

Guitar

Core



Supplemental lessons in the
Core Subjects via the guitar

by Peter Honan

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Introduction

The demands of school testing have put increasing focus on English and math to the exclusion of other subjects. The joy of learning has been lost in the modern high school classroom. Having taught guitar in high school for 12 years, I can bear witness to the power of music and the guitar to increase student motivation and engagement. This project will seek to harness that power to foster increased interest and engagement in the four core subjects, math, science, English and social science.

This project will be taught in a regular guitar class where students are taught music basics and how to play the guitar. In addition to the regular guitar curriculum, this project will include supplemental lessons that will teach the core subjects (math, science, English, social science) through the guitar. The curriculum development completion date is projected to be June of 2014.

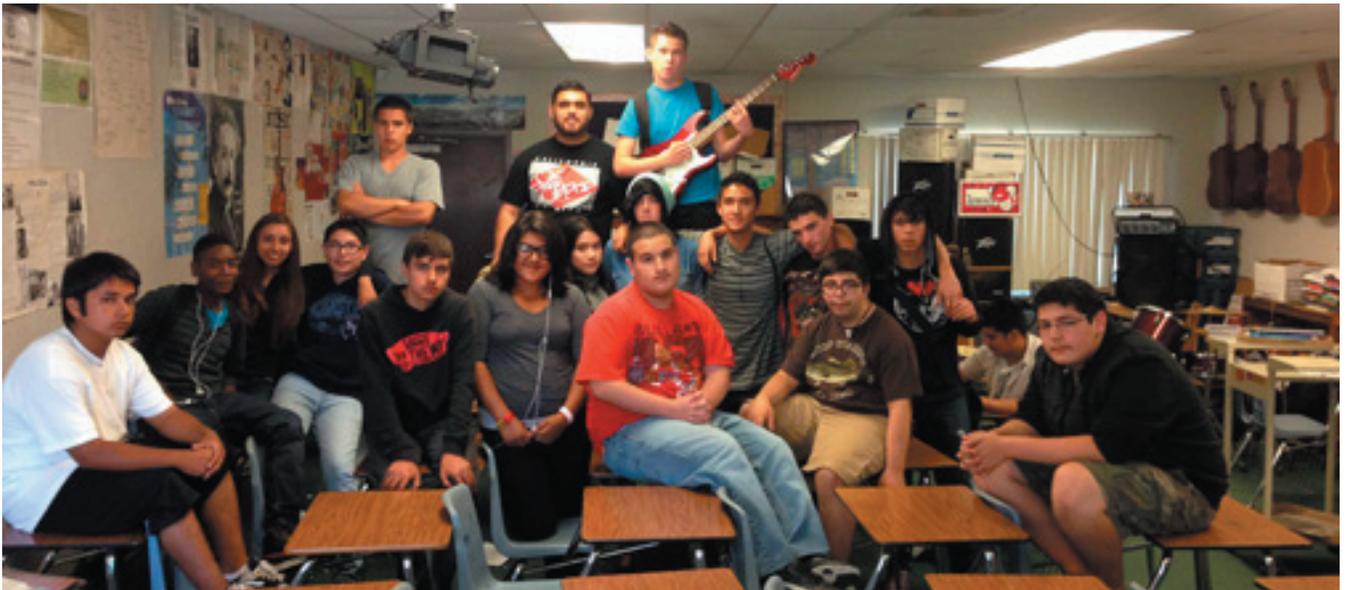
Examples of the curriculum include-creative writing through the study and composing of song lyrics, social science through the study of protest, spiritual and inspirational music, science through the study of electronics, electromagnetism and other components of the electric guitar, and math through the study of math formulas used in making musical scales.



Leonardo Castro dazzles his classmates with his musical virtuosity.

The Class

The school where I teach is Mar Vista High School in Imperial Beach CA, the most southwesterly school in the continental U.S., not far from where Mexico, the U.S. and the Pacific Ocean converge. The class is called Beginning Guitar and has 32 students-25 boys and 7 girls. Playing guitar is somehow seen as a masculine activity and is therefore less appealing to girls. 24 are Latino, 7 are white and 1 African-American. Although all students speak English, 17 speak Spanish at home, 15 speak English at home and 7 are designated as English Language Learners, where they are yet to be classified as officially being fluent in English. Eight are special-needs students. Their grade levels are almost equally divided among 9th, 10th, 11th and 12th.



Mar Vista High School's Guitar Class of 2012-2013 (minus Seniors)

Mathematics

Music and mathematics

“Studying musical forms can help children understand complicated mathematical and scientific concepts; conversely, studying mathematics can help the comprehension of the physical properties of musical elements such as pitch and overtones. There are some incredible correlations to be found between musical structures, patterns found in the natural world, and complex mathematical formulas.”

-from Music Makes Your Child Smarter by Phillip Sheppard 2005

The following 2 worksheets illustrate the math used to create musical scales. The Pure scale Math Worksheet (p.6) can be used when the subject of improper fractions come up and the Tempered Scale Math (p.7) worksheet can be used to illustrate exponents. The Computer Math Worksheet (p. 9) can be used to introduce the surprisingly simple Binary Number System that computers use. This can be introduced at a VERY early grade level (I’m surprised it hasn’t already) and leads into the Science lessons on electricity and electromagnetism that electric guitars use to do what they do.



Daniel Rios uses an iPad and Garage Band for multi-track recording of guitar and vocals.

Pure Scale Math Worksheet

Background

The ancient Greek philosopher and mathematician Pythagoras, originator of the *Pythagorean Theorem*, discovered the ratio of frequencies that make up the musical scale. About 600 BC, he discovered that strings under equal tension sounded harmonious if their lengths were in ratios of small whole numbers like $2/1$, $3/2$, $4/3$, $5/3$ etc. This came to be called the *pure scale*. The pure scale did not work in all musical keys and over time was replaced by the *tempered scale* during the Baroque musical era.

Objective;

To learn how to use improper fractions in the making of the pure musical scale.

Procedure;

Convert the following improper fractions to decimals, then multiply the decimals by the root frequency of 261.6Hz to find the frequency for each note. Round off your frequencies to the nearest tenth.

Note	Fraction	Ratio	Root	Frequency
1	$1/1=$	1	x 261.6=	
2	$9/8=$		x 261.6=	
3	$5/4=$		x 261.6=	
4	$4/3=$		x 261.6=	
5	$3/2=$		x 261.6=	
6	$5/3=$		x 261.6=	
7	$15/8=$		x 261.6=	
8	$2=$	2	x 261.6=	

Tempered Scale Math Worksheet

Background

During the Renaissance and Baroque era of Western music, the pure mode of tuning using improper fractions worked in some musical keys, but not all. The tempered mode of tuning was a way to enable musical instruments to play in all musical keys. It was popularized by *The Well-Tempered Clavier*, written by Johann Sebastian Bach in 1722, which were keyboard musical pieces written in all 24 major and minor keys.

Objective;

To learn how to use mathematical exponents in the making of musical scales used in the creation of all modern music.

Procedure;

Using a scientific calculator, calculate the ratio of the following exponents using a root note frequency of 261.6 Hz.

Note	Exponent	Ratio	Root	Frequency
1	$1=$	1	$\times 261.6=$	
2	$2^{1/6}=$		$\times 261.6=$	
3	$2^{1/3}=$		$\times 261.6=$	
4	$2^{5/12}=$		$\times 261.6=$	
5	$2^{7/12}=$		$\times 261.6=$	
6	$2^{3/4}=$		$\times 261.6=$	
7	$2^{11/12}=$		$\times 261.6=$	
8	$2=$	2	$\times 261.6=$	

Binary Math and Digital Logic

Electric guitars are usually connected to a digital effects processor; so knowing the basics of how digital computers work is essential to the well-rounded guitar player. Not only guitar players but EVERYONE on the planet who uses computers needs to know these basics. This section should be the foundation on which any type of Career Technical Education curriculum is built on.

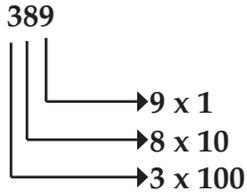
Computers operate on electricity and electricity has only 2 states -on or off, so computers need a number system that has only 2 numbers, that is where the binary number system comes in handy since it uses only 1s and 0s. The following worksheet compares the Binary Number System with the Decimal Number System students are familiar with. Students learn to add binary numbers and convert them to decimal and convert decimals to binary.



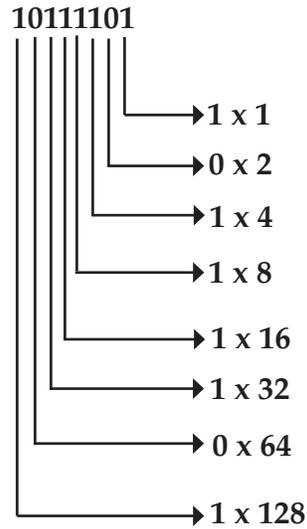
Students learn the use of hand tools to repair and upgrade acoustic and electric guitars. Here, Eloy Rodriguez goes one step further and repairs one of the broken desks in class.

Computer Math Worksheet

Decimal Number System



Binary Number System



Add these numbers.

1.
$$\begin{array}{r} 0001 + \\ \underline{0010} \end{array}$$

2.
$$\begin{array}{r} 1001 + \\ \underline{0110} \end{array}$$

3.
$$\begin{array}{r} 0101 + \\ \underline{0101} \end{array}$$

4.
$$\begin{array}{r} 0111 + \\ \underline{1100} \end{array}$$

5.
$$\begin{array}{r} 10010111 + \\ \underline{00110010} \end{array}$$

6.
$$\begin{array}{r} 10010111 + \\ \underline{00110010} \end{array}$$

Convert these binary numbers to decimal numbers.

7. $0011 = \underline{\hspace{2cm}}$

8. $1011 = \underline{\hspace{2cm}}$

9. $11111111 = \underline{\hspace{2cm}}$

Convert these decimal numbers to binary numbers.

10. $2 = \underline{\hspace{2cm}}$

11. $5 = \underline{\hspace{2cm}}$

12. $14 = \underline{\hspace{2cm}}$

COMPUTER LOGIC SYMBOLS

INPUT

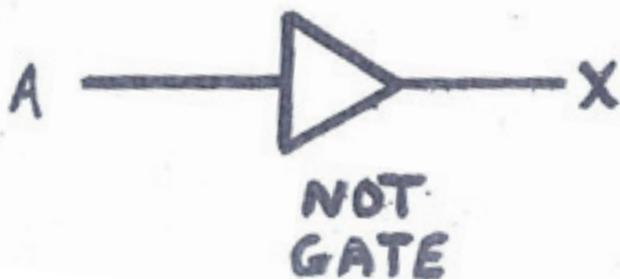
OUTPUT



The output is 1 if all the inputs are 1.



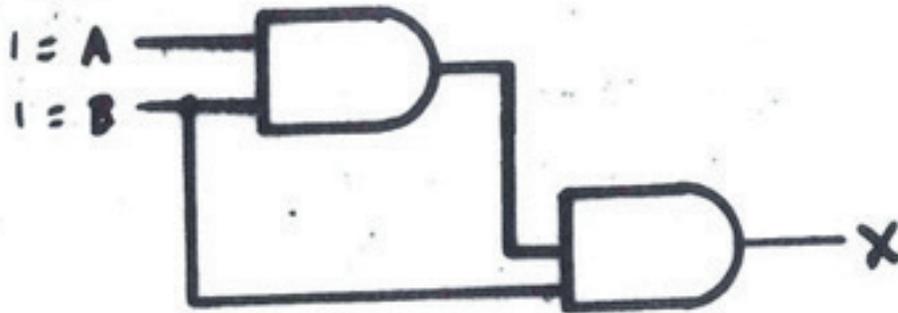
The output is 1 if any one or more of the inputs are 1.



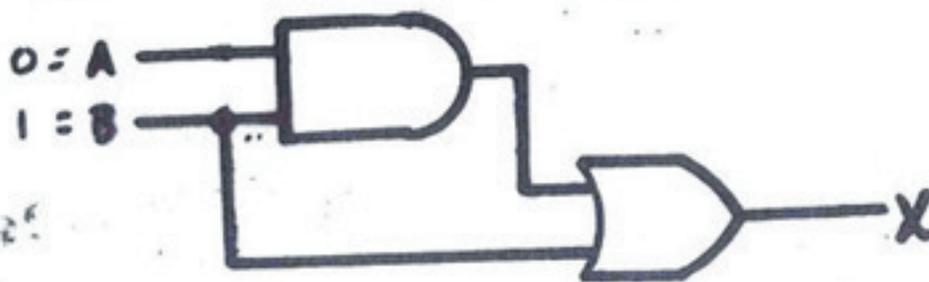
The output is 0 if the input is 1.
The output is 1 if the input is 0.

COMPUTER LOGIC QUIZ

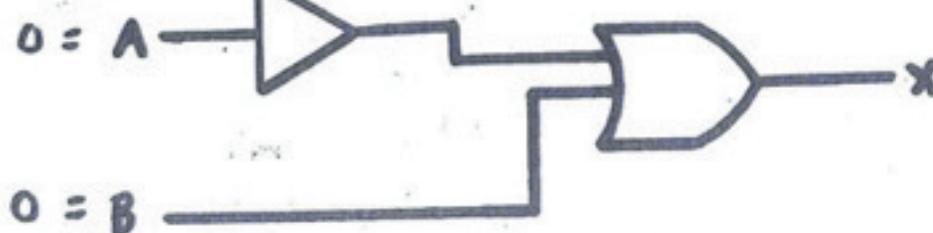
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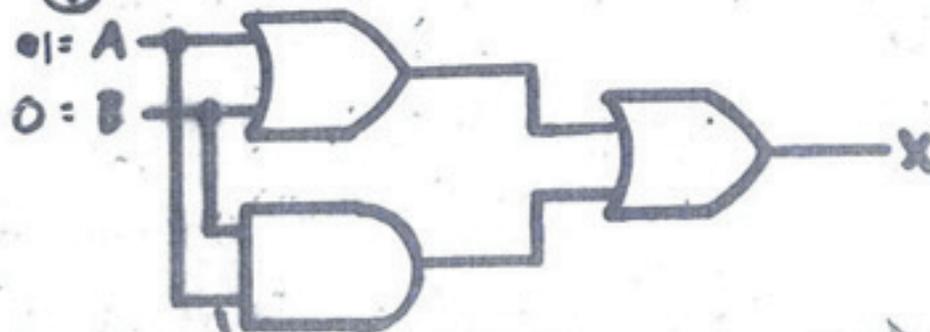
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③



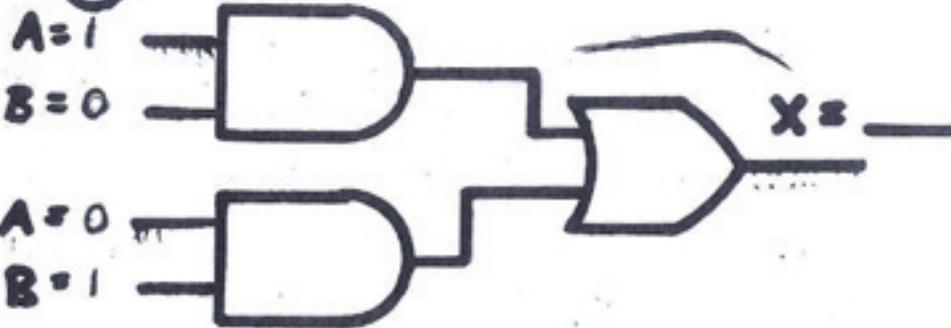
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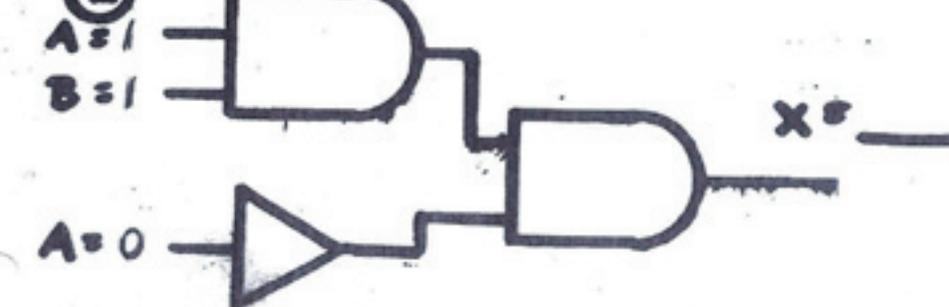
DIGITAL LOGIC TEST

Name _____

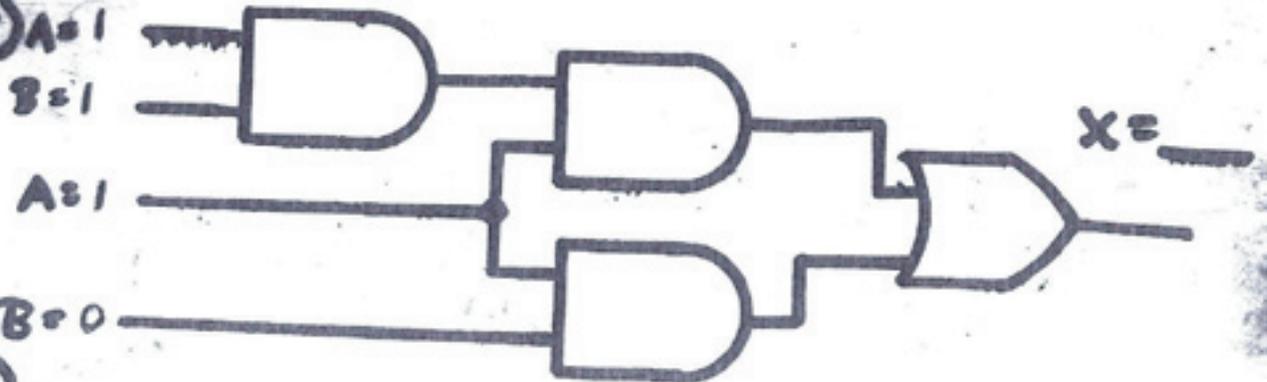
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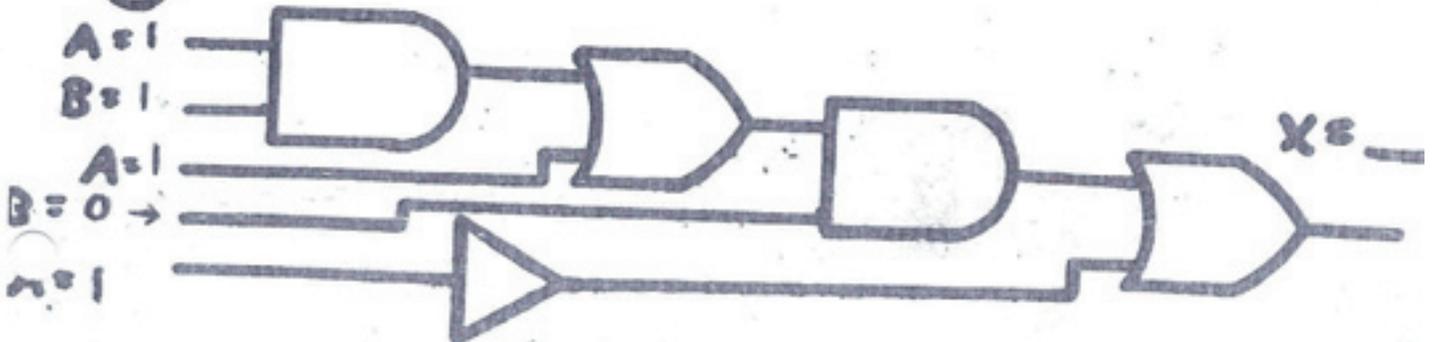
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③



④



Science

Science is probably the one area of K-12 education that is in most need of an update. Considering the amount of technology young people are surrounded with, you might be shocked to know that students are taught exactly nothing about how that technology works. Even the very basics of modern electronics are totally missing from the secondary school curriculum. Electronics, what makes cell phones, video games, computers, and the Internet work is totally absent from the science and mathematics curriculum. This was brought home to me when I was discussing the electromagnetic spectrum to a class of high school seniors. One of the more knowledgeable students asked “what’s that?” It turns out that the electromagnetic spectrum, which makes all modern communications (radio, WI-FI, TV and cell phones) possible, and also a multi-billion dollar public resource, was a total unknown to students who had made it to the final year of secondary education.

SCIENCE Activities

Fortunately, the electric guitar is an excellent vehicle for teaching the basics of electronics. The activities that I’ve used are as follows;

- 1) Handout and short lecture on electricity- (p. 14-15) voltage, direct and alternating current, resistance, insulators, conductors and semiconductors.
- 2) Handout and presentation of electronic components used in electric guitars- electromagnetic pickups, variable resistors and capacitors (p. 16) Next students will fill out a Guitar Schematic Worksheet and a Guitar Schematic Quiz (p. 17-18) where they will be required to label electric guitar components correctly.

Electricity

Two kinds of current-

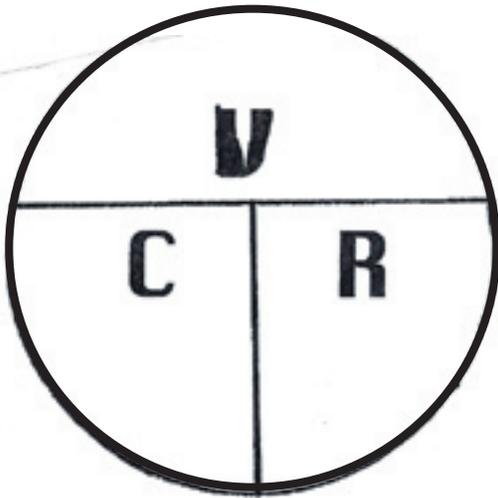
1) Direct current- Where electrons only flow in one direction. In a battery they flow from the positive terminal to the negative terminal.

2) Alternating current- Where electrons will flow in both directions. The electricity that comes from the wall socket will change direction 60 times every second.

Current measured in amps.

1 amp = 6,280,000,000,000,000,000 electrons per second.

Electricity (continued)



**V=voltage , measured
in volts**

**C=current, measured
in amps**

**R=resistance,
measured in ohms**

$$\frac{V}{R} = C$$

$$\frac{V}{C} = R$$

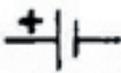
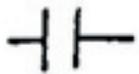
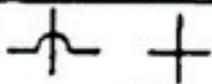
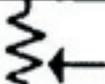
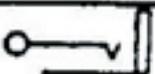
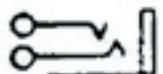
$$C \times R = V$$

**Materials that hold tightly to their
electrons are called insulators**

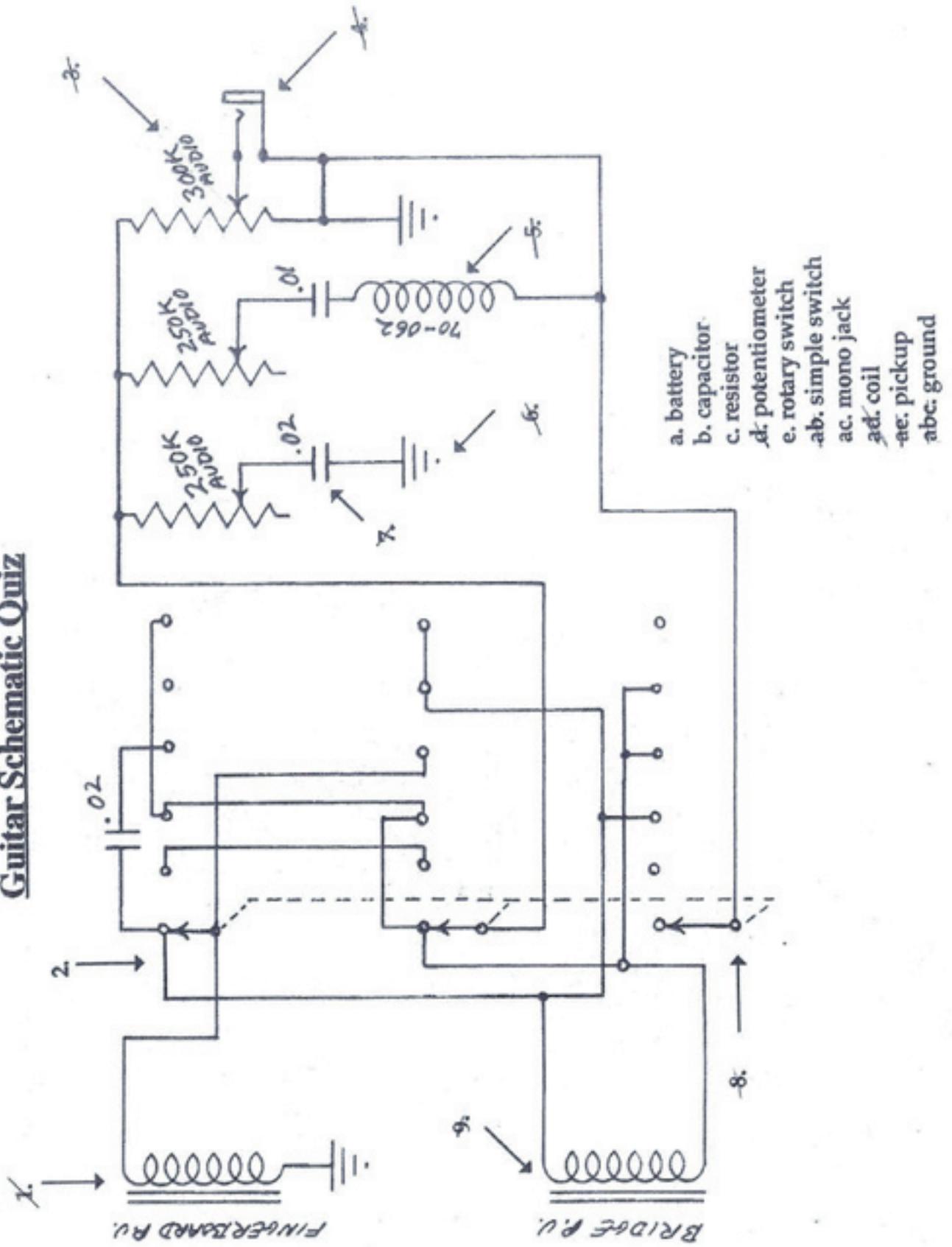
**Materials that give up their electrons
very easily are called conductors.**

**Materials that are neither good insulators
or conductors are called semiconductors**

Guitar Schematic Symbols

Battery	
Symbol for ohms	Ω
Capacitor	
Resistor	
two wires crossing but not touching	
Wire junction	
Potentiometer	
Simple switch	
Rotary switch	
Mono jack	
Stereo jack	
Piezo crystal	
Symbol for 1,000	K
Symbol for 1,000,000	M

Guitar Schematic Quiz



The Electronic Learning Center

I came across a great educational kit called the Electronic Learning Center (photo below) at a local Radio Shack, and found it a perfect learning aid for basic electronics.

With it students can construct up to 130 different electronic circuits that form the building blocks of all the technologies they're surrounded with. The thing about the learning center is that it is adaptable to many different age and complexity levels. Each circuit can be constructed using a recipe/cook book format where it is constructed step by step by connecting wires at numbered spring terminals. At minimum, students, even at the elementary school level, get a feeling of accomplishment by creating an actual electronic device without having to know the details of how circuits operate. From there, depending on the student's age and background, the details of circuit theory and design can be taught. I was especially surprised at how 2 special needs students took to the Electronic Learning Center-where students put together simple electronic circuits that form the building blocks of all the technologies they're surrounded with. I even had them teach other students how to use them. Playing the role of teacher was something they seemed to really enjoy.



Left; The Electronic Learning Center

Right; Gabriel Saldana and Brandon Labit try it out



English

The connections between music and language are almost too obvious to list. Most pop songs are simply poems set to a melody, they are examples of storytelling. Music has been called the Universal Language. Lyric writing, be it in rock, pop or hip-hop, is just a form of creative writing. The very first great work of Western literature-The Iliad, was originally performed in song.

There are 4 components to any language, in this case English-speaking, listening, reading and writing. Here are 2 activities that will develop all four.

Song Lyric Activity

The entire class, using a rhyming dictionary and thesaurus, will write the lyrics to a song.

You can distribute copies of rhyming dictionaries and thesauruses to everyone or have students with Internet access on their phones to go to one online, www.rhymezone.com is an excellent website which will give you rhymes, near rhymes, synonyms, antonyms and definitions of any word. Ideally, the teacher will want to have rhymezone on an overhead projector to help focus the students to work as one unit.

On page 21 are the lyrics to a song that the Guitar Class came up with as a group. As of this writing, melody and chords and a title are yet to be added.

Music Reviews This could be a review of either a CD, an individual song, or an individual musician or group. There will be one due on the last school day of each month.

Minimum length: 2 paragraphs. 2 paragraphs doesn't sound like much but given the unstructured nature of the average high school guitar class, it will be the most you can expect. Most music reviews from publications like Rolling Stone magazine, the Reader or City Beat will have a similar length.

Guitar Class Song and Lyrics Assignment

The guitar class is fun

Pay off in the long run

If you get your work done

You can become the one

Code red in my bed

That's what she said

I'd rather be dead

A train wreck ahead

CHORUS

Shine, shine, shine

Down the line, line, line

Social Science

The Social Science Curriculum, at least in California, is as follows;

4th grade California History

5th grade; U.S. History

6th grade; World History

7th grade; World History

8th grade; U.S. History

9th grade; 9th grade students are offered elective courses, where each school district has the option of offering a variety of classes. The California History-Social Science Framework has 20th century California history, Physical Geography, World Regional Geography, Humanities, Comparative World Religions, Anthropology, Psychology, Sociology, Women in Our History, Ethnic Studies, and Law-Related Education.

10th grade; World History

11th grade; U.S. History

HISTORY

A well-taught History class can almost be a metaphysical experience for students. Ideally, students are time travelers where they are transported into the different historical periods that are being studied. Well-made, historically accurate movies are ideal for this and so is music. As an example, I will share the songs of the Civil War that I perform when we are studying it in U.S. history

Songs of the Civil War

1. Follow the Drinking Gourd (p. 24) A song that contained directions for runaway slaves. The Drinking Gourd was the Big Dipper constellation, which contained the North Star, which runaway slaves would follow to gain freedom in the northern states.
2. Swing Low, Sweet Chariot (p. 25) A black spiritual, also with references to the Underground Railroad, the resistance movement that helped runaway slaves escape to freedom in the North and Canada.
3. Wayfarin' Stranger (p. 26) Another folk/spiritual song of a sad soul's journey through life.
4. Dixie (p. 27) The song of the south. Actually one of Abraham Lincoln's favorites.
5. Battle Hymn of the Republic (p. 28-29) The song of the north.
6. When Johnny Comes Marching Home. (p. 30-31) Classic song about welcoming weary soldiers home after a war.

Follow the Drinking Gourd

^G Follow the drinking gourd, ^{Dm} follow the drinking gourd
^F For the old man is awaiting for to carry you to freedom if
^C you follow the drinking gourd. ^{Dm} ^A

^{Dm} When the sun comes back and the first quail calls, follow the
^{Am} drinking gourd. ^{Dm} For the old man is awaiting for to carry you
^F to freedom if you follow the drinking gourd. ^C ^{Dm}

^{Dm} Now the riverbank makes a very good road. The dead trees
^{Am} will show you the way. ^{Dm} Left foot, peg foot traveling on.
^{Am} Follow the drinking gourd. ^{Dm}

^{Dm} Now the river ends between two hills. Follow the drinking
^{Am} gourd. ^{Dm} There's another river on the other side. Follow the
^{Am} drinking gourd. ^{Dm}

^{Dm} When the great big river meets the little river, follow the
^{Am} drinking gourd. ^{Dm} For the old man is a-waiting for to carry you
^F to freedom. ^C Follow the drinking gourd. ^{Dm}

Swing Low Sweet Chariot

CHORUS ^C ^F ^C
Swing Low, sweet chariot, ^{C7} Comin' for
to carry me home, ^{G7} Swing Low, sweet
^F ^C ^{G7} ^C
chariot, Comin' for to carry me home.
END CHORUS

^C ^F
I looked over Jordan and what did I
^C ^{G7}
see, Comin' for to carry me home, A
^{C7} ^F ^C
band of angels comin' after me, Comin'
^{G7} ^C
for to carry me home. CHORUS

^C ^F ^C
If you get there before I do, Comin' for
^{G7} ^{C7}
to carry me home, tell all my friends
^F ^C
I'm comin' there too. Comin' for to
^{G7} ^C
carry me home. CHORUS

Wayfarin' Stranger

I'm just a poor, wayfarin' stranger.

A travelin' through this world of woe.

And there's no sickness, toil nor danger,

In that bright land, to which I go.

I'm goin' there, to see my mother

I'm goin' there, no more to roam.

I'm just a goin' over Jordan,

I'm just a goin' over home.

Dixie

Oh, I wish I was in the land of cotton,
Old times there are not forgotten,
Look away! Look a-way! Look away
Dixie land.

In Dixie Land where I was born in,
Early on one frosty mornin' Look away!
Look a-way! Look away Dixie Land.

I wish I was in Dixie, Hooray! Hooray!

In Dixie Land I'll take my stand to live and
die in Dixie, Away, away, away down
south in Dixie,
Away, away away down south in Dixie.

The Battle Hymn Of The Republic

Mine ^E eyes have seen the glory of
the coming of the lord, He is ^A trampling
out the vintage where the ^E grapes of
wrath are stored; He hath loosed the
fateful lightning of His terrible swift
sword; His ^A truth is ^E marching ^B on. ^E

CHORUS ^E Glory, glory, Halleluyah! ^A Glory,
Glory ^E Hallelujah! ^E Glory, glory,
Hallelujah! His ^A truth is ^E marching ^B on. ^E
END CHORUS

I have ^E seen Him in the watchfires of a
hundred ^{cl} circling camps; They have
^A builded Him an altar in the ^E evening
dews and damps: I can read His

The Battle Hymn of the Republic (continued)

righteous sentence by the dim and
flaring lamps, His ^A day is ^E marching ^B on ^E

CHORUS

I have ^E read a fiery gospel writ in
burnish'd rows of steel' "As ye ^A deal
with My ^E contemners, so with you My
grace shall deal"; Let the Hero, born of
woman crush the serpent with His heel,
^A Since God is ^E marching ^B on. ^A **CHORUS**

When Johnny Comes Marching Home

^{Cm}
When Johnny comes marching home

^{Gm}
again, Hurrah! Hurrah!

^{Cm}
We'll give him a hearty welcome then,

^{Eb G7}
Hurrah! Hurrah!

^{Cm} ^F
The men will cheer, the boys will shout, the

^{Cm} ^{D7}
ladies they will all turn out and we'll

^{Cm Fm G7} ^{Cm} ^{Fm}
all feel gay when Johnny comes marching

^{Cm}
home.

^{Cm} ^{Gm}
Get ready for the jubilee, Hurrah! Hurrah!

^{Cm}
We'll give the hero three times three,

^{Eb G7}
Hurrah! Hurrah!

^{Cm} ^F ^{Cm}
The laurel wreath is ready now to place

^{D7} ^{Cm Fm G7}
upon his loyal brow, and we'll all feel gay

^{Cm} ^{Fm} ^{Cm}
when Johnny comes marching home.

When Johnny Comes Marching Home (continued)

^{Cm}
In eighteen hundred and sixty-four, Hurrah! ^{Gm}
Hurrah! ^{Cm} Abe called for five hundred
thousand more, Hurrah! ^{Eb} ^{G7} Hurrah!
^{Cm} ^F
In eighteen hundred and sixty five, they
^{Cm} ^{D7} ^{Cm} ^{Fm}
talked rebellion, strife and we'll all drink
^{G7} ^{Cm} ^{Fm}
stone wine when Johnny comes marching
^{Cm}
home.

History Through Music

For the early 20th century, I would perform Ragtime Guitar instrumentals, The Music of Spain, which always resonates with Latino students, and classical guitar music-ranging from the Renaissance to the Romantic era. The emotional power of music can be an effective tool for a History teacher, and if it's performed by a real live person, it can be even more so. Students nowadays are so conditioned to hearing music from electronic devices that some students become uncomfortable when seeing a real live person performing music, no matter how well it's done. In the battle of man versus machine, we must do what we can to restore the human dimension in our student's environment. I see this as one of the main objectives in a well-designed Social Science curriculum.



Conclusion

This book is a Progress Report of sorts for the Guitar Core learning project. It is now at the halfway point, with a projected completion date of June of 2014. My hope is that making the core subjects more relevant to their lives and the world around them will make school a wondrous and magical place once again.