



Teaching A Computer To Sing

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Legal Notices and Credits

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Bartlett Community School Collaborators

- Music Teacher Rachel Crawford
- Math Teacher Firas AL-Rekabi

What We Tried To Do

Simple Overall Goal

- Get middle school students programming



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What We Tried To Do

Not-So-Simple Environment

- After-school, that is, after they've already been in school for about 7 hours
- All they really want to do is hang out with their friends
- So how can we "hook 'em"?



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Our Approach

The Magic Music Teacher

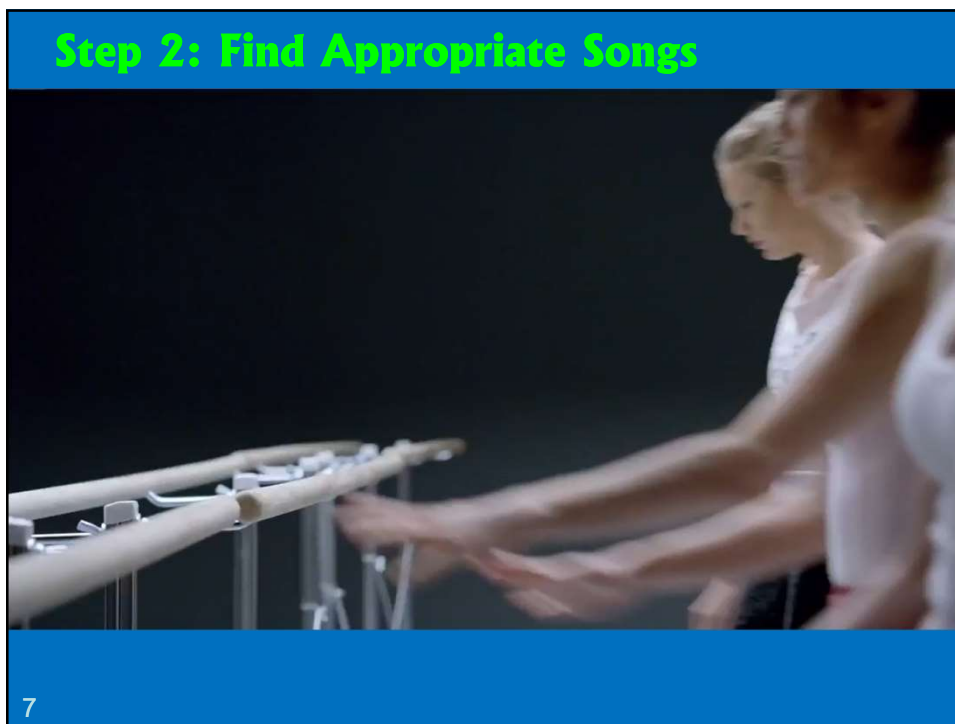
- We enlisted the assistance of a dynamic music teacher whom the children loved



Step 1: Get 'Em Singin'

"Stitches" by Shawn Mendes





Step 2: Find Appropriate Songs

Sheet Music Plus Order 747073550. 1 copy purchased by jesse_heines@uml.edu on Sep 14, 2015.

SHAKE IT OFF

Words and Music by TAYLOR SWIFT,
MAX MARTIN and SHELLBACK

Fast beat

I stay out too late, got noth - ing in my
beat; I'm light - ning on my

brain; that's what peo - ple
feet. And that's what they don't

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Step 3: Teach Reading a Simple Score

Shake It Off

Words and Music by Taylor Swift, Max Martin, and Shellback

I stay out too late, got no thing in my brain;
beat; I'm light-ning on my feet.

that's what peo-ple say, mm, mm. That's what peo-ple say, mm,
and that's what they don't see, mm, mm. That's what they don't see, mm,


mm. **What do we really have here?** but I can't make 'em stay;
mm. I make the moves up as I go.

at least that's what peo-ple say, mm, mm. That's what peo-ple say, mm,
And that's what they don't know, mm, mm. That's what they don't know, mm,

0 #

Step 3: Teach Reading a Simple Score

NOTES ON THE STAFF



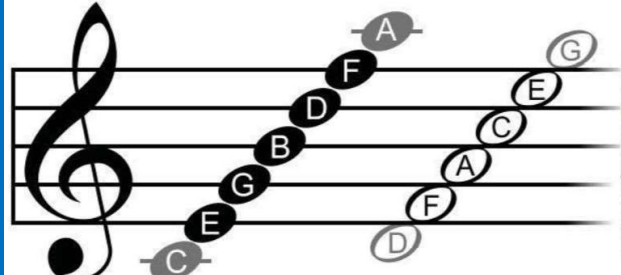
The musical alphabet uses seven letters:
A B C D E F G

After G you start over again at A.

The notes on the staff are on a line or in a space.

Remember the line notes by the saying:
Every **G**ood **B**urger **D**eserves **F**ries

Remember the space notes by spelling out:
F-A-C-E



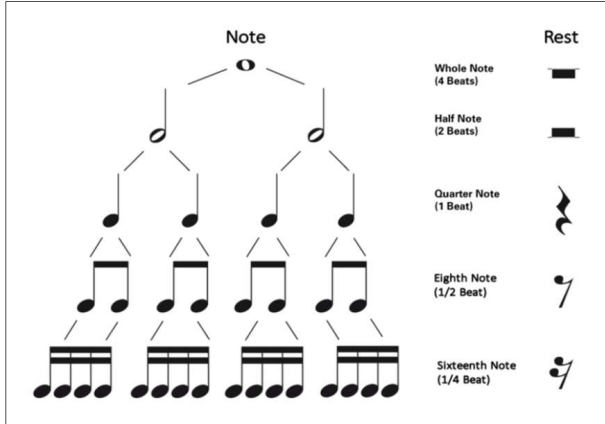
© 2015 Brandy Kraemer

Sources:

- <http://musicsmitheb.weebly.com/notes-on-the-staff.html>
- http://f.tqn.com/y/piano/1/S/G/7/-/-/Treble-notes_Grand-Staff.png

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Understanding Note and Rest Values

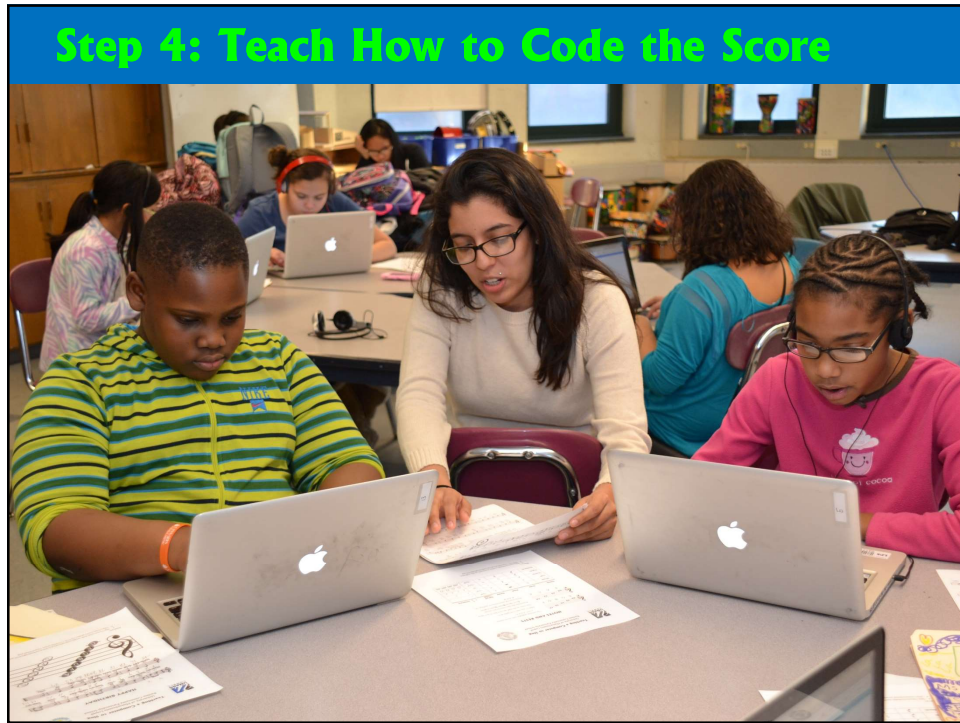


Note	Rest
Whole Note (4 Beats)	
Half Note (2 Beats)	
Quarter Note (1 Beat)	
Eighth Note (1/2 Beat)	
Sixteenth Note (1/4 Beat)	

ABC Notation

A4	whole note (4 beats)	z4	whole rest (4 beats)
A2	half note (2 beats)	z2	half rest (2 beats)
A or A1	quarter note (1 beat)	z or z1	quarter rest (1 beat)
A/ or A/2	eighth note (1/2 beat)	z/ or z/2	eighth rest (1/2 beat)
A/4	sixteenth note (1/4 beat)	z/4	sixteenth rest (1/4 beat)

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Step 4: Teach How to Code the Score


ARE YOU SLEEPING


Traditional
Arranged by CATHERINE DELANOY

$\text{♩} = 150$

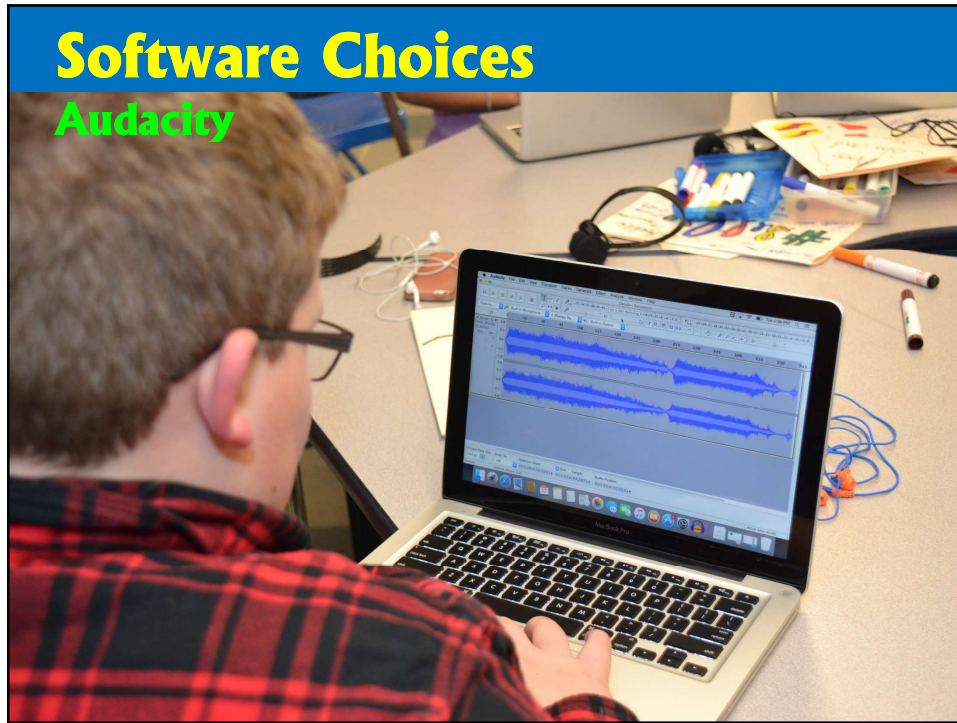
Are you sleep - ing, are you sleep - ing, Broth - er John, Broth - er John?

Morn - ing bells are ring - ing, morn - ing bells are ring - ing. Ding, dang, dong. Ding, dang, dong.

 Singing
Themselves

 Teaching Their
Computer to Sing

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Software Choices

Audacity

A screenshot of the EasyABC software interface. The window title is "EasyABC 1.3.7.7 2017-08-31 - C:\H-Drive\Proposals\NSF\ChordsAndComputing\BartlettSchool\AreYouSleeping_v1-3.abc". The interface shows a musical score for the song "ARE YOU SLEEPING" in 4/4 time, with a tempo of 150. The score includes two staves of music with lyrics: "Are you sleep - ing, are you sleep - ing, Broth - er John, Broth - er John?" and "Morn - ing bells are ring - ing, morn - ing bells are ring - ing. Ding, dang, dong. Ding, dang, dong." Below the score is the ABC code for the piece. The code includes settings for the file name, title, composer, key signature, time signature, and tempo, followed by the musical notation in ABC format.

EasyABC 1.3.7.7 2017-08-31 - C:\H-Drive\Proposals\NSF\ChordsAndComputing\BartlettSchool\AreYouSleeping_v1-3.abc

File Edit Settings Tools View Internals Help

Musical score

EasyABC

ARE YOU SLEEPING

Traditional
Arranged by CATHERINE DELANOY

$\text{♩} = 150$

Are you sleep - ing, are you sleep - ing, Broth - er John, Broth - er John?

Morn - ing bells are ring - ing, morn - ing bells are ring - ing. Ding, dang, dong. Ding, dang, dong.

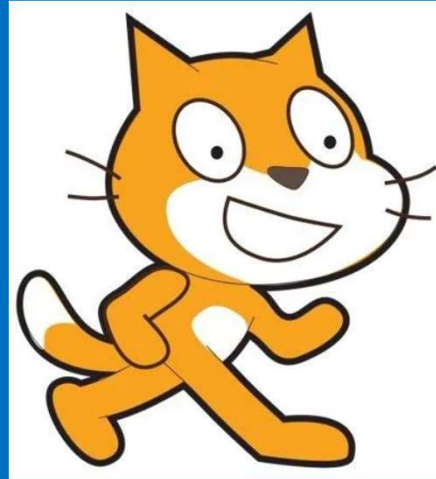
ABC code

```
1 $abc-2.1
2
3 X:1
4 T:ARE YOU SLEEPING
5 C:Traditional
6 C:Arranged by CATHERINE DELANOY
7 M:4/4
8 L:1/4
9 K:F
10 Q:150
11 F G A F | F G A F | \
12 w:Are you sleep-ing, are you sleep-ing,
13 A B C'2 | A B C'2 |
14 w:Broth-er John, Broth-er John?
15 C'/2D'/2C'/2B/2 A F | C'/2D'/2C'/2B/2 A F | \
16 w:Morn-ing bells are ring-ing, morn-ing bells are ring-ing.
17 F C F2 | F C F2 | ]
18 w:Ding, dang, dong. Ding, dang, dong.
```

Demonstration(?)
Documentation

Software Choices

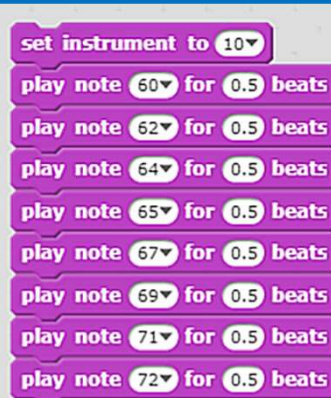
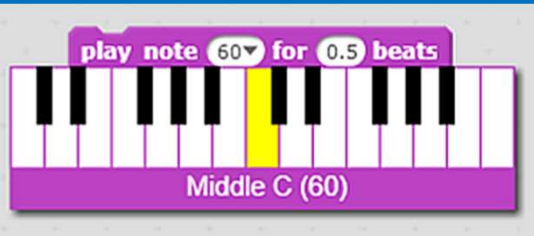
We truly love Scratch, but ...



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Software Choices

... Scratch music is encoded in MIDI numbers that bear no resemblance to musical scores



What does this code play?


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Software Choices

Scratch Minuses

- MIDI numbers
- Synchronization issues

What does this code play?



The image shows a Scratch script starting with a 'when green flag clicked' event. It contains four 'repeat' loops, each labeled 'Phrase #1' through 'Phrase #4'. Each loop contains 'play note' blocks with specific MIDI numbers and durations. Phrase #1: 55 (0.5), 57 (0.5), 59 (0.5), 55 (0.5). Phrase #2: 59 (0.5), 60 (0.5), 62 (1). Phrase #3: 62 (0.25), 64 (0.25), 62 (0.25), 60 (0.25), 59 (0.5), 55 (0.5). Phrase #4: 55 (0.5), 50 (0.5), 55 (1).

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Software Choices

Scratch Minuses

- MIDI numbers
- Synchronization issues

Scratch Pluses

- Looping structures
- Variables, even Arrays
- Conditional statements
- Branching via “broadcasts”
- Indirect referencing
- and other such constructs



The image shows a Scratch script identical to the one on slide 19, starting with a 'when green flag clicked' event and containing four 'repeat' loops for 'Phrase #1' through 'Phrase #4' with 'play note' blocks and durations.

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PENCIL
code


Dream it. Code it.


Learn professional programming languages using an editor that lets you work in either blocks or text. Create art, music, games, and stories. Or invent a program that will change the world.

Let's play!

```
dot thistle, 1000  
dot snow, 100  
fd 80  
dot snow, 80  
fd 60  
dot snow, 50
```

 Draw
Create art

 Jam
Make music

 Imagine
Code an adventure

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drjay

Blocks

- Move
- Art
- Text
- Sound
- Control
- Operators
- Sprites
- Snippets

```
play 'c G/G/ AG z'  
play '[fA] [ecG]2'  
tone 'B', 2, 1  
tone 'B', 0  
tone 440, 2, 1  
tone 440, 0  
silence()  
await listen defer x  
listen (x) ->  
write x  
say 'hello'  
new Audio(url).play()
```

```
1 for [1..2]  
2   play "G, A, B, G,"  
3 for [1..2]  
4   play "B, C D2"  
5 for [1..2]  
6   play "D/2 E/2 D/2 C/2 B, G,"  
7 for [1..2]  
8   play "G, D, G,2"  
9
```

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What does this code play?

drjay FrereJac-inC

Blocks

- Move
- Art
- Text
- Sound
- Control
- Operators
- Sprites
- Snippets

```
play 'c G/G/ AG z'  
play '[fA] [ecG]2'  
tone 'B', 2, 1  
tone 'B', 0  
tone 440, 2, 1  
tone 440, 0  
silence()  
await listen defer x  
listen (x) ->  
write x  
say 'hello'  
new Audio(url).play()
```

```
1 for [1..2]  
2   play "G, A, B, G,"  
3 for [1..2]  
4   play "B, C D2"  
5 for [1..2]  
6   play "D/2 E/2 D/2 C/2 B, G,"  
7 for [1..2]  
8   play "G, D, G,2"  
9
```

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Software Choices

Pencil Code Pluses

- Virtually all the features of Scratch, at least as far as music is concerned
- Dynamic keyboard available
- Completely web-based in native JavaScript
- Code view as well as block view

```
drjay FrereJac-inC  
{ } code  
1 for [1..2]  
2   play "G, A, B, G,"  
3 for [1..2]  
4   play "B, C D2"  
5 for [1..2]  
6   play "D/2 E/2 D/2 C/2 B, G,"  
7 for [1..2]  
8   play "G, D, G,2"
```

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Software Choices

Pencil Code Pluses

- Virtually all the features of Scratch, at least as far as music is concerned
- Dynamic keyboard available
- Completely web-based in native JavaScript
- Code view as well as block view

Pencil Code Minuses

- Not as intuitively obvious as Scratch
 - Neither is “Snap! (Build Your Own Blocks)”
- No longer under active development

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Software Choices

Pencil Code

- As with all software, doing complex stuff is complex
- We therefore created templates with prewritten functions that students could copy and edit for their own purposes

Demonstrations(?)

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Partner Songs

One Bottle of Pop

(View on DVD: Chapter 5, Track 4)

①

One bot-tle of pop, two bot-tle of pop, three bot-tle of pop, four bot-tle of pop,
five bot-tle of pop, six bot-tle of pop, sev'n bot-tle of pop, Pop!

Traditional.

Don't Throw Your Trash

②

Don't throw your trash in my back-yard, my back-yard, my back-yard.
Don't throw your trash in my back-yard. My back-yard's full!

Traditional.

Fish and Chips

③

Fish and chips and vin-e-gar, vin-e-gar, vin-e-gar.
Fish and chips and vin-e-gar, vin-e-gar, Pop!

Traditional.

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1. **Are You Sleeping?** (0:42) — recorded by the TACTS Chorus, December 1, 2016
 2. **Are You Sleeping?** (0:41) — recorded by the TACTS Chorus, December 1, 2016, with original lyrics composed by the TACTS Kids
 3. **Are You Sleeping?** (round) (0:20) — programmed by Saif AL-Rekabi
 4. **The More We Get Together** (1:02) — recorded by the TACTS Chorus, December 1, 2016
 5. **The More We Get Together** (0:25) — programmed by Hessell Rivera
 6. **The More We Get Together** (0:24) — programmed on two synchronized computers by Hessell Rivera and Taliya Chan
 7. **The More We Get Together** (0:24) — programmed on Kathryn Pen
 8. **Let It Snow** (1:02) — recorded by the TACTS Chorus, December 8, 2016
 9. **Let It Snow** (0:39) — programmed on Angelina Kong & Isabella Burigo
 10. **Let It Snow** (0:56) — programmed on Breanna Em
 11. **Let It Snow** (0:58) — programmed on Saif AL-Rekabi
 12. **Rudolph the Red-Nosed Reindeer** (1:40) — recorded by the TACTS Chorus, December 8, 2016
 13. **Rudolph the Red-Nosed Reindeer** (1:26) — programmed by Ethan Southimath
 14. **When the Saints / This Train Medley** (1:22) — recorded by the TACTS Chorus, November 29, 2016
 15. **When the Saints Go Marching In** (0:32) — partner songs programmed by Nelle Feliciano
 16. **Dona Nobis Pacem** (0:16) — programmed by Jackeline Hernandez-Cobon
 17. **Candy** (0:38) — original song programmed by Fernanda Lozano
 18. **Fight Song** (2:35) — recorded by the TACTS Chorus, December 10, 2015
 19. **Shake It Off** (3:29) — recorded by the TACTS Chorus, March 3, 2016
 20. **Stitches** (2:25) — recorded by the TACTS Chorus, March 3, 2016
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Primary Research Questions

1. Can middle schoolers follow the connections from singing to digitized sound to computer notation and back to music to help them learn to program using songs they like to sing?

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Primary Research Questions

1. Can middle schoolers follow the connections from singing to digitized sound to computer notation and back to music to help them learn to program using songs they like to sing?
2. Conversely, can programming their individual parts help students learn to sing in three- and four-part harmony?

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Secondary Research Questions

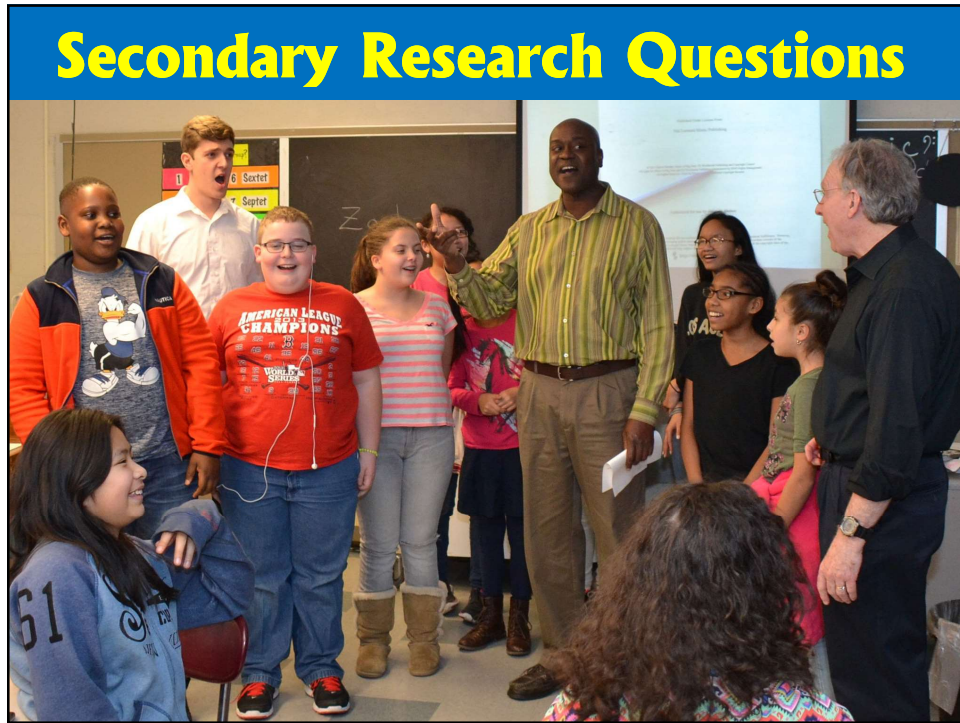
3. What resources, models, and tools are necessary to integrate STEM into a middle school, after-school choral program?
 - restricted network and Internet access
 - YouTube and music sites blocked
 - software installation prohibited
 - from laboratory model to clubhouse model
 - need for additional university student assistants
 - one-on-one instruction

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Secondary Research Questions

4. Can the involvement of older students and teachers who match the students' racial and/or cultural backgrounds have a positive effect on the “people like me don't (or can't) do that” belief that some researchers claim is a factor in underrepresented groups' disproportionately small participation in STEM?

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Secondary Research Questions

Formal Research Evaluation

Table 1. Facilitators' Perspectives on Program Objectives

Objective	Year	N	Mean	Std.Err.	Sig.
Follow connections both ways	1	4	2.00	0.577	p < .05
	2	8	3.88	0.350	
Learn to program using songs	1	4	3.50	0.289	no
	2	8	4.13	0.295	
Improve efficacy for programming	1	4	3.50	0.289	no
	2	7	3.71	0.184	
Racial/cultural matching positive	1	4	2.75	0.479	no
	2	7	3.71	0.184	



thank you

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CCSCNE, Manchester, NH April 20, 2018