78%	60%	**70%**	69%	82%	52%	**62%**

Design and technology are important to my life	64%	67%	60%	**64%**	69%	80%	57%	**64%**
Design and technology are important to my community	67%	78%	75%	**69%**	61%	100%	57%	**69%**
I can design or create things to make the world a better place	58%	78%	75%	**60%**	67%	100%	46%	**60%**
I can contribute to my community by using my design skills	56%	56%	54%	**56%**	47%	70%	43%	**47%**
I can use design or technology to help people with disabilities	61%	67%	72%	**63%**	67%	80%	48%	**59%**

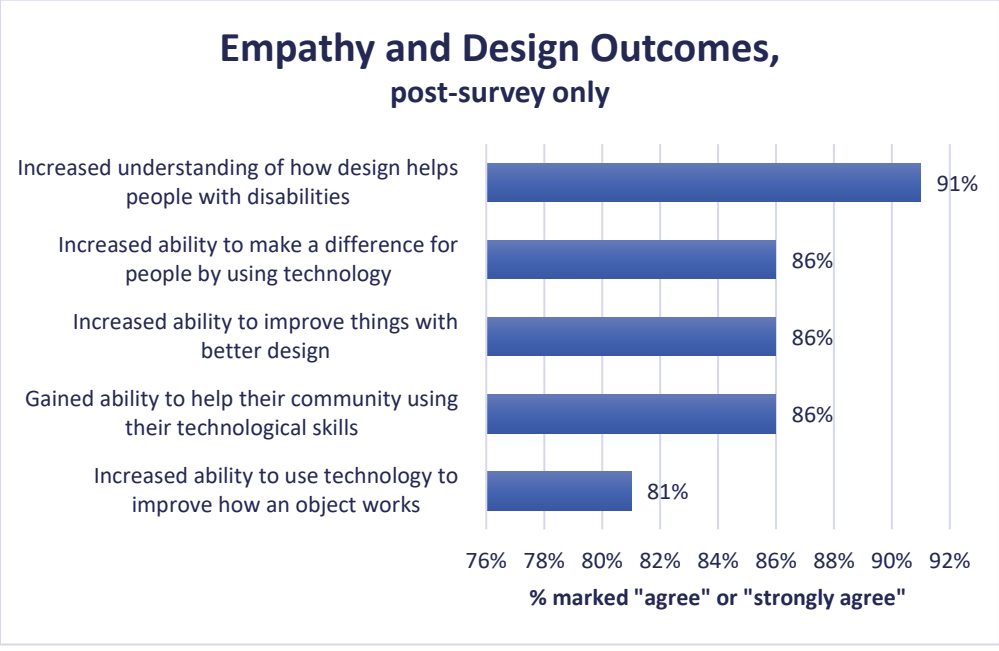
Despite students' responses on the empathy scale items, students reported that accessibility activities and interactions with people with disabilities were very meaningful aspects of the BBB program. In fact, all students who talked with someone with a disability as part of their program marked it as a meaningful activity. Results are shown in the following figure.

Figure 13. Importance of Accessibility Activities to Students



When reflecting on the specific impact of the BBB program on their ability to use design and technology to help people, students displayed much stronger gains from the program. The vast majority of students reported that they had gained design skills that would help people with disabilities (see figure 13).

Figure 14. Empathy and Design Outcomes, post-survey only



Similar to previous years, facilitators and students affirmed in interviews that the development of empathy was one of the most powerful outcomes from the BBB program. For example, 100% of facilitator interviewees from expansion sites observed gains in empathy and altruism in their students. Facilitators observed that students gained understanding of the experiences of people with visually impairments and became more aware of their needs and strengths. Facilitators also observed that students were motivated by the opportunity to help people. Multiple facilitators noted that interactions with people with visual impairment were the most helpful program element in developing empathy and motivation in students. Accessibility activities also helped students to understand how people with visual impairments experience the world, but to a slightly lesser extent than actual interactions with blind or visually impaired people. Some facilitators were so enthused about the empathy-building aspect of the program that they sought to share it with the widest possible audience. To this end, one school engaged their entire 7th grade in the blind Pictionary activity. The school librarian described the impact of the activity on the students and the subsequent work of BBB students:

> *I actually did the blindfolded Pictionary with almost all of the seventh graders in our school through a literacy class. It was a lesson on empathy. All the kids had that experience. Even just in that quick activity, I saw the majority of kids really having light bulb moments of, "Oh, I never thought of that," or, "Oh, wow, what if you had to do this?" Then that definitely extended into our group working on the book. There were a couple kids who were really interested in, "Well, if I learn how to write in Braille, then I can do this and then I could help people with this." I think it just made them really think about the different ways that people learn and they started to connect like, "Well, this would help people even if they're not blind and this could work for people." They were really starting to think differently. (School librarian)*

Another in-school program facilitator described the progression of interest and empathy in her middle school students over the course of the project. Real-life interactions with blind and visually impaired people helped to generate the greatest amount of interest and developed more awareness and empathy in students than accessibility activities along.

> *I just think it was something they had never even thought about before probably, they're junior high. In the beginning, when we were talking about it, they were kind of like, "Meh." We showed them some of the videos and that was not really… I mean, we hadn't really hooked them in there. Then we did a Skype with the person who wrote the book about a blind person, and they were still not. They were just kind of like, "Yeah, whatever." Then when they actually Skyped and talked to him, that made it much more real because he was very open and upfront with them. They really started engaging, but I think the biggest flip we saw was after the students who were blind came in, and talked to them, and felt some of their projects, and shared things. I think that was the flip. That*

made it a real thing to them just like, "Oh, yeah. This is more than just a project we're supposed to do." In that sense, I would say they probably have a little bit more awareness. (Facilitator, in-school program)

Many facilitators also commented that it had raised their own awareness of disability and design and, subsequently, they had also developed a stronger sense of empathy and understanding of the visual impaired community. For instance, a facilitator who had worked in design and engineering throughout most of his career commented:

Learning about Braille for me was not just eye opening, but I think for me it was really important to kind of piece together, I've been working on universal design and I knew I'd never really worked with visually impaired students before. So to start understanding how Braille works and how little of the visually impaired population actually uses Braille and how it's actually not a good thing. That Braille is important. So I think learning more about what it's like for someone is really important. That was really important. (Facilitator, in-school program)

In interviews, 85% of students in the five programs profiled discussed gains in empathy and a sense of altruism from their participation in Build a Better Book. For nearly all students, this was a new area of inquiry with which they had little background. A few students noted that they had blind or visually impaired relatives or schoolmates, but they were the exception. Most students had little prior experience with disability or visual impairment. Overall, students found the opportunity to help people highly appealing and motivating

I think the moral part of it is very interesting to me. What we're trying to do for people who can't see as good as us. And trying to innovate things that are better. (Pre-Collegiate program)

Students also gained awareness of the ways in which engineering and design can be used to help people, especially in the visually impaired community.

Just how engineering is a big part for those disabled people. Creating something for them is very rewarding. Doing something for others. One thing that I'd take from this is to look at things different in perspectives on more details. I never thought about making a book that was 3D. I never thought of it. It's so obvious, which you never think of such obvious things. (Pre-Collegiate program)

Students began to take an assets-based or strengths-based approach to disability, recognizing that they lead full, rich lives. Students gained a better understanding of how people with visual impairments draw on other senses to experience the world.

Well they experience the world through sound or they experience the world through different types of their senses. Smell and eyesight can't be the only pathway to being able

to figure things out. And they develop new ways to do things and it's just a really inspiring thing. (ACCESS student)

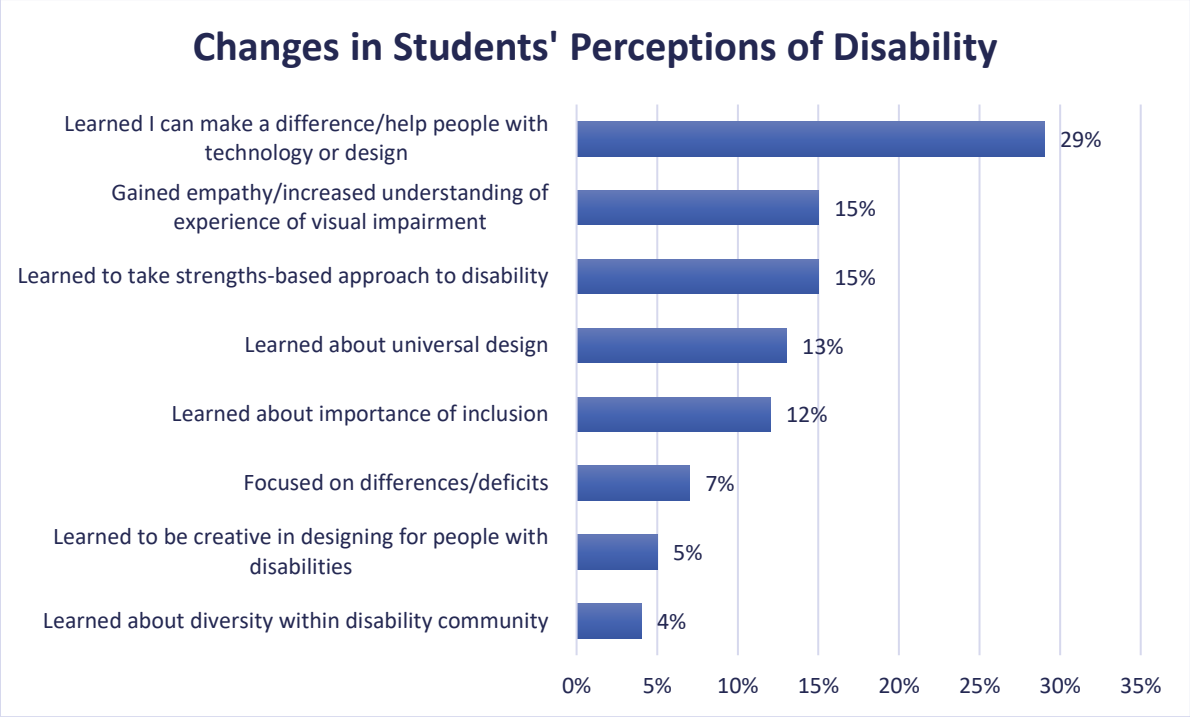
Students, especially those in the Museum of Boulder internship program, came to a better understanding of the range of disability and visual impairment and how that might affect someone's experience. Students gained awareness of the terms and definitions associated with disability.

I hadn't even thought about [visual impairment] before so one now I'm not going to go anywhere without thinking about that which is actually a good thing. And I just think about all different types of impairments and disabilities. And so when I'm going somewhere I just think about that. But yeah I've never really done that before but I will think differently about it too now. (Museum of Boulder intern)

But now I understand what is a disability, how it can be defined, and how someone defines themselves. If they say that they're blind, or visually impaired, or just how they identify themselves can be an important part of their disability to them. How some people identify, I didn't know that that was such a big part of the community as well. So that was a fun new thing to learn along with stuff like general accessibility. (Museum of Boulder intern)

Finally, students affirmed these new understandings of disability on their written responses to the survey question which asked what they had learned about helping people with disabilities. This question was designed to elicit perceptions of disability and the growth of understanding and empathy. The most common response was that students felt empowered to be able to help people with disabilities through technology or design. Students also wrote that they gained awareness of the experiences of people with visual impairment and learned to take a strengths-based approach to disability. Other students learned about the important need to include people of all abilities (see figure 15).

Figure 15. Changes in Students' Perceptions of Disability



Following are typical responses from students about their changes in perception of disability.

Learned that I can help people with disabilities:

- *That everyone who wants to try it can do it, at first it can be hard but if you really want to do it, it's going to end up being a little easy. I learned that to make a book you need a lot of time, but it is worth it because you are helping others.*
- *If you put time and effort it is fun to help people with disabilities.*
- *I learned that I can help people with disabilities*
- *I learned that helping people with disabilities can improve their way of life and can put smiles not only on their faces but ours as well.*
- *I learned that we can help people with disabilities in many different ways.*
- *I learned that helping people with disabilities is a kind thing to do.*

Gained empathy/understanding of experience of visual impairment:

- *You have to think outside the box and you have to put yourself in the shoes of others.*
- *I learned that you have to go through their shoes to find out how to help them.*
- *That people rely a lot more on the senses they can use than I thought.*

Learned to take assets-based approach:

- *They are really talented because they know how to read braille.*
- *That everyone can be able to do thing that people didn't think they could've done*
- *That they can do some things people that don't have disabilities did not even think of*
- *I learned that people with disabilities are like regular people.*
- *I learned that even if they lost one ability in life they are able to open the rest of their abilities.*

Learned about importance of inclusion:

- *That it is important to include everyone and that texture is important to people who r blind*
- *Blind people shouldn't be excluded so we found ways to bring blind people in the mix.*
- *They don't have much accessibility*
- *This is important, helpful and it can help kids with disabilities to learn or to have fun. I would like this to continue because I would like this kind of help in the future.*

Learned about universal design:

- *I learned that when designing for people with disabilities, having empathy for them is really important and that you should design as if you are the person using the product.*
- *That you need to get feedback from them and you need to make sure it works to their ability*
- *I learned that you have to be really specific when designing, or speaking for people with disabilities, I also learned that when you 3D print for people with disabilities you have to make sure to put in enough details that they know what it is, but not too many details to make it confusing.*

Following is a word cloud comprised of students' responses to the question about their perceptions of disability.

Figure 16. Word cloud of students' responses to open-ended question about perceptions of disability

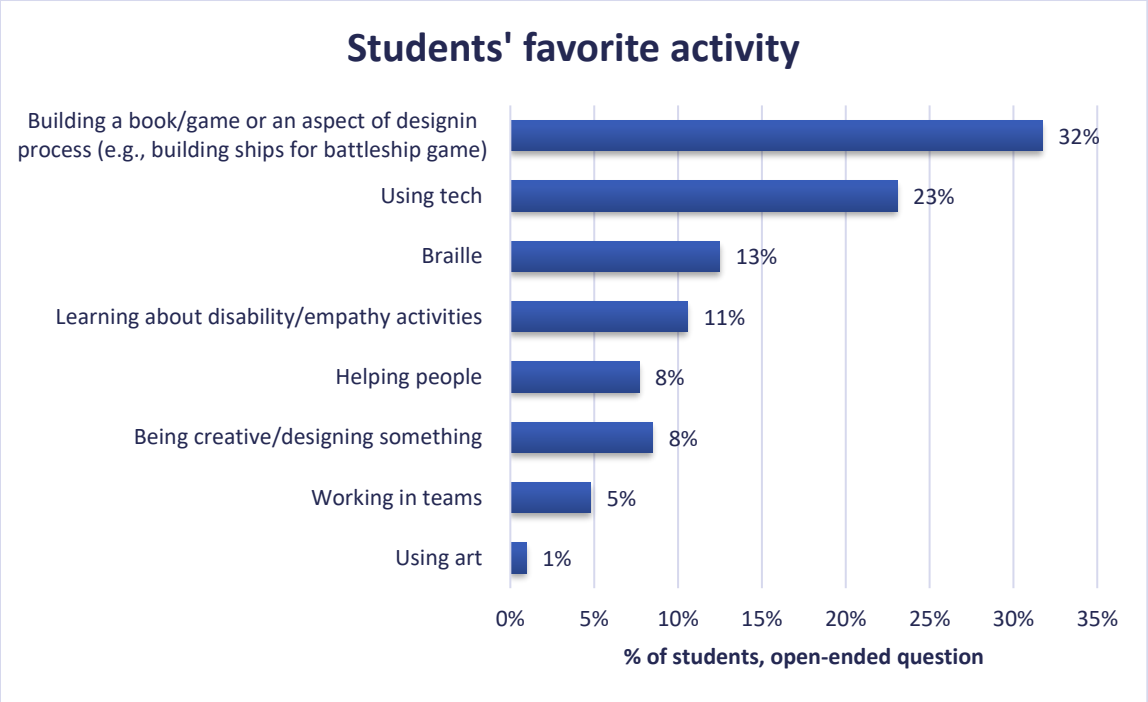
In conclusion, the development of empathy, understanding and awareness of the needs and experiences of people with disabilities was one of the most significant outcomes from the Build a Better Book program in both local programs and expansion sites. Students gained a more nuanced understanding of the range of visual impairment as well as the importance of inclusion for people with disabilities.

Students' Favorite Aspects of Build a Better Book

Students' favorite aspect of the program was the process of designing their books or games, creating its elements, and assembling them. Students also enjoyed learning new technology. Students also reported that they enjoyed learning braille and gaining awareness of people with disabilities. Unlike prior years, students did not necessarily highlight 3-d printing as their favorite aspect of the program, but this may be because not all programs used 3-d modeling and printing technologies. There were a few notable differences across different

types of programs. In-school program students enjoyed learning new technology more and out-of-school program students enjoyed learning about disability more. Both groups liked the process of building the book equally. This difference may be because in-school students did not opt in to the program so may have been less interested in or motivated to learn about disability.

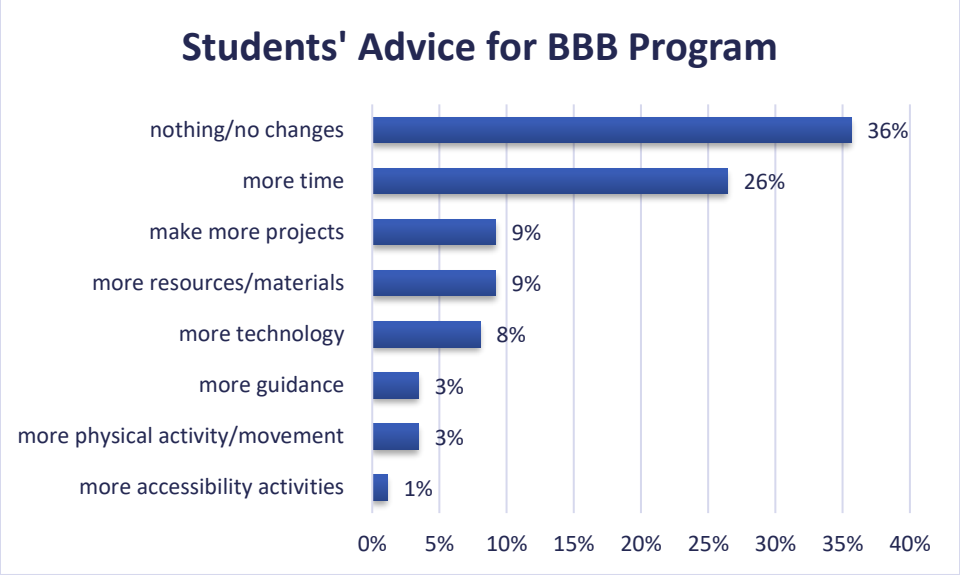
Figure 17. Student' favorite aspects of Build a Better Book, open-ended question



Student and Librarian/Teacher Advice for Improving Build a Better Book

Most students had no suggestions for the BBB programs because they were happy with the program as is. About ¼ of students suggested that the program could benefit from more time to work on designs and iterate. Some students ran out of time to complete their designs or felt rushed at the end of the program to finish and assemble their product. Otherwise, students had few suggestions. A few students suggested more technology, resources, or materials available to make their creations. Other students wanted to work on multiple projects, rather than a single book or game. For the most part, students were highly satisfied with the program, including at expansion sites.

Figure 18. Students' Advice for BBB program



In interviews, facilitators provided advice for future implementation and discussed their lessons learned from program implementation at the expansion sites. Facilitators had little advice for the program itself as they felt adequately prepared and supported (to be discussed in the next session). However, they did offer lessons learned for future expansion sites. These lessons learned included:

- *Use a wide variety of technology*. 3-d pens can be delicate, so it is helpful to supplement with 3-d printing, lasercutting or other technologies as available.
- *Develop partnerships*. Facilitators overwhelmingly reported that their partnerships with community agencies or county offices for the disabled, community members with visual impairment and/or school or district special education offices were essential to the success of their program. Partnerships helped to bring in the perspective of the visually impaired community and made it more "real" for the students.
- *Provide enough time* on consecutive days or weeks for the students to fully design, test, and iterate their products. The design process takes time and almost all facilitators noted that new programs should definitely allow adequate time for student exploration, creativity, and failure.
- *Give students a range of choices and encourage creativity*. A few programs constrained student choice to allow for student completion of products within a limited time window (e.g., all students make a page for an alphabet book). In retrospect, some of these facilitators felt they may have limited students' creativity and felt that more options should be provided (e.g. work on a different book or game). Similarly, some facilitators felt that students mimicked each other and all chose the same end product even if they had a wide choice of products and materials. These facilitators felt they

needed to implement a better process to encourage students to be creative and not to simply replicate what other groups had done.

- *Add more discussion of universal design*. While 100% of facilitators at expansion sites included accessibility activities and/or discussion of universal design into their programs, some programs felt that they could have spent more time introducing students to the topic. A lesson learned across some of the programs is that this is a new concept for students, and it takes some time and experience for them to fully understand and embrace the concept of universal design.

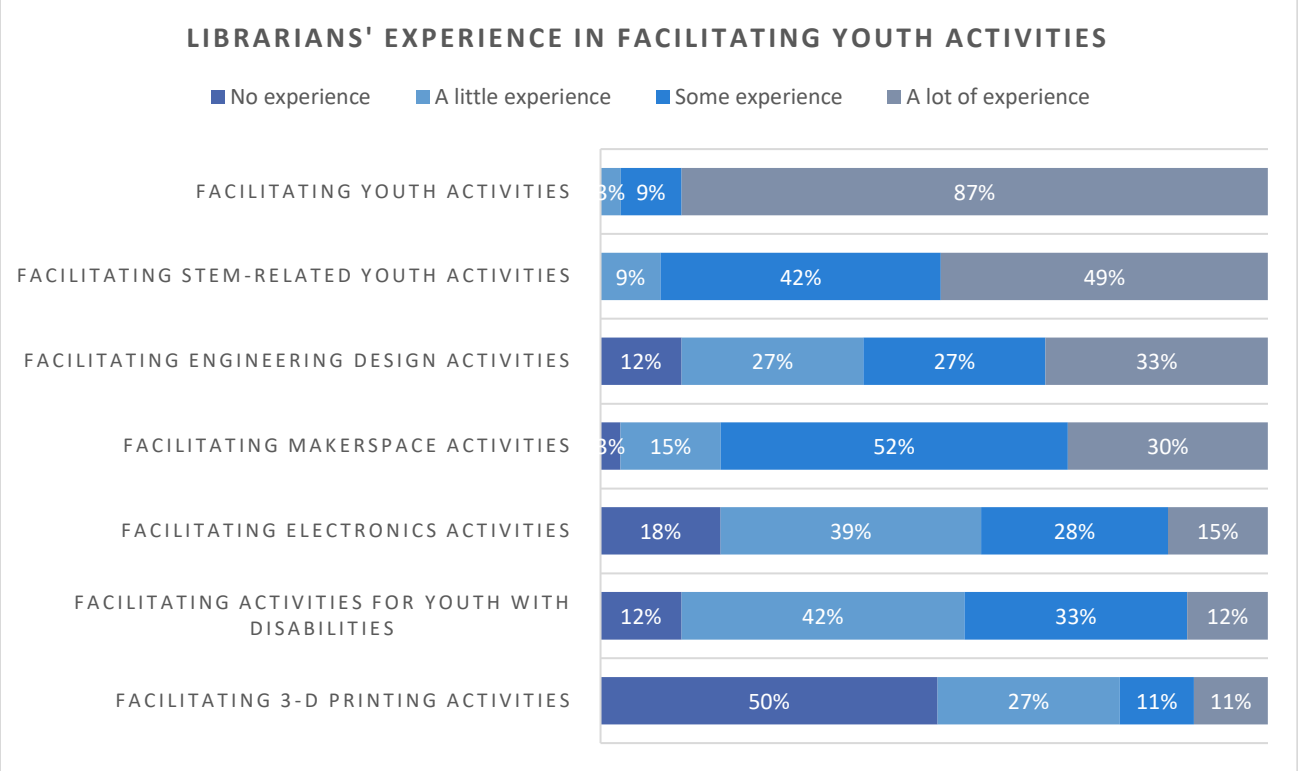
Librarian and Teacher Outcomes

This section describes the findings from the workshop survey administered to 2019 workshop participants. This section will describe participants' prior experience in facilitating STEM programming and programming for youth with disabilities will be discussed, workshop outcomes, resources and challenges related to capacity to implement Build a Better Book will then be discussed, and participants' feedback for future workshops.

Participants' prior experience in facilitating youth or STEM programming

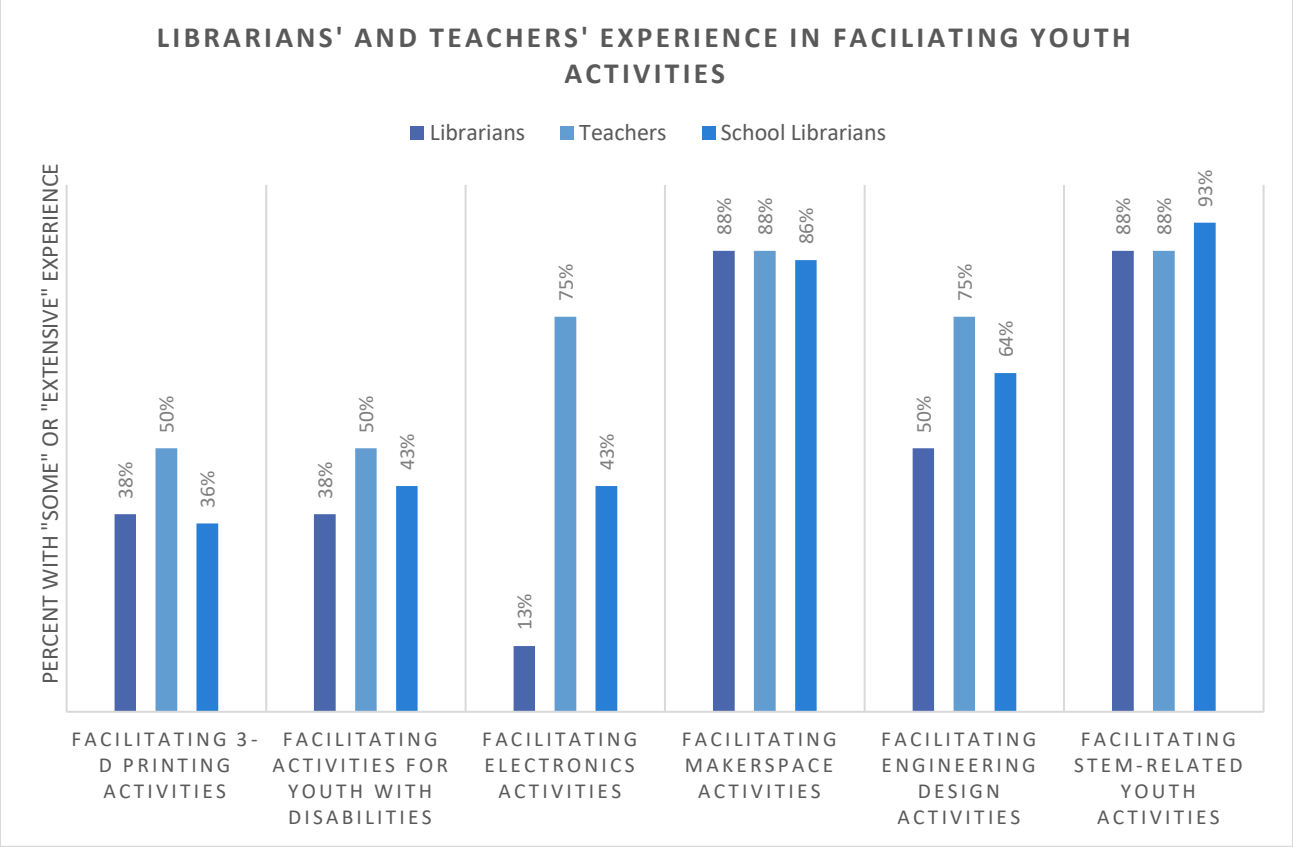
Similar to prior cohorts of trainees, almost all of the librarians and teachers had extensive experience in educational programming for youth. The 2019 cohort had slightly more experience than past cohorts in implementing STEM-related youth programming and programming for youth with disabilities. As Build a Better Book has disseminated its model and expanded its reach, it seems that librarians and teachers who are doing work that is aligned with the Build a Better Book vision are beginning to hear about the program. This may also suggest that librarians' and teachers' prior experience in these areas may strengthen their implementation of the program as it is not new territory for them, compared to some past trainees. For instance, 2019 workshop participants had extensive experience with youth activities in general (82% in past cohorts and 97% this year). A fair number of 2019 attendees had prior experience in working with youth disabilities (18% in past but 45% of this year's cohort had some or a lot experience). The vast majority of current attendees had experience facilitating makerspaces (59% in past, 82% this year). Nearly half of current attendees had past experience in facilitating 3-d printing activities, more than double the rate of previous cohorts (e.g., 22% in past years, 40% this year).

Figure 19. Librarians' experience in facilitating youth activities



There were few differences in teachers' and librarians' prior experience in facilitating youth activities. Teachers had more experience than their librarian counterparts in several areas, including electronics/circuits and engineering design/design thinking activities. The groups had similar experience in facilitating STEM activities for youth. Generally, all groups had limited experience in facilitating activities for youth with disabilities. The only one of these differences that was statistically significant was prior experience in facilitating electronics activities ($\times$= 13.527, df=6, p=.035).

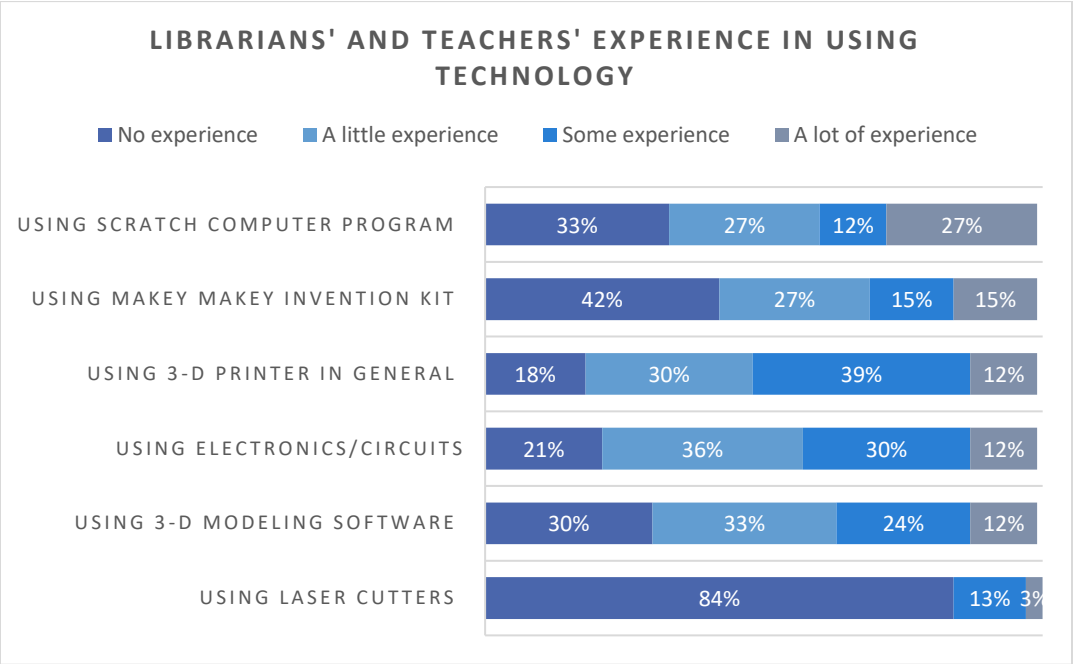
Figure 20. Librarians' and Teachers' Experience in Facilitating Youth Activities



Librarians and Teachers' Experience in Using Technology

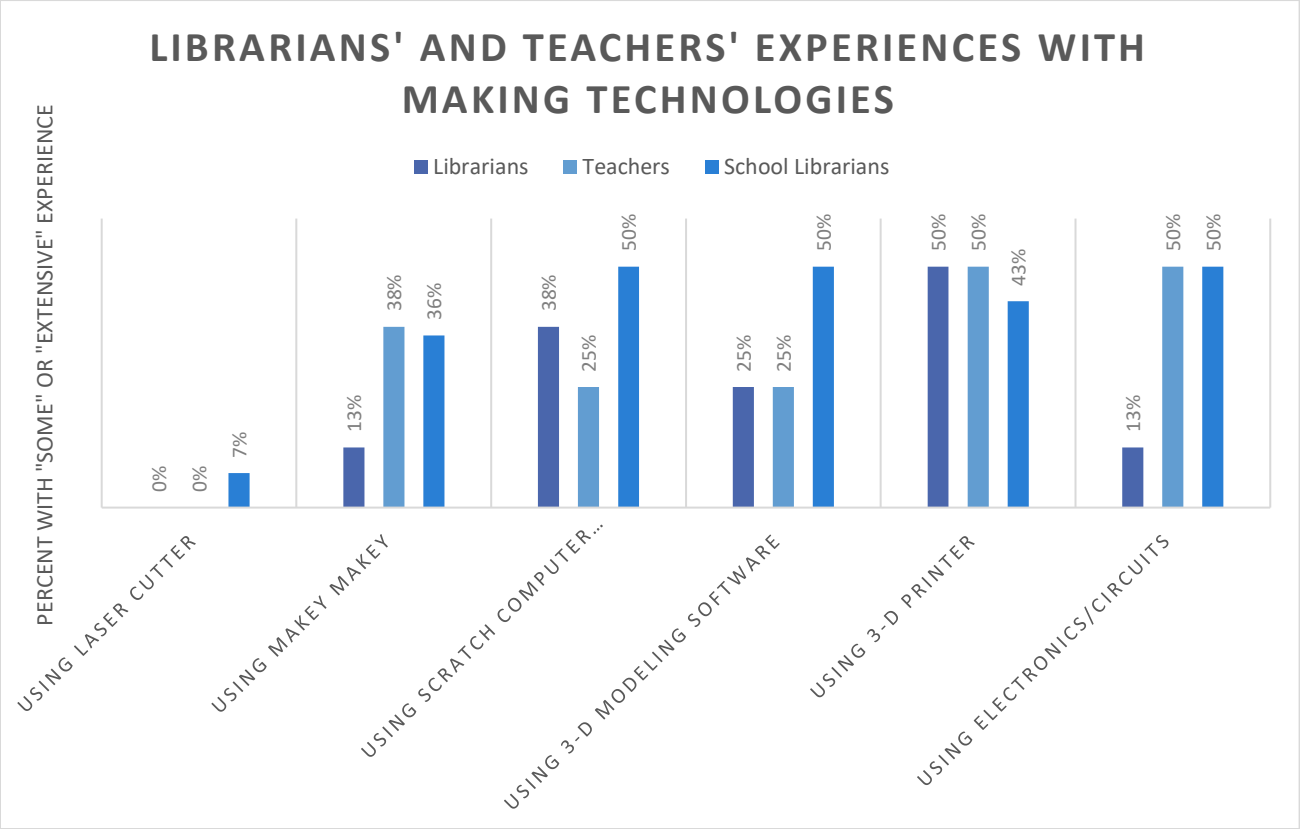
Librarians and teachers in the 2019 training had more extensive prior experience in makerspace technologies than participants in prior trainings, especially in 3-d printing. For instance, more than half of the 2019 workshop participants had prior experience using a 3-d printer, while only 30% of past cohorts had used a 3-d printer prior to the workshop. Rates of prior experience in Makey Makey, Scratch, and using electronics/circuits were similar between the 2019 cohort and past cohorts. Notably, very few participants in the 2019 training had prior experience in using a laser cutter. This question was not asked on previous workshop surveys. Nonetheless, 84% of 2019 workshop participants had not used a laser cutter. While the 2019 cohort was slightly more experienced than past cohorts in using STEM and "making" technologies, the results show that there is still a strong need to train librarians and middle school teachers in how to use and facilitate makerspace technologies.

Figure 21. Librarians' and teachers' experience in using makerspace technology



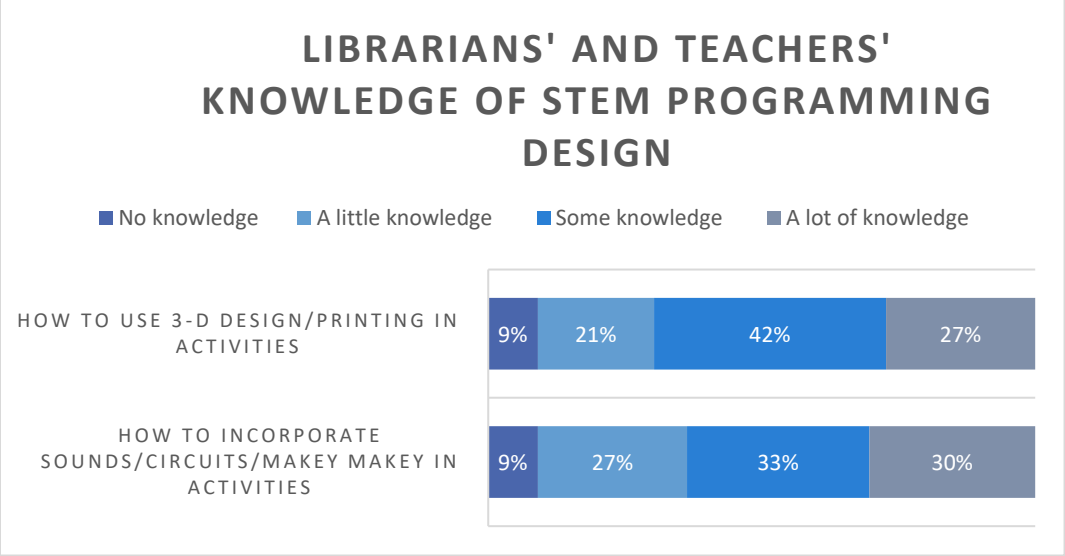
Librarians and teachers reported varying levels of experience with specific technologies commonly used in Makerspaces. Generally, teachers and school librarians had similar levels of prior experience in particular technologies, such as electronics/circuits, while librarians had less experience in several technologies, such as electronics/circuits or Scratch. Classroom teachers, on the other hand, had less experience with Scratch than librarians or school librarians. Librarians and teachers both had less experience with 3-d modeling software than with using a 3-d printer in general. None of these differences was statistically significant.

Figure 22. Librarians' and Teachers' Experiences with Making Technologies



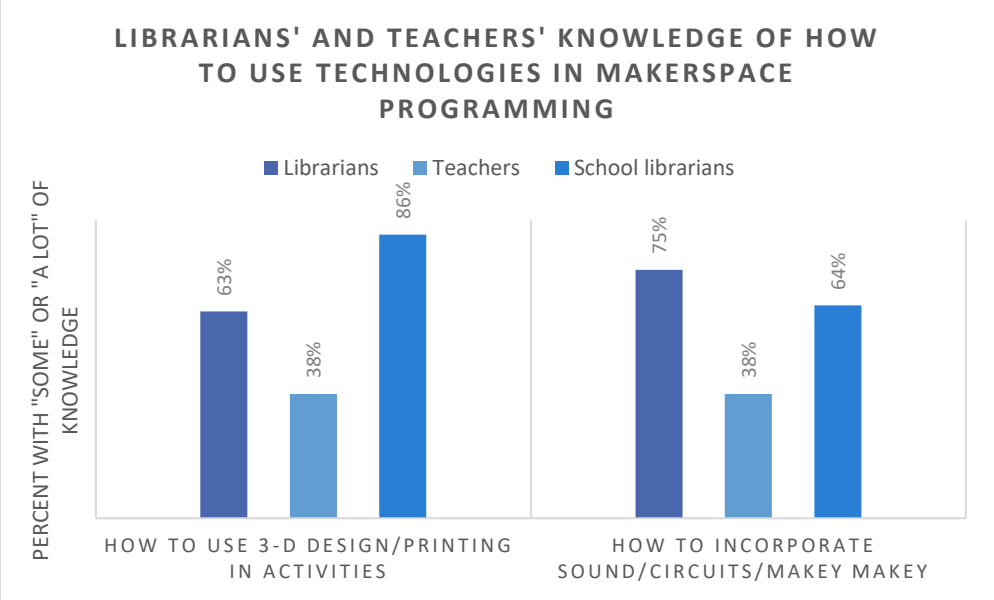
Librarians and teachers reported that they had moderate knowledge about using making technologies in educational programming for youth. Participants in the 2019 workshop had greater knowledge about how to integrate making technologies into youth activities than did workshop attendees from previous years. For example, 63% of 2019 workshop participants knew how to use sounds, circuits, or Makey Makey in youth activities, while only 38% of past workshop participants had the same knowledge. The gap between the 2019 and previous cohorts was even wider for 3-d printing and design (70% and 29%).

Figure 23. Librarians and Teachers' Knowledge of STEM Programming Design



There was little variation in teachers' and librarians' knowledge of how to incorporate 3-d design or printing into STEM programming for youth. Generally, librarians and school librarians had more expertise than classroom teachers in using 3-d printing in educational programming. These differences were not statistically significant.

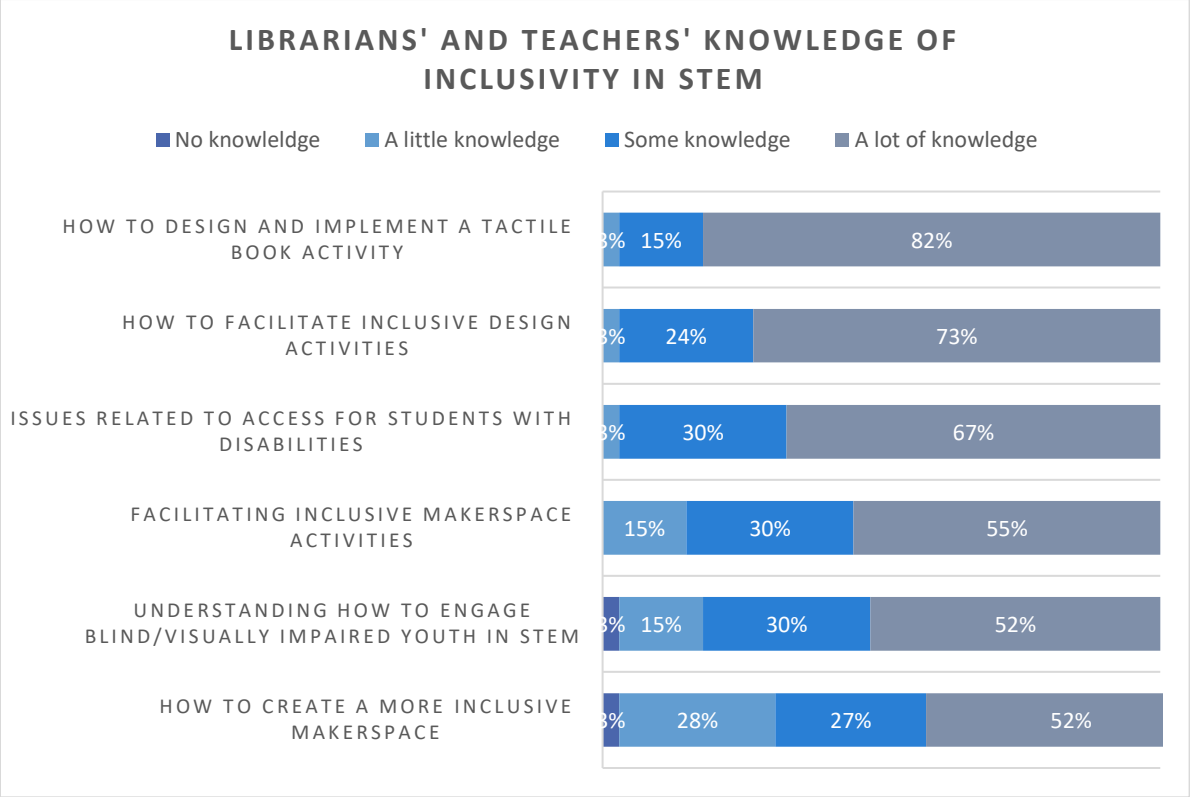
Figure 24. Librarians' and Teachers' Knowledge of How to Facilitate Makerspaces



Workshop Outcomes: Participants' gains in knowledge about how to facilitate inclusive environments in STEM programming

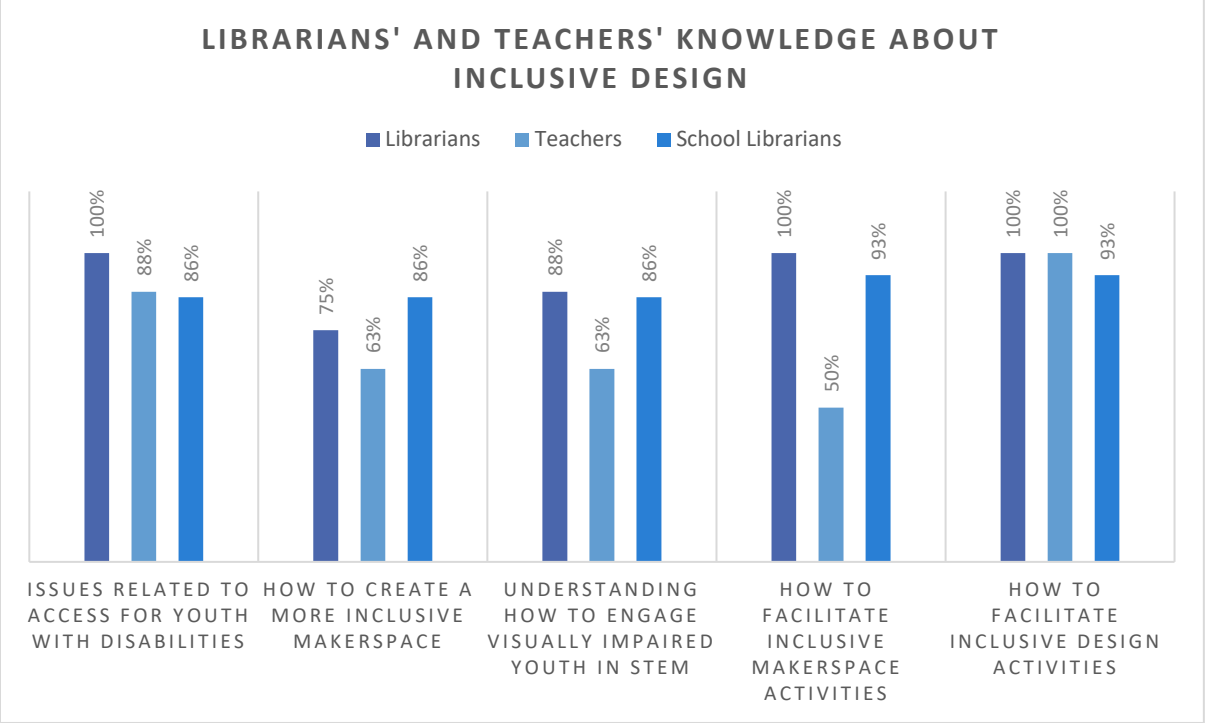
After the workshop, librarians and teachers reported extensive knowledge about how to design inclusive Makerspaces, including how to design and implement a tactile book activity. Almost all workshop participants (97%) reported after the workshop that they knew how to design and implement a tactile book program. Additionally, almost all participants (97%) could facilitate inclusive design activities. Participants also gained a better understanding of issues related to students with disabilities. Most participants (79%) knew how to create a more inclusive makerspace after the workshop.

Figure 25. Librarians and Teachers' Knowledge of Inclusivity in STEM



Librarians and teachers did not differ substantially in their growth in understanding from the workshop about how to design and facilitate inclusive STEM programming. To some extent, teachers gained less knowledge than librarians or school librarians, especially in knowing how to facilitate inclusive makerspaces and engage youth with visual impairments in STEM. This may indicate that teachers have slightly different roles and needs than librarians/school librarians when designing STEM-oriented makerspace programming.

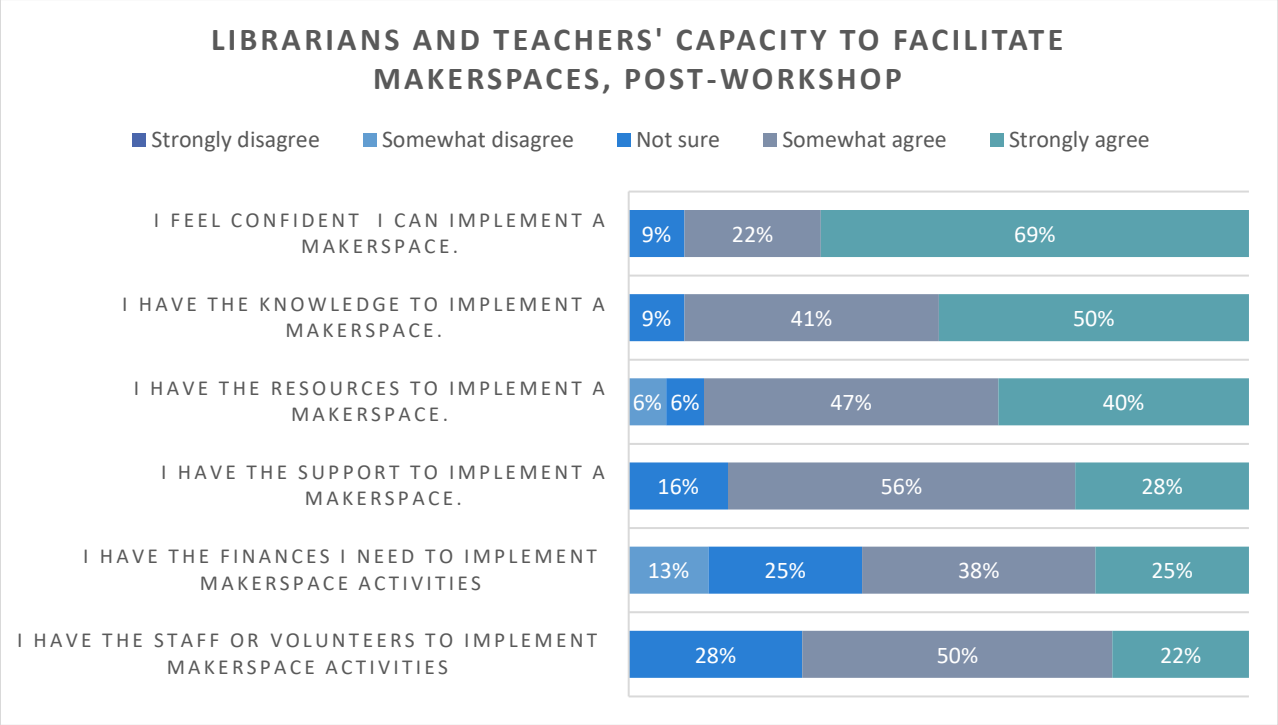
Figure 26. Librarians' and Teachers' Knowledge about Inclusive Design



Librarians' and teachers' capacity to implement makerspaces

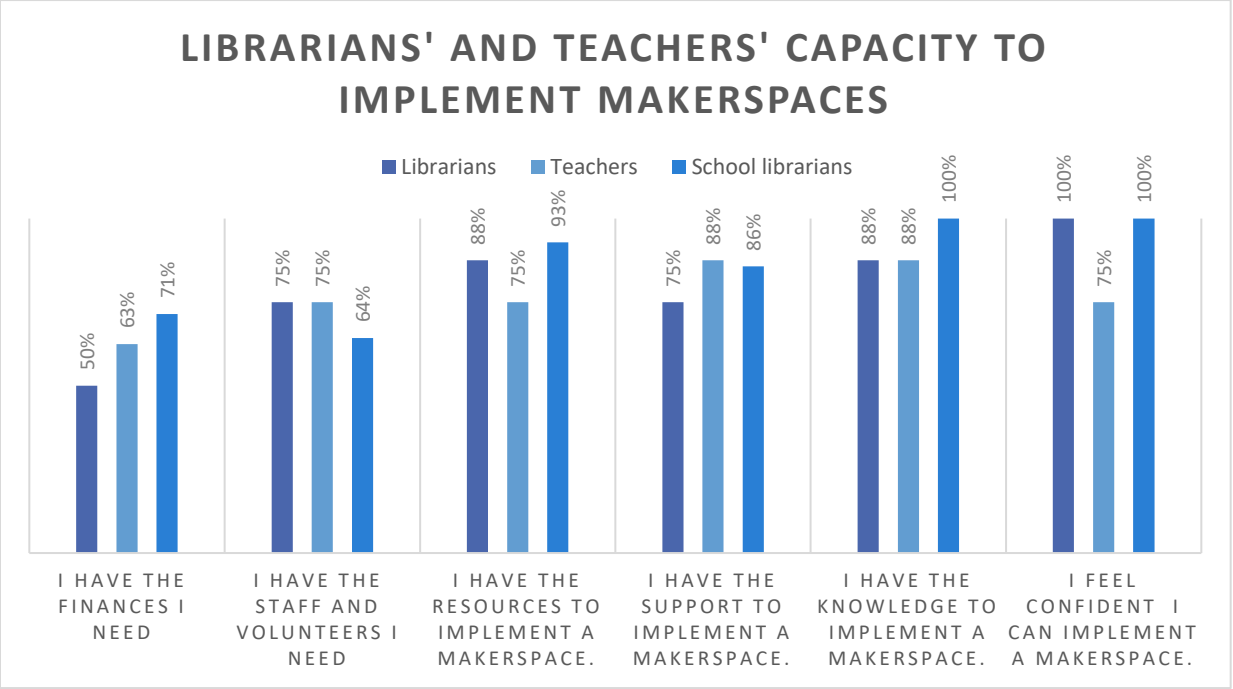
After the workshop, librarians and teachers reported that they generally had the capacity and knowledge to facilitate makerspaces or making activities within their organization. For example, almost all (94%) workshop participants felt confident that they can facilitate a youth makerspace. In contrast, about half of past workshop participants reported the same level of confidence, suggesting that this cohort was somewhat expert in their knowledge of makerspaces than prior cohorts. Librarians and teachers also gained the knowledge they needed to facilitate making activities with youth. After the workshop, nearly all (91%) participants reported that they had adequate knowledge about makerspace facilitation. In past workshops, about 70% of participants felt they had enough knowledge to successfully implement a makerspace. The 2019 cohort were also more likely than past cohorts to report that they had the resources, support, and staff/volunteers to facilitate a makerspace or STEM programming for youth. None of these differences was statistically significant among the groups.

Figure 27. Librarians' and Teachers' Capacity to Facilitate Makerspaces, Post-workshop



There was little difference in librarians' and teachers' capacity to implement makerspace programming. There were few to no differences across any category, such as resources or support. Nearly 100% of attendees reported that they had the knowledge to implement a makerspace as this was a major focus of the Build a Better Book workshop. However, public librarians had fewer financial resources than K-12 school personnel. Additionally, teachers felt that they had fewer makerspace resources than librarians. Teachers also expressed less confidence in their ability to implement makerspace programming.

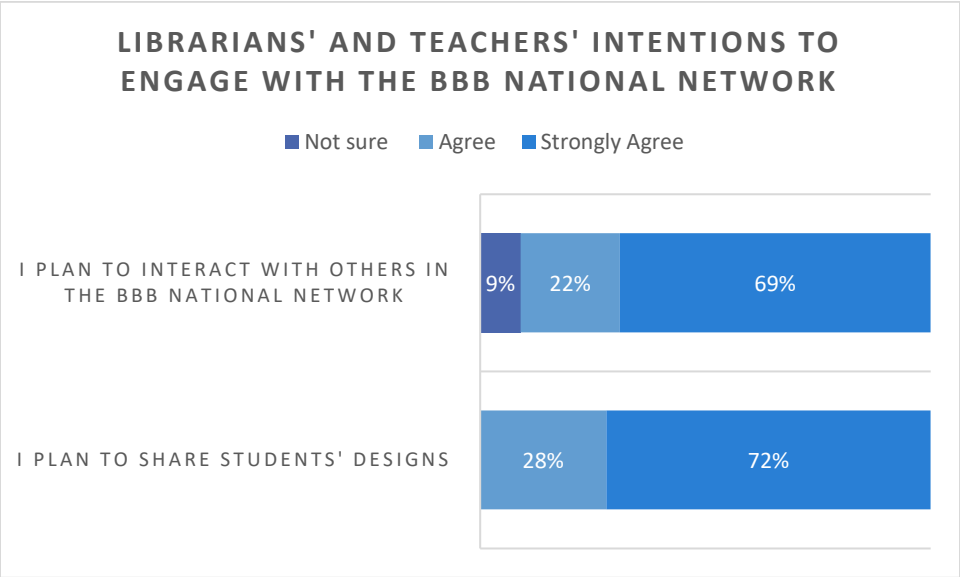
Figure 28. Librarians' and Teachers' Capacity to Implement Makerspaces



Engaging with the National Network

Participants in the 2019 workshop were eager to engage with the Build a Better Book national network. Because the network was still emerging in earlier years of the grant, this question was not asked on previous training surveys. Nonetheless, librarians and teachers from the 2019 workshop expressed strong intentions to remain engaged with the Build a Better Book national work. Participants were also highly committed to sharing their students' work and projects on media platforms, such as Workbench.

Figure 29. Librarians' and Teachers' Intentions to Engage with the BBB National Network



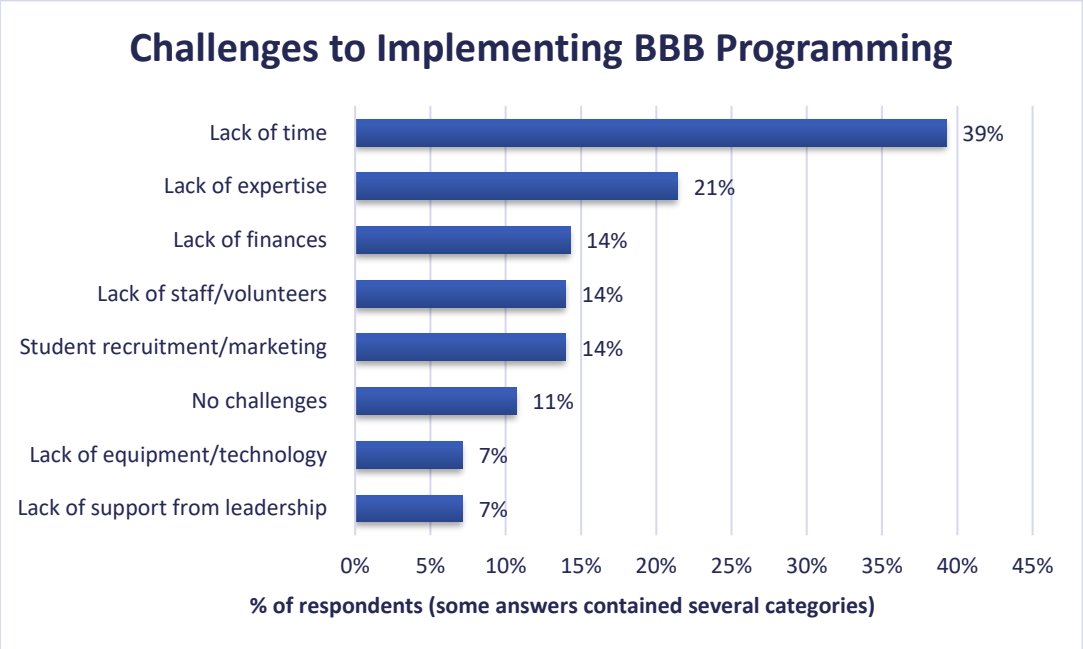
There was strong consensus among teachers, librarians, and school librarians as far as intentions to remain engaged with the Build a Better Book national network. In fact, 100% of each group expressed that they were planning to share their students' designs and projects. Almost all across each group also planned to network with the BBB community (only one person in each of the three groups stated that they were "not sure" about networking with the national community). Therefore, there do not appear to be any obstacles to participation in the national community based on professional roles or organization type.

In follow-up interviews with facilitators at 11 expansion sites, about 50% of facilitators stated that they were actively engaged with the national network. The remainder were engaged through the listserv, but not necessarily active on Twitter or other social media outlets. Additionally, all facilitators reported that they had uploaded or tried to upload student work onto Workbench. A few facilitators had difficulties in using Workbench or encouraging students to upload their projects. A few librarians and teachers had issues with student privacy and were not entirely sure how to reconcile those issues with uploading student work. For those who were actively engaged in the network, Twitter was a more helpful format for networking and sharing ideas than the listserv. Facilitators liked that they could upload pictures on Twitter which made it easier to share and use multiple activities or program practices.

Challenges to hosting makerspace programming in libraries and schools

Similar to past cohorts, the 2019 BBB workshop participants cited a lack of time to implement the program as their greatest challenge. There were a few differences among professional roles; for instance, 50% of public librarians expressed that lack of time was a challenge. 25% of public librarians cited lack of funding as a challenge. No public librarians cited a lack of expertise. Interestingly, 75% of classroom teachers cited a lack of expertise. As a teacher commented on the survey: "My own capacity [is a challenge]. I will be learning along with my students, and I want to be able to push them (and keep up with them)." Other classroom teachers expressed that they had doubts about their ability to make it as meaningful for students as they envision, in part, because of their technological skills or experience in working with students with disabilities. Similar to classroom teachers, school librarians generally cited a lack of time and lack of expertise.

Figure 30. Challenges to Implementing BBB Programming



Following are typical comments on the survey about challenges faced by librarians/teachers in implementing technology or makerspace programming. Many of the comments focused on lack of space, lack of expertise, and lack of staff to run the programs.

> *I think figuring out how to expand the project with very limited access to a lot of the technology we saw these past two days. – Public librarian*

> *Maintaining steady attendance and location of our program. Our library has no evening hours and is open one Saturday in the month. – Public librarian*

Not being shallow- students create a one and done book or project without any real development— want to make sure that we take the time to give the students a meaningful experience for them. – Classroom teacher

Designing and implementing the projects in a way that participants don't feel lost. I want to give some fairly set guidelines for the first year that the participants feel like they have freedom to operate within a pathway as opposed to open country. I think simply making sure that I'm communicating the point clearly enough while providing enough support will be the biggest challenge. – Classroom teacher

I'm worried about not having enough time. Especially since we are nearing the end of the school year. Also can be difficult at my school to get time with the students. – School librarian

My challenge will be time. I see my students 90 minutes a week, and there is little flex time. – School librarian

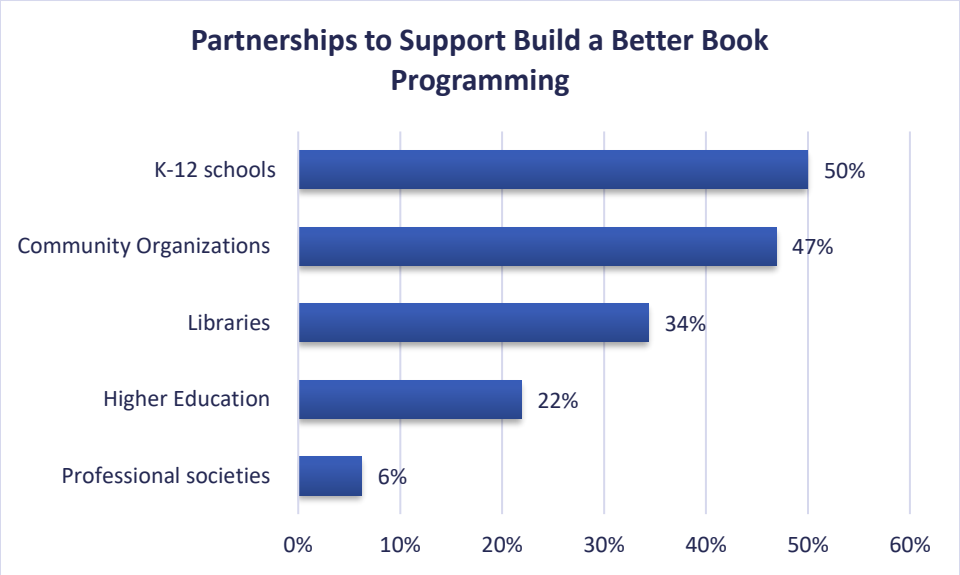
Partnerships

Partnerships are one way in which libraries and schools can support STEM programming and makerspaces because partners can provide the technical expertise and, possibly, materials and equipment or expertise on disabilities. In contrast to past years when up to 30% of workshop participants did not have partnerships, only two respondents in the 2019 cohort noted a lack of partnerships. On the other hand, some attendees wrote about partnerships in future tense which might imply that the partnerships do not currently exist but are in development. Nevertheless, nearly all attendees noted partners that they will collaborate with to develop or implement their Build a Better Book program.

Indeed, 70% of librarians/teachers reported on the survey that they had existing partnerships to facilitate STEM-oriented youth programming at their library or site. Partners included STEM or library professional societies, community members, non-profits, local government agencies, and K-12 districts or schools. These organizations provide programming, training, curriculum and materials, volunteers, instructors, or support for library-hosted STEM programs serving youth. Therefore, partnerships are an essential aspect in building the organizational capacity of libraries to provide and deliver STEM programs and activities for youth. The majority of librarians/teachers reported one or two partner organizations, although some reported multiple partners. Additionally, a full 30% of respondents noted that they had no partners to assist with STEM programming for youth, indicating a need for organizational partnerships to enhance the capacity of libraries to deliver STEM programming. The most common type of partnership was K-12 schools, although this usually referred to special schools serving the blind or visually impaired or school district special education offices. Community organizations were another common partner. Community organization partners were typically government or not-for-profit organizations

serving people with disabilities or people with visual impairments. Other community partners included arts centers and youth groups. Libraries were also common partners and most of the libraries listed were state libraries for the blind or local public libraries. There was little difference in partners between schools and libraries. Schools often chose to partner with other schools and external libraries and vice versa.

Figure 31. Partnerships to Support Build a Better Book Programming, survey responses



In follow-up interviews with facilitators at 11 expansion sites, 81% of programs had developed partnerships for the implementation of their program. Almost all of these partnerships served to facilitate the disabilities aspect of the program. Most facilitators, with the exception of a few special education teachers and others, felt least prepared and knowledgeable about disabilities. Partnerships with blind schools or special education offices helped to facilitate the focus on disability within the BBB program by bringing in expertise in that area. Several programs brought in blind community members to work with students and test prototypes. 100% of programs with partnerships found these partnerships to be highly beneficial in developing students' empathy and ability in universal design. The partnerships most often served three purposes: 1) To provide an audience for the products of the BBB program so that students could have a direct relationship with the population that they were designing for, 2) To test and provide feedback on students' prototypes or at other points during the design process and 3) To expose students to the visually impaired community so they will gain empathy and develop a better understanding of the lives of people with visual impairments. The students also learned more about universal design from their interactions with the visually impaired community, as described by a librarian:

> *So, I reached out to the school I had worked with and asked them, "Do you know anybody that would be good to come talk to these kids about what is their reading experience like*

for a blind person and help us." You can kind of talk about that element of the project, because I didn't feel like I had the experience to do a really good job of giving them that information or that perspective. So she came in for the first day with her dog and she talked to them about the importance of texture and how things feel on the page. And she showed them some braille and answered questions. She was there for the day that we were brainstorming and we decided to make an alphabet book and so we were trying to come up with ideas for what kind of things we should choose to represent each letter. So she could give kind of input on like "Oh, I don't know how you would differentiate this from something else." (Librarian)

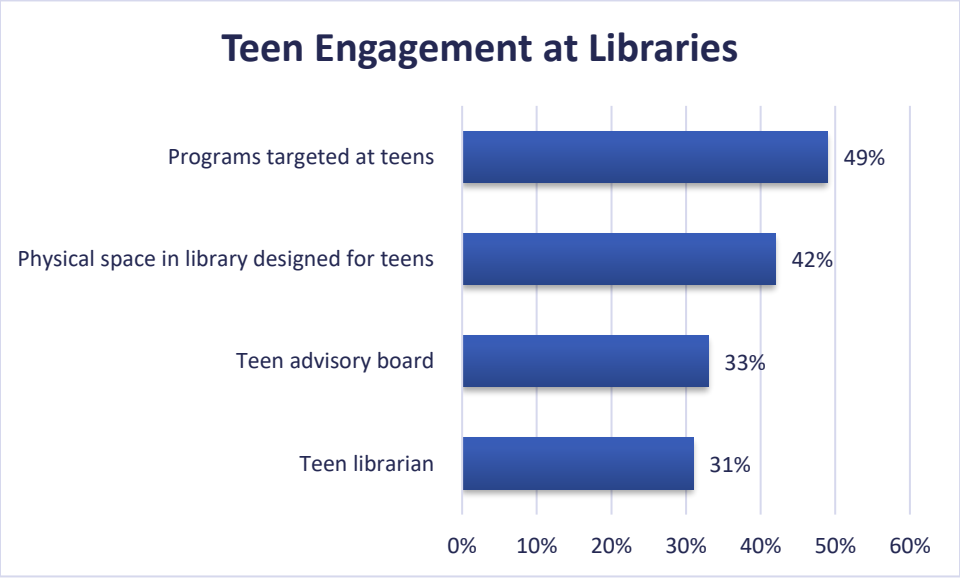
Librarians' and teachers' preferred programming formats

In prior years, librarians have tended to prefer one-time workshops, but the 2019 cohort appeared to be more committed to implementing the program at full-scale. In fact, 41% of librarians preferred multi-day workshops on weekday afternoons or evenings. An additional 24% preferred multi-week workshops on the weekend. The remainder preferred one-time workshops on weekdays. In contrast, almost all K-12 teachers and school librarians (85%) preferred multi-week or multi-day in-class activities. The remainder preferred after-school programs (only two teachers).

Teen Engagement at Libraries

Librarians in the 2019 cohort did not offer as many teen services as librarians in previous workshops. Nonetheless, nearly half of libraries offered programs specifically targeted towards teens. About the same number of libraries offered a physical space for teens within the library. A smaller number took guidance from a teen advisory board (33% in the 2019 cohort compared to 70% in previous cohorts).

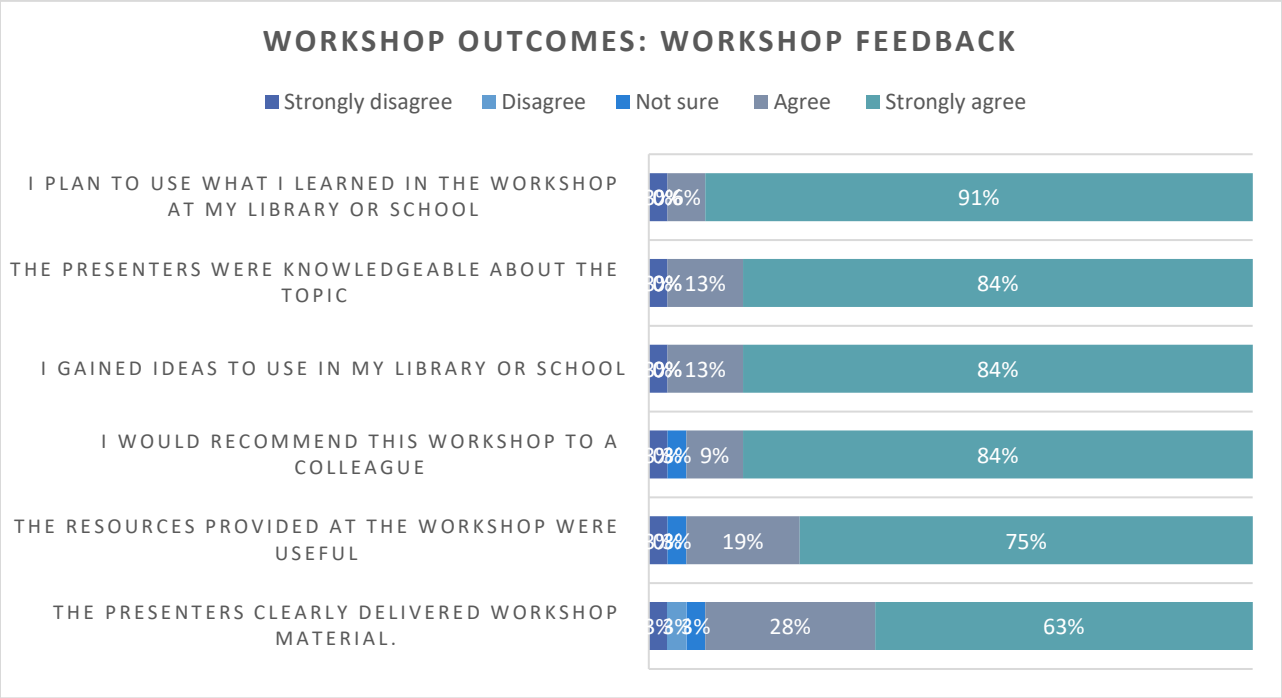
Figure 32. Teen Engagement at Libraries (Librarians Only)



Workshop feedback and BBB program uptake

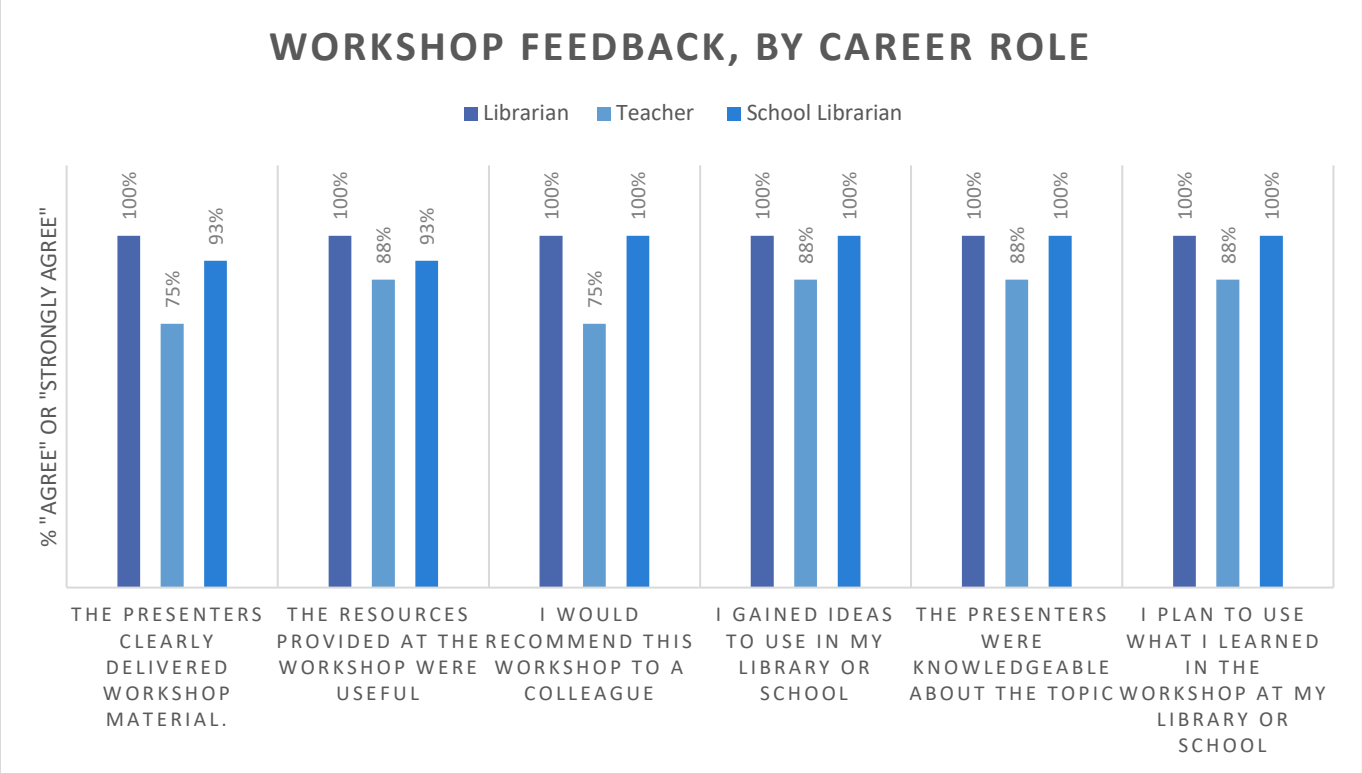
Similar to previous workshops, the 2019 cohort expressed a strong desire to implement the Build a Better Book program. In fact, 97% of participants planned to use what they learned from the workshop in their programming at their library or school. Overall, teachers and librarians found the workshop to be useful and informative, especially in increasing their awareness of and knowledge about disabilities. There was strong agreement (97%) that the presenters were knowledgeable about the topic and that participants gained ideas they would use in their library or school. The vast majority of participants also felt that they would use the resources provided to them at the workshop. Therefore, attendees found the workshop to be highly valuable and almost all would recommend it to a colleague who is interested in STEM programming or inclusive design.

Figure 33. Participants' Ratings of the Build a Better Book Workshop



Thus, there was strong consensus among attendees about the value of the workshop and the knowledge gained from it. Overall, librarians overwhelmingly reported that the workshop was valuable, and they gained knowledge and resources that they will use in their own work. School librarians also found immense value in the workshop, especially in the ideas and knowledge gained. K-12 teachers found the workshop to be highly valuable, but to a slightly lesser extent than librarians or school librarians. Because the program was originally conceived as a program to be hosted in libraries, a small cohort of the K-12 teacher participants may have had more difficulty in seeing the application for their classrooms.

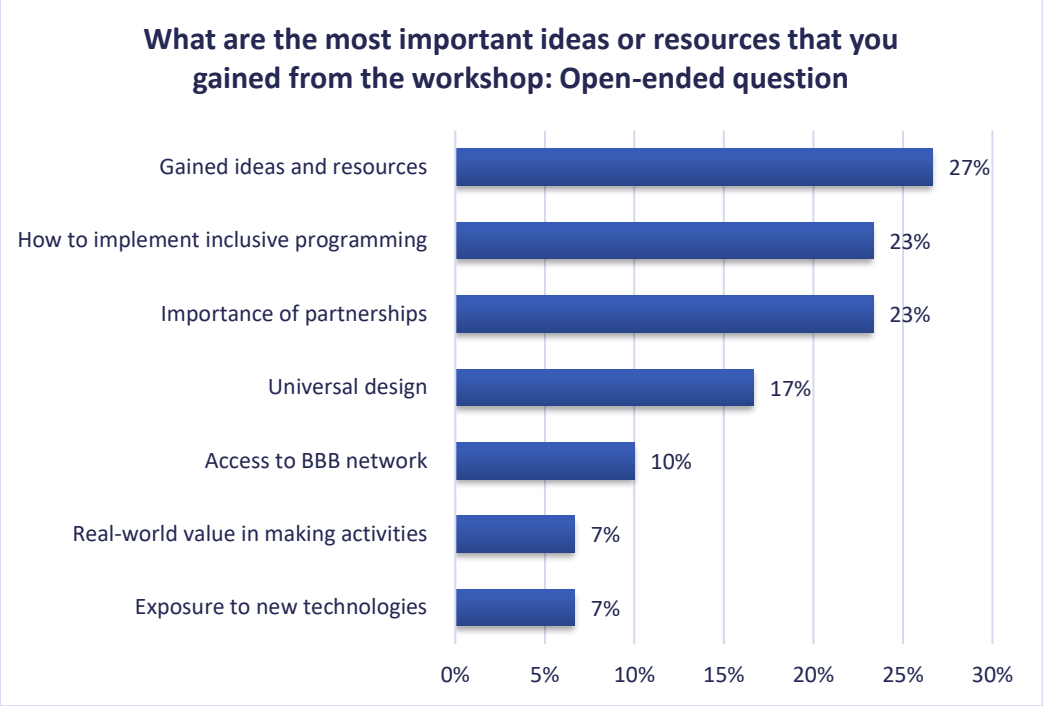
Figure 34. Workshop Feedback, By Career Role



Most important ideas and resources gained by participants from the workshop

Workshop attendees learned about inclusive design and how to implement inclusive, accessible programming for youth. In response to an open-ended question about ideas gained from the workshop, the largest number of participants wrote that they gained ideas about how to implement accessible programming and gained resources to do so. Some attendees learned about universal design and came away with a deeper understanding and appreciation of inclusive design. Some participants also gained an awareness of the importance of partnerships—especially with schools or libraries that serve the visually impaired—to the success of a program like Build a Better Book. In particular, the Build a Better Book program appealed to librarians because of the option to engage youth in tactile making through crafts and other low-tech options that may be more easily available to them than 3-d printers or laser cutters.

Figure 35. Participants' most important learning gains from the workshop



Typical responses were:

> *The BBB suitcase actually provides the materials that I was planning on purchasing for the beginning of my program. The most important idea was the foundations of program design to actually make it happen. I am much more familiar with the deaf community, so being introduced to things that are important and essential for the visually impaired community was very important. – K-12 teacher*

> *What came to the surface for me was the value of giving students an opportunity to create something with a purpose in the real world— often in PBL students (and teachers) struggle to find a problem that kids can actually tackle effectively. A lot of problems end up being staged (or faked) based on standards and content and those kind of problems have no true (in my opinion) validity. This is an opportunity to produce something of benefit to specific people in the local community- with a built-in network to share with a larger community via the Internet. I love that the point is to use technology as a tool while students are engaged in creation— not just to use technology. – K-12 teacher*

> *Swell machine - we were being asked to 3d print consumable worksheet items for next day… the swell machine will make this task astronomically easier. Most important idea…. I have always struggled with purpose, relevance, and rigor related to maker space. This workshop was my missing piece. – K-12 teacher*

I learned that you don't need a lot of high-tech equipment to create a lasting impression on a student. Sometimes you just need cotton balls and the space to create. I also learned to be more aware of how others learn in order to be more inclusive and minimize frustrations. – Librarian

I learned that making something look like an object does not mean it will help someone understand the object. Texture is important. – School librarian

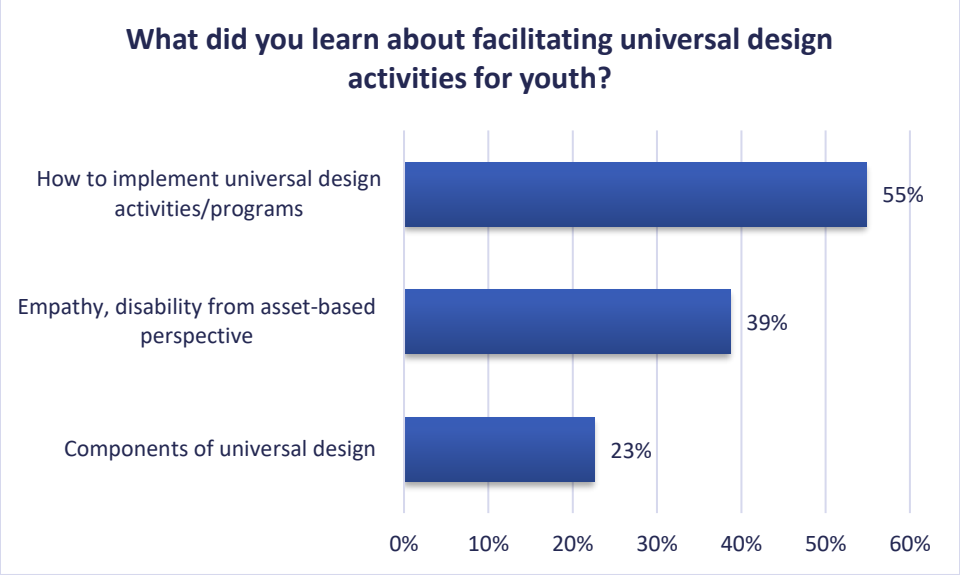
The tips from the presenters who have done this with students already and all of the connections of people in the growing BBB family! – School librarian

The idea of using craft materials and low tech to create accessible books was my biggest take away. It makes the project very doable with my young students. I will be partnering with a local school for blind and vision impaired children, and I learned how critical it will be to invite them in as mentors throughout our work. – School librarian

Participants' learning about universal design

Workshop attendees gained a better understanding of how to implement universal design activities for youth, especially the importance of enlisting community partners and the process of engaging youth in design activities. A significant share of participants gained empathy for people with differing abilities and realized the importance of empathy as a learning goal in the Build a Better Book program. Many of these comments focused on their shift to viewing disability from an asset-based perspective, rather than a deficit-based perspective. Finally, nearly a quarter of participants wrote about learning about the components of universal design, such as the realization that how something feels is more important than how it looks.

Figure 36.Participants' learning about universal design from workshop



Typical comments were:

I learned how to look at things from the perspective of someone who is disabled instead of trying to have a disabled person meet my perspective.

That it is very important to not just jump into the project/tech - otherwise the focus will easily become creating something 'cool' for the maker— introduce the empathy activities first and focus the students on a real person (if possible) or population for whom the product is being created so that students will view what they are building through that filter. They need to try and think or 'see' things from a perspective different from what they are familiar with.

I learned how to set the stage for empathy, how to have conversations about design needs, how to scaffold a design project, and how to integrate different tools to support multi-modal learning. Empathy must be established so the students will see relevance in designing. You do not have to have a lot of money to facilitate workshops. Include VI students and their families through face to face conversation or videos online to truly understand their needs and wishes. What good is it to design something that will never be used. Celebrate and encourage interaction with designs for all users, not just VI. Thinking about how tactile resources can assist ELL students was eye opening.

To have a purpose with a makerspace activity instead of just an open-ended tinkering session

That the work is as much about process as product.

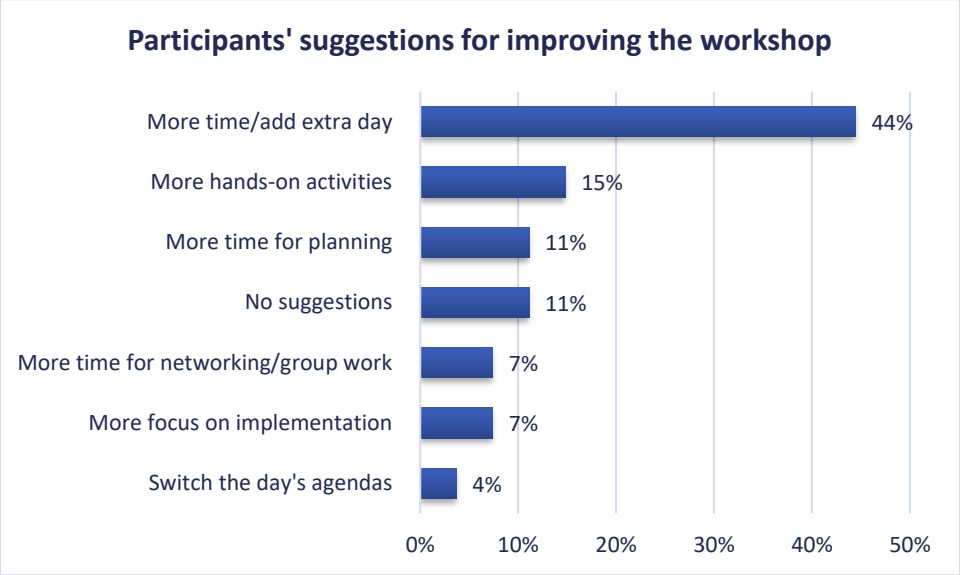
It's not about technology as much as it is about making materials accessible to those who authentic representation of things tactically is more important than visual appearance. Less is more on a page. Pick one thing to highlight. Crafts can work as well if not better than electronics. More Braille books are needed.

The progression of activities modeled for facilitating projects was what I needed to implement this, along with the underlying principles of accessibility and design.

Participants' suggestions for improving the workshop

Workshop attendees had a few suggestions for improving the workshop. The majority of participants wanted the workshop to be longer because it was a lot of material to absorb in two days. Nearly half of attendees requested more time for the workshop. Some participants suggested adding an extra day, while others suggested adding a few hours in the afternoon or evening prior to the workshop or extending the workshop days. Some participants also requested more hands-on time to practice technologies or BBB activities. A few participants wanted more time for planning or more advice about implementing the BBB program. One participant suggested that it could be helpful to switch the day's agendas and cover the second day's activities on the first day as they offered more of an introduction to the program.

Figure 37. Participants' suggestions for improving the workshop (n=27)



Typical comments were:

The tour to sparkfun was really cool, but I would have rather had more time doing hands on activities that we can implement at school, and talking about ways to incorporate our ideas.

I think it would've been cool to learn more from previous schools with how they structured their programs. Also more about book binding and using 3Doodler pens.

The workshop was well managed and the leaders were knowledgeable and flexible. More time would be awesome, but maybe not practical for the participants or leaders. It is intense, and maybe that is the way it should remain.

There was so much, having a third day would have allowed for more in-depth knowledge during the breakout sessions.

It might need to be longer since we were rushing most of the time and we had a lot to do. I wouldn't want to cut anything out because it was so good and fun!!

More time. Seriously though, it was life changing!

Workshop was incredible. The pace was incredibly fast. The only thing I might suggest is more time for cross collaboration.

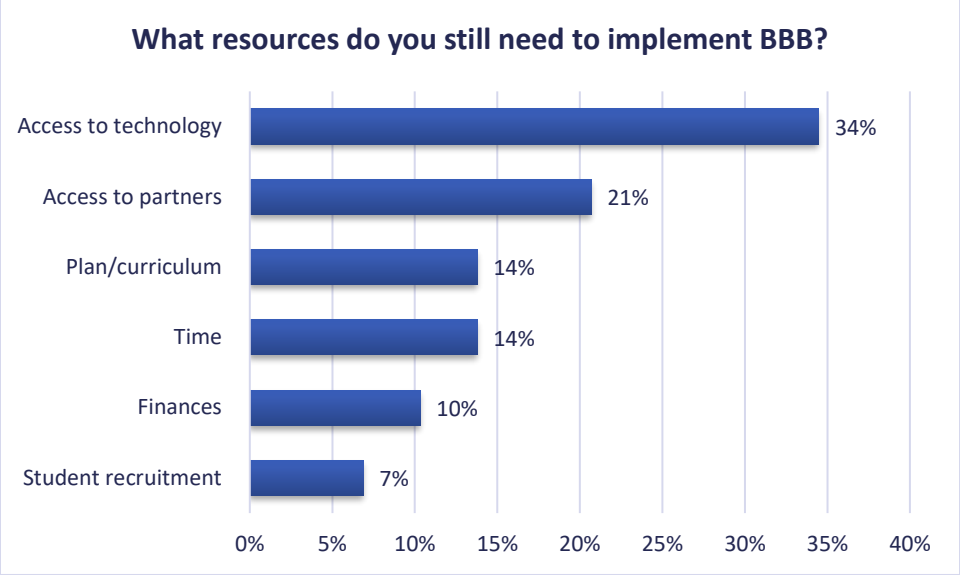
Everything has been great! I feel the panel went a little too long, and I would have liked more time to work on our plan, while the experts were available for feedback.

It was really good. One of the best workshops/conferences attended. Day 2 really calmed me, because I felt like we learned a lot about what we could do without access to a lot of technology and smaller spaces. As well, I liked seeing everything on Day 1, because it showed what libraries with bigger budgets are able to accomplish and how they took the BBB project to the next level. It was also really cool to get experience with technology we don't have access to at the moment.

Resources to implement Build a Better Book

Technology was the most frequently cited resource that participants needed to implement the Build a Better Book program. About a third of workshop participants would like greater access to technology, such as 3-d printers or laser cutters to implement the program. Librarians and school personnel were equally likely to cite a lack of technology as an obstacle to implementation. Some participants noted a lack of partners or mentors to help facilitate the program. For the most part, school personnel were more likely to cite a lack of partners, although one librarian mentioned a lack of partnerships with schools as a challenge to implementation. Some participants also commented on a lack of a plan or formal curriculum as an obstacle to implementation—these were all school personnel. Likewise, all the attendees who commented on a lack of funding to implement were also school personnel. A few librarians commented that student recruitment might be a challenge. Librarians and school personnel were equally likely to report that a lack of time was an obstacle to implementing Build a Better Book.

Figure 38. What resources do you still need to implement BBB?



Conclusion

In the third year of implementation, the Build a Better Book increased its reach and expanded to over a dozen new sites. These sites implemented the program in a variety of ways: In-school programs integrated BBB into existing academic curriculum, in-school enrichment or elective programs, out-of-school programs in libraries or makerspaces, and a museum internship. All of the programs were extended in duration and ranged from a minimum of eight contact hours to a maximum of 40 hours of contact time. Programs also ranged from a condensed, one-week summer camp model to an extended afterschool or in-school offering that ranged over a period of 10 to 12 weeks. Thus, there was a wide variety of implementation models and contexts.

The BBB continued to provide an extended, authentic making experience for students, including expansion sites. The BBB program in observed programs and through the observations of facilitators of expansion programs provided extensive student choice, engaged students in the design process, used a variety of tools and resources, and allowed for creativity and problem-solving. The observed programs achieved the highest marks on the observation rubric for attention to audience, use of out-of-school tools, and engagement in project-based learning. As seen in previous years, the program also scored very highly on teacher-student interactions as teachers built strong rapport with students and gently guided and supported them on their projects. Likewise, interviews with expansion site facilitators also affirmed that those sites valued student choice and design, attention to audience, inclusion of all learners, and student engagement in the design process. Sites used varying degrees of technology with a few that used little to no technology and a few that used high levels of technology, including sound, 3-d printing and modeling, lasercutting and other techniques.

One of the strongest outcomes of the BBB program was high levels of student engagement in their projects and in the design process. Observed programs achieved the highest rating on the observation rubric for student engagement ("appears interesting to students") and expansion site facilitators all described very strong student engagement. Students immersed themselves in their projects and took great care in designing books and games that would work well for their intended audience of youth with visual impairments. Students were motivated by the altruistic and "real-world" aspects of the program. Therefore, some of the hallmarks of the BBB program—attention to audience, immersion in a creative design process, authentic making experiences, and strong student engagement—appear to transfer well to expansion sites.

Similar to previous years, one of the most powerful outcomes from the program was students' enhanced understanding of universal design and their development of empathy and understanding of the experiences of people with blindness or visual impairment. Many students were not well-informed about disabilities and had nearly no knowledge of universal design prior to the program. Students came to a better understanding of the importance of inclusion for people with disabilities and how to adapt or modify everyday objects to be more accessible. Students developed empathy through accessibility activities at the beginning of the program and from their deep engagement with the universal design process during the program. This outcome also appeared to transfer to expansion sites as it was one of the most important outcomes highlighted in students' survey responses and in interviews with facilitators of expansion site programs. Facilitators at expansion sites also observed that partnerships and interactions with visually impaired community members helped to foster empathy and understanding of universal design in students.

Librarians and teachers benefited from the training and support provided by the Build a Better Book team. Facilitators strengthened their understanding of disability and increased their empathy and awareness related to the experiences of the visually impaired community. Expansion site facilitators were highly enthusiastic about the program and many of the core elements of the program seemed to transfer well to expanded sites. While all workshop participants had prior experience with youth education and makerspaces, the integration of disability and inclusion with makerspace experiences was new to some of them. Nonetheless, all facilitator interviewees from expansion sites had adopted and implemented the mission of the program. Facilitators expressed strong satisfaction with the level of support provided by the BBB team during their implementation. For those actively involved in the national network, peers from the training served as a wealth of resources and ideas. In conclusion, in the third year of the grant, the BBB program expanded quite substantially, and the new sites appeared to adopt the mission and activities of the program, yielding strong student engagement in universal design and increased empathy and understanding of disabilities.