Integrating Music and Mathematics:
A Collaboration Between Scott Beall And Zhania Aubakirova's College
Almaty, Kazakhstan

Introduction/Overview

In the spring of 2002, Scott Beall received an email from Nigmet Ibadildin of Zhania Aubakirova's College in Almaty, Kazakhstan, inviting Mr. Beall to visit the college and hold workshops on the topic of integrated music and mathematics curriculum and teaching pedagogy. The college was interested in Mr. Beall's curricular publication, Functional Melodies‹Finding Mathematical Relationships In Music (Key Curriculum Press, ©2000). The interest of the college stemmed from the desire to extend and inform their own independent project, Music and Mathematics: Learning and Mastering. The college discovered Mr. Beall¹s work in a Key Curriculum Press catalog brought to the school in 2001 by David Rusin, a visiting mathematics professor from Northern Illinois University. The trip took place February 6-23, 2003. During the visit Mr. Beall,

- taught classes daily to grades 3-11
- led teacher workshops daily
- observed instruction by teachers at the college
- held interviews with staff, students, and Zhania Aubakirova
- attended special musical performances by students and Zhania Aubakirova
- reviewed assorted pieces of student work and special projects
- arranged student exchanges with his school in the United States
- gave a lecture to the staff of the Conservatory of Music in Almaty
- met with Stephen Guice, the Cultural Affairs Officer from the U.S. Embassy
- attended special student assemblies and gatherings
- compiled 8 hours of video tape of the visit
- This document presents an account of the visit.
- A general narrative is followed by a summary/reflection and recommendations for further collaboration.

Narrative of Events

Orientation and Setting the Agenda

My first day at the school focused on general orientation and establishing goals, priorities, and a plan for the work of my 2-week visit. I expressed the desire to observe a variety of classroom lessons as taught by the teachers of the school, meet students, see facilities, and end the day with a meeting with teachers and administrators so that we might best assess their needs and set an agenda for the coming weeks. The end of the day also included a meeting with Zhania

Aubakirova. This meeting proved very useful in focusing the coming work. I first observed a 5th grade and 9th grade math class. The younger students were diligently working on arithmetic; working series of problems multiplying decimals with paper and pencil. My interpreter mentioned that they "never" use calculators here, only maybe in the later grades, 10 and 11. The class environment was warm, supportive, safe and friendly, with students presenting solutions on the board while some watched, and others continued work at their desks. The teacher and students obviously had a mutually respectful and nurturing relationship. There were about 10 students in the class, which was generally the average class size for all classes at the college. (The term "college" is used to refer to K-12 schools in Kazakhstan).

The 9th grade curriculum content involved solving quadratic equations by the quadratic formula and completing the square. The classroom environment was the same as that of the 5th graders, with a similar process of individual work mixed with board presentations and teacher prompting and questioning. Teachers used inquiry based questioning approaches, leading students to correct errors on their own through thoughtful questioning. No technology was present in either classroom. Overhead projectors, manipulatives and use of any special handouts was not present. The text, the teacher, and fellow students were the resources. From these observations I was able to begin setting a plan to determine which music and mathematics activities would be appropriate for various grade levels. I also learned something about the teaching style that the students were accustomed to. The balance of the day included listening to various student musical performances, a teacher meeting, and a meeting with Zhania Aubakirova.

In my meeting with Zhania and the teachers I discussed the philosophy and methodologies of my integrated music and mathematics curriculum work. I then explained how Functional Melodies is a specific application of the work that targets teaching mathematics through the medium of music. We explored the various reasons to integrate disciplines. I explained learning transfer theories and ways that integrated music and math curricula can raise all students¹ understanding of the disciplines and open access for students of diverse learning styles and intelligences. I then emphasized how integrating music and math inspires curiosity and imagination, and generates an enhanced sense of meaning and relevance for mathematics. Finally we acknowledged the integration as a model and metaphor to teach interdependence and unity within diversity in many realms, including culture, language, and nations. The meeting was very inspiring and we left with a strong sense of connection and shared purpose regarding the importance of this integrated vision for teaching. It appeared clear at this time that the international, cross cultural dimension of this consult (American--Kazakhstani) was metaphorical to the integrated music and math work. We acknowledged that the theme of exploring commonalties between cultures and the conceptual nature of boundaries and divisions was as a meaningful and important metaphor/extension of integrating disciplines. This became more significant than we originally expected as the work progressed, and is currently evolving as students pursue their exchanges and everyone involved reflects on the experiences of the visit. More on this aspect is discussed in the summary section of this document.

It was ultimately decided that the primary goal for my work of the visit should be to train the teachers in the College to teach the integrated music and math curriculum contained in my book, Functional Melodies. A further goal was that they might eventually be able to share the knowledge with other teachers in Almaty. I suggested to the team that the most effective means to accomplish this would be through two primary strands: 1) modeling instruction with students and 2) direct teacher workshops. I would teach an assortment of the lessons to students of

various levels in the first part of each day with various teachers observing and taking notes. Each afternoon a teacher workshop would be held. Due to the busy schedules of teachers, it happened that not all teachers could attend all workshops, nor would the same teachers who observed the modeled teaching necessarily be present in that day¹s teacher workshop. Given this situation, it was not necessary for me to structure days such that the modeled lessons of the day were the topics in the following teacher sessions, so these two strands followed their own sequences unto themselves. I planned the various student classes based on the needs of the students using a sequence of lessons that would be most coherent for the grade level and the number of sessions I would meet any specific grade level. This varied for each grade level. For the teacher sessions I began with a theoretical overview of integrated curriculum, worked through a series of activities, and concluded with a general lecture on various pedagogical methods of progressive education that have evolved in practice the United States over the past 40 years.

Student Classes

Instruction delivered to students over the subsequent 9 working days was scheduled as follows:

Grades 3/4 1 class, 6 sessions
Grade 5 1 class, 6 sessions
Grade 7 1 class, 2 sessions
Grade 8 1 class, 3 sessions
Grade 9 2 classes, 3 sessions each
Grade 11 1 class, 4 sessions

My decisions regarding which activities to do with each grade level included, but were not limited, to the following considerations:

Students¹ prior knowledge and pedagogical conditioning
Relevance to the mathematical content of the students¹ primary curriculum
Logistical practicality of the setting: facilities, available technology, language, and time
Action research: To gain insights into interdisciplinary transfer and general student response at various grade levels to various activities.
The goals of the student sessions were (in order of priority):

1. to model the teaching methods for teachers
2. to expose the students to new ideas, generate new questions and open their minds to the underlying complexity and interconnectedness of the universe
3. to enhance their knowledge and understanding in mathematics and music

Grades 3/4

Lessons for the 3/4 grade students began with Multiples of Drummers, and progressed to an adapted and supplemented version of Functional Composer. I was unsure if they would be able to grasp the concepts of Functional Composer, but after some careful reflection and consideration of the research nature of this project I decided to include that activity.

All of the activities with these students proceeded very smoothly. I made adaptations in pacing and structure as the lessons progressed and as I got to know the students¹ abilities, prior knowledge and learning styles. With this age group I usually do not attempt to establish the general rule for finding least common multiples, however I decided to push on with these kids to see if it was possible. Many seemed to grasp the idea, and I reviewed it upon several meetings. Their ability surprised me. Many retained the concepts and were able to complete the final problems at the end of the lesson. These problems have been known to cause 9th graders difficulty. This class proudly determined the LCM of 2, 3, 4, 5, 6, and 7 to be 420, using the general rule in many cases!

To introduce the concepts of Functional Composer I began singing graphs of scales and various melodic patterns. We then played "name that graph," a multiple choice melody-graph matching exercise requiring students to hear melodic intervals and match them to an appropriate graphic representation. These students performed famously (obviously due to their extensive musical training and talent) and we moved on to dictation of the song, "A Lion Sleeps Tonight," where the students made graphs from the sung melody. Again, the students musical prowess was impressive, as they finished the graph very quickly and more efficiently than many students twice their age, based on my teaching experiences in the US. We then moved on to Functional Composer.

Again, in the Functional Composer activity the students¹ performance was beyond my expectations. It was especially significant considering that they had had little experience working with graphs in the previous schooling. From what I could tell, this activity served as an introduction to graphing for the students. More is discussed regarding the significance of these students¹ performances in the summary section of this report.

In many cases, the observing teachers would roam and assist students, further involving themselves beyond mere observation.

Grade 5

This grade did three activities: Multiples of Drummers, Record Producer Algebra, and Functional Composer. We were able to complete all of them, with the exception of one problem at the end of Record Producer Algebra.

In Multiples of Drummers students had some difficulty grasping the general rule for LCM. Some of this may have been a communication issue, as this was the first group I taught it to at the college. I was adjusting to the process of working through the interpreter was and learning the extent of the students¹ vocabulary in English, as well as how to articulate instruction in ways that would translate well. In Functional Composer a significant number of students were visibly touched by the higher message of that activity. They considered the limits of rational thought, the essence of creativity, and how subjective and rational ways of knowing interrelate. They also considered the cognitive complexity of the process of musical composition. I considered this a significant accomplishment for 5th graders, especially under the circumstances of such a short instructional sequence.

Grade 7

This class was very adept, and we were able to do both Record Producer Algebra and Functional Composer in two sessions. In Record Producer Algebra, students were initially a little stiff, as it was obvious that they had never engaged an activity quite like it before. Also, they were inevitably adjusting to the presence of an American teacher in their class. They quickly warmed up however. There were marked differences between students¹ involvement within the class, as is often the case with this activity. Some remained silent and seemed uninvolved and others calculated and discussed with each other. Only two groups actively performed their solutions to the class. It was clear that the others were considering the mathematics and musical problems of the activity as well, but were too shy to rap the English phrases in front of the whole class. I was originally planning to do Multiples of Drummers with this group, but on Natalia¹s suggestion I did Functional Composer. The time was short, so it amounted to more of a presentation than an interactive activity, but students were attentive and very interested. By all measures the ideas were new to them, and the activity raised their level of awareness, curiosity, interest, and understanding of functions and transformations.

Grade 8

This class did Functional Composer, Name That Function, and Record Producer Algebra. The class was relatively small and possibly less interactive than some of the others, though they did excellent work. We were able to explore some math applications to the transformation concepts in Functional Composer with this class since their math background included graphs of quadratics. It presented an interesting opportunity to introduce the graph of the sine function, a topic they had not yet studied in their regular classes. I demonstrated to them that even though they did not yet completely understand the function itself, the principles learned in Functional Composer would enable them to identify the formulas for various transformed trigonometric graphs when referencing the parent graph of y=sin x. After Functional Composer, we spent a significant amount of time working through two games of Name That Function. This became very challenging (as it is for most students) and those with the most musically developed ears clearly had the advantage. I could see students¹ frustration here when confronted with a non routine problem with no previously studied method available. This problem solving temperament of the students also surfaced with the 9th graders in another context.

Grade 9

I began these classes with a special problem unrelated to music, and followed it with Functional Composer, Name That Function, and then a condensed, adapted version of Scaling the Scale, parts I and II. The special problem, "Corey the Camel," is based on strategic thinking and logic, and asks students to determine the maximum number of bananas that a camel can get to a market, given: 1) the market is 1000 miles away, 2) the camel must eat 1 banana per mile of walking, 3) the camel can carry only 1000 bananas at a time, 4) there are 3000 bananas that need to be transported. I chose to begin my work with this problem for two reasons: 1) to learn about the student¹s problem solving style and 2) to establish a classroom culture of inquiry, cooperation, and teacher as facilitator. The problem was borrowed from "The Interactive Mathematics Program," a progressive integrated math curriculum published by Key Curriculum Press. Corey the Camel is one of genera of math problems referred to as "non routine" and open ended problems that are given to students to solve over time, often as a "Problem of the Week." In this case, we devoted one class session to work on the problem, completed it at the beginning of the following session. It revealed a great deal to me regarding the students¹ temperament and approach to problem solving (which had also surfaced the 8th graders). In

many ways they reacted as students in the US would, eager to solve it, and frustrated that it did not fall into some previously studied formula. Since the student¹s experience with this problem was condensed in time, I gave hints more quickly than I normally would have. Some students almost solved the problem on the first day. They continued to ask me in the halls about the solution that afternoon. They had obviously discussed with their peers, as other students asked me about the problem. It frustrated them, but intrigued them. At the end I suggested the possible extensions of generalizing the problem for all parameters and creating a formula.

It is very difficult to make a generalization, but these students, clearly very adept in their usual math studies, felt less comfortable with this problem than the American students that I teach. I expected this. It is no mystery that confronting non routine problem situations requires practice with non routine problem situations. This was not the type of practice these students had had. More is discussed on this topic in the summary to follow.

Functional Composer was very effective and the mathematical knowledge and ability of these students allowed me to make connections to specific mathematical applications they have studied in their texts. These connections were not as obvious for the students as I expected however. Their performance led me to believe that the math curriculum in their schooling did not emphasize graphing to the extent of many curricula in the US. In any event, we applied the music composition concepts to quadratic functions and trigonometric functions.

Originally designed as a directed discovery activity to last 100 minutes, I conducted Scaling the Scale Parts I and II as a presentation, and condensed it into 45 minutes. Many of the ideas were new to the students, however not to all, but the context was new to all. I used my guitar to demonstrate harmonics, discussed timbre, frequency ratios, Pythagoras¹ method to determine scale tones, and the development of the tempered scale and the logic and mathematics therein.

Grade 11

This class did Corey the Camel, Functional Composer, (Movement I and II), Name That Function, and Scaling the Scale Parts I and II. I also briefly demonstrated the activity, Inside Out. Each activity moved more quickly than other classes due to the advanced level of these students.

Teacher Workshops

With the expressed goal of preparing the teachers to teach as much of my curriculum as possible, I began the first day's session with a workshop based on a variety of topics from the introduction of Functional Melodies. This included general theoretical and philosophical points that my work is based on as well as methodologies, learning pathways and expected learning outcomes for students.

On the days that followed I conducted a series of Functional Melodies activities with the teachers. These were structured to treat the teachers as though they were a class of students. I paused for discussion points along the way to elaborate on pedagogical considerations and issues presented in the opening session. In side discussions we considered such topics as how to adapt to different grade levels or music/math expertise on the part of the students, as well as

connections to the primary math or music curriculum that teachers could capitalize on. While many of these topics are covered in the teacher text of Functional Melodies, some are not, particularly the adaptations for elementary grades. These adaptations included "name that graph" activities, variations of the worksheet formats to larger sizes, and ways to change language and pacing. All together, the activities we covered were Sound Shapes, Multiples of Drummers, Functional Composer, Name That Function, Scaling the Scale Part 1 and 2, Record Producer Algebra, and a brief overview of Measures of Time and Inside Out.

The final session was directed toward general theory and methods of interdisciplinary project based curriculum design and implementation. The curricular examples used did not involve music and mathematics. I used a variety of curricular examples that I developed Homestead High School in Cupertino, California for the Foundation Integrated Studies Program (FISP) under a special Annenberg school reform grant. These were integrated units of geometry, physics, algebra and biology for 9th and 10th grade students. General pedagogical topics covered or introduced in this final session included:

1. Discovery based learning and constructivism
2. Multiple contexts for access and understanding
3. Multiple intelligences theory and Howard Gardner
4. Strategies and benefits of cooperative group work
5. Role of the teacher as facilitator and coach
6. Student status relationships in the classroom
7. Problem and project based learning
8. Interdisciplinary transfer
9. Thematic based curriculum and essential questions
10. The role of culminating projects
11. Curriculum spiraling and layered mastery
12. Interdisciplinary curriculum designs

As previously mentioned, the teachers who attended any given workshop varied, however several music and math teachers were consistently present for most. My interpreters were very effective, and for the most part teachers were very attentive, taking notes and participating in the activities. I did my best to pause for side discussions as the activities progressed to address teaching issues.

Classroom Observations and Collaborations

In addition to a busy schedule of teacher workshops and student classes throughout my visit I was able to observe a variety of classes taught by the teachers at the college. The following observations occurred on the days following my initial observations of the mathematics classes.

I first observed a 3rd/4th grade class taught by Olga, the school psychologist. Students were involved in an interesting spatial reasoning type of puzzle activity. They were given a colored graphic design and the task was to recreate the design with a set of cubes that had various colors and shapes on each surface. I joined in with the class. We then did some tangram puzzles, some of which were very challenging. Olga gave me a set of the tangrams, which she said were created by a famous Russian family many decades ago that traveled around the

Soviet Union providing educational materials to children. I plan to incorporate these into a group dynamics activity I use in my school in the U.S.

I also visited the computer lab and had several discussions with Martina, the computer instructor. I had to use an interpreter here, and the communication was a little difficult. She was very interested in ways that the computers could be used in integrated music-math activities. I first attempted to discuss MIDI (Musical Instrument Digital Interface) with her but that was a little difficult, and any fruitful application would depend on a fair amount of software and some hardware which did not appear to be present. We then moved to some topics that actually were more relevant to the type of integration we were working on. We experimented with the Microsoft Excel program to find meaningful ways that students could represent melodic graphs. We programmed a starting motif as a number sequence and applied a wide variety of mathematical operations on it in the manner of Functional Melodies. It soon became very apparent that the computer would allow us to experiment with a vast number of different functions; natural logs, trigonometric, cubic, etc. In order for the resulting function values to be meaningful musically (to be within a playable range) we would adjust coefficient values and experiment with other operations that would adjust the shape of the graph in ways that seemed interesting and had the potential to be musical. We discussed how many composers of "new music" of the 20th century use such techniques to compose, and that it could be a very interesting project for her students to work through the behavior of various mathematical functions in the context of making musical judgments. I shared with Martina that I have been working on a project to create a software that combines the graphing and computational capacity of Excel with a music sequencing program and tone generator, so students could immediately hear the music created by their mathematical functions. I will definitely keep them informed of this as it develops.

I then observed a very interesting 4th grade mathematics class that was integrating music. The teacher had several large posters with musical motifs written on them. Some posters were duplicates of others, and others were different. The teacher would put up a combination of musical motifs, and the students were asked to draw the geometric figure that represented the set of motifs. For each exercise a student from the class was asked to go to the piano and play the motifs so that the musical "period" could be heard as well as seen in notation. Initially this appeared similar to my activity, SoundShapes, but it was distinctly different. The emphasis here was on form. In this activity four repeated identical motifs (AAAA) were represented by students as a square, three identical motifs (AAA) as an equilateral triangle. The exercise then got more complex, with an ABA musical form being represented by an isosceles triangle, and an ABAB form represented by a rectangle. Students all seemed to generate the same geometric figure for each form, as though it was clear to them the type of interpretation the teacher was seeking. This continued for some time to include more complex geometric shapes. I was especially impressed with the level of abstraction that the young students were working with. The activity then moved to some pure geometrical area problems.

A music theory class I attended proved to be very interesting. This teacher was responsible for mentoring Allehan Aubakirova¹s special music and mathematics project that had recently won a major award in Almaty. This was an 8th grade class with only a few students present. After viewing her explanation of pivot chords between relative major and minor keys, the teacher and I had an extended discussion on the mathematical relationships within the cycle of 5ths. She demonstrated a number line method that she created to help students see and use the

mathematical "distances" of various key centers on the cycle of 5ths. She gave me a poster that demonstrated her work.

Interviews

In addition to ongoing conversations throughout the visit, several more formal interviews were held during my visit, both of and by the staff and students of the school. I conducted two interviews, one with Aina, Natalia (administrators) and music teacher and another with Zhania Aubakirova at the conclusion of the trip. I was interviewed by Zhania at the beginning of the trip, by the students in a town hall meeting, and again informally by teachers in various meetings. Most of these interviews were video taped.

My interview with Aina, Natalia and the music teacher followed several performances by some students. It focused on some general aspects of the school and how students are identified for special music training. I learned that the college has a strong reputation in Almaty for being a high quality school with a nurturing and intellectual atmosphere. The low student teacher ratio and overall numbers made it a highly desirable environment. Most students study music, but they are not required to. All of the students go to a university upon graduation. Every student begins study of English in 1st grade, in addition to another language, hence upon graduation they are typically fluent in four languages that include Kazak, Russian, and English. We also discussed their use of technology. While I did not observe students using any technology in the classrooms, a substantive computer lab was available and Natalia and Nigmet informed me that most students are proficient in Power Point, Excel and the school emphasizes technological proficiency in their students.

My final interview with Zhania confirmed a strong shared vision between us for the common purpose, motivation and value of the integrated music and math teaching we were pursuing. She expressed her belief that the "easy, divided world" is far less interesting to students than the "linked and interconnected world." The importance of the work was "obvious" to her. She also acknowledged the challenges of the integrated vision, and how it was clearly not in the mainstream of thought in Kazakhstan. We both expressed the desire to stay in touch, and agreed that visionary work that challenges mainstream views gains credibility and can progress more rapidly when leaders connect and work together.

I was later interviewed by a large group of students in a town hall atmosphere. This lasted over an hour as the students asked me a broad assortment of questions ranging from my personal life and hobbies to the war on Iraq. They were fascinated to get to know as much as possible about me. I took the opportunity to share with the students my philosophical outlook on many topics, and we gravitated to the importance of my visit that extended beyond learning music and math. I suggested how the exploration of boundaries between disciplines shed light on percieved cultural differences. The students were fascinated with finding out about the essence of cultural differences. We moved on to topics of globalism, the phenomena of a shrinking world given exponential population growth and the internet. We discussed how humanity is being challenged in unique ways in our current age as we reach the threshold of a finite earth to absorb waste and provide resources. Unique (interdisciplinary) ways of thinking, and indeed, being and acting, will be necessary in the coming decades to cope with the challenges we face. Music and math is in some ways a model of that kind of thinking.

My final luncheon with the teachers was very significant, a wonderful time and very heart warming. Teachers expressed sincere and heartfelt gratitude and appreciation for my work with them. It was another confirmation of how our work together seemed to extend well beyond music and math. A teacher gave me a toast that said it all in a very touching way. It gave me the impression my visit had to some extent opened their minds and provided inspiration. In this way I served as an ambassador and representative of country through teaching.

Boy's Day Assembly

The students had a tradition to honor boys on a specific day and girls on another day. Boy¹s day included an academy awards style assembly of award presentations for the "best boy" in a variety of categories, e.g. kindness, gentleman, academic, etc. The awards were interspersed with a variety of performances ranging from modern, traditional, serious and whimsical. It was marvelously entertaining and very revealing as to the character of the students, their sense of humor, versatility of style, diversity of culture, and commitment to high standards and discipline evidenced by the impressive musical performances.

New York--Kazakhstan Student Exchanges

Before I left the United States for Kazakhstan I made a proposal to the teachers in C.V. Starr Intermediate school in Brewster, NY, (a school in the district where I am employed) to generate an exchange between their students and those in Zhania Aubakirova¹s College. As a result, forty Brewster fourth graders created artwork, wrote notes and assembled photographs addressed to "students of Kazakhstan," a country which at that time they knew virtually nothing about. The messages were heartwarming, all expressing the desire for closer connections between peoples of the world, world peace and specifically, to begin a friendship with a distant student in Kazakhstan. I hand delivered these packets to the college when I arrived.

The students in Kazakhstan responded enthusiastically with forty beautiful pieces of artwork, notes and photographs of their own including home addresses, each requesting to be "friends" and issuing messages of world peace and happiness. The teachers and students in Brewster were extremely excited and touched by the response. We will be displaying the Kazakhstani students¹ work in a gallery in our school, and the students will soon begin correspondence with their new "friends" from Kazakhstan. This clearly promises to be the beginning of many long and enriching relationships for years to come.

Students at H.H. Wells Middle School also embarked on a curricular project which is currently leading to student exchanges with Kazakhstan. Before leaving I wrote a "webquest" curriculum for my students to follow during my trip (see www.brewsterschools.org/cvstarr/sbeall and go to "Kazakhstan Webquest"). The primary focus of that curriculum is for students to learn about the nature of knowledge acquisition, specifically with regard to learning about distant cultures. Students compared different methods. Knowing virtually nothing about Kazakhstan, students initially made hypotheses based on inference and their prior knowledge. This was followed by

internet research. They then referred to a journal I posted on my website while I was working at the college in Kazakhstan. On my return with I shared 1.5 hours of video and discussed my visit with the students. A powerful theme that emerged was the realization that many cultural differences are shallower that we might initially believe, and that our common humanity is a strong unifying force. These students have expressed a strong desire to travel and learn more about the world on a first hand basis. The first step will be to establish email relationships with students from Zhania Aubakirova¹s College.

Summary/Reflection

Two weeks is just a snapshot into the life of any school. It is important to emphasize that the comments that follow in this section are observations and impressions I received from my visit regarding the culture of teaching and learning at the college, not conclusions or verified facts. I also gained insights into the intricacies of interdisciplinary teaching in general, as well as specific aspects of my and music and mathematics curriculum. While many of these insights are very compelling and suggest a focus for further research, they too are observations and case studies only, (not formal research findings) and must be considered in that light.

The work begun during my visit to Kazakstan is still in progress in many respects. As I mentioned to the teachers and students upon my departure, the end of our two weeks together was just the beginning of another vital stage of the work. We now can begin the process of reflection and application of the skills, knowledge and insights gained. It was obvious to all involved that a follow up visit in the future would greatly enhance the effectiveness of this visit toward realizing the goal of enabling the teachers at the college to confidently teach Functional Melodies and incorporate some of the pedagogical principles into their overall practice. I told the teachers I would be happy to have conversations by email over the coming months to answer questions and give advise. Given the language barrier however, it is questionable how realistic or productive that could be. Also, in the final teacher workshop, many teachers expressed a great deal of interest in the topics presented. A follow up visit would allow us to pursue some of those topics in a substantive way, increasing the extent to which they would significantly affect the teachers¹ practices, and the learning experiences of the students.

School Culture

When the students asked me "what I thought of their school," my first and most direct response was it was a "dream school." With 10 students per classroom and a total of approximately 140 students in the entire school of grades 1-11, the level of personalization was maximized. Myself included, many would argue that this in itself is one of the most influential factors for a "successful" school. The school size and intimacy created a wonderful family atmosphere. Everyone knew everyone else, and teachers could follow students over their entire academic life. The benefits of this are immeasurable. This fact alone makes it very difficult to draw fair or accurate comparisons to public schools in the United States regarding the effect of teaching methodology, content and style. The dynamic created by these numbers affects every aspect of learning. Indeed, many curriculum designs, programs and classroom strategies studied by

teachers in the U.S. and elsewhere are created to deal with large heterogeneous classrooms. In a setting like the college in Kazakhstan, many of these simply do not apply.

The Students

One of the highlights of my visit was spending time with the wonderful students at the college. They were extremely respectful, warm, and diligent, and they radiated a grounded sense of purpose.

In art, music and mathematics, the student work I observed was of exceptionally high quality for each grade level. Many of the musicians played with a remarkable level of maturity and expression. The artwork was equally impressive. Students at grade 3 and 4 showed an impressive command of watercolors, that was expressive and thematically mature.

In mathematics studies and their general classroom demeanor they were highly organized and motivated to succeed, clearly taking their studies very seriously. In some of the higher grades I detected some hesitancy from the students when they faced non routine problems and situations that required them to take the lead. This was inevitably connected to a bit of shyness on their part, undoubtedly accentuated by having an American stranger teaching them in their classroom, however I believe this characteristic also reflected the culture of the school pedagogy as well as their society at large. The students appeared to be accustomed to a very teacher-centered pedagogy with less emphasis on inductive, discovery based teaching. They respected teachers¹ authority as the expert in all cases, eagerly waiting to be explained to and shown the way. In some respects this made them less active risk takers in the classroom, less proactive, and less apt to take ownership of their own ideas and creative insights. Much can be said on this topic, but it highlights a cause and effect relationship where overly prescriptive and formulaic approaches to the learning of mathematics can inhibit students¹ ability to creatively problem solve and approach non routine situations with confidence. This is a consideration in the U.S. that drives many math education reform efforts.

A quality in the students that I was struck by was their readiness to consider higher connections, abstractions and philosophical dimensions of the subject matter. It was as though they did not feel bound to evaluate everything being learned in terms of its instant and/or obvious practical application. There seemed to be an atmosphere of intellectual risk taking and willingness to wonder about interesting ideas for their own sake. I believe this stemmed from a culture of learning that was deeply rooted in an appreciation for the virtues of intellectualism. This was very refreshing, and an interesting counterpart to the students¹ shyness and reluctance to be proactively creative in other respects. Their acceptance of intellectual adventure was tied to their dependence on the teacher however; they appeared to need the teachers¹ "permission" and guiding hand to be led down that path. Once the hand was extended, they surprised me in the extent to which they engaged and wondered about abstract ideas, such as the relationship of subjective and rational ways of knowing that comes to the fore in activities such as Functional Composer. Likely, because of the students¹ trust and respect of my role as teacher, I found it easier to bring them to higher levels of thinking about the subject matter than I have been able to with the vast majority of my students in the U.S. I also noticed this quality in many of the classrooms I observed as well, especially the music-math class where students made abstract geometric models of musical forms. At the time, I questioned how much of their engagement

was self generated, and how much they really understood what they were doing. I wondered how much of it simply followed out of their duty to be good respondents to their teacher. As they progressed it became evident that they did know what they were doing and the student-generated aspect became moot. It did not matter how the ball got rolling, simply that it was rolling. If it took a strong teacher directed experience initially, should this matter? I think not.

In the United States it has grown increasingly "fashionable" in progressive pedagogical thinking to emphasize the teacher as facilitator vs. "sage," and to reduce the students¹ overall dependence on the teacher for their learning. This has noble intent and has become an important evolution from the almost draconian practices of rote and mechanistic learning in the 40¹s and 50¹s. My experiences with students at the college was cause for reflection. I wondered, have we lost something in the process? Has our pendulum swung so far that we have lost sight of any value of "teacher as sage?" The Kazakhstani students¹ respect for their teachers as intellectuals with much to offer them genuinely facilitated their higher development. This trust and respect of their teachers made them willing to venture into territories where the relevance was not immediately apparent. This served them well and yielded impressive results. Teachers in the U.S. often spend an inordinate amount of time and creative energy devising ways to "sell" content to kids. "Successful" curriculum is evaluated often first and foremost for its ability to motivate students and "make learning fun." Students, teachers, and even administrators too often find themselves evaluating teachers and curriculum with an almost blind emphasis on how student-centered it is, and how much fun the students are having. Students watch this, and their values reflect it, and it becomes self-perpetuating.

My experiences in Kazakhstan provided perspective on what I perceive as an imbalance in our system in the U.S. In teaching these students I did not get the impression that they needed to be continually entertained. It was not my responsibility to make the case for the relevance of the subject matter at every turn. The students accepted and trusted my judgement. This context had a liberating affect in some respects. With student "buy-in" established at the outset, I could devote more time to probing the subject matter, which in turn allowed me to bring students to higher levels of thinking.

The Teachers

The discussion on students says a great deal about the teachers. The teachers were very highly trained in their disciplines. They were true intellectuals with very high standards, and levels of commitment to their students and disciplines. These values transferred to the students.

It was unclear to me initially what the teacher¹s background was with regard to the pedagogy and theory of progressive education in the U.S. (topics addressed in the teacher workshop mentioned earlier in this document). I soon realized that they knew little of these things, at least in the formalized and researched form that we are accustomed to. But in many ways it did not seem to matter. These teachers accomplished great things with their students, which is a testament to the effectiveness of a strong expertise in a subject, great intuition, compassion and commitment. Of course the very small class sizes (10 students) and a self-selected student population (being a relatively expensive private school) was a strong factor as well. But in any context these teachers would be highly effective. It would be reasonable to assume that their teacher training emphasized content knowledge over pedagogy. And this led to reflect on the

emphasis of much professional development in the U.S. Teachers in the U.S. spend a large percentage of their time in professional development courses that emphasize methodology and teaching strategies as opposed to learning pure content, and improving their expertise in their discipline(s). This is cause to consider another imbalance in U.S. education‹emphasis on pedagogy over content knowledge and expertise.

The teachers had other wonderful qualities that Americans might envy. They expected a great deal from students. They were not as bound to beliefs in the developmental limitations of students at various ages. A problem I have run into with teachers in the U.S. is the firm belief that students at various ages are incapable of understanding or benefiting from certain levels of abstraction‹that they cannot understand, or would be scared by, introductions to higher order thinking. The Kazak teachers were more open to the possibilities of what students were capable of, as though they naturally intuited Jerome Bruner¹s idea that all topics can be taught at all levels, as long as it is presented in an intellectually appropriate form. They had no formal knowledge of Bruner, but appeared to apply his ideas.

Teaching of the arts emphasized expression and intention as well as technique. This led to students at very young ages demonstrating highly mature work.

In the midst of all these strong qualities, there were many ways the teachers could benefit from what I was offering. While some teachers were involved with interdisciplinary work in their Learning and Mastering project with music and math, most were not used to the idea. Their orientation to mastery of their disciplines made them very curious about how a single teacher could actually teach two disciplines, especially when they are integrated in a common curriculum. To summarize, they were challenged by my work in two primary ways: 1) how to gain adequate confidence and mastery in two disciplines to teach them in an integrated way and 2) general confidence and buy in of the various pedagogical principles as mentioned earlier in the teacher workshop section of this document (e.g. constructivism, multiple intelligences, differentiation, etc.).

I left the school reflecting very deeply on these ideas, and how education in both America and Kazakhstan seem to be in different phases of development and how each has so much to offer the other. I strongly believe that the pendulum needs to swing back a little in the U.S. education reform efforts to recognize and value the teacher as intellectual and primary source of knowledge, to place this in balance. In Kazakhstan, the teachers¹ high standards and intellectual orientation would be well complemented by the progressive student centered, authentic learning pedagogies that I presented. Again, a matter of balance. Continued collaboration would undeniably improve both educational systems, and in turn, the education of many children in both countries.

The Conservatory of Music In Almaty

Zhania invited me to give a lecture at the Conservatory of Music in Almaty. The audience consisted of the staff of the conservatory and various other colleagues of theirs. Few spoke English, so the entire lecture was translated, phrase by phrase.

I spoke about the general intent of my work, the theoretical basis and the larger implications for the type of thinking necessary for humanity to solve the problems of the 21st century. I sensed a mixed reaction of interest and skepticism from the audience. As Zhania mentioned in an interview format portion of the talk, they were very steeped in their disciplines of music, in most cases being very ignorant, if not scared, of mathematics. Initially I was surprised at the level of traditional thinking in this group, but on second thought it made perfect sense. They had been trained at time and in a culture that was very traditional in its thinking and methods. One gentleman had written a book on geometry and music and showed great enthusiasm, however he seemed to be the exception. This group brought to mind many of the challenges I have faced in the U.S. as well. The educational system in the U.S. trains specialists, and few educators are actually trained in several disciplines, or at least enough so as to give them the necessary insight and confidence to consider an interdisciplinary approach. This was a reminder of the longitudinal nature of reform, that to effect significant changes in thinking regarding education, be it interdisciplinary or some other, it needs to begin with the early stages of teacher training. Staff development of established teachers will always be a hit and miss proposition, with mixed results, though certainly worth the effort. A true transformation must be considered a long term project, and comprehensive results cannot be expected sooner than a generation.

Integrated Disciplines and Transfer

Zhania Aubakirova expressed a strong vision and belief in the value of interdisciplinary teaching, especially music and mathematics. In my interview with her at the end of the trip, she was quick to explain that, while not being a trained educator herself, it was clear through her experience in musical work that the application of mathematical principles and laws are ever present. Indeed this is true, and I felt that I was listening to myself speak during that interview. As a practicing musician and mathematician myself, this central observation has been a prime motivator of my work. Each teaching experience sheds new light on the possibilities for how to utilize the connection educationally and raises new questions for research.

The relationships between music and mathematics can be thought of educationally in two fundamental ways: as a relationship to know, or a relationship to use. The first approach considers the connection of music and mathematics as a knowledge base unto itself. Students learn can learn about the myriad ways music and math interrelate, some more meaningful than others, some more relevant or practical than others, and some just interesting curiosities. The second approach utilizes the connection as a pedagogical tool; using the medium of one discipline as a vehicle to enhance understanding in the other, either using music as the vehicle with math understanding as the goal, or vise versa. Here the question of interdisciplinary transfer arises, and whether or not it is even possible as many theorists and researchers debate. In my work with the 3rd grade classes I gained some insights into this debate. Before discussing that it would be useful to briefly summarize come concepts of transfer.

I acknowledge three primary ways that interdisciplinary transfer can happen. I refer to these transfer types as true transfer, readiness transfer, and indirect transfer. True and readiness transfer are facilitated by an interdisciplinary curriculum design where indirect transfer does not. In the case of music and mathematics, true transfer learning begins initially in the music medium. A principle is expressed in the medium of music and learned as a musical experience. Once the principle is learned in this medium it can be perceived by the learner as an entity unto

itself, expressible in various ways. It is translated to the mathematical medium and then expressed and understood as mathematics, in mathematical language. This process allows musically adept students to more easily access the understanding of the principle. It is something like teaching a math topic to a person in their native language and once learned, translating it to expression in a language that they have less command with. This transfer depends on utilizing special connection points between the disciplines, and is not possible for all principles in each discipline, only for those shared principles. Learning through readiness transfer occurs primarily as a mathematical experience that is facilitated by a musical context. Examples of this might be using songs to remember math formulas, using musical subjects for math problems, etc. Also, students¹ love and interest in music renders the mathematics more friendly and lessens the trauma and perceived difficulty that is often associated with learning math. Here the primary cognitive function is mathematics, but it is effectively dressed up in musical clothes. Indirect transfer is not controlled or directed by a curriculum or program. It happens within the student by an indirect symbiosis, such as the case where a student studies music and mathematics independently in school, and the learning gains in music, by nature of their cognitive similarities to and overlap with mathematics, have the affect of improving the students abilities in mathematics. Much research remains to be done to inform these ideas however some exists, with varying degrees of conclusivity in the results. The essential idea of true transfer has been presented by Howard Gardner in Frames of Mind.

Utilizing true transfer in the classroom is no easy task. Functional Composer is an activity that most directly utilizes true transfer, however I have come to learn that the extent to which transfer happens can be largely dependent on the students' strength in the discipline used as a vehicle (in this case, music). This can present some problems for heterogeneous classrooms where a significant percentage of the students are not musical, or have no musical training. For non musical students, transfer of the mathematical principles in Functional Composer (e.g. meaning of a function, graphs, and characteristics of various families of transformations) can occur, but not as predictably.

In common practice most classrooms are heterogeneous with respect to students' musical strength. In my action research with Functional Melodies over the past several years I have had the opportunity to work with two exceptions, Williams Syndrome students at Music and Minds (University of Connecticut) and Berkshire Hills Music Academy (Hadley, MA) and now, students from Zhania Aubakirova's College in Kazakhstan. William's Syndrome students have a strong sensitivity and natural feeling for music but are very low functioning mathematically. True transfer with Functional Composer was very successful with these students (see "A Case Study of Teaching to Multiple Intelligences," Williams Syndrome Journal or at www.scottbeall.com). The students at Zhania Aubakirova's College were high functioning in both disciplines. This presented a new opportunity to explore these ideas from an action research point of view.

I gained a some strong insights on the nature of transfer or what I might call symbiotic curricular resonance while working with the combined 3rd and 4th grade class. Initially I doubted that Functional Composer was appropriate for them. After all, most math teachers would immediately dismiss the idea of teaching functions and transformations to 3rd and 4th graders. In addition, these students did not appear to have studied graphing much at all. I decided to proceed however, and the results were remarkable. All of the students grasped the ideas very quickly and created perfect graphs. They were able to characterize the families of transformations (translation, reflection, stretching/shrinking) and make predictions, and seemed to have no problem with function notation and used it to make algebraic representations of the

transformations. Their proficiency with these tasks appeared to follow directly from their musical ability, and by their conceptualization of a mathematical function as a musical motif. The melodic variations were natural for them, and their ease in understanding them transferred, simply and elegantly, to the concepts of mathematical transformations. This activity was effectively a first time introduction to graphing, functions and algebraic representations, and the students performed famously!

This was an exciting moment for me and cause for reflection. It was clear that the students were able to grasp advanced concepts and perform at a higher level by virtue of the integrated aspect of the curriculum. The integrated approach proved not only more efficient, but may have actually facilitated learning to a level that separate study could not have achieved. I received the inescapable impression that a sort of symbiosis was taking place. And in regard to transfer through integrated curriculum, this suggests that it can happen most effectively when students have the prerequisite strengths in both disciplines separately; that there needs to be some baseline ability in the disciplines initially for an interdisciplinary experience to generate transfer. And once the baseline is established through traditional curriculum, a interdisciplinary curriculum can increase learning exponentially in ways the separate curriculum cannot. Such gains are not limited to improved understanding of complex ideas in the disciplines at an early age, but include an understanding of a new knowledge base as well--that of relationships and interconnections.

My work to date with music and mathematics has focused primarily on using music as a medium to teach math, as opposed to teaching music with math as the medium. This focus was not chosen because of any indication that it was the "best," most efficient, or even the most useful application of integrating music and math. It has in some senses been a starting point. It could be that using mathematics to teach music could be more relevant in traditional school settings by virtue of the fact that all students have a baseline ability in math, the vehicle medium. I have already begun this work at C.V. Starr Intermediate school in Brewster, NY, using mathematical methods to teach young people music theory and improvisation.

Integrating Cultures, The World, And The Universe

The meaning and import of this collaboration extends beyond integrated music and mathematics curriculum. A broader theme, almost unwittingly, emerged and surrounded all of the work as it progressed. Questions, ideas and awareness of boundary constructs and perceived differences between all realms (e.g. language, culture, ideology, religion, national boarders, musical genres, etc.,) emerged and became conspicuously present in the work. Our work with music and mathematics suggested a universal principle that many of the differences and boundaries we embrace daily can soften and become less distinct upon deeper study and contemplation; that there exists a deeper essence to most phenomena that somehow binds it all together. We considered that many of these boundaries are in fact human constructs as opposed to some absolute reality, and are open for reconstruction. As this was revealed to be true through the study of the interrelationships between music and math, the work became a catalyst and access point that raised all the participants[1] awareness and curiosity about these more broad and general ideas. When Zhania and I met initially we agreed that one of the important benefits of integrating music and mathematics was to instill in young children this sense of the unity and interdependence of all phenomena in the universe. In our work to

accomplish these ends, the teachers and myself found ourselves to be the students of our own teachings. Our awareness and understanding of these ideas grew through efforts to teach children, and in this process we recognized that another boundary had begun to dissolve right in our midst; the boundary and distinction between "teacher" and "learner."

Consider this: The evolution of human consciousness from premodern world views to modernity has been characterized by a differentiation of the value spheres of art, science, and morals. In our current post modern world these differentiations have proceeded to complete dissociation, creating an unhealthy condition; science and religion are at odds, secularism struggles to come to grips with the human need for meaning, the subjective fights the empirical, the head fights the heart, and so forth. Today, the tendency toward interdisciplinary thinking can be seen as an historical inevitability; as a part of the necessary consciousness evolution to reintegrate and establish a healthy balance between art, science and morals; heart, head, meaning; subjective, rational, and spiritual, etc. The pull for this reintegration is strong and evidenced in many facets of life including "green" environmental movements, interfaith societies, holistic medicine, integral business management systems and integral education, to name a few. In this context it seems only natural and inevitable that a concert pianist from one side of the world would share a vision with a music and mathematics educator from the other side of the world, seek each other out, and teach, not only the common essence of music and mathematics, but the universal connectedness of the universe itself. Inevitable? Maybe. In any event, raising awareness of the illusory and conceptual nature of human boundaries and differences might be just what the world needs most right now.

Recommendations For Further Collaboration

A follow-up trip to the college would be highly effective toward maximizing the benefits from this trip. In many respects this trip was a first step that served as an orientation and overview of the possibilities of integrating music and math while providing an introduction to a host of other progressive pedagogical principles. After the teachers have worked with the materials and processed and applied some the ideas presented, specific areas of need can be targeted to ensure practical implementation. As previously suggested, the ideas of music and mathematics integration are very new to many teachers and are counter to many long held habits and beliefs about teaching and learning. Even for teachers trained in some of the pedagogical ideas of discovery learning and project/problem based curriculum, the interdisciplinary piece is challenging. Change can only expected to be incremental, and must evolve over time.

A follow-up trip would include:
Mr. Beall team teaching with teachers from the college
Professional development workshop content informed and planned from email consults regarding the progress of implementation of concepts and curriculum from the first visit.
Follow-up exchanges and development of co-curricular student projects between Brewster Schools in New York and the Zhania Aubakirova¹s College in Almaty.
Other programs developed through email correspondence over coming months as the need is expressed by the teacher and recommended by Mr. Beall.