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Music: Highly Engaged Students Connect Music to Math

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Abstract

A musician and a mathematics educator create and implement a set of elementary school lessons integrating music and math. Students learn the basics of music theory including identifying notes and learning their fractional values. They learn about time signatures and how to determine correct note values per measure. Students are motivated by listening to popular culture music such as Miley Cyrus and Justin Bieber and clapping to the beat. The culminating activity involves students creating their own four-bar phrase using their knowledge of time signature, note values, and fraction addition. Finally, the music teacher or capable student can sing or perform student-created phrases. The lessons described in this article provide strategies to help music educators and elementary school classroom teachers integrate music with math.

Keywords

composition, creativity, listening, elementary general music, music education, mathematics, integration

The *National Standards for Arts Education* (Consortium of National Arts Education Associations, 1994) and the *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000) encourage teachers to help students make connections between the arts, mathematics, and other disciplines inside and outside the classroom. Some researchers have found increases in academic achievement for students who study music (e.g., Catterall, Chapleau, & Iwanaga, 1999; Fitzpatrick, 2006) compared with students who have not studied music. This is, in part, due to the overlap between music skills and math skills. For example, Rauscher and Hinton (2006) assert the part-whole concept that is necessary for understanding fractions, decimals, and percentages is highly relevant in understanding rhythm.

Although most classroom teachers believe in the importance of teaching with and about the arts, few feel qualified or comfortable in doing so (Bohannon & McDowell, 2010). Argabright (2005) acknowledges that the current trend in education has focused on accountability based on student achievement. As such, general music teachers are being asked to "facilitate the integration of state language-arts and math standards with their general music curriculum" (p. 5). The purpose of this article is to illustrate how music educators and elementary school classroom teachers can collaborate to teach music with math. In an effort to exploit this overlap in skills, the authors of this article have created a set of lessons with explicit instruction on connecting music and math. The lessons described in this article provide strategies to help integrate music (reading and notating music) and match (development of understanding fractions as part of unit wholes).

The authors, a musician and a mathematics educator, were motivated to create these lessons after co-presenting several math conference sessions about music and math connections for teachers and also a one-day math conference for middle school students. Interjecting pop stars such as Miley Cyrus, Justin Bieber, Michael Jackson, and others to exhibit music and math connections proved to be an engaging motivation tool. Planning and implementing these sessions with teachers and students provided the authors with invaluable information in creating the following lessons.

The Note Value Chart (Lesson One, Part I)

At the beginning of the first lesson, which can be taught by the general music teacher or co-taught with

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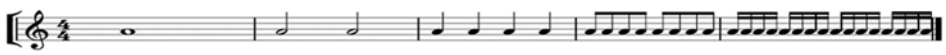


Name of Note	Whole	Half	Quarter	Eighth	Sixteenth
Note Symbol					
Fraction of Measure	$\frac{1}{1}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$
Number of notes that fit into one Measure	$1 = 2^0$	$2 = 2^1$	$4 = 2^2$	$8 = 2^3$	$16 = 2^4$

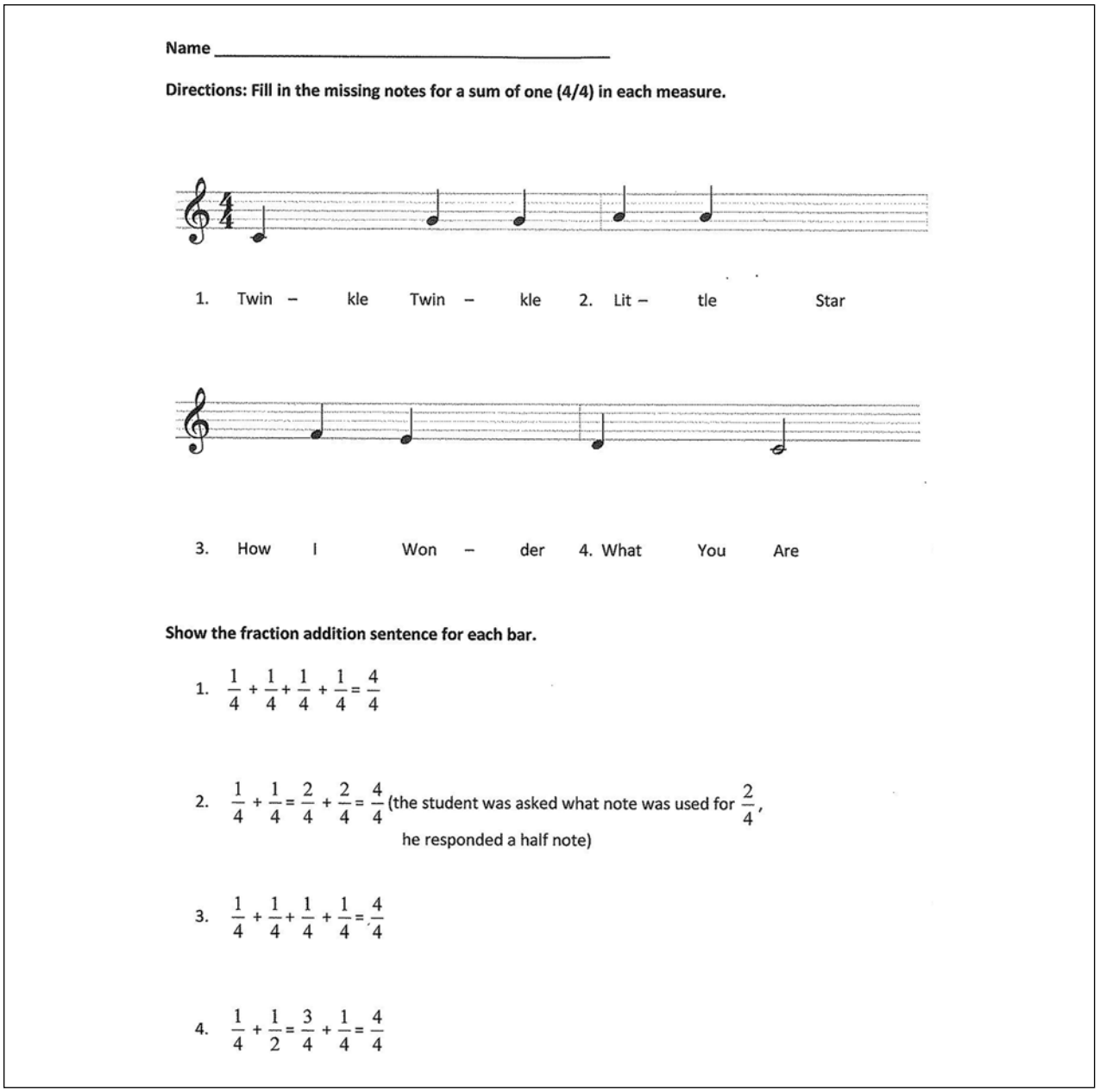
Figure 1. The math value of musical notes.
Source. Chart adapted from Garland and Kahn (1995).

the classroom teacher, students were introduced to the concept that rhythm measures time. The information discussed in this introduction included basic terminology. When putting a piece of music on paper, the notes are divided into measures (or bars) each representing the same unit of time. Within each measure, the number of beats is organized by the time signature. As we know, the time signature resembles a fraction with the "numerator" telling us how many beats are in each measure and the "denominator" telling us what type of note gets the beat (Garland & Kahn, 1995). Students learned how to identify the notes and the fractional value of each note (see Figure 1). This chart will be a valuable resource for the classroom teacher who may not be familiar with what is taught in music class. The bottom row of the chart can be used by the music teacher to make a connection between the number of beats and the powers of two.

Once students have learned the note values, we further examine the time signature. For example, a time signature of $\frac{4}{4}$ tells us that we need four quarter notes per measure (or combinations of other notes that equal four quarter notes). At this time, we could ask students what other combinations of notes would equal four quarter notes (one whole note, two half notes, a half note, and two quarter notes, etc.). We asked students to name a few songs and we then sang the songs to "feel" the beats. You can also have songs ready to play on a CD and ask students to sing along if they know the songs or clap along if they do not. We then played the Bee Gee's song *Staying Alive* because it is easy to clap along and "find the beat." As students sing or clap the songs, they begin to "feel" the $\frac{4}{4}$ count (1, 2, 3, 4, 1, 2, 3, 4, . . .) to determine the time signature.

"Twinkle, Twinkle, Little Star" (Lesson One, Part II)

To gauge student understanding of time signature, measures, and note value, we used a familiar song, "Twinkle, Twinkle, Little Star" (see Figure 2). The worksheet consisted of the sheet music with the complete lyrics of the song and some of the corresponding missing notes. Students were asked to fill in the missing note values based on the $\frac{4}{4}$ time signature. It was our intention to keep the focus on the fractional value of the notes; therefore, we excluded any information about the pitches of the notes. (Although the students at our sessions were not asked to properly place the notes on the staff, it could be appropriate at this time for the music teacher to continue with instruction on the notes and the pitches of the corresponding lyrics.) After finding the missing notes, students were asked to show the fraction addition sentence for each bar. A fraction addition sentence shows the fractions added including the plus sign and equal sign to achieve a sum of $\frac{4}{4}$ in math talk, or one whole. An example of this is shown here $\frac{1}{4}+\frac{1}{4}+\frac{1}{4}+\frac{1}{4}=\frac{4}{4}=1$ and also shown at the bottom of Figure 2. Some students used their knowledge of fractions to find the missing note values and some students used their knowledge of the number of beats because they were already familiar with number of beats from their music classes. Another example of how students found the missing note values is in the second bar of the song. The students were given the lyrics, "Lit-tle-Star" and two quarter notes under "Little." They might then show that $\frac{1}{4}+\frac{1}{4}=\frac{1}{2}$ and therefore a half note was needed to complete the bar. Many students did not show that $\frac{1}{4}+\frac{1}{4}=\frac{1}{2}$ because when asked,


Name _____

Directions: Fill in the missing notes for a sum of one (4/4) in each measure.

1. Twin – kle Twin – kle 2. Lit – tle Star

3. How I Won – der 4. What You Are

Show the fraction addition sentence for each bar.

1. $\frac{1}{4}+\frac{1}{4}+\frac{1}{4}+\frac{1}{4}=\frac{4}{4}$

2. $\frac{1}{4}+\frac{1}{4}=\frac{2}{4}+\frac{2}{4}=\frac{4}{4}$ (the student was asked what note was used for $\frac{2}{4}$, he responded a half note)

3. $\frac{1}{4}+\frac{1}{4}+\frac{1}{4}+\frac{1}{4}=\frac{4}{4}$

4. $\frac{1}{4}+\frac{1}{2}=\frac{3}{4}+\frac{1}{4}=\frac{4}{4}$

Figure 2. "Twinkle, Twinkle, Little Star" missing notes worksheet.

they said they did that part in their head. If they completed the missing notes because they knew how to count the number of beats, they were asked to also show the fraction sentences at the bottom of the page to prove their number of beats. If students finished early, they were given another song, "Mary Had a Little Lamb" to complete. (The "Little Lamb" worksheet could also be used for homework.) A follow-up discussion and further activities on equivalent fractions and fraction addition is appropriate at this time for the classroom teacher.

During our first session with middle school students, we found that students knew a connection between reading music and fractions existed. However, they rarely used that connection when asked to find the missing note values. Instead, they used the number of beats based on the time signature. This is great, but why not help these same students use the fraction connection as well? The student work shown in Figure 2 is representative of the many students who had little or no prior music instruction. Instead, these students quickly "found" the missing

note values by using fraction addition but did not explain that $\frac{2}{4}$ is equivalent to $\frac{1}{2}$ and therefore the missing note was a half note. We believe that by sixth grade the equivalence of $\frac{2}{4}$ and $\frac{1}{2}$ is so basic that students do not feel the need to explain. The missing notes activity is appropriate for students in Grades 4 to 6.

Differentiating Instruction

After learning the basic notes we proceeded to dotted notes, which can be used to differentiate instruction. A dot is worth a half of the value of the note it follows. For example, a dotted half note is a half note plus half of a half note. For younger and less capable students, you can use drawings to show $\frac{1}{2}$ of a $\frac{1}{2}$. For more capable students; however, you can use fraction multiplication to find $\frac{1}{2}$ of $\frac{1}{2}$ or $\frac{1}{2}$ of any other note. For example, $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$.

Assessment

To assess students' knowledge of all the notes, including dotted notes, students were given a worksheet of seven bars of music with notes. They used fraction addition (and multiplication) to show which bars were correct and which were not. Students were allowed to work with a partner. The collaboration among students was great and although some students were able to figure this out using the note values, they were asked to show fraction sentences to prove their decision (see Figure 3). The time signature for the first seven problems was $\frac{4}{4}$. If students finished early they were able to move on to other time signatures, including $\frac{3}{4}$, and $\frac{6}{8}$. Students who moved ahead to other time signatures were later asked to explain their work to the class.

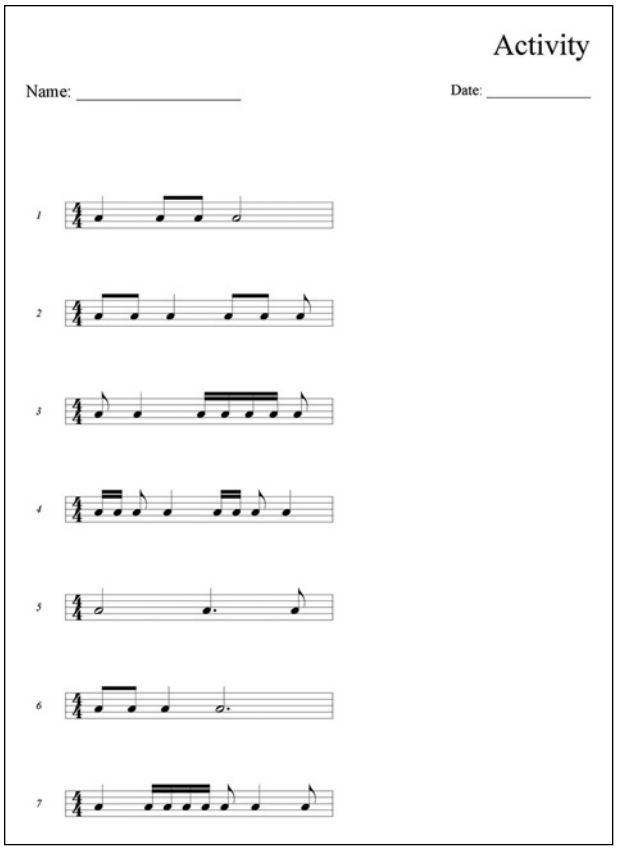


Figure 3. Music bars worksheet: Find the bars that work and do not work.

Popular Culture Music (Lesson Two, Part I)

To make a real life connection to the previous lesson, we had students listen to popular culture music (e.g., *The Climb* by Miley Cyrus) and clap to the beat and then identify the time signature. This was a lot of fun because although students were told that most songs are in $\frac{4}{4}$ time, this activity helped to reinforce this point. We also listened to a few older tunes as well such as Kool and the Gang's *Celebrate* and The Beatles' *Yesterday*.

Students were now ready to write four-bars using correct note values. The first time we did this activity, more students had problems than we anticipated. The task was for students to write four bars using each note value (whole note to 16th note) at least once. Although we had reviewed time signatures, bars, and notes, students were overwhelmed when confronted with the task of writing a four bar phrase. The next time we did the activity with another group of students, we added in a visual exercise in which students were given a worksheet with five squares. They had to divide the squares into parts of a whole using the note values of whole note, $\frac{1}{2}$ note, $\frac{1}{4}$ note, $\frac{1}{8}$ note, and $\frac{1}{16}$ note. They were encouraged to try different combinations of notes/fractions to make sums of one on their squares. For example, a student could divide the square into four equal parts and show that each part is equal to one fourth (see Figure 4). Once students completed five squares, they were instructed to choose four of the squares to create their four-bar phrase. Each of the four squares would be translated into the notes of each bar. For the example given, the student would write $\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} = 1$ measure in $\frac{4}{4}$ underneath the square to show the math and then draw four quarter notes in one measure on the music sheet to represent the square being divided into quarters. The students were surprised to learn that the square activity connected directly with the writing of their phrase. An example of a divided square is shown in Figure 4.

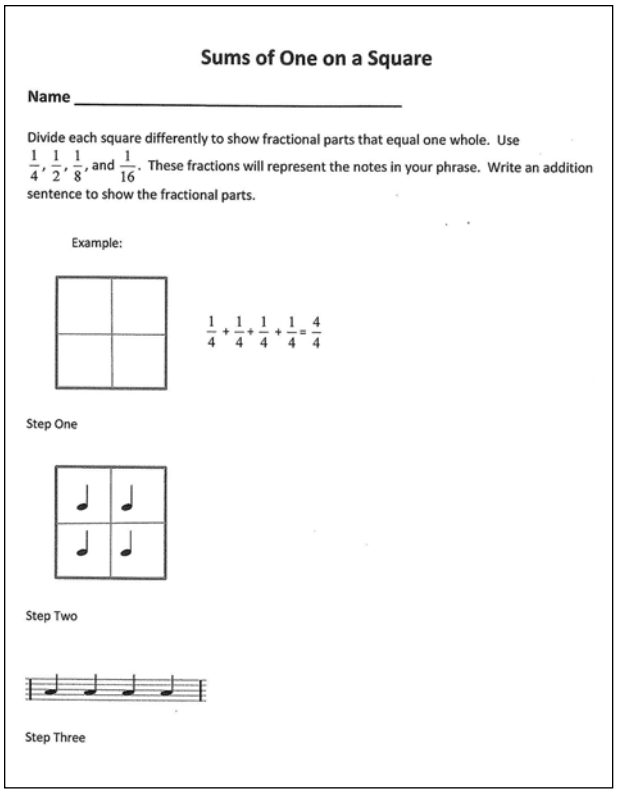


Figure 4. Example of divided square to translate to musical notes.

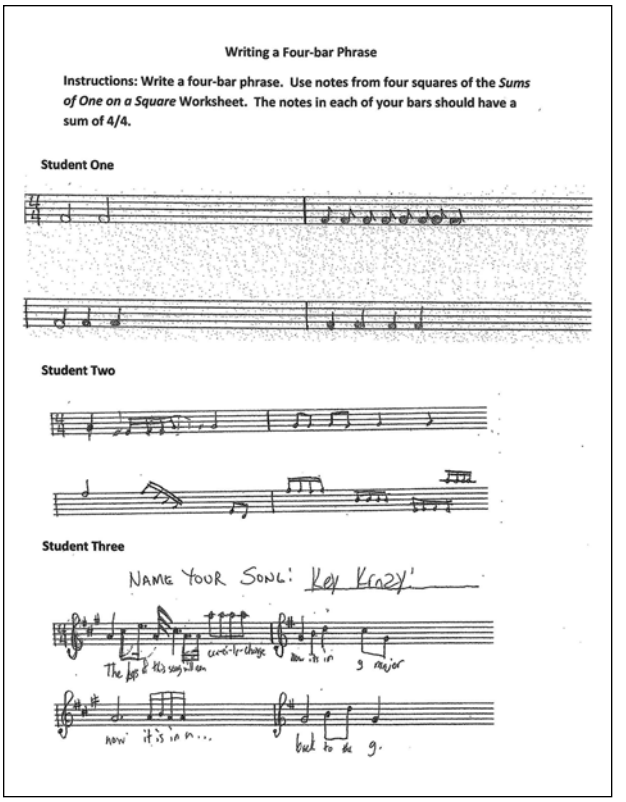


Figure 5. Sample student-created phrases.

The culminating activity was very exciting because students were able to hear their music come to life. This is a perfect time to have the general music teacher or a capable student play the student-created' four-bar phrases. One of the presenters of the conference session is a pianist. Because there is usually not a piano available, he played a sample of students' songs on the melodica along with prerecorded and edited accompaniment music. Michael Jackson's "Billie Jean" was edited as a two-bar drum intro to engage students to clap to the beat. The next four bars were the string bass and drums. This allowed the melodica to be used to perform the four bars of students' phrases (whom again had not focused on pitch). The melodica performances were done in an improvisational pentatonic minor scale. Other accompaniment music featured basic I, IV, V cadences for students that used diatonic scale choices (see Figure 5, Student Two). Student Three even wrote words to create "Key Krazy." The accompaniment music was a popular hip hop/pop beat. The pianist played the chords on the melodica and the student was challenged to sing his song. Each student received a rousing ovation for each effort. A practical alternative to this form of playback could be for the music teacher to use Orff instruments so that students can perform their own phrases. Remember that the sessions described above were done with students of varying music abilities and music instruction experiences.

Subsequent lessons will depend on the unit objective(s). These lessons are appropriate for the music educator to teach on their own and would satisfy the call for connecting music with other disciplines. As we know, music integrates well with many disciplines, mathematics is but one of them.

In the student work shown above, each student shows a different level of understanding of the concept of rhythm and note values in music as well as fraction addition. Student One has the correct fraction addition in each bar; however, the student uses mostly all like denominators except in the third bar the student uses a half note ($\frac{1}{2}$) and two quarter notes ($\frac{2}{4}$). In addition, the placement of the notes on the staff shows this student had little or no prior music instruction. Student Two has a good understanding of the math and as the song progressed (bars three and four) and the student began to create a musical flow of notation and sense of musical cadence using II V I. "Key Krazy" shows that Student Three has music knowledge and applied our program to the student's desire to show that he understood both the math and music skills. Bar one has some notation flaws that if notated correctly would have worked mathematically. The remaining bars

are perfect rhythmically. The created lyrics are syllablically correct to the corresponding music notes. The math challenges are both correct and creative. This student is clearly advanced in music in terms of grasping rhythm and language concepts!

Final Thoughts

Much of the literature connecting music and mathematics has focused on either students listening to music or students having music instruction in school as well as private instruction. On the other hand, little research has been done on the effects of learning music and math when the two are taught in an integrated way. The scope of this article falls short of researching this phenomenon; however, the authors acknowledge that this is a necessary next step. The authors further agree with Argabright (2005) when she said, "since children naturally love music, we [music educators] become natural funnels for integrating other areas of learning" (p. 5). The integration of music and math in classroom instruction becomes more accessible for both music and classroom teachers with materials specifically created for that purpose (Colwell, 2008). The lessons presented in this article are the first steps in the creation of such materials. It is the authors' hope that the materials help to facilitate future research to add to the literature on the effects of teaching music and math in an integrated fashion.

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References

Argabright, R. (2005). Connecting with music. *General Music Today*, *18*(2), 5-6.

Bohannon, R. L., & McDowell, C. (2010). Art, music, and movement connections for elementary education teacher candidates. *General Music Today*, *24*(1), 27-31.

Catterall, J., Chapleau, R., & Iwanaga, J. (1999). Involvement in the arts and human development: General involvement and intensive involvement in music and theatre arts. In E. B. Fiske (Ed.), *Champions of change: The impact of the arts on learning* (pp. 1-18). Washington, DC: The Arts Education Partnership.

Consortium of National Arts Education Associations. (1994). *National standards for arts education*. Reston, VA: MENC.

Colwell, C. M. (2008). Integration of music and core academic objectives in the K–12 curriculum: Perspectives of music and classroom teachers. *Update: Applications of Research in Music Education*, *26*(2), 33-41.

Fitzpatrick, K. R. (2006). The effect of instrumental music participation and socioeconomic status on Ohio fourth-, sixth-, and ninth-grade proficiency test performance. *Journal of Research in Music Education*, *54*, 73-84.

Garland, T. H., & Kahn, C. V. (1995). *Math and music: Harmonious connections*. Upper Saddle River, NJ: Dale Seymour.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

Rauscher, F. H., & Hinton, S. C. (2006). The Mozart effect: Music listening is not music instruction. *Educational Psychologist*, *41*, 233-238.

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