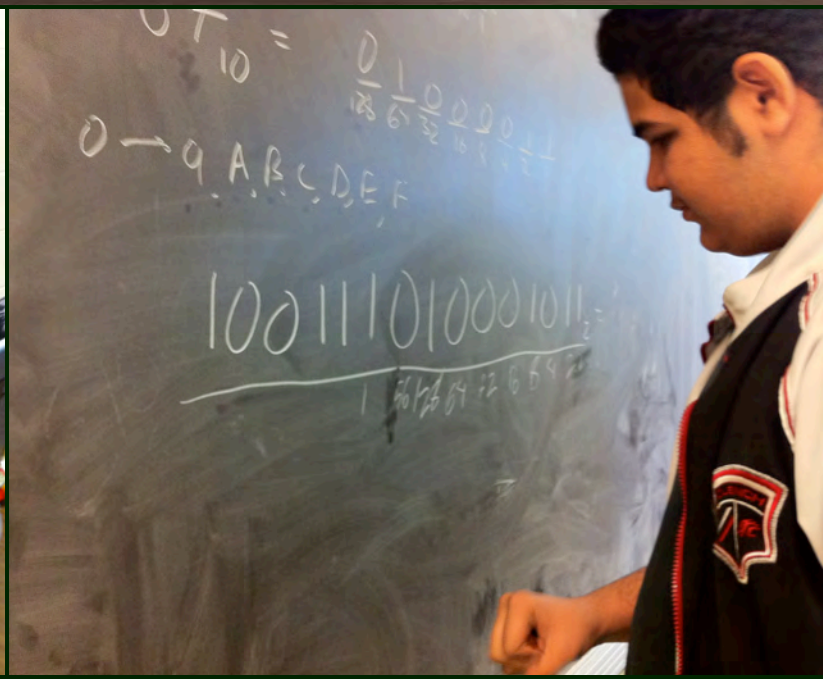
learning exchange



Program Summary

by Nabeel Gillani and Amit Jain

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Introduction

Learning Exchange is an after-school math initiative by Brown University students aimed at helping Providence middle schoolers get excited about learning math and working with computers. We believe that children are brilliant, but may lack motivation when they are unable to see the value of what they learn in the classroom. To address this, we are committed to sharing Brown students' passion for learning with their peers in Providence middle schools in order to create a community of engaged young people with a thirst for knowledge. The goals of Learning Exchange are as follows:

1. To help students experience real-world **applications** of the math skills they learn in school so that they can connect them to broader life/career goals;
2. To enable students to use these math skills and computer technologies to develop an **expertise** in their particular area of interest in a very short amount of time;
3. To empower students to **take ownership** of their education through a sustained, self-designed project that utilizes these skills and expertise;
4. To build an **excitement** around undertaking new intellectual challenges so that students can become the leading thinkers, and doers, of tomorrow.

All Learning Exchange classes are designed and taught by enthusiastic Brown students with an interest in sharing the cutting edge of their field with their younger peers. Course content is structured around the four pillars of **math**, **technology**, **project-based learning**, and **pursuit of passion**.[1]

Pilot Structure

We worked with Providence After School Alliance (PASA) staffers in the AfterZone program at Samuel W. Bridgham Middle School to implement the Learning Exchange pilot. During the two-hour AfterZone framework's six-to-ten-week program cycle, program providers run one- or two-hour programs on Monday/Wednesday or Tuesday/Thursday. Because of the pilot program's experimental nature and brief duration, we recruited kids in the Tuesday/Thursday cohort who were already enrolled in one-hour programs. We worked with these students during their spare hour, known as "Club AfterZone," in which they would otherwise have been doing homework.

Students in the sound processing class share their projects.

The pilot stretched over four weeks from late April to mid-May, with two one-hour classes a week. The first class period was dedicated to recruitment of students, with the remaining seven classes consisting of actual teaching and project creation. The two subjects offered were an introductory computer programming course, in which students would work in the MIT Scratch environment to craft simple animations and games,[2] and a digital sound processing course, in which students would use Apple's GarageBand software to create original remixes from songs and loops. We also offered an abbreviated art course for one hour every Monday over the four weeks, in which four kids worked with a RISD student to develop intricate tessellations.

Overall, we had a total of three programming instructors that attended at least six classes and one that attended three classes, while the two

[1] Our emphasis on project-based learning is inspired by the success of Citizen Schools. More information on this organization can be found at www.citizenschools.org.

[2] More information on Scratch is available at scratch.mit.edu.

sound processing instructors were both present for all seven classes. Out of these six instructors for biweekly classes, one was a sophomore, three were juniors, and two were seniors. For students, we had eleven kids who attended at least half of the sound processing or computer programming classes, and eight who both started and completed a course. Of the eight students who both started and completed one of the courses:

- Four were female, four were male
- Three were in sixth grade; two were in seventh grade; three were in eighth grade

The overall attendance rate across the seven classes was 86% (88% for sound processing and 82% for computer programming) and the overall ratio of students to instructors was approximately 1.5:1. This small ratio was crucial due to the advanced nature of the technology used and the material covered.

Course Content

Computer Programming

Computer science (CS) is a rapidly evolving field that allows users to express their creativity through the development of software. Part of the beauty of CS is its close relationship with mathematics, and learning math is often more fun when it is done in the context of CS.

A student uses the interactive drawing feature of Scratch.

The concept of teaching math through CS was inspired by the work of Project Bootstrap, an after-school organization that teaches math to middle schoolers by introducing them to video game development in a language called Scheme.[3] Similarly, our goal was to take the excitement of making games and animations and present it in a way that was accessible and educational for students.

Environment and Class Structure

We decided to use Scratch, a visual programming interface that allows users to make games and animations by assembling blocks of code together to produce a set of instructions for the computer. We chose Scratch because it offered a balance of abstraction and functionality; the code blocks were general enough to make programming syntax accessible for students but specific enough to give them a concrete understanding of how manipulating their code would impact their applications.

In all, the program ran for seven one-hour sessions. We spent the first session building interest and excitement around making fun applications with computer science, showing samples found in the Scratch example gallery. We followed this introduction with some broader examples of applications that students could easily create in Java and other conventional languages in order to emphasize the endless creative potential of CS.

The remaining six sessions had the following general structure:

1. 10 minutes – Recapping the previous class, including having students talk about what they learned or demo something exciting they created with Scratch
2. 40 minutes – Working in the Scratch environment either one-on-one or two-on-one with a teacher (some students opted to have partners)
3. 10 minutes – Regrouping, demoing new creations, and talking about what students learned

[3] More information on Project Bootstrap is available at www.bootstrapworld.org.

Teaching Experiments

To take full advantage of the pilot setting, we tested different teaching strategies to boost our effectiveness and gauge student understanding:

1. **Show-and-tell** – To push students to own/take pride in their work and demonstrate the expertise they gained in producing a particular application, we had them regularly share their projects with peers.
2. **Group discussion** – To encourage abstract thinking, we would introduce new concepts (e.g. functions) in broader discussion-based settings before moving into Scratch.
3. **Asking about the non-canonical case** – To promote critical thinking, we often skewed the way students were used to seeing math concepts. For example, when considering X-Y coordinates, we would look down either the X- or Y-axis and then determine character location instead of always viewing a standard 2D coordinate plane.
4. **Building off of Scratch examples** – After giving students the opportunity to learn how existing blocks of code worked, we would use them to extend existing applications.

Math Standards Covered

Through a combination of discussion and hands-on Scratch development, we applied a number of NECAP Grade Level Expectations for math in each of the main standard areas.[4] Below are a few sample activities and the math standards they covered.

Activity	NECAP Math Standard
Character positioning and movement	Geometry and Measurement – Applies the concepts of congruency (M(G&M)-7-4)
Random perturbations in character movement	Data, Statistics, Probability – Analyzes patterns, trends, or distributions in data (M(DSP)-6-2)
Changing direction of moving projectile (Pong)	Geometry and Measurement – Uses properties of angle relationships (M(G&M)-7-1)
Changing character size	Number and Operations – Accurately solves problems using proportional reasoning (M(N&O)-8-4)
Changing character speed	Functions and Algebra – Demonstrates conceptual understanding of algebraic expressions (M(F&A)-6-3)
Conditional character responses	Functions and Algebra – Demonstrates conceptual understanding of algebraic expressions (M(F&A)-6-3)

[4] The full list of NECAP GLEs in mathematics for grades K-8 can be found on the Rhode Island Department of Education website at http://www.ride.ri.gov/instruction/DOCS/gle/GLE pdf/FINAL/RI_Math_K-8_GLEs_Final_Version_PDF.pdf.

Student Projects

One student's fish-chomping application.

Students greatly enjoyed working with Scratch to modify existing applications or create original ones, and they were able to use their creativity and math skills to solve problems as they arose. One pair of students analyzed the single-player Pong game in the Scratch example gallery and then modified it to make it into a two-player game (with two paddles controlled via different keyboard inputs). Another girl extended a basic fish-chomping example by adding a user-controlled shark that grew in size as it ate more fish on-screen. Yet another student was so excited to make his own animations that he went home after two classes and downloaded Scratch onto his netbook; before returning to class the following Tuesday, he had already created two

original animations of a man dancing in between two trees.

After their projects were complete, an instructor presented the kids with CDs of their work. Students were visibly proud of their projects and excited to share them with family and friends.

Digital Sound Processing

Digital sound processing and mixing is an integral part of the modern music industry, and the inherent math tie-ins are plentiful, from frequency calculations and tempo matching to data storage and unit conversion. As one of the many intersections of computing and the creative arts, we felt that this topic would be a particularly exciting one for students, especially given the popularity of hip-hop and rap music.

Three students listen to a peer's final mix.

The course design was heavily influenced by one instructor's experience with the MIT Splash program, in which he taught a sound processing lecture course for high school students. Because of the nature of the environment used, the math tie-ins were more intentional and less directly applied during project creation, but they were nevertheless abundant. For their course project, students created original mashups of popular songs overlaid with effects and loops; our goal was to utilize students' creativity and love of music to demonstrate the enjoyment and limitless potential of learning math.

Environment and Class Structure

The five students worked with Apple's GarageBand software on three MacBook laptops provided by instructors. We had hoped that GarageBand's user-friendly interface would prove useful in teaching middle school students to use complicated sound processing techniques; however, as the pilot went on, we came to realize that with this ease of use came an unfortunate masking of the underlying math concepts.

The first course offered a basic introduction to the science of sound: students learned about wave energy and watched a speaker blow out a candle, then turned to the chalkboard to discuss the concepts of frequency, wavelength, and amplitude. After some quick math comparing the speeds of light and sound waves, the students were introduced to the GarageBand environment and taught how to drag in loops, set tempos, add effects, and cut tracks.

For the remaining seven classes, students were split into two groups of 2-3 with the following structure:

1. 5 minutes – Setting up speakers and laptop stations
2. 25 minutes – First group mixing 1:1 on computers; second group learning relevant effects and underlying math concepts
3. 25 minutes – Groups switched
4. 5 minutes – Reviewing material and closing

After the first week, Brown student teachers compiled a small library of tempo-matched instrumentals, acapellas, and songs based on student requests. In subsequent weeks, the top two performers in each class (determined by instructors based on behavior and effort) were each allowed to request one or two additional songs to add to the library. Students also made liberal use of GarageBand's built-in library of instrument loops, beats, and effects.

Teaching Experiments

As with the computer programming course, we used the pilot environment to test a number of different teaching techniques, including:

1. **Show-and-tell** – Just as in the computer programming course, we encouraged students to share their evolving musical creations with their peers. Throughout the course, students were clearly proud of their accomplishments.
2. **Concrete demonstrations** – To scaffold new abstract concepts, we grounded them in concrete analogies. For example, when explaining the concept of functions to sixth grade students, we had them stand up to represent "inputs" and then run them through a "function" in which students wearing different clothing would sit or stand.
3. **Teaching back** – To prevent students from pretending to understand concepts in order to avoid appearing confused, we pushed them to demonstrate their thinking process for each problem by explaining concepts back to us.
4. **Extrinsic/intrinsic rewards** – To motivate students of diverse interests and personalities, we balanced concrete prizes such as candy and the aforementioned song additions with more intrinsic rewards such as positive verbal feedback and affirmation.

Math Standards Covered

Because of the GarageBand environment, the math component was less directly applied than in the computer programming course. Below is a sampling of the NECAP standards covered.

Activity	NECAP Math Standard
Understanding sound processing effects as functions	Functions and Algebra – Evaluates linear algebraic expressions (M(F&A)-6-3)
Linear and quadratic functions	Functions and Algebra – Evaluates an expression within an equation (M(F&A)-7-3)
Wavelength, amplitude, and frequency calculations	Numbers and Operations – Demonstrates conceptual understanding of ratios (M(N&O)-6-1); multiplies and divides fractions (M(N&O)-6-3)
Tempo comparisons and conversions	Numbers and Operations – Solves problems involving proportional reasoning (percent increase or decrease, interest rates, markups, or rates) (M(N&O)-8-4)
Binary and hexadecimal conversions	Numbers and Operations – Uses a variety of mental computation strategies to solve problems and mentally calculates benchmark perfect squares (M(N&O)-8-6)

Conversions across bases proved surprisingly popular: one sixth grader even requested a binary conversion challenge that spanned the entire chalkboard, while the older cohort mastered base 16 and even practiced some conversions to and from base 35. For the math component of the final class, students reviewed their learning in a trivia game with candy prizes.

Student Projects

One student's final mix in GarageBand.

As in the computer programming course, Brown student teachers burned music CDs for each student with the projects of the entire class. Students clearly had fun while mixing – in fact, one student enjoyed it so much that he purchased his own MacBook after the second week of class. The kids also took individualized approaches to their projects depending on their interests. Some stuck largely to mixing together beats, rhymes, and vocals from popular songs, as did one sixth

grader, who made a 10-minute mix of his favorite new hip-hop songs. On the other end of the spectrum, one eighth grader created an entirely original 22-track song out of GarageBand loops alone. Meanwhile, one seventh grader split the difference, opening with remixes and new beats created from loops before closing out with a rap song overlaid with effects and DJ scratches. Each of the five students created at least one mix track, and they were all visibly proud of their creations and excited to share them with their peers.

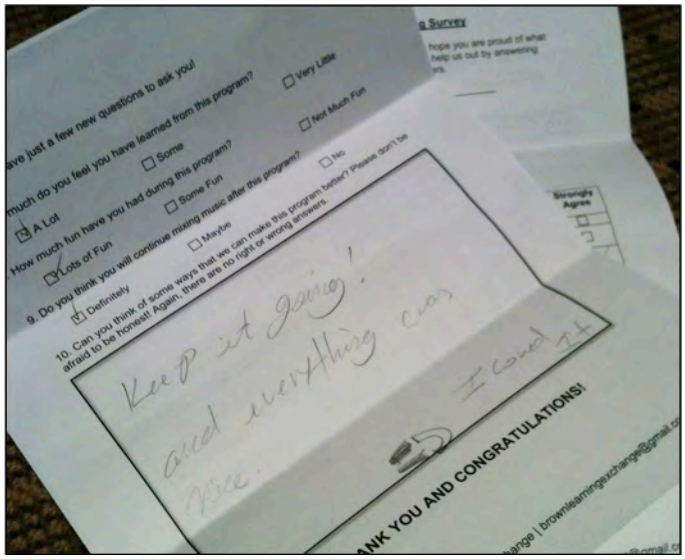
OUTCOMES

Given that the four-week pilot was our first opportunity to test our program concept, we wanted to evaluate the model's potential to get kids excited about math, boost their intellectual confidence, and engage them in fun, fresh educational activities.[5] We took a four-tiered approach to evaluation: first, we administered a written assessment to gauge whether student attitudes changed over the course the program;[6] second, we conducted informal group interviews with students; third, we spoke with course instructors to obtain their feedback; and lastly, we met with on-site PASA staffers to solicit their input as well.

Written Student Assessments

One challenge we found with our written evaluations was that some students simply did not take them seriously. Although instructors repeatedly stressed the importance of these assessments, some students nevertheless selected answers arbitrarily, skewing our results. Still, we were able to extract a few themes:

1. **Students felt that they had learned.** When given options "A Lot," "Some," and "Not Much," 7 out of 10 respondents said that that they felt like they had learned "A Lot," while 3 said that they had learned "Some."
2. **Students had fun.** When given options "Lots of Fun," "Some Fun," and "Not Much Fun," 7 out of 10 respondents said that they had "Lots of Fun," while 3 out of 10 said that they had "Some Fun."
3. **Students started to think math was cool.** When asked if they thought they could do cool things with math on a scale from 1 to 4, students demonstrated an average 0.375-point increase over the course of the program.
4. **Students improved their academic self-concept.** When asked to rate their own math skills on a scale from 1 to 10, students demonstrated an average 0.375-point increase over the course of the program.



Two completed post-pilot assessments.

Student Interviews

Because not all students provided accurate written assessments, the informal group interviews proved more revealing. Students from biweekly classes were divided into their program groups and asked the following questions:

1. What was the most fun about this experience?
2. What, if anything, would you change about the experience?
3. Did you feel smart?
4. Will you continue (programming/mixing) after the end of the program?

[5] We only conducted the full evaluation process with the computer programming and sound processing courses, since the art program only ran once a week and therefore could not be evaluated on the same standard.

[6] Samples of our pre- and post-pilot surveys can be found in Appendix I of this report, and the full set of results is provided in Appendix II.

Computer programming students said that they had the most fun when making the actual games and animations. Students seemed to want less math, but they also appeared to understand that it was an important and useful part of making the applications. Students said that they felt smart after the program, and all of them were enthusiastic about continuing to develop Scratch applications at home.

Similarly, sound processing students said that they had the most fun when mixing, but they also enjoyed some of the math covered, particularly converting binary numbers to base 10. Some students felt that the math component was too difficult, and one requested a simpler mixing application. It was unclear whether all students felt smart during the program; however, they all expressed enthusiasm at continuing to mix music after the program's conclusion.

Across both biweekly classes, students agreed that they would continue attending their program if it was offered for more than four weeks. Students also expressed interest in topics covered in other classes: two computer programming students asked for information on free music mixing programs available for Windows.

A student develops a flying-fish animation in Scratch.

Instructor Interviews

All seven instructors from the programming, sound processing, and tessellation courses were interviewed individually after the pilot's conclusion to discuss program challenges and successes.

Challenges

Instructors unanimously agreed that one of their biggest challenges was holding the attention of students. Five teachers said this was made more difficult by the limited number of computers: students were most engaged while working in Scratch or GarageBand, but the shortage of technology meant that not all of them could work at the same time, which appeared to decrease their attention span. Feedback from the tessellations instructor confirmed this, as the complete lack of technology in the curriculum apparently led to significantly lower student interest and engagement. To compensate for this, teachers experimented with different student management techniques. One emphasized the importance of paying careful attention to each student to boost motivation, while another stressed balancing extrinsic and intrinsic rewards. Others noted the effectiveness of patiently working with students in small groups or one-on-one to maintain focus.

The instructors also acknowledged the difficulty of teaching students to use entirely new development environments such as Scratch and GarageBand. In addition, some teachers felt that both programs masked some of the underlying math applications. To fix this, instructors in both classes suggested developing or customizing environments in-house to align them more directly with the academic mission of Learning Exchange.

Lastly, all of the instructors cited the difficulty of working within the time constraints of the pilot. A few expressed that an hour per class was insufficient, given the amount of time it would take to get students focused at the beginning of each class; a sound processing instructor complained that between setting up, exploring the computing environment, building projects, and tearing down, there was little to no time remaining for group discussion or feedback. Others wanted a longer program cycle, and a programming teacher noted that the kids had complex ideas but were unable to master the environment enough to bring them to fruition in only four weeks.

Successes

Instructors all felt that the students had plenty of fun, and a few saw this excitement translate into a newfound passion for mixing, programming, and learning. Instructors cited specific success stories across both groups, including the programming student who downloaded Scratch on the weekend and the mixing student who bought a MacBook to work in GarageBand.

Some instructors also pointed to the pilot's success in revealing the types of problems that the kids most enjoyed solving. The programming group particularly appreciated applications of math skills that allowed them to achieve the desired effect onscreen, as when they calculated coordinates and distances to move an animated character; meanwhile, sound processing students most enjoyed multi-step problems with clear pay-offs, such as conversions between binary and base 10. Instructors also learned the value of tying complicated concepts to concrete ideas, and one stressed the importance of "testing" what students learned by asking follow-up questions instead of allowing them to simply nod in agreement. In addition, a few teachers noted that the program's flexibility served the students well, explaining that being willing to adjust activities to respond to student needs while maintaining overarching goals proved essential in delivering a quality program.

Finally, all of the student teachers expressed a renewed appreciation for the challenges of teaching, particularly in the inner-city public school environment, and affirmed their immense respect for teachers. They also described working in K-12 schools as a vital opportunity for student growth. In particular, one graduating senior explained that she felt like she "understood more about the world" after working with students at Bridgham.

PASA Staff Interviews

In a post-pilot discussion, the PASA AfterZone site coordinator expressed enthusiasm for the program and its results. She said she was most struck by the program's flexibility and the instructors' ability to manage and work with students. Under the first category, the coordinator articulated the value of having fresh faces who were willing to adjust their offerings to students' varied interests and learning abilities. She emphasized that such adaptability was critical, urging us to retain it even as we continued to solidify our program structure. Regarding student management, the site coordinator said she was very impressed with our ability to both treat students with respect and be strict enforcers when necessary. She attributed this in part to our age, noting that college students were uniquely positioned to be young enough to relate to the kids but also old enough to earn the respect afforded to adult staffers.

The site coordinator also stressed the importance of including computers in our coursework; she argued that this component would not only help attract and retain students but also build crucial skills that they might not otherwise have the opportunity to develop. Finally, when asked what she felt the students took away from the program, the coordinator cited their strong sense of pride over their creations. She said that she found the project-based component to be a valuable method of pushing the students to pursue their passions and take ownership of their academic interests.

Two students play their modified two-player Pong game.

Outlook

Timeline

Overall, our experiences with the Learning Exchange pilot have given us much to hope for and build upon. In the weeks and months ahead, we will use the feedback we have collected to refine our curricula and program structure in order to better help students pursue their interests and build excitement for learning math. Our current timeline is as follows:

- **Summer 2011:** Recruit more student teachers, refine existing courses, and begin developing new curricula. Solidify Brown institutional support and technology funding.
- **Fall 2011:** Run a scaled-up program during Club AfterZone (1 hour per class) for the full 10-week fall AfterZone cycle at DelSesto Middle School (20 hours total), enrolling 24 students in courses taught by 12 instructors.
- **Winter 2011:** Re-assess program status, continue Brown student recruitment and curriculum development, and apply for a Spring 2012 PASA grant to become a full program provider.
- **Spring 2012:** Run a full program (2 hours per class) for the 6-week spring AfterZone cycle at DelSesto (24 hours total).

As the timeline indicates, we plan to continue adding curricula to expand beyond computer programming and sound processing, though all future curricula will be tied together with a focus on mathematical applications, technology, and project-based learning. The Learning Exchange coordinators will screen all class and project proposals from instructors, and PASA on-site staff will review all topics for approval as well. Courses will then be developed by college students with expertise in the area, in conjunction with coordinators, and will be designed to include application tie-ins with the NECAP math standards for grades 5-9.

Special Thanks

We would like to thank the following individuals for their help, advice, and inspiration during the pilot phase of Learning Exchange:

- Our instructors: Alex Feldman, Claire Goetschel, Jessica Liu, Stephen Poletto, and Alex Unger
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- Allison Quinn from the Providence After School Alliance
- Alan Flam and Alan Harlam from the Swearer Center for Public Service
- Jesse Cohen and Ralph Johnson from the College Advising Corps
- Jo Brown from the Brown University Science Center
- Callie Kozlak, Jill Corsi, and Emily Stainer of Citizen Schools
- Principal Brearn Wright from Roger Williams Middle School
- Andrew Coburn from the MET School
- Shriram Krishnamurthi, Associate Professor of Computer Science at Brown and co-creator of Bootstrap
- Matthew Harrison, Assistant Professor of Applied Mathematics at Brown
- Chad Jenkins, Associate Professor of Computer Science at Brown
- Amon Millner, co-creator of Scratch
- Our family and friends
- All of the kids at the Bridgham AfterZone

Appendix I: Written Assessments

Pre-Pilot Survey

Learning Exchange Attitude Survey
Students

Thank you for joining Learning Exchange! We want to learn more about you. Please answer these questions honestly and to the best of your ability. There are no right or wrong answers.

1. What is your name? _____

2. What grade are you in?

☐ 6th Grade ☐ 7th Grade ☐ 8th Grade

3. What is your gender?

☐ Male ☐ Female

4. How much do you agree with the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree
Solving math problems can be fun.	☐	☐	☐	☐
I want to spend less time in school doing math.	☐	☐	☐	☐
When a math problem seems hard, I often think, "I can't do it."	☐	☐	☐	☐
I remember what I learn in math class.	☐	☐	☐	☐
I will need to know math when I'm older.	☐	☐	☐	☐
I like being able to work out a math problem on my own.	☐	☐	☐	☐
I can do cool things with math.	☐	☐	☐	☐
I'm good at math.	☐	☐	☐	☐
Doing math problems makes me nervous.	☐	☐	☐	☐
I want to learn more math.	☐	☐	☐	☐
I don't think I will learn anything useful in math class.	☐	☐	☐	☐
It is important to be good at math.	☐	☐	☐	☐
If I work hard, I can get better at math.	☐	☐	☐	☐
Math can be interesting sometimes.	☐	☐	☐	☐

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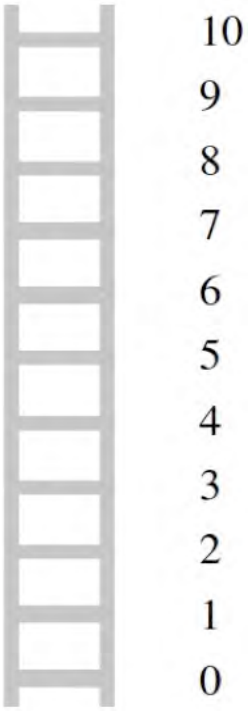
5. How important is it to your future career for you to be good at math?

☐ Very Important ☐ Kind of Important ☐ Not Important

Please imagine a ladder with steps numbered from zero at the bottom to ten at the top. The top of the ladder represents the best possible math skills and the bottom of the ladder represents the worst possible math skills.

6. On which step of the ladder do you feel you stand right now?



(best possible math skills)

(worst possible math skills)

THANK YOU!

Post-Pilot Survey

Learning Exchange Closing Survey

Thanks for your hard work over the past four weeks! We hope you are proud of what you have accomplished. Before we say goodbye, please help us out by answering these questions again. There are no right or wrong answers.

1. What is your name? _____

2. What grade are you in?

☐ 6th Grade ☐ 7th Grade ☐ 8th Grade

3. What is your gender?

☐ Male ☐ Female

4. How much do you agree with the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree
Solving math problems can be fun.	☐	☐	☐	☐
I want to spend less time in school doing math.	☐	☐	☐	☐
When a math problem seems hard, I often think, "I can't do it."	☐	☐	☐	☐
I remember what I learn in math class.	☐	☐	☐	☐
I will need to know math when I'm older.	☐	☐	☐	☐
I like being able to work out a math problem on my own.	☐	☐	☐	☐
I can do cool things with math.	☐	☐	☐	☐
I'm good at math.	☐	☐	☐	☐
Doing math problems makes me nervous.	☐	☐	☐	☐
I want to learn more math.	☐	☐	☐	☐
I don't think I will learn anything useful in math class.	☐	☐	☐	☐
It is important to be good at math.	☐	☐	☐	☐
If I work hard, I can get better at math.	☐	☐	☐	☐
Math can be interesting sometimes.	☐	☐	☐	☐

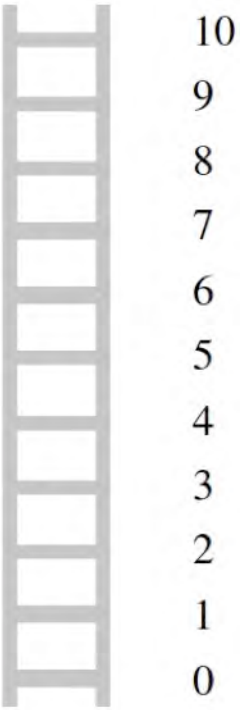
(continued on back side)

5. How important is it to your future career for you to be good at math?

☐ Very Important ☐ Kind of Important ☐ Not Important

Please imagine a ladder with steps numbered from zero at the bottom to ten at the top. The top of the ladder represents the best possible math skills and the bottom of the ladder represents the worst possible math skills.

6. On which step of the ladder do you feel you stand now?



(best possible math skills)

(worst possible math skills)

Lastly, we have just a few new questions to ask you!

7. How much do you feel you have learned from this program?

☐ A Lot ☐ Some ☐ Very Little

8. How much fun have you had during this program?

☐ Lots of Fun ☐ Some Fun ☐ Not Much Fun

9. Do you think you will continue making animations/mixing survey after this program?

☐ Definitely ☐ Maybe ☐ No

10. Can you think of some ways that we can make this program better? Please don't be afraid to be honest! Again, there are no right or wrong answers.

THANK YOU AND CONGRATULATIONS!

Appendix II: Responses to Written Assessments

We standardized the responses to the 14 agree/disagree questions on a scale of 1-4, from most negative to most positive. For positively phrased questions (unshaded), 1 represents "Strongly Disagree" and 4 represents "Strongly Agree." For negatively phrased questions (shaded in yellow), 1 represents "Strongly Agree" and 4 represents "Strongly Disagree."

Pre-Pilot Survey Responses

Computer Programming

Student	CS1	CS2	CS3	CS4	CS6	CS7	*Avg*	*Total Avg*
Grade	8th	6th	6th	8th	8th	8th	--	--
Gender	M	F	F	M	M	M	--	--
Classes Attended	3	7	7	6	1	3	4.50	5.40
Solving math problems can be fun.	3	3	1	3	2	3	2.50	2.70
I want to spend less time in school doing math.	2	2	4	3	2	2	2.50	2.60
When a math problem seems hard, I often think, "I can't do it."	3	2	2	4	3	3	2.83	2.60
I remember what I learn in math class.	3	3	3	4	2	2	2.83	3.00
I will need to know math when I'm older.	3	3	1	3	3	4	2.83	3.10
I like being able to work out a math problem on my own.	4	3	1	4	4	3	3.17	3.30
I can do cool things with math.	3	3	1	3	3	3	2.67	2.90
I'm good at math.	3	3	1	4	3	2	2.67	3.10
Doing math problems makes me nervous.	2	2	3	4	2	2	2.50	2.70
I want to learn more math.	3	3	1	3	3	3	2.67	2.40
I don't think I will learn anything useful in math class.	4	3	2	4	3	2	3.00	3.00
It is important to be good at math.	4	3	2	3	3	3	3.00	3.20
If I work hard, I can get better at math.	3	3	4	4	4	3	3.50	3.60
Math can be interesting sometimes.	3	3	3	3	3	3	3.00	3.40
How important is it to your future career for you to be good at math?	Very	Very	Kind of	Very	Very	Very	--	--
On which step of the ladder do you feel you stand right now?	7	7	3	6	7	5	5.83	6.70

Digital Sound Processing

Student	SP1	SP2	SP3	SP4	*Avg*	*Total Avg*
Grade	6th	7th	7th	8th	--	--
Gender	M	F	F	M	--	--
Classes Attended	7	6	7	7	6.75	5.40
Solving math problems can be fun.	3	3	3	3	3.00	2.70
I want to spend less time in school doing math.	3	2	3	3	2.75	2.60
When a math problem seems hard, I often think, "I can't do it."	4	2	1	2	2.25	2.60
I remember what I learn in math class.	4	2	4	3	3.25	3.00
I will need to know math when I'm older.	4	3	3	4	3.50	3.10
I like being able to work out a math problem on my own.	4	3	3	4	3.50	3.30
I can do cool things with math.	3	3	3	4	3.25	2.90
I'm good at math.	4	4	3	4	3.75	3.10
Doing math problems makes me nervous.	4	2	3	3	3.00	2.70
I want to learn more math.	1	3	2	2	2.00	2.40
I don't think I will learn anything useful in math class.	4	3	2	3	3.00	3.00
It is important to be good at math.	4	3	3	4	3.50	3.20
If I work hard, I can get better at math.	4	4	3	4	3.75	3.60
Math can be interesting sometimes.	4	4	4	4	4.00	3.40
How important is it to your future career for you to be good at math?	Kind of	Very	Kind of	Very	--	--
On which step of the ladder do you feel you stand right now?	7	10	8	7	8.00	6.70

Post-Pilot Survey Responses

Computer Programming

Student	CS1	CS2	CS3	CS4	CS5	*Avg*	*Total Avg*
Grade	8th	6th	6th	8th	8th	--	--
Gender	M	F	F	M	M	--	--
Classes Attended	3	7	7	6	2	5.00	5.60
Solving math problems can be fun.	4	3	1	3	4	3.00	2.60
I want to spend less time in school doing math.	2	2	4	3	3	2.80	2.30
When a math problem seems hard, I often think, "I can't do it."	3	2	2	4	2	2.60	2.50
I remember what I learn in math class.	3	3	2	3	4	3.00	3.10
I will need to know math when I'm older.	4	3	1	3	4	3.00	3.30
I like being able to work out a math problem on my own.	3	3	2	3	4	3.00	3.00
I can do cool things with math.	3	3	3	4	4	3.40	3.10
I'm good at math.	3	3	1	4	4	3.00	3.30
Doing math problems makes me nervous.	4	2	1	4	4	3.00	3.30
I want to learn more math.	3	3	3	2	4	3.00	2.70
I don't think I will learn anything useful in math class.	4	3	4	3	4	3.60	3.60
It is important to be good at math.	3	3	2	3	4	3.00	3.10
If I work hard, I can get better at math.	3	3	2	3	4	3.00	3.20
Math can be interesting sometimes.	3	3	2	3	4	3.00	2.90
How important is it to your future career for you to be good at math?	Very	Very	Kind of	Very	Kind of	--	--
On which step of the ladder do you feel you stand now?	8	7	3	5	9	6.40	7.60
How much do you feel you have learned from this program?	Some	Some	A Lot	A Lot	A Lot	--	--
How much fun have you had during this program?	Lots	Some	Lots	Lots	Lots	--	--
Will you continue making animations after this program?	Def	Maybe	Def	Maybe	Def	--	--

Digital Sound Processing

Student	SP1	SP2	SP3	SP4	SP5	*Avg*	*Total Avg*
Grade	6th	7th	7th	8th	6th	--	--
Gender	M	F	F	M	M	--	--
Classes Attended	7	6	7	7	4	6.20	5.60
Solving math problems can be fun.	1	3	3	3	1	2.20	2.60
I want to spend less time in school doing math.	1	2	3	2	1	1.80	2.30
When a math problem seems hard, I often think, "I can't do it."	4	2	1	1	4	2.40	2.50
I remember what I learn in math class.	4	3	4	4	1	3.20	3.10
I will need to know math when I'm older.	4	3	4	4	3	3.60	3.30
I like being able to work out a math problem on my own.	1	3	4	4	3	3.00	3.00
I can do cool things with math.	3	3	4	3	1	2.80	3.10
I'm good at math.	4	3	4	4	3	3.60	3.30
Doing math problems makes me nervous.	4	3	3	4	4	3.60	3.30
I want to learn more math.	1	3	3	4	1	2.40	2.70
I don't think I will learn anything useful in math class.	4	2	4	4	4	3.60	3.60
It is important to be good at math.	3	3	3	4	3	3.20	3.10
If I work hard, I can get better at math.	4	3	4	4	2	3.40	3.20
Math can be interesting sometimes.	3	3	3	4	1	2.80	2.90
How important is it to your future career for you to be good at math?	Kind of	Very	Kind of	Very	Very	--	--
On which step of the ladder do you feel you stand now?	9	10	9	7	9	8.80	7.60
How much do you feel you have learned from this program?	Some	A Lot	A Lot	A Lot	A Lot	--	--
How much fun have you had during this program?	Some	Lots	Lots	Lots	Some	--	--
Will you continue mixing music after this program?	Maybe	Maybe	Def	Def	Maybe	--	--

Can you think of some ways that we can make this program better? Please don't be afraid to be honest! Again, there are no right or wrong answers. CS1: "More better demos and that's it." | CS2: "I don't know!" | CS3: "I don't know" | CS5: "Add more graphics and action games, more animations like anime" | SP2: "Better songs, good materials" | SP3: "Keep it going! And everything was nice =) I loved it" | SP4: "More options in garageband. Show more things about the computer."

Response Changes

Positive values, shaded in green, represent improvement. Negative values, shaded in red, represent decline.

Computer Programming

Student	CS1	CS2	CS3	CS4	*Avg*	*Total Avg*
Grade	8th	6th	6th	8th	--	--
Gender	M	F	F	M	--	--
Classes Attended	3	7	7	6	5.75	6.25
Solving math problems can be fun.	1	0	0	0	0.25	-0.13
I want to spend less time in school doing math.	0	0	0	0	0.00	-0.38
When a math problem seems hard, I often think, "I can't do it."	0	0	0	0	0.00	-0.13
I remember what I learn in math class.	0	0	-1	-1	-0.50	0.00
I will need to know math when I'm older.	1	0	0	0	0.25	0.25
I like being able to work out a math problem on my own.	-1	0	1	-1	-0.25	-0.38
I can do cool things with math.	0	0	2	1	0.75	0.38
I'm good at math.	0	0	0	0	0.00	0.00
Doing math problems makes me nervous.	2	0	-2	0	0.00	0.25
I want to learn more math.	0	0	2	-1	0.25	0.50
I don't think I will learn anything useful in math class.	0	0	2	-1	0.25	0.38
It is important to be good at math.	-1	0	0	0	-0.25	-0.25
If I work hard, I can get better at math.	0	0	-2	-1	-0.75	-0.38
Math can be interesting sometimes.	0	0	-1	0	-0.25	-0.50
Average change across 14 agree/disagree questions	0.14	0.00	0.07	-0.29	-0.02	-0.03
How important is it to your future career for you to be good at math?	0	0	0	0	0.00	0.00
On which step of the ladder do you feel you stand now?	1	0	0	-1	0.00	0.38

Digital Sound Processing

Student	SP1	SP2	SP3	SP4	*Avg*	*Total Avg*
Grade	6th	7th	7th	8th	--	--
Gender	M	F	F	M	--	--
Classes Attended	7	6	7	7	6.75	6.25
Solving math problems can be fun.	-2	0	0	0	-0.50	-0.13
I want to spend less time in school doing math.	-2	0	0	-1	-0.75	-0.38
When a math problem seems hard, I often think, "I can't do it."	0	0	0	-1	-0.25	-0.13
I remember what I learn in math class.	0	1	0	1	0.50	0.00
I will need to know math when I'm older.	0	0	1	0	0.25	0.25
I like being able to work out a math problem on my own.	-3	0	1	0	-0.50	-0.38
I can do cool things with math.	0	0	1	-1	0.00	0.38
I'm good at math.	0	-1	1	0	0.00	0.00
Doing math problems makes me nervous.	0	1	0	1	0.50	0.25
I want to learn more math.	0	0	1	2	0.75	0.50
I don't think I will learn anything useful in math class.	0	-1	2	1	0.50	0.38
It is important to be good at math.	-1	0	0	0	-0.25	-0.25
If I work hard, I can get better at math.	0	-1	1	0	0.00	-0.38
Math can be interesting sometimes.	-1	-1	-1	0	-0.75	-0.50
Average change across 14 agree/disagree questions	-0.64	-0.14	0.50	0.14	-0.04	-0.03
How important is it to your future career for you to be good at math?	0	0	0	0	0.00	0.00
On which step of the ladder do you feel you stand now?	2	0	1	0	0.75	0.38