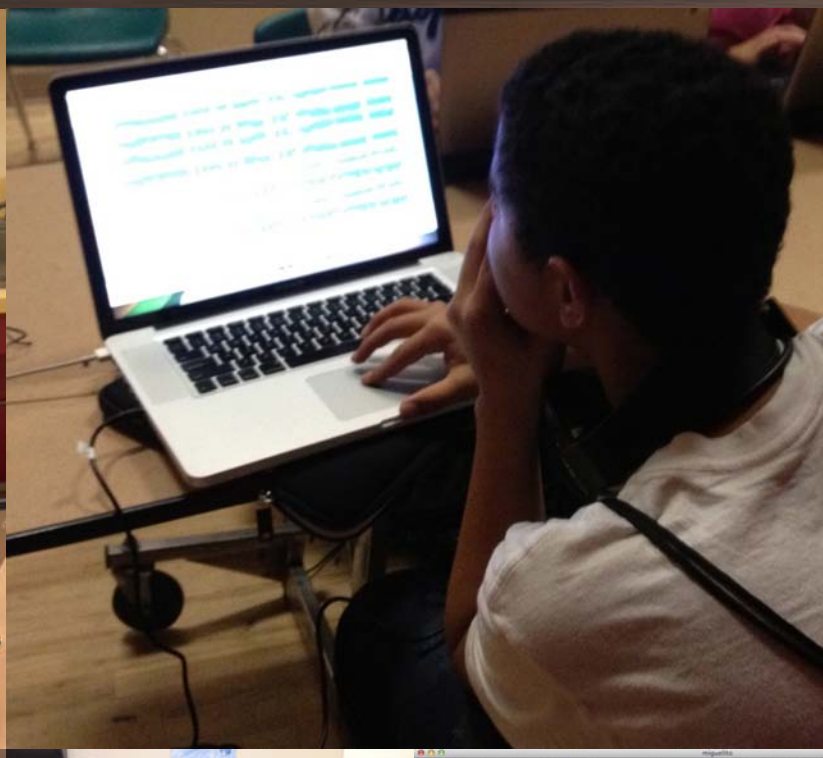
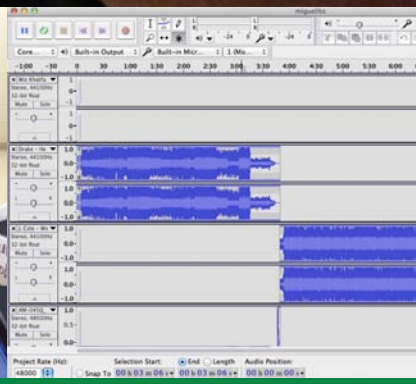
learning exchange

Fall 2011 Program Review





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December 20, 2011

sponsored by the Dean of the College through Science Center Outreach

INTRODUCTION

Learning Exchange (LE) is an afterschool initiative by Brown University students aimed at engaging Providence middle schoolers. 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 our passion for learning with our younger peers in order to create a community of students with a thirst for gaining, creating, and sharing knowledge. The goals of Learning Exchange are as follows:

1) To **build mentoring relationships** between Brown students and Providence learners
2) To **engage students in creating projects** and learning exciting new skills that they are proud of
3) To **connect mathematical and analytical thinking** to these projects in order to make math more relevant for students

All Learning Exchange classes are structured within a project-based approach, with abundant analytical tie-ins throughout the experience. The goal is to get students to gain excitement about their learning, demonstrate ownership of their projects, and better understand the broader relevance of mathematical thinking.

PROGRAM STRUCTURE

Learning Exchange began with a four-week pilot at Samuel W. Bridgham Middle School in Spring 2011. Based on encouraging results, we decided to expand the program to a full ten-week cycle within the Providence After School Alliance (PASA) AfterZone at DelSesto Middle School. During the two-hour AfterZone framework's ten-week program cycle, program providers run one-hour M/W or T/Th programs. Because we were not an officially funded PASA provider, we recruited students to work with them during their spare hour, known as "Club AfterZone."

The program stretched from early October to early December, with two one-hour classes a week. We used the first class period to recruit students, with the remaining fifteen to sixteen classes consisting of actual teaching and project creation. We offered two sections of a computer programming course, in which students used MIT's Scratch environment to make animations and games, and two sections of a music mixing course, in which students used the open-source Audacity software to create original remixes from their favorite hip-hop tracks.[1]

LE teachers take part in a training offered by Citizen Schools.

Our 14 teachers and 2 curriculum developers applied through an online survey and in-person interview. We recruited teachers by marketing in the Music, Education, and Computer Science departments, reaching out to personal networks, and running a booth at the Activities Fair. Teachers attended a two-hour teacher orientation run by the Director of Curriculum and Learning at Citizen Schools, a leading nonprofit in after-school, project-based education. Throughout the semester, pairs of teachers were tasked with designing weekly lesson plans, and each course team would meet twice weekly on top of their teaching commitments to review the plans before class. During these meetings, teachers would also reflect on previous classes and discuss effective teaching techniques and growth opportunities.

Initially, music recruited eighth graders and computer programming took seventh graders. However, due to attendance issues and student attrition – a challenge faced by many PASA afterschool providers – three sections recruited a new batch of sixth graders in November. Seven music students and two programming students

[1] For more information on these platforms, please visit: http://scratch.mit.edu/ | http://audacity.sourceforge.net/

completed the full ten weeks. Of the students who were recruited halfway, six music and nine programming students persisted to completion. In total, 24 students completed the courses, and 15-20 others attended at least one class.

The ratio of students to instructors was approximately 1.5:1, and in many cases was 1:1 due to attendance issues. This small ratio was crucial due to the advanced material covered.

CURRICULA

Computer Programming

Introduction

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 that it often requires the computer scientist to understand and exercise mathematical reasoning. Doing math becomes more fun and rewarding because it is viewed as a concrete input into making a computer program.

The concept of using CS as a tool for learning math 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.[2] 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.

An LE instructor helps a student with her BrickBreaker game.

Environment and Lesson Plans

We divided the 10-week course into two distinct phases. The first phase had two objectives – to familiarize students with Scratch and expose them to math concepts that would be vital in making their programs. The second phase allowed students to use what they learned through the mini-projects and lessons of phase 1 to make a game or animation of their very own.

For the first five weeks, we set up lessons and mini-projects that taught students how to program in Scratch and think mathematically about programming challenges. To teach X-Y coordinates, we had students program a "Maze" game that required moving a character onscreen by appropriately changing its coordinates in Cartesian space. To learn about rates of change and encourage practice with basic fractions, we had students extend a "Speed Racer" game from the Scratch examples library to add in code that would slow the car down when it traveled on grass and speed it up while on asphalt.

Once students were familiar with Scratch and some of the math behind programming, they began developing their own creations. Naturally, as students worked on their novel games and animations, they ran into math challenges that we had not previously discussed as a group. For example, one student found the need to use variables in his Mario game in order to keep count of how many times Mario had touched an enemy. To address these challenges, LE instructors worked with students and asked them questions to guide their discovery of new concepts. Towards the end of the session, students would also help one another if their peers faced a problem they had recently solved.

Student Projects

Most students split the remaining five weeks working on about 2 different applications, as after a few weeks of working on one, they decided that they were either finished or were interested in trying out a new project. Student projects ranged from games such as Pac-Man and BrickBreaker to novel animations, like one about a character with laser eyes.[3]

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

[3] We have uploaded these student projects and more at http://learningexch.wordpress.com/projects.

All students were given a USB drive with a folder containing the following: their final projects, a copy of the Scratch installer (for both Windows and Mac), and instructions on how to install Scratch. The motivation behind this was to encourage students to make their own programs even after the end of the session.

Music Mixing

Introduction

Music mixing is an integral part of the modern entertainment industry, and the inherent math tie-ins are plentiful, from frequency calculations and tempo matching to data storage and unit conversion. Given how passionate students are about hip-hop music, we felt that this topic would be a particularly exciting one to connect with their classroom learning.

In the pilot program, we had used Apple's GarageBand environment, which was only available on Apple laptops and masked many of the math applications we hoped to reveal. For cost considerations during the Fall 2011 run, we switched to Audacity, which was free and ran well on the Windows laptops provided by the Dean of the College and the Science Center.

A student counts the beats of a song with an LE instructor.

Environment and Lesson Plans

As with the computer programming course, we structured the first portion of the music mixing course around different modules to build student abilities within the mixing environment while also establishing math connections.

We started with a series of mini-projects called "labs," which were mixing set-ups where students would learn how to match up pre-determined songs using worksheets and teacher guidance. In the first lab, students simply moved a series of tracks to create a remix. In the second lab, they imported tracks and looped a beat. In the third and fourth labs, students learned to beat- and pitch-match, and by the fifth and sixth, students were applying sound processing effects.

Interspersed with these labs were lessons on the "science of sound" and digital music in particular. Before teaching students about pitch, for example, we discussed the basic structure of a sound wave and introduced the concept of frequency. We also introduced binary number systems as an analog to digital storage, and briefly touched upon mathematical functions as analogs to sound processing effects such as amplification, equalization, and AutoTune.

Halfway through the course, we began shifting our focus from skills development to application. Students filled out project planning worksheets in early November and worked towards their projects for the remainder of the cycle. As students progressed further in their projects, we gradually replaced our labs and other direct teaching techniques with project creation and learning by doing.

Towards the end of the program cycle, we began to worry that students were falling into their own cycle of "beat-match, pitch-match, align, repeat" when mixing. To address this, our teachers began to further challenge students by encouraging them to add effects and additional samples to mixes instead of simply starting over.

Student Projects

Some students opted to create portfolios of shorter mixes, whereas a few created single longer mixes of existing songs. No students wanted to record their own content. Students' mixes varied in genre, tempo, and style, since we selected the acapellas and instrumentals in the music library by direct student request.

At the end of the course, we gave each student an audio CD with a copy of their creations and the creations of their classmates. In the one section in which all six students persisted

for the full ten weeks, they created a combined total of 90 minutes of music, which was too long to fit onto one CD; as a result, we gave each of these students everything they made along with samplings of their classmates' creations.

Outcomes

Written Student Assessments

We had students fill out pre- and post-evaluations gauging their attitudes towards math as well as their mathematical reasoning skills. The attitudinal survey focused on gauging each student's level of math self-efficacy and appreciation, whereas the skills assessment gave students a number of practice problems gauging their ability to do whole-number operations, manipulate fractions, and explain math topics conceptually in a timed setting.

Unfortunately, the general results of these evaluations remain largely inconclusive. Due to variability in attendance and challenges in having students take the evaluations seriously, we were only able to collect 11 completed pre- and post-attitudinal evaluations for music and 3 for CS; the numbers for the skills assessment were 6 and 3, respectively.

There were some encouraging results from individual surveys, however:

- 4 music students and 1 CS student showed increased confidence in attempting challenging math problems.
- 5 music students and 1 CS student demonstrated an increase in how interesting math is to them.
- In terms of skills, 2 out of 3 CS students demonstrated improved understanding of Cartesian coordinates, and 4 out of 6 music students showed improvements in their ability to do whole number operations.

Student Reactions

The qualitative responses from music and CS participants were much more telling than their written assessments. Students were excited to receive CDs and USB drives with their final projects – in fact, knowing that they would receive these items further motivated them to work hard to complete their projects. At the end-of-year PASA celebration, students from both courses came up to the Learning Exchange booth and discussed with enthusiasm their plans to sign up for LE offerings in the Winter 2012 session.

LE teachers guide sixth graders as they mix their masterpieces.

Students also developed strong relationships with teachers. Teachers from one music session spent time talking to their students about academic and social life at DelSesto before each class. One CS student contacted a teacher after the last class for help with installing Scratch on her computer. The student mentioned how her mother was extremely proud of the game she had made and that she was excited to build on her work. Another student proudly brought his USB drive to the PASA celebration and plugged it into an LE laptop to continue working on his animation with teacher support.

Instructor Reflections

Overall, LE instructors felt like they had an impact through the program. After facing challenges early on with spotty attendance, teachers worked hard to improve the curriculum and recruit excited students to participate. Teachers expressed increased comfort in dealing with middle school students. Many also demonstrated a growing passion for education and an interest in longer-term involvement within the field. Teachers had excellent ideas on how to improve LE for the next session, many of which are discussed in the next section.

We had a high rate of teacher retainment, with 11 of 14 volunteers expressing a desire to continue in the spring semester, class schedules permitting.

Next Steps

Program Improvement

On the computer programming side, teachers suggested beginning the course with animations, since they were simpler and offered a more immediate reward than games. They also suggested strengthening the focus on modules by offering students structured but more open-ended assignments and addressing obstacles as they arise organically. One additional suggestion was to focus on the application of math concepts first through programming and mixing, and then introducing the math behind these applications more rigorously later in the session once students and teachers built strong relationships.

On the music end, most suggestions from teachers and students alike concerned the environment: Audacity's interface was so drab and frustrating that students often used up their patience while surmounting environmental roadblocks and had little energy left for creative thinking or math applications. To resolve this, we are considering a shift in focus to music creation in order to boost student ownership and allow for the use of intuitive programs such as Ableton Live. Some volunteers have also offered to attempt to develop an all-new environment with an intuitive GarageBand-esque interface coupled with Scratch-like math tie-ins.

Finally, one instructor conducted a case study on improving student retention and engagement as a final project for *EDUC1010: The Craft of Teaching*. His research and in-class experience yielded the following suggestions to further improve LE for Winter 2012:

- Better tailor content instruction to different student needs by using hint slips to scaffold challenging math concepts
- Continue using Scratch but switch the music mixing environment to something significantly more intuitive (see above)
- Imbue student work with additional meaning by selling student mixes on iTunes (copyright laws permitting) and uploading animations and games to scratch.mit.edu
- Collect regular feedback by having students write daily two- to three-sentence reflections and self-assessments
- Promote collaboration through carefully calibrated group assignments and group teaching that plays to complementary student strengths
- Shift assessments to be more project- and presentation-based
- Organize a trip to Brown's campus to celebrate student success and give out awards

Program Expansion

Alongside our commitment to strengthen our courses for next semester, we have a number of ideas for program expansion. We have been awarded PASA funding as a full program provider for the 10-week Winter 2012 AfterZone. AfterZone starts on January 23, and for the first time, our students will be signing up for our program exclusively through the PASA brochure. We aim to serve a similar number of students as this semester: 24 students across four sections of three to four teachers each.

A student shares her animation with an LE teacher.

In addition, after a Scratch demo, a teacher from Vartan Gregorian Elementary School expressed a desire to see our program at the local middle schools that lack PASA support. Because the Winter AfterZone ends in March, we plan to

reach out to one of these schools to explore the possibility of starting a program there from late March to early May.

We are also exploring other ways of connecting Brown's resources to the Providence community and the broader world of education. A teacher at Esek Hopkins has approached us to help find volunteers to work with students in her Chemistry course in the spring. In addition, many of our teachers have expressed interest in bringing back a defunct edtech course previously offered as a seminar in Brown's CS department. We are in discussions with professors and other students to investigate the possibility of a research-based revival. Lastly, we held a joint recruitment session with Citizen Schools for next semester, and we plan to host more events that bolster the organization's presence on Brown's campus.

A student shows off his animation at the AfterZone celebration.

Special Thanks

We would like to thank the following people for helping us create and strengthen Learning Exchange:

- Our Fall 2011 teachers and curriculum developers: Shweta Bhatt, Sam Birch, Emily Cacciatore, Erin Corzine, Andrew DiMarco, Yudi Fu, Lucas Johnson, Matt Krukowski, Ryan McVerry, Aparaajit Sriram, Hannah Rosen, Danielle Rothermel, Sandra Yan, and Min Jung Yoo
- Previous Learning Exchange volunteers
- Our Citizen Schools partners: Emily Stainer for her teacher training, Philip Parham for his recruitment support
- Our advisors: Dean Oludurotimi Adetunji and Jo Browne from the Science Center
- Administrative support: Jodie Gill from the Science Center and Elizabeth Malone from the DOC
- Our PASA sponsors: Camely Machado from the John Hope Settlement House and coordinator of DelSesto's PASA program, Alison Quinn, Co-Director of PASA
- Emannuel Schanzer, Founder of Project Bootstrap
- Karen Brennan and Sayamindu Dasgupta of the Lifelong Kindergarten group at the MIT Media Lab
- Other professors and advisors at Brown, namely: Shriram Krishnamurthi, Chad Jenkins, Matt Harrison, Alan Harlam, and Alan Flam

THANK YOU!