Soulful science: using electric guitars to teach electromagnetism

A workshop for the California All State Music Educators Conference
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Electric guitars are not so much electric as magnetic. The solid body pickup that powers the electric guitar consists of several magnets wrapped in a copper coil. This combination results in *electromagnetic induction*, the process by which an electrical signal is generated by a magnetic field.

Electromagnetism is part of the 3rd grade California Science Standards. Using electric guitars to demonstrate the principles of magnetism puts these concepts into the sort of real world context our national education standards say are likely to inspire kids. Guitars are also an important component in the history of pop music, rock and roll in particular, and are a great way to introduce that subject as well.

Activity 1 -- Balloon dance

The slack key slide guitars used for this session (and which I use in my classroom) are unlike guitars most students and adults are familiar with. There are no frets boxes. Instead, the strings are effectively shortened or lengthened by use of a metal bar called a "steel."

This activity is a fun way to introduce this unusual way of playing. Inflate several large (36") balloons. There should be one balloon for each electric guitar.

Have students toss the balloons in the air to themselves and/or to each other. As they do, have them vocalize by making their voice rise on "ahh" as the balloon rises and fall when it falls.

Add a drum -- either a performance or from a recorded track. (The idea is to provide a little rhythmic context, since the guitars and balloons tend to be arrhythmic.)

Introduce the electric guitars. They are strummed with the right hand, while the steel, held in the left hand, slides back and forth on the strings.

As some students toss the balloons, others use the slide guitars to follow with the pitch. The goal is to get students comfortable making sounds on the guitar.

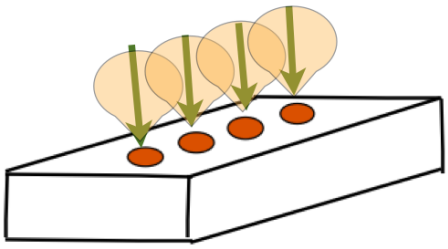
Harry Watson's "Frying Pan"

A Little History

The need for a louder "electrified" guitar arose during the expansion of the horn section of the jazz dance bands in the 1920s.

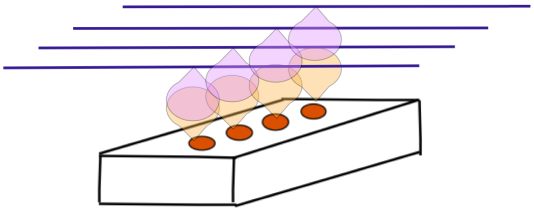
In 1931, Harry Watson developed the first solid body electric guitar, a lap steel nicknamed "the Frying Pan," for the Rickenbacker Company. In 1936, Gibson developed the first commercially successful electric guitar. Both companies still produce electric guitars today.

How electric guitar pickups work



Guitar pickups contain one or more permanent magnets. These magnets radiate a magnetic field.

When the field comes in contact with ferromagnetic (iron) material in metal objects such as steel guitar strings, it turns that material into a temporary magnet. When the fields of the permanent and temporary magnets interact, the permanent magnet field picks up the resonance or "flavor" of the temporary magnet field.



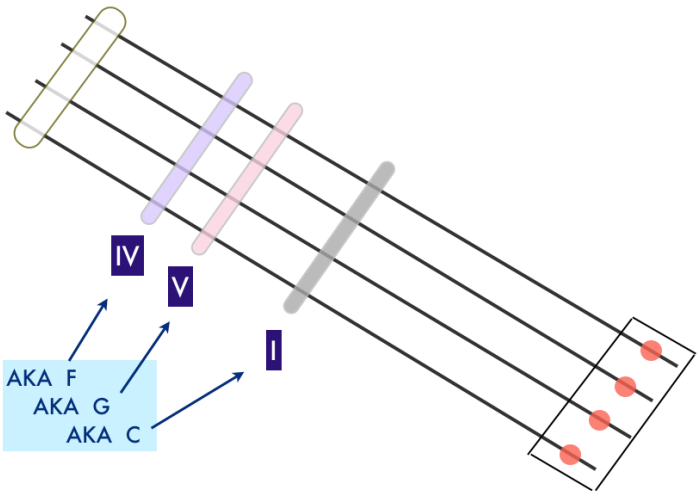
The copper coil wrapped around the permanent magnets converts this flavored field into a small electrical signal, which flows to the amplifier. There additional power is added to make the signal audible.

Activity 2 -- Opposites Attract

By fourth grade students know a lot of things about magnets. Guitar pickups can be used to reinforce and develop this understanding in a way that is sure to get student's attention.

These demonstrations include allowing students to observe the interaction of opposite and like poles, using magnets to move objects, and creating temporary magnets.

There are also some experiments that are distinctly musical. For example, a guitar pickup on a paint stick -- what I call a "ferometer" -- can be used on different acoustic stringed instruments to determine which have strings that contain iron and which do not.

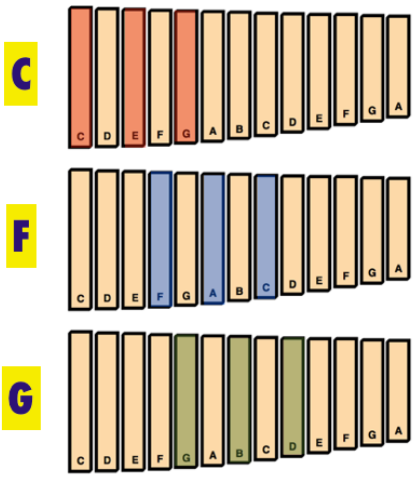


Slack Key Tuning/Bar Chords

Slack key tuning features open triads, meaning that major chords can be played by barring across all the strings.
The four string guitars we are using are tuned to a C triad. This enables

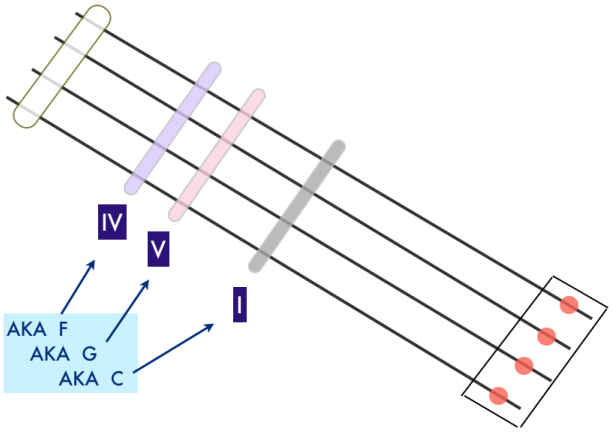
them to be played easily with other instruments that also play well in C -- ukuleles, Orff xylophones, recorders.

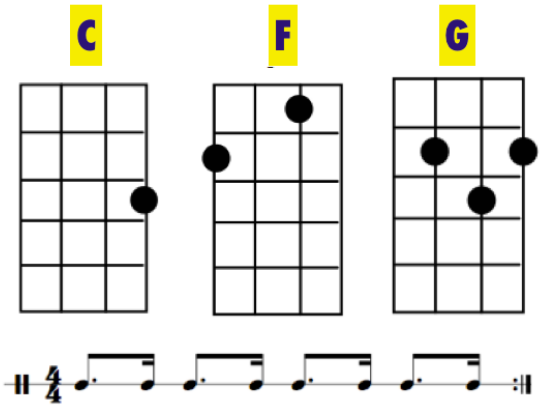
Activity 3 - Wimoweh



In the jungle, the mighty jungle,
The lion sleeps tonight.
In the jungle, the quiet jungle,
The lion sleeps tonight

In the village, the peaceful village,
The lion sleeps tonight.
In the village, the quiet village,
The lion sleeps tonight





Wimoweh is one of many I-IV-V tunes that present an opportunity to use slack key slide guitars as part of the classroom instrument ensemble.

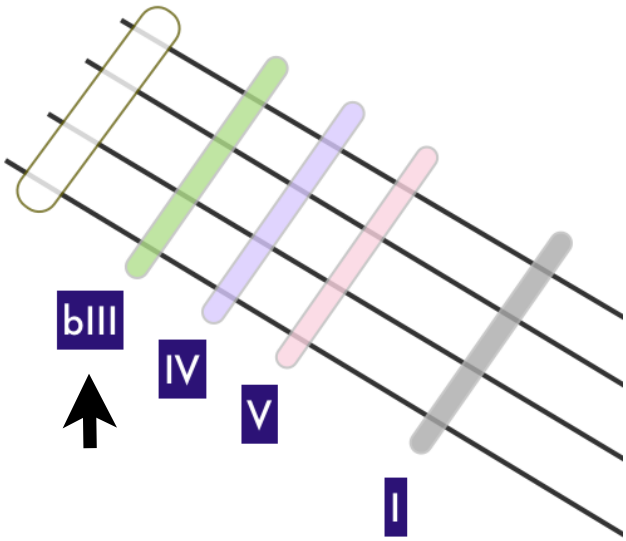
Begin with movement to the 4 beat phrase "Wimoweh oh Wimomeh oh." Have students come up with movements to represent each of the 3 chords and develop a dance that follows the pattern of the song -- 4 beats on I (C), 4 beats on IV (F), back to I for 4 (C), 4 beats on V (G). (Usually I accompany them by playing the tonic of each chord for 4 beats on bass xylophone.)

Establish how to find I, IV and V chords on the guitars using the colored bands (or with stickers, if using prepared conventional guitars.) Remember - no bar or "open" is also a I chord.

While some students are getting comfortable with their "slide chops," distribute the rest of the instruments -- ukuleles, tubanos, xylophones. (I find it is easier to play the shuffle associated

with Wimoweh on the drums and ukes and let the xylophones play one or two of the notes from each triad on straight quarter note beats.)

Sing and perform the song. Remember to encourage kids to use the slide guitars selectively, such as during an instrumental break.



Playing the blues

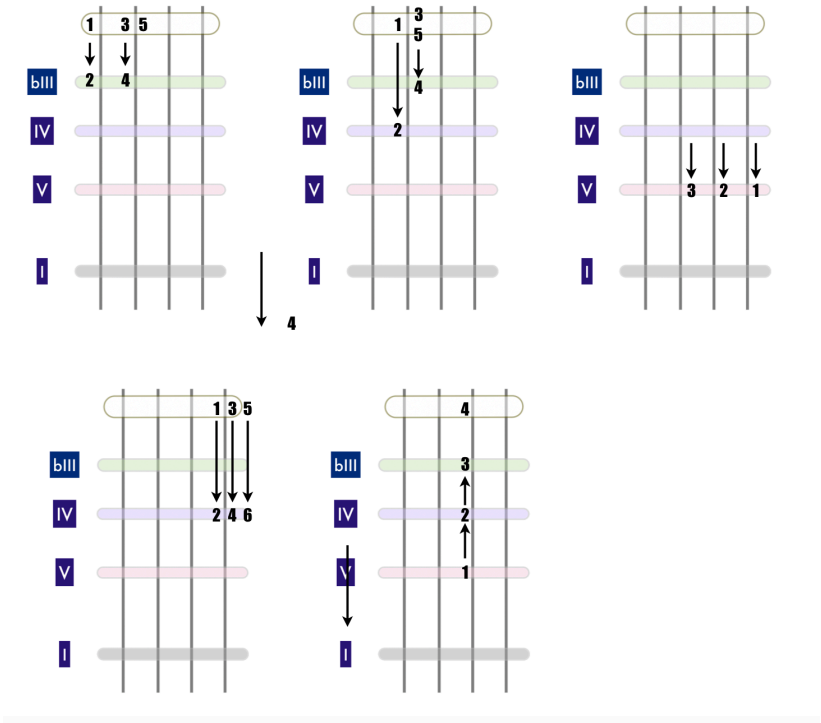
Originally associated with Hawaiian music, the pitch-bending slide guitar timbre has come to be associated with the blues. During the 1950s, slide players like Elmore James had an enormous influence on young English guitarists. This led to the development of hard rock

The key to an authentic blues sound is a healthy use of the minor or flatted third (in the key of C, that's Eb.) At the same time, the instruments should be played in short bursts of a few notes -- the so called "blues licks." It is important to remember that blues guitar vocabulary developed when the first blues men used the guitar as a way of responding to their own vocal "call." Young guitarists need to learn to play these short responses soulfully before they can get about shredding.

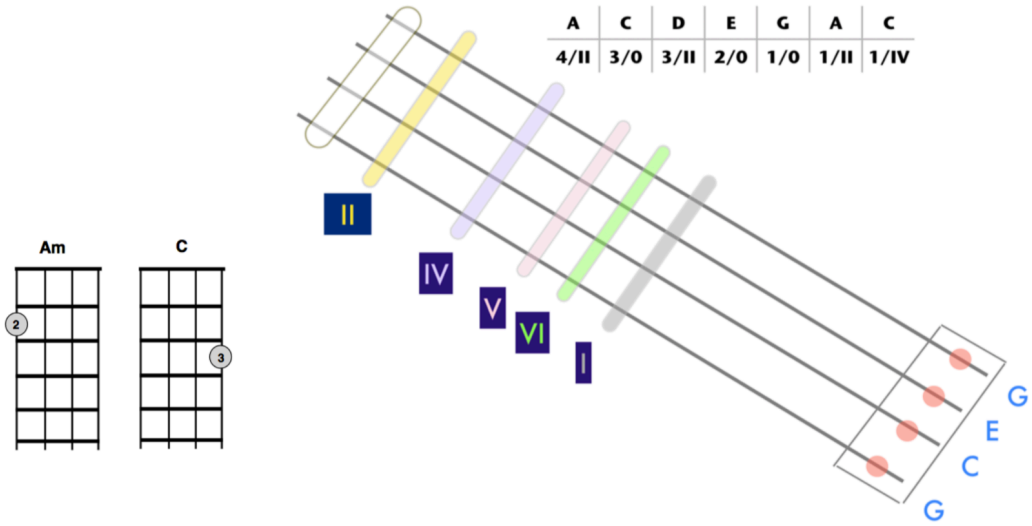
Activity 4 - John Lee Hooker Jam-along

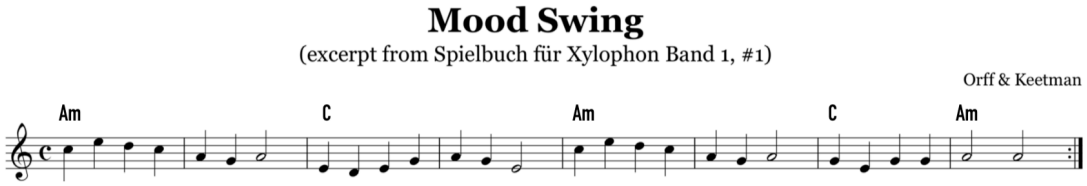
Develop some blues licks of 6 or fewer notes on individual strings. Emphasize the slide in transition, and remember to employ a sense of swing. Play with attitude!

Once a collection of cool licks has been developed, try playing them against a recording of blues in C. I like Graveyard Blues by John Lee Hooker (available on iTunes.) Hooker played in guitar in a unstructured, improvisatory way, often on one chord — perfect for our purposes!



It is possible to use the slide guitars as in conjunction with the Orff instrumentarium in another way. All four open strings are part of the C pentatonic and "sliding" up to the *II position D and A to be played completing the pentatonic.*





Activity 5 — Mood Swing

This piece from the Orff Schulwerk supplement, Spielbuch für Xylophon is a great way to illustrate the slide guitar's emotional quality.

Teach the melody as shown on barred instruments. Add additional student composed color parts that amplify the relative minor shift throughout. Add ukuleles and alto recorders as well.

Review the la pentatonic on A positions on the guitars, and then develop the piece, alternating between the given material and a series of slide guitar solos using la pentatonic on A.

Richard Lawton *is the general music teacher at Roscomare Road Elementary School in Los Angeles and the recorder instructor in the LA County and University of South Florida Summer Orff courses. Richard is a past presenter at numerous state and national conferences and the 2018 California Music Educators Association/Peripole General Music Teacher of the Year.*

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