# A Case Study of Teaching to Multiple Intelligences--Music and Mathematics

by Scott Beall

From the moment I set foot into the classroom to begin my teaching career I have been drawn to explore the potential, value and complexities of interdisciplinary curricula. As a young teacher I was struck by a fundamental and basic observation; students too often receive an anemic, sterilized and disjointed view of the world through their schooling, partially as the result of knowledge and skills being differentiated into discreet subject areas. Content is rarely, or often inadequately, re integrated into its original, authentic and whole state, rendering meaning and relevance scarce. I looked further. I became intrigued with how interdisciplinary instruction might in fact be able to open access to students of diverse "abilities" or "affinities" and enhance understanding for all students. Inspired by the work of Howard Gardner and his theory of multiple intelligences, my questions took on more focus: Could one discipline be used as a medium to teach another discipline in real practice? To what extent could real instructional experiences be created that would allow transfer to happen on a substantive level? And might it be true that in some instances a principle may be understood more deeply when taught in a medium not typically associated with it, as opposed to its "native" discipline?

My insights as a musician and mathematician suggested an obvious context for my work. Music and mathematics integrate naturally, yet in practice speak to very different parts of a students' experience. For a large majority of adolescents, music is an ultimate expression of their identity, associated with passion, mood and emotional release, while mathematics is a tool one must learn to use to survive and get by, often difficult and boring, even scary. As a high school mathematics and music teacher, I created integrated math and music activities which, among other objectives, spoke to my questions of interdisciplinary transfer and multiple intelligences teaching. These efforts are now in the form of a supplemental curricular publication (Functional Melodies--Finding Mathematical Relationships In Music, Key Curriculum Press). The work is designed to accommodate the constraints of course definition and content coverage found in high schools, and to a lesser extent, middle schools.

In June of 1999 I was invited to the University of Connecticut in Storrs to participate in "Music and Minds," a 9-day special learning program for students with Williams Syndrome. Williams Syndrome is a relatively rare genetic defect affecting a wide assortment of cognitive functioning. Of particular interest and relevance for my work was the Williams subjects' marked affinity for and skill with music, and deficiency in spatial reasoning and mathematics. The combination of these characteristics made them ideal candidates to explore the potential of transfer in teaching to a weakness though the medium of a strength, specifically in this case, the extent to which mathematical concepts could be taught to the students through the medium of music. I was excited that absent the constraints of the high school setting, I could explore the principle of interdisciplinary transfer more completely and in a pure form. Over the nine day program, I could first teach a concept in a musical context and then, incrementally, through a carefully planned sequence of activities, the students would find themselves expressing the same ideas mathematically. The goal would be to make the transfer as seamless, organic, and intuitive as possible, so that no great leap would be involved in the transfer of the musical to the mathematical expression and application of the concept.

Music and Minds was primarily a music and performance program with one class of mathematics, which I designed and taught. I was unsure of what to expect going into this project. I had never met Williams students before, but had read assorted literature describing their "roughly second grade mathematical abilities" and "strong musical abilities, or at least, affinities." Thus it was clear that while I could map out a prospective curricular plan and establish a unit problem (goal) for the 9-day course, a great deal of improvisation would be inevitable as I got to know the students and their specific abilities and needs. Many of the activities were adaptations from my book, Functional Melodies--Finding Mathematical Relationships In Music. In the end, some completely new activities were developed that have become the basis for a series of complete units based on music and math integration.

Math Objective

The specific target outcome in math skill and understanding was for the students to be able to make and interpret a graph on two axes, the specific application being the daily temperature at UConn for 7 days of the program. Each day of the class the daily temperature would be noted and entered into a data table on the board. The data table would be visible each day, and its creation over time would provide a great deal of familiarity with the idea of ordered pairs of numbers by the last day of the program when they would actually plot the points and make the graph. The graph's creation on the last day would be their "exhibition" of sorts--the performance assessment for the program.

Math anxiety was considered as a significant factor in the entire process. Without exception, the students suffered from acute low self esteem regarding math and associated it with traumatic experiences. Hence, particularly in the early class sessions, most of the emphasis was placed on musical activities with the mathematical aspects kept to a minimum. From the students' perspective, noting the temperature each day was just a fun conversation piece that preceded each lesson. They were specifically not told why they were observing temperature. I did not want the students' thinking about the temperature chart clouded by the fear of what they may be asked to do with it at this point.

The Program

The instructional strategy for the program fell into three stages. Stage 1 engaged students in activities that focused on time values in rhythm and their representations by a horizontal position (horizontal axis). Stage 2, developed the notion of musical pitch and its representation by a vertical position (vertical axis) and combined this with the notion of the horizontal representation of time. Stage 3 applied the concepts used in the musical representations to a mathematical application.

Stage 1, The Horizontal Axis As Time, Days 1-4

Our first activity, "Multiples of Drummers" involved clapping various rhythmic patterns in groups and representing the claps on horizontal, scaled lines. The class was divided into two groups, each group simultaneously clapping at different beat intervals. The objective was to determine the beat number where the patterns would sound simultaneously by observing both aurally and graphically. The beat number of the simultaneous clap would be noted as the least common multiple of the two primary rhythms, and the resulting combined rhythm noted to be a "polyrhythm." For more advanced students, various polyrhythms would be charted, multiples observed and a general rule conjectured for finding least common multiples. This objective was clearly beyond the level of the Williams students. Many students were unable to accurately

represent the clapping patterns graphically. They had great difficulty tracking along a single line and placing dots at the intersection of lines. In many cases they lacked the ability to place dots in a consistent pattern, such as a dot every two scale units. It was difficult to tell at this point if it was a problem with hand/eye motor coordination of the physical placement of the dot, or inability to conceptualize the pattern and transfer the idea of claps to dots. The days to follow lent some insight into this. In any event, I became wary at this point as to whether or not the temperature graph was a realistic goal for these students. I seriously considered abandoning it, but decided to persevere with the original plan.

In days 2-4 I kept an open mind as to whether or not the temperature graph was a realistic goal. We continued with clapping various rhythmic cycles, representing the claps with dots. More simultaneous patterns were clapped and noted as polyrhythms. Student observers noted where cycles overlapped (multiples of the primary rhythms). These exercises were great fun with the students, and they improved on their ability to represent the clapping patterns with dots.

After the polyrhythms, a rap game was conducted where students had to determine an entrance point for a lyric line in relation to an existing drum part. This required the use of graphic materials as well, representing dots as beats and counting, adding and subtracting beats (dots) to determine the correct entrance beat. The performance nature of this activity was great fun, and continued to build on the skill of using graphic representation to represent auditory patterns. The students were having a wonderful time in class at this point, commenting that "this is the best math class I've ever had," and cheering wildly at each success. Classes would commonly begin and end with songs.

Each day a real world "problem of the day"(POD) was presented at the beginning of class. PODs were analogous to the music problems mathematically, and served as a warm-up for the class, while presenting another context for the math they would be doing with the music. At the end of the class the POD was revisited, solved, and connected to the music. This was something of an experiment, and not the primary focus of the lessons so I did not expect many of the students to make the connection, though some did on various levels. A POD example would be the following: Candy bars are 2 for $3. If you purchase 6 candy bars and give the cashier a $20 bill, what will be your change? The corresponding musical activity involved finding the entrance beat in a 25 beat drum passage for a 4-beat phrase, repeated 3 times, which must end on the last beat.

Stage 2, The Vertical Axis As Pitch, Day 5-8

The balance of the program followed a carefully designed sequence of activities that used melody to establish the concept of a graph on two axes. The following steps occurred over the 4 day period.

1) Qualitative Pitch Graph: This sequence began qualitatively, establishing a pitch as "high" or "low", and connecting this idea to the high and low area of a picture frame (graph without grid lines). Melodies were sung and drawn. A vertical placement on the graph was naturally associated with pitch value through their experience (high placement-high pitch, low placement-low pitch). The horizontal axis evolved to be the order of the note, which would later be associated with time.

2) Introduce Grid Lines: Numbers were then assigned to the pitches and a grid was added to the picture (graph). The C major scale was used and each note was assigned the corresponding integer, 1-8. "Name that graph" games followed where a melody was played and students were shown three graphs, one of which accurately represented the melody.

3) Data Tables From Existing Graphs: The next day students began analyzing melody graphs by locating the notes, determining the ordered pair that represented them and entering the pairs on a table.

4) Graphs From Data Tables: Students reversed the process in step 3 above and plotted melody graphs from given data tables.

5) Enrichment/Variation: To build on this skill in an interesting musical context, the melody graphs were altered by the students using the mathematical operations of adding 2 to each data value (pitch) and then multiplying each pitch value by 2. This process created transformed data tables which the students graphed and a musical composition was played that utilized the transformed melodies with the original.

Stage 3, Transfer to Math--The Temperature Graph

On the last day the students were presented with the task of graphing the temperatures that had been accumulating in the data table on the board all week. The temperature data were very similar to the melody graphs (by design) in that the melodies had 7 notes, and the temperature table had 7 days. The only leap for the students at this point was to work with different units; days and degrees (temperature) as opposed to note sequence and pitch values The students performed famously. Nearly half of the class had the graph accurately created within 10 minutes with no assistance from the staff. Most others finished with minimal assistance. This was a remarkable moment, considering our doubts about accomplishing this at the outset of the program. We were done with the lesson 20 minutes before the end of class!

Extension: To finish off the day we viewed a temperature graph and a stock market graph from the newspaper. Maggie had brought these graphs to our attention at lunch the day before, actually giving us some advise on when it would be appropriate to buy stocks. She clearly understood the graphs. The balance of the class faltered somewhat in the ability to interpret the newspaper graphs, but I left convinced that if the program were to continue, that our perceived limits of what these students could accomplish would continue to be re drawn given appropriate pacing, context, environment and support. I do not have any hard data regarding their attitudes toward math, but all indications are that the class was a great success in this area. The students loved the experience and consistently commented (emphatically) how different and fun this math class was. How deep and lasting it may be remains to be seen, and will be born out over time. The curriculum created at Music and Minds is the beginning of a new book I am developing targeting elementary level students.