National Federation of the Blind

SABER: NFB EQ Program—Year One

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Introduction

The National Federation of the Blind (NFB), in partnership with scholars from Utah State University and educators from the Science Museum of Minnesota (SMM), has developed the Spatial Ability and Blind Engineering Research (SABER) project to assess and improve the spatial ability of blind teens in order to broaden the participation of blind students in STEM fields. The goals of the project include:

1. Contribute to the knowledge base of effective practices regarding informal STEM education for the blind, particularly relating to the development of spatial reasoning abilities.
2. Educate families, blind youth, and museum personnel about the techniques, tools, and instructional practices rooted in problem solving that are used to effectively develop spatial ability skills in blind youth in informal STEM settings.
3. Incorporate promising techniques, tools, and instructional practices from the developed interventions into ongoing programming for both blind and sighted learners.

Activities began this summer (2018) with a week-long, residential engineering design program for thirty blind high school students at NFB headquarters in Baltimore. The evaluation focused on perceptions of process and measures of efficacy around the key themes. The evaluation questions that guided the NFB EQ program evaluation were:

1. How does this program contribute to the participant's development of spatial reasoning abilities?
2. How do these factors influence a participant's interest in STEM?
3. What is the participant's intention to pursue STEM study and career?
4. How does this program contribute to the participant's interest and intention toward STEM?

COSI's Lifelong Learning Group conducted an evaluation of this program and prepared this report.

Methods

Researchers collected data for this program evaluation from teen participants using three different methods:

1. Passive observations throughout the program; comparing these notes with the goals of the program.
2. Brief open-ended, semi-structured interviews conducted with participants pre- and post - program.
3. A web-based questionnaire following the program.

The interview and questionnaire focused on the teens' interest in STEM, future career intentions, and the impact of the NFB EQ program. Appendix A contains the instruments used in this study.

Data were analyzed collectively. During analysis, categories of participant responses about their knowledge were developed inductively through the coding process (i.e., they emerged from the data itself rather than being prescribed). Quantitative data were analyzed using Excel and the Statistical Package for the Social Sciences (SPSS); descriptive statistics were used to present overall patterns in the data.

The Program

The NFB EQ program involved teens in an intense STEM-based program where each individual designed and created a model of their personal retreat. Teens developed a portfolio that included graphic artifacts (front elevation, side elevation, structural column plan), narrative artifacts (inspiration, parts list, self-reflection), algorithmic artifacts (force propagation calculations, truss analysis), and a scale model of their personal retreat.

This program was primarily composed of two types of sessions:

1. Learning sessions involved the content expert facilitating experiences to provide all participants with a baseline knowledge of the concept, including engineering concepts, physics, math, and technical drawing.
2. Building sessions, where content experts supported teens as they constructed and refined elements of their portfolio, including drawing elevations, constructing their wood model, and working through the math used to justify the slope of the roof.

While limited in number, a third type of session involved blind engineers sharing their successes and challenges of navigating various engineering fields. These sessions, an essential element of NFB programs, foster the Community of Practice among blind STEM professionals and youth interested in pursuing STEM careers.

This program contributed to the teen's development of spatial learning, which will be studied as part of a larger research project, through technical drawing experiences that included isometric and scale drawing. Additionally, this program supported the iterative engineering design process, through trial and error, and through critical feedback from instructors. On the last day of the program, teens shared their work and what they learned throughout the week with each other and invited guests in a Student Showcase.

Findings

The Participants

There were 30 blind teens (grades 9 – 12) in the NFB EQ program during the summer of 2018. Additionally, seven blind adults served as group leaders, and four adult content experts led the various learning experiences. Teen participants were a diverse group of race and ethnic backgrounds from 19 different states. Half of the teens self-reported they were female, 14 reported they were male, and one reported as non-binary. The majority of teens were in the eleventh grade, see Table 1 for a complete breakdown of student grades during the prior school year.

Table 1. Teen participants grade during the previous school year

Grade Previous School Year	Frequency
9	2
10	9
11	12
12	7
Total	30

Half of the participants identified their race/ethnicity as white (see Table 2), 6 teens reported they were of Hispanic origin. Parents granted permission for all teens to participate in the evaluation.

Table 2. Race/ethnicity of teen participants

Race/Ethnicity	Frequency
White	15
Asian	5
Black or African American	3
Pacific Islander	1
White and Other	1
Black or African American, White, and Other	1
Other	3
Prefer not to answer	1

N=30

All teens were interviewed pre/post program and 28 of the 29 teens (97%) completed a post-experience web-based questionnaire, although not all participants answered every question. Researchers analyzed data based on the number of respondents, and therefore the number of respondents for an individual question may vary. The 28 teens who completed the web-based survey shared additional information about their "blind identity" and tools they use to access written materials and computers.

The majority of teen participants (80% or 20 of 25 teens) shared they were blind since birth. Half of the teens (14 of 28) who completed the web-based survey identified as visually impaired, eleven identified as blind (39%), and three identified as low vision (11%). Cane use varied among participants, 7 used it all of the time and 7 never used it. See Table 3 for a complete breakdown of teen's use of canes. The majority of participants (18 of 26) indicated they know Braille.

Table 3. Participant cane use

	Frequency
Always	7
Most of the Time	9
About half of the time	3
Sometimes (i.e., at night, in unfamiliar environments)	1
Never	7

N=27

Teen participants used a variety of mediums to access written material; including accessible electronic documents (79% or 22 of 28), audio (57% or 16 of 28), Braille (50% or 14 of 28), and large print (46% or 13 of 28). When accessing a computer, these teens use screen readers (61% or 17 of 28), Braille display (46% or 13 of 28) and screen magnification (43% or 12 of 28). In math and science class teens prefer to access diagrams, tables, and figures using large print/high contrast graphics (11 number one rankings , reverse-rank total 74) or dual media graphics (7 number one rankings, reverse-rank total 74). Few (19% or 5 of 26) use a slate and stylus. See Appendix B for all data tables.

Participant interest and opportunity to engage in STEM

The majority of teens attended the NFB EQ program because they were interested in STEM. In pre-program interviews, 72% (21 of 29) of the teens indicated they were interested in STEM. Additionally, two teens shared they wanted to have this STEM experience due to limited access within their current school situation. Throughout the interview, teens expressed an interest in STEM for reasons including a desire to develop technology to support the blind and a desire to solve problems. These teens talked about the engineering classes they are taking at school including robotics, mechanical engineering, and computer programming.

Many interviewees shared they did something afterschool with technology, either on their own or in an organized school-sanctioned club like Science Olympiad or Engineering Club. Several students mentioned they liked to tinker or build things, one helped his grandfather build a garage and another helped her uncle who ran an auto repair shop. Teens also shared they participated in organized sports and music, both of which have components that link to STEM.

In the post-program questionnaire, teens indicated they looked forward to science class in school (x=3.893 on a 5-point scale). They would rather solve a problem in science class by doing an experiment (x-4.259) and felt more time should be spent on hands-on projects in science class (x=4.731). They disagreed with the statement Science is a difficult subject (x=2.000).

While they have positive feelings toward STEM, these teens indicated their experience in science class included limited hands-on experiences. Teens were unlikely to design and build something (x=2.741) or draw something to better understand a concept (x=2.741). Additionally, this data indicates teens had limited opportunity to participate in STEM-related play as a child, represented by means of 3.2 or lower on a 5 point scale where 1 represents Never and 5 represents Always. See Table 4. The relatively high standard deviation indicated the data could be bi-modal, with equal distribution on both ends of the scale. This was ultimately the case with the statements "Play with blocks" and "Doodle," where relatively equal amounts of teens selected responses above and below the midpoint.

Table 4. Frequency of STEM-related play as a child

	Mean	Std. Dev.
Play with blocks, legos, or other building toys/kits	3.214	1.343
Construct models	2.538	1.272
Build puzzles	2.500	1.304
Play with radio controlled toys	2.615	1.416
3-D Video Games	2.400	1.708
Doodle or draw	3.200	1.528

N varies from 27 - 28

Teens also reported limited experience with engineering-type activities prior to the workshop. Participants had little experience with drafting and woodworking prior to the workshop, as evidenced by mean ratings of 2.269 or lower on a 5-point scale where 1 represents No Experience and 5 represents A Great Deal of Experience. See data tables in Appendix B.

NFB EQ's contribution to the participant's interest and intention to pursue a STEM career

Data supports that this experience contributes to teen's interest and intention to pursue a STEM career. The NFB EQ program "boosted" teen's confidence to pursue their goals; solidified the goals they had prior to the program, or provided insight into additional STEM-related careers or by helping them understand the expectations.

The questionnaire revealed that participants believed the NFB EQ program helped them understand engineering better, as evidenced by a mean rating of 3.929 on a 5-point scale where 1 represents Strongly Disagree and 5 represents Strongly Agree. These teens also felt increased confidence in their abilities to participate in engineering activities post-program and a better understanding of their career goals. See data tables in Appendix B. Teens interviewed were asked how the NFB EQ program impacted their interest in engineering. Themes that emerged include:

- Enhanced interest in engineering as a career, potentially clarifying the type of engineering the teen might pursue.
- Introduction and experience working with construction and drawing tools, including the blackboards, saws, and hot glue guns

Engineering as a career

The quantitative data illustrates the program had a limited effect on increasing participant's interest in studying science and engineering, as evidenced by a mean rating of 3.115 on a 5-point scale were 1 represents Strongly Disagree and 5 represents Strongly Agree. Additionally the qualitative data indicates two of 29 teens' became interested in a STEM career as a result of this program. However, about half (14 of 29 interviewed, 14 of 24 who completed the questionnaire) of the teens entered the workshop with a desire to pursue careers in STEM, ranging from oncology to robotics. Those who were not interested in pursuing a STEM career had definite career goals, predominantly in the helping professions, i.e., teaching, ministry, and therapy. Teens not planning a career in STEM felt the drawing and building could provide additional creative outlets and they believed the tools they used, i.e., blackboards, Braille rulers, would be great tools to use in the future.

Although several teens were already interested in engineering, one teen shared the NFB EQ program "definitely boosted" their interest in engineering as a career. A teen who "hadn't had experience, or expertise, to think about engineering" prior to the program, indicated they had "more knowledge about engineering" during the post-program interview. A teen that didn't know much about architecture pre-program, stated post-program that "architecture seems like a viable option." Another interviewee shared they "might take some [STEM] classes, didn't think it was an option" before the NFB EQ program.

The NFB EQ program also helped teens understand the job expectations that would be required of them if they pursued an engineering career. One teen shared they had "more respect for civil engineers [and all they] have to calculate for structures before building." Several teens indicated they appreciated hearing from the blind engineers, especially the specifics about how they were able to function in this role in a sighted world, i.e., the architect who explained he used wikisticks to share his idea with sighted colleagues. Finally, the NFB EQ program helped at least one teen realize

engineering and/or architecture was not necessarily for them, stating that the NFB EQ "confirmed suspicions that I prefer computer over [structural] engineering."

STEM and 21st Century Skills

Participants enhanced STEM and 21st Century skills in the NFB EQ program. STEM skills include ways of thinking about and interacting with phenomena that can lead to an understanding of STEM ideas and concepts.[1] These skills include observing, questioning, planning and investigating. In addition to STEM skills, research suggests teens need 21st century skills in order to be successful in STEM careers. These skills include adaptability, complex communication, and self-management.[2]

As teens came to the program with a variety of knowledge, the gains varied. One teen learned that inch does not equal a centimeter while others shared about the formulas they used to calculate the weight of the load on a roof in order to ensure the building they constructed could withstand the weight of snow. A participant shared, they will "never look at building without thinking about supports and weight on roof."

Four 21st Century skills recognized by the National Education Association are critical thinking, communication, collaboration, and creativity. Researchers observed teens using these skills as they drew and built their personal retreat. One teen shared how they had to think critically when they "had to take 2 pieces of wood and stick them together." Another stated the NFB EQ engaged them in "problem solving--think through--how thick is the wood--how are you using it building?"

Researchers observed teens developing communication skills throughout the NFB EQ. Teens talked to each other one-on-one and in small groups. They listened to instructors as they explained physics and math concepts, those that understood the concept explained it to others, those that were unclear asked clarifying questions.

Observers witnessed teens collaborating with each other as they reviewed concepts introduced by instructors during learning sessions and helped each other build their personal retreat. One teen interviewed said they were "better at working with people" after the NFB EQ program, another said, "team work- connecting ideas" was necessary to create and build a building. This program helped one teen develop their collaboration skills, they were better able to "understand [other participant's] strengths and ask for help from instructors."

Woven throughout the fabric of the NFB EQ program was creativity. A favorite after-dinner activity was building with cardboard. The final project, the construction of the personal retreat, provided teens an opportunity to be completely creative.

STEM-Related classes

[1] Definition of STEM skills adapted from the Exploratorium's Professional Development Curriculum from the Institute for Inquiry® Available at www.exploratorium.edu/sites/default/files/pdfs/ifi/Process_Skills.pdf

[2] Definition of 21st century skills adapted from National Research Council. (2010). Exploring the Intersection of Science Education and 21st Century Skills: A Workshop Summary. Margaret Hilton, Rapporteur. Board on Science Education, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. Available at www.nap.edu/

The workshop also did not appear to have an impact on teen's class selection. Respondents indicated in the post-program questionnaire they were not likely to think about different classes they might take in school, as evidenced by a mean rating of 2.815 on a 5-point scale where 1 represents strongly disagree and 5 represents strongly agree. See data tables in Appendix B. This may be due to the number of classes participants had already taken in high school, including biology, geometry, and Algebra I. Participants were less likely to have completed higher-level math (Pre-Calculus, Calculus), specialized science (Anatomy), or vocational arts classes, possibly due to their grade level or school offerings. See Table 5 for a complete listing of classes taken by participants.

Table 5. STEM classes taken by participants

Class	Frequency
Biology	25
Geometry	24
Algebra I	24
Pre-Algebra	23
Algebra II	19
Chemistry	16
Geography	15
Trigonometry	12
Pre-Calculus	7
Physics	5
AP Physics	4
Computer Aided Design/ Drafting/Solid Modeling	4
Vocational Arts (Welding, woodworking, sewing, etc.)	2
Calculus	1
Anatomy	1

N= 28

Half of the teens interviewed (15 of 29) said the NFB EQ program would not influence their high school course selection. Reasons for this include taking their school's prescribed course, or that they were already taking engineering classes. One said, "No room for courses, already planned out." Only three of the 29 teens interviewed indicated this experience would impact their course selection. One said the NFB EQ program will "push me into engineering class. Put [structural] engineering on the front burner."

Construction Tools

The challenge to design and build something was the highlight for the majority of teens interviewed. Researchers observed all teens in this program using tools to build their personal retreat. While the majority of these tools were common tools available at hardware stores, these teens had not had the opportunity to use them before the workshop. Several teens shared "experiencing new tools" was their favorite part of the NFB EQ program.

The development of measuring skills are fundamental to engineering, yet independently measuring anything can be challenging for blind youth when they do not have access to accessible measuring tools. Teens interviewed felt this program provided them with the materials they needed to be independent, including tactile graphs and images, Braille caliper, Sensational Blackboard, etc.

Through building teens gained knowledge of science, math, and engineering. One teen said you "have to calculate everything for structures before building," another said they "know a lot more about basic concepts" because they constructed their personal retreat.

Drawing

The NFB EQ program provided teens the opportunity to develop technical drawing skills so they could develop a plan for their personal retreat. One interviewee shared their favorite part of the NFB EQ was learning how to draw, they "hadn't been exposed to drawing but wanted to try." Another shared that "drawing isometric [and] interpreting drawings . . . were all new." In addition to learning how to draw, teens developed an understanding of the importance of drawing in the engineering process. One teen shared they needed to "pay attention to the drawings" and another stated, they were "better at spatial ability, taking things . . . putting them on paper."

Non-STEM Related Benefits to Participants

As with prior NFB teen programs, this evaluation found that participants interviewed went beyond STEM skills in describing the benefits of the NFB EQ program. Larger themes identified during interviews included:

- Opportunities for teens to network with like-minded peers
- Increased self-confidence
- Increased independence

This program fosters a Community of Practice by providing teens an opportunity to network with like-minded peers. One teen stated they valued "meeting other people like me, blind, who like to learn," another indicated by getting to know students/instructors--you [realize you] are not alone." One interviewee shared the NFB EQ program created an "incredible sense of camaraderie. We all have similarities. We are all of the same mind and can talk to each other with understanding."

Teens cited the challenge provided by the program "boost[ed] confidence." Another stated, "Disability does not stop you. Engineering isn't the easiest career, but you can do it." One appreciated that program leaders "expect us to be on time, [and we] do what we need to do." Teens valued the opportunities this program gave them to be independent, including traveling to Baltimore and going out to dinner. One teen talked about how the program encouraged participants to navigate on their own which increased their independence. Another participant shared they appreciated there is "NO mention of blindness, [staff] expect you to do things." This is different from school, which "puts blindness into everything."

The NFB EQ Program

Participants Appreciated

Teens interviewed indicated their favorite parts of the workshop were building and designing their personal retreat. One teen shared they liked the building part-because they could physically touch

it and make adjustments as needed. Several pointed out that this is a rare opportunity; one stated, "[I] don't get this opportunity often." They also enjoyed working with tools, including the drafting blackboards, saws, and glue guns. Teens indicated that NFB EQ "teachers know how to teach us" all teachers "were verbally describing lessons." Another teen shared that the NFB EQ instructors "did their research to learn how to accommodate their audience." Teens appreciated the hands-on opportunities, which they do not get in school. In addition to an interest in STEM, teens shared other aspects of the program they appreciated were opportunities to travel and be with other blind teens.

Feedback for Further Improvemen

As this was the first NFB EQ program in this series, participants were asked post-program, "if you were in charge, how would you change this workshop?" The following themes emerged for your consideration:

- Time and appropriate learning structure
- Outside time
- Highlight various types of engineering in future programming
- Small groups for learning

Some teens felt they needed "more time or less tasks to make things less confusing. There was a whole lot going on this week." One would like to suggest the following learn/work method, "Instead of a learn everything and then build everything program, I would change it so that you learn something and then you work on the part of your project that has to do with what you just learned. For example when we learned about rafters, after that we should built our roof." Finally, one participant wrote in the post-program questionnaire, "The only thing that I would change would be to provide more time to be taught and to work. I would like it to be two weeks instead of one, in order to focus one week on the concepts, and another on the design and construction of the actual project, with ample time left for other group activities."

While one participant wanted to spend less time outside due to his/her albinism, others wanted to be outside more. Two teens suggested incorporating the outdoors in learning, possibly learning math in the park (diameter of trees, length of the bench, etc.). Others wanted to balance more recreation time, including exercise, with learning time. While outside, one suggested doing exercise because "I think we spent long periods of time each day just sitting."

A few teens were disappointed that the program focused on structural engineering and architecture. They would like "an engineering program that had influences from all seven recognized engineering disciplines." The final suggestion deals with group size. One student stated, "I would schedule in groups of 4 students to learn the math concepts and go step-by-step to make sure everyone understands what's happening."

Conclusions and Recommendations

Researchers used the following questions to guide this evaluation:

- *How does this program contribute to the participant's development of spatial reasoning abilities?*
- *How do these factors influence a participant's interest in STEM?*
- *What is the participant's intention to pursue STEM study and career?*
- *How does this program contribute to the participant's interest and intention toward STEM?*

How does this program contribute to the participant's development of spatial reasoning abilities?

As this was part of a larger research question, this evaluation question will be answered in consultation with the research team in a future report.

How do these factors influence a participant's interest in STEM?

The NFB EQ program supported participant's interest in STEM. The majority of teens attended the NFB EQ program because they were interested in STEM. Additionally, teens not interested in STEM shared they wanted to have this experience due to limited access to STEM within their current school situation. Teens expressed an interest in STEM for several reasons including a desire to develop technology to support the blind and a desire to solve problems. Participants interested in STEM had taken classes in school to support their STEM interests, including robotics, mechanical engineering, and computer programming.

What is the participant's intention to pursue STEM study and career?

While the data suggests the program had a limited effect on increasing participant's interest in studying STEM; this is most likely due to the number of participants (50%) that entered the workshop with a desire to pursue careers in STEM, ranging from oncology to robotics. Those who were not interested in a STEM career had definite career goals. Teens not planning a career in STEM felt the drawing and building could support their creative outlets and they believed the tools they used, i.e., blackboards, Braille rulers, would be helpful tools to use in the future.

How does this program contribute to the participant's interest and intention toward STEM?

This program contributed to participant's interest and intention toward STEM. Teens who arrived with limited engineering experience left with "more knowledge about engineering." The program supported and/or increased the interest of those who were already interested in engineering. Participants left the NFB EQ program believing that architecture and engineering were options they could pursue.

Appendix A: Instruments

NFB EQ Pre- Interview

Hi,

My name is _____ and I'm an evaluator for the NFB EQ program. To help the organizers of this program better understand your experience with the program, I'd like to talk to you for about 10 minutes. Your participation is voluntary and your responses are completely confidential. You can stop at any time. Do you have some time to answer questions?

1. Do you know your ID number for this program?
2. Were always curious, what made you want to sign up for this program?
3. What do you think will be the highlight of your week here?
4. Do you participate in any STEM based extracurricular activities, either through your school, scouts, etc.? If so, what are they? How did you get involved in them? (examples include First Robotics, JETS, Future City, Lego engineering, Botball, etc)
5. When you are 30 years old, what job would you like to be doing? How do you think this workshop might help you?
6. Do you have a role model, someone that you admire or someone that has encouraged you to pursue that career?
7. What do you know about spatial ability? (ask if they give answer--How do you think it might be important for you? How do you think it might be important for an engineer?)
8. Some of the things you are going to be doing in this program are what college students studying engineering do. It might be frustrating. How do you deal with frustration?

Thanks for talking with me. I hope you have a great time this week.

NFB EQ Post- Interview

Hi,

It's _____ again, and I'm still evaluating the NFB EQ program. Again, I'm working with the organizers of this program to better understand your experience with the program, I'd like to talk to you for about 15 minutes. Your participation is voluntary and your responses are completely confidential. You can stop at any time. Do you have some time to answer questions?

1. Do you know your ID number for this program?
2. What has been your favorite part of the week so far? Why?
3. How has the NFB EQ program impacted your interest in engineering?
4. How will this impact the courses you take at school?
5. When you are 30 years old, what job would you like to be doing? Why?
6. Did this workshop have any impact on what you plan to do when you are 30 years old?
7. Tell me about any skills or ways of thinking you acquired and/or enhanced during this program? (measuring, critical thinking, data collection or analysis, etc.) What are your big takeaways from this week?
8. What do you know about spatial ability? (ask if they give answer--How do you think it might be important for you? How do you think it might be important for an engineer?) Have you had any experiences that you believe improved your spatial ability before this workshop?
9. What did you think of the products you produced this week? How, if any, did these products help you develop your spatial reasoning abilities? Did they help you understand math and/or science?
10. Just one more question, if you were in charge, how would you change this workshop?

Thanks for talking with me. Have a great rest of your day.

NFB EQ Questionnaire

Track Student ID Number

NFB EQ Teen Survey

To help the organizers of the NFB EQ program better understand your experience, please take 10 minutes to answer the following questions. You may decide to quit or skip any questions that you don't feel comfortable answering. This is not graded. There are no right answers.

This set of statements was designed to help us what you did in your free time when you were growing up. Tell us what you think about these statements by selecting the number that indicates how much time you did these activities. Enter a 1 if you never did them, 2 if you did them less than half of your free time, 3 if you did these things about half of the time, 4 if you did them more than half of the time and 5 if you always did them in your free time.

1. In your free time as you were growing up, how often did you . . .

	1 Never	2	3 About Half of the time	4	5 Always
Play with blocks, legos					
Construct models					
Build puzzles					
Play with radio controlled toys					
3-D Video Games					
Doodle or draw					

This set of questions focuses on experiences you might have with engineering-type activities. Tell us what you think about these statements by selecting the number that indicates how much experience you have with these activities. Enter a 1 if you have no experience, 2 if you have a little bit of experience with them, 3 if you have some experience, 4 if you have a lot of experience and 5 if you believe you have a great deal of experience with these activities.

2. Before this workshop, how much experience did you have with the following?

	1 None	2	3 Some	4	5 Great Deal
Woodworking, cabinetry, construction					
Welding, fabrication					
Electronics, building computers, computer coding					
Mechanics (automobile, small engine)					
Gardening					
Artistic painting/drawing					
Textile arts (sewing, embroidery, knitting, etc.)					
Cooking					
Sports (soccer, dancing, basketball, skiing)					
Drafting					

This set of questions focuses on your science and math classes in school. Tell us what you think about these statements by selecting the number that indicates how much you disagree or agree with these statements about your science and math classes in school. Enter a 1 if you Strongly Disagree with this statement, 2 if you Disagree, 3 if you Neither Disagree or Agree, 4 if you Agree, and 5 if you Strongly Agree.

	1 Strongly Disagree	2	3	4	5 Strongly Disagree
I look forward to science class in school.					
I look forward to math class in school.					
I would rather solve a problem in science class by doing an experiment than be told the answer.					
More time should be spent on hands-on projects in science class.					
Science is too hard when it involves math					
Science is a difficult subject.					
Doing experiments in science class is frustrating.					

These statements are about things you may do when you are working on school activities or assignments. Tell us what you think by selecting the number that indicates how often you believe you will do these activities. Enter a 1 if you will never do this, 2 if you will not do this very often, 3 if you will do this about half of the time, 4 if you will do this most of the time, and 5 if you will always do this.

	1 Never	2	3	4	5 Always
Design and build something.					
Explain math or science to my friends.					
Find the information that I need to solve difficult problems.					
Read books, magazines, or websites about science or math.					
Learn about how something works.					
Draw an object I plan to build before building.					

This set of questions focuses on how you feel about science and engineering now that you've participated in the NFB EQ workshop.

Tell us what you think about these statements by selecting the number that indicates how much you disagree or agree with these statements. Enter a 1 if you Strongly Disagree with this statement, 2 if you Disagree, 3 if you Neither Disagree or Agree, 4 if you Agree, and 5 if you Strongly Agree. The NFB EQ workshop . . . .

	1 Strongly Disagree	2	3	4	5 Strongly Disagree
Helped me understand engineering better.					
Led me to a better understanding of my own career goals.					
Increased my interest to study science and engineering.					
Increased my ability to understand geometric shapes and engineering drawings.					
Made me think more about what I will do after graduating from high school.					
Made me think about different classes I might take in school (including college) than I had planned.					
Increased my confidence in my ability to participate in engineering projects or activities.					

If you were in charge, how would you change this workshop?

Just a couple more questions about you. What grade were you in during this last school year?

- 9
- 10
- 11
- 12

Which of these classes have you taken (check all that apply)

- Pre-Algebra
- Geometry
- Algebra I
- Algebra II
- Trigonometry
- Pre-Calculus
- Calculus
- Biology
- Chemistry

- Physics
- AP Physics
- Anatomy
- Computer Aided Design/Drafting/Solid Modeling
- Geography
- Vocational Arts (Welding, woodworking, machining, sewing, etc.)

Do you identify as (check only one)

- Blind
- Low vision
- Visually impaired
- Sighted
- Other _____

What medium do you use for accessing written material? (check all that apply)

- Braille
- Large print
- Audio
- Accessible electronic documents
- Other _____

What assistive technology do you use when accessing the computer? (check all that apply)

- Screen reader
- Screen magnification
- Braille display
- Other _____

Do you think you will pursue a career in a science, technology or engineering-related field?

- Yes
- No
- Don't Know

Have you been blind since birth?

- Yes
- No

If No, How old were you when your vision began to change?

Do you know Braille?

- Yes
- No

If yes, How long have you been reading Braille?

How often do you use a Braille slate and stylus?

- Never
- Sometimes
- About half of the time
- Most of the time
- Always

In math and science class, how do you prefer to access diagrams, tables and figures? Please rank your preference with number 1 being your most preferred and number 5 being your least preferred.

- Someone describes it to me verbally
- Read a written description of the diagram
- Tactile graphics and Braille
- Large print/High contrast graphics
- Dual media graphics: graphics that include visual (high contrast/large print) and tactual (Braille, raised line) components (6)

When do you use a cane in your daily life? (choose only one)

- Never
- Sometimes(i.e., at night, in unfamiliar environments)
- About half of the time
- Most of the time
- Always

Is there anything else you'd like to share about your experiences this week?

Thank you for your feedback. Have a great day exploring science, engineering, math, and technology in your daily life.

Appendix B: NFB EQ Post Teen Questionnaire Data

Table 6. Feelings regarding school science and math classes

	Mean	Std. Dev.
I look forward to science class in school.	3.893	1.133
I look forward to math class in school.	3.333	1.468
I would rather solve a problem in science class by doing an experiment than be told the answer.	4.259	0.859
More time should be spent on hands-on projects in science class.	4.731	0.604
Science is too hard when it involves math	1.926	1.269
Science is a difficult subject.	2.000	1.074
Doing experiments in science class is frustrating.	2.222	1.368

Rating based on a 5 -point scale, where 1 represents Strongly Disagree and 5 represents Strongly Agree
N varies from 26 - 28

Table 7. Things teens do when working on school activities

	Mean	Std. Dev.
Design and build something.	2.741	1.130
Explain math or science to my friends.	3.357	1.446
Find the information that I need to solve difficult problems.	3.963	0.898
Read books, magazines, or websites about science or math.	2.654	1.355
Learn about how something works.	4.192	0.801
Draw an object I plan to build before building.	2.815	1.594
Draw something to better understand a concept	2.741	1.289

Rating based on a 5 -point scale, where 1 represents Never and 5 represents Always
N varies from 26 - 28

Table 8. Pre-workshop experience with engineering-type activities?

	Mean	Std.Dev.
Woodworking, cabinetry, construction	2.259	1.289
Welding, fabrication	1.321	0.723
Electronics, building computers, microcontrollers, computer coding	2.760	1.234
Mechanics (automobile, small engine)	2.000	1.209
Gardening	2.360	1.186
Artistic painting/drawing	3.040	1.399
Textile arts (sewing, embroidery, knitting, etc.)	2.360	1.254
Cooking	3.269	1.185
Sports (soccer, dancing, basketball, skiing)	3.654	1.468
Drafting	2.269	1.251

Rating based on a 5 -point scale, where 1 represents No Experience and 5 represents A Great Deal of Experience
N varies from 25 - 28

Table 9. Frequency of STEM-related play as a child—NFB EQ teens were somewhat likely to play with building toys (i.e., blocks, legos) or draw/doodle a engage in STEM-related play as a child.

	Mean	Std. Dev.
Play with blocks, legos, or other building toys/kits	3.214	1.343
Construct models	2.538	1.272
Build puzzles	2.500	1.304
Play with radio controlled toys	2.615	1.416
3-D Video Games	2.400	1.708
Doodle or draw	3.200	1.528

Rating based on a 5 -point scale, where 1 represents Never and 5 represents Always
N varies from 25 – 28

Table 10. Feelings regarding school science and math classes

	Mean	Std. Dev.
I look forward to science class in school.	3.893	1.133
I look forward to math class in school.	3.333	1.468
I would rather solve a problem in science class by doing an experiment than be told the answer.	4.259	0.859
More time should be spent on hands-on projects in science class.	4.731	0.604
Science is too hard when it involves math	1.926	1.269
Science is a difficult subject.	2.000	1.074
Doing experiments in science class is frustrating.	2.222	1.368

Rating based on a 5 -point scale, where 1 represents Strongly Disagree and 5 represents Strongly Agree
N varies from 27 - 28

Table 11. Feelings toward science and engineering post NFB EQ

	Mean	Std. Dev
Helped me understand engineering better.	3.929	0.940
Led me to a better understanding of my own career goals.	3.333	1.177
Increased my interest to study science and engineering.	3.115	1.275
Increased my ability to understand geometric concepts and engineering drawings.	3.370	1.115
Made me think more about what I will do after graduating from high school.	3.296	1.353
Made me think about different classes I might take in school (including college) than I had planned.	2.815	1.331
Increased my confidence in my ability to participate in engineering projects or activities.	3.500	1.476

Rating based on a 5 -point scale, where 1 represents Strongly Disagree and 5 represents Strongly Agree
N varies from 26 – 28

Table 12. Blind identity

	Frequency
Blind	11
Low vision	3
Visually impaired	14
Sighted	0

N=28

Table 13. Medium used for accessing written material (check all that apply)

	Frequency
Braille	14
Large print	13
Audio	16
Accessible electronic documents	22
Other	2

N=27

Table 14. Assistive technology used when accessing the computer (check all that apply)

	Frequency
Screen reader	17
Screen magnification	12
Braille display	13
Other	5

N=27

Table 15. Interest in pursuing a STEM career

	Frequency
Yes	14
No	4
Don't Know	6

N=24

Table 16. Blind since birth

	Frequency
Yes	20
No	5

N=25

Table 17. Knowledge of Braille

	Frequency
Yes	18
No	8

N= 26

Table 18. Use of a Braille slate and stylus

	Frequency
Never	21
Sometimes	5
About half of the time	0
Most of the time	0
Always	0

N=26

Table 19. Preference when accessing diagrams, tables and figures (Reverse Ranking)

	1	2	3	4	5	Total
Someone describes it to me verbally	0	20	21	8	4	53
Read a written description of the diagram	5	20	12	12	5	54
Tactile graphics with Braille	30	12	0	0	11	53
Dual media graphics: graphics that include visual (high contrast/large print) and tactual (Braille, raised line) components	35	16	9	12	2	74
Large print/High contrast graphics	55	4	6	4	5	74

N= 22

Table 20. Cane use in daily life (choose only one)

	Frequency
Never	7
Sometimes (i.e., at night, in unfamiliar environments)	1
About half of the time	3
Most of the time	9
Always	7

N=28