

Connecting Two Worlds



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"Mathematics is music for the mind; music is mathematics for the soul."
Anonymous

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Purpose Statement and Hypothesis

Engineering is a field of study that utilizes the knowledge of the past and combines it with innovative ideas for the future. From elevators to airplanes, and from the kitchen table to the operating table, no field of technology is left untouched by engineers of some sort. The field of music is no exception. Digital recording studios are fast replacing the analog systems of old. Digital effects processors work hand in hand with computer processors to produce the seamless billboard hits that flood the airwaves every day all over the world.

Most children decide their career paths by the end of junior high school. Students usually choose to steer either towards the liberal arts and humanities, or towards technically related classes. However, many students at this age do not understand what careers are available to those who interested in mathematics and the sciences.

Furthermore, the general trend in education is that girls who do well in science in math early in their educational careers are eventually overshadowed by boys. This trend is not due to boys becoming smarter at a later age, or the equally ridiculous opposite, but societal pressures tend to push girls away from these scientific and mathematical fields.

The Society of Women engineers (SWE) is a group of women whose goal it is to make known the need for women engineers and encouraging young women to consider an engineering education. The mission statement, adopted in 1985, states: The Society of Women Engineers stimulates women to achieve full potential in careers as engineers and leaders, expands the image of the engineering profession as a positive force in the quality of life, and demonstrates the value of diversity. SWE encourages women engineers to attain high levels of educational and professional achievement (<http://www.swe.org>).

Through the University Honors program at UT, I was fortunate enough to participate in Dr. Elaine Seat's seminar entitled "Electric Strings in the Classroom." The premise of the class was the same as it is for this project—to introduce the fundamentals of science and engineering through music technology to elementary and middle school students who are interested in music, and to foster existing interests. With the generous help of the Society of Women Engineers, Dr. Seat and her honors seminar in the spring of 2002 developed a curriculum for this expressed purpose. We were also able to purchase an electric orchestra and computer software that essentially turns a laptop into a recording studio.

The following pages detail an example of a script the presenter can follow when visiting the classroom and a "Quick Hookup Guide" for the hardware involved. The script is certainly modifiable based on what the presenter wants to teach, but it provides a good baseline approach to the curriculum that should be established.

Curriculum Script

I. Introduction

A. Introduce yourself (SWE) and explain purpose of visit.

“Hi, my name is _____. I am from _____ and I go to __ (UT) _____ and major in engineering. I am a member of the Society of Women Engineers. I brought all this stuff with me to show you guys all kinds of fun things you can do with music and engineering. First of all, who here knows what engineers do?” <play UT engineering clip>

B. Propose the idea that math, science, and music are all related.

“So how many of you don’t think you’ll ever use the information you learn in science and math class in the real world? How many think you all use science and math in HERE?”

C. Ask them questions about how they use math and science in the music classroom.

“You all use math and science in here all the time. Can anyone think of a way to use either one?”

II. Introduction to sound waves

A. Nature of sound waves

“All movements produce sound waves, we just can’t hear them all. When I wave my hand in the air like this <wave hand>, it produces sound waves that are sent out all over the room. They are just too quiet to be heard. Our eardrums don’t pick up waves that small.

B. Ask for explanation of sound waves.

“So does anyone understand sound waves? Have you studied them in science yet? Can someone explain one to me? What do they look like?”

C. Explanation of sound waves.

“A sound wave is formed by the air molecules bumping into each other. It looks kind of like an ocean wave with the crests and troughs.”

D. Jump rope example—define frequency and wavelength

“We’re going to use this jump rope to recreate a sound wave and show kind of what it looks like. I need _____ and _____ (names provided by teachers or take volunteers) to hold the ends of the rope. Now one person wave your end up and down—this is what a sound wave looks like. If we move it faster, then the FREQUENCY increases because there are more waves in any amount of time. The WAVELENGTH is the amount of space in between each wave. It decreases if they are closer together. These things affect the actual sound the wave makes.” <Add more info> <want picture of sound waves on power point>

E. Transition to looking at sound waves on the computer

“Now we’re going to recreate the sound waves of what YOU play so we can actually SEE your music on the screen, so you all can sit down and help play the note we’re going to record.”

III. Visual frequency analysis

A. Observe whole class playing same note and compare to computer generated pitch.

“Now I need everyone here to play an A. We’re going to record it and see what it sounds like. <record and narrate computer steps> See the computer generated pitch has a very even wavelength and frequency. The waves that we recorded are different because they include overtones and are therefore richer sounds.”

B. Record rubber bands and play back

“We can use rubber bands to demonstrate octaves and the harmonics of the strings. When we make the string half as long, the sound it makes is exactly one octave higher than the full string.” <record on the rubber band with help of students>

C. Record individual playing octaves and observe

“Now _____ (specific student from teacher or volunteer) play a 2 octave jump of a G. We’re going to record it and see if we can figure out what is different about the octaves. <Record and observe> The higher octaves have a higher frequency of waves, which is what makes the pitch higher.”

D. Transition to electric vs. acoustic instruments (video?)

“All of your instruments are acoustic. The ones we brought are all electric. Does anyone know what’s different about them? Why do they look different? Why don’t the electric instruments make a sound when they aren’t plugged into the amplifier?”

IV. Acoustic vs. electric

A. Explain differences

“The electric instruments don’t have a chamber inside for the sound waves to resonate. They need an amplifier to transfer the sound waves from the instrument to the air. <rewrite accurately>” <can we get a flow chart on power point?>

B. Record 2 students on each instrument and observe differences

“Now I need _____ (2 students for each instrument [not all instruments] chosen by teacher or volunteers) to come up here and play (some simple phrase—ask teacher) on their instruments. Then we are going to look at and talk about the differences in the sounds of each kind of instrument.”

C. Transition to digital effects

“Electric instruments will never replace acoustic instruments because even using our computers it’s almost impossible to make them sound exactly the same. But, there’s a lot we can change and edit using engineering.”

V. Digital effects processing

A. Knock-knock joke

“I need everybody’s help for this one, so you guys can go ahead and sit down. When I point to you guys, I want you to read these signs. The first one says, “Who’s there.” The second one says “Boo Who?” We’re going to play around with these when we’re done with them and show you what you can sound like. <explain what is being done on computer then play joke with mistake and correct it>”

B. Duplicate sound to produce fuller orchestral sound

“You know, with this technology, we can make you all sound like a one thousand piece orchestra. I want _____ (one student from each instrument) to play (chord) for me. <double chord until we get very full sound and play it>

C. Duplicate voice sound

“So who here likes Britney Spears? Have you ever heard her talk? She sounds different than when she sings, doesn’t she? Can somebody sing one of her songs for me? Then we’ll try to make you sound like she does. <record voice and duplicate>”

D. Tie into recording industry

“This is exactly the way recording studios make the stars we listen to sound like they do. The recording engineers have figured out how to do all of this stuff using math and science. (let them ask questions, etc.)”

Supplies:

Rope

Stringy Rubber Bands

Ruler to measure rubber band

2 students for jump rope example

1 student to play 2 octave jump of G

2 students for each instrument for electric/acoustic comparison

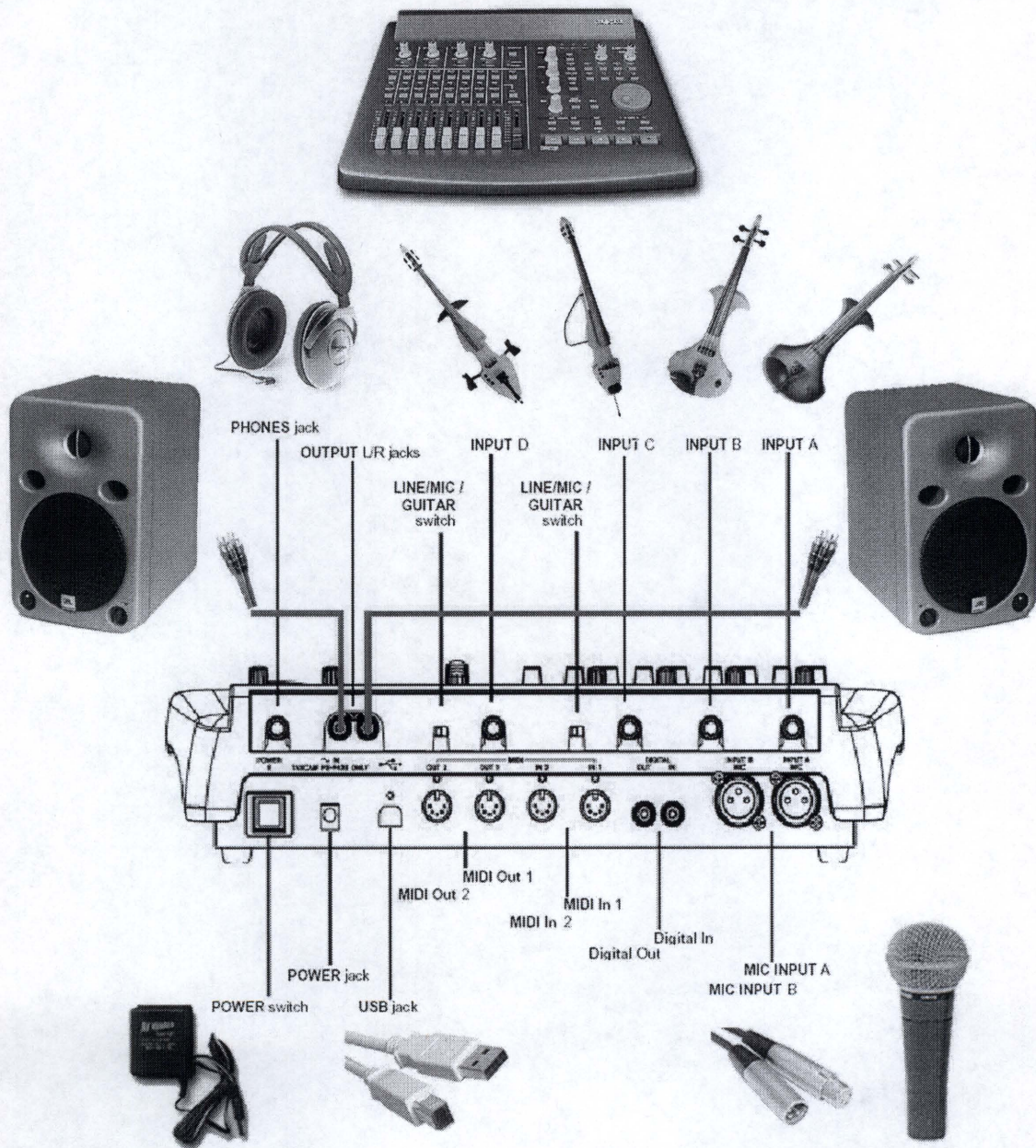
Signs saying “Who’s there?” and “Boo who?”

Pre-record teacher reciting knock-knock joke

One student from each instrument to play chord to be doubled

One or small group of students to sing if time allows

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Conclusion

If we can influence children at a young age in such a way as to spark their interests in math and science related subjects, perhaps some children will focus their high school careers in this direction and eventually go on to seek professional degrees in these fields. We plan to interest them by engaging them in the scientific aspects of things in which they are already interested--music. The incredible technically innovative program that we are designing, with the help of a generous grant from SWE, will bring together hardware as diverse as laptop computers, sound boards, mixers, microphones, and electric orchestras, to softwares such as Microsoft PowerPoint, HyperCam, and Cool Edit Pro digital recording interface. When completed, the project will be as thorough as it is easy to use. In short, my senior project will be to 1) Create an interactive multimedia presentation displaying how to use this project. 2) Implement the project in area middle school classrooms. 3) By doing so, create an interest in SWE members to further the development of this project. The eventual goal of this project is a lofty one—we would like to see this project implemented in some form or fashion in middle school classrooms across the nation in the future.

References

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Title: Electronic Strings in the Classroom

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Abstract: Most children decide their career paths by the end of junior high school. Students usually choose to steer either towards the liberal arts and humanities, or towards technically related classes. However, many students at this age do not understand what careers are available in areas such as mathematics and the sciences. Furthermore, the general trend in education is that girls who do well in science in math early in their educational careers are eventually overshadowed by boys; one factor may be because societal pressures tend to push girls away from these scientific and mathematical fields. With the generous help of the Society of Women Engineers, Dr. Seat and her honors seminar in the spring of 2002 developed a curriculum to introduce the fundamentals of science and engineering through music technology to elementary and middle school students who are interested in music, and to foster existing interests. If we can influence children at a young age in such a way as to spark their interests in math and science related subjects, perhaps some children will focus their high school careers in this direction and eventually go on to seek professional degrees in these fields. We plan to interest them by engaging them in the scientific aspects of things in which they are already interested--music. The incredible technically innovative program that we are designing, with the help of a generous grant from SWE, brings together hardware as diverse as laptop computers, sound boards, mixers, microphones, and electric orchestras, to software such as Microsoft PowerPoint, HyperCam, and Cool Edit Pro digital recording interface. When completed, the project will be as thorough as it is easy to use. In short, this project will 1) Contain an interactive multimedia presentation displaying how to use this project. 2) Implement the project in area middle school classrooms. 3) By doing so, create an interest in SWE members to further the development of this project. The eventual goal of this project is a lofty one—we would like to see this project implemented in some form or fashion in middle school classrooms across the nation in the future.

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