

Studying STEM by Building Guitars

When Debbie French introduced material from the National Science Foundation (NSF)-funded National STEM Guitar Project in her physics classroom to teach about topics like sound waves, electricity, and magnetism, her students were eager to learn physics by building electric guitars. “When I first started [teaching physics at New Philadelphia High School in New Philadelphia, Ohio], I had 14 students: nine gentlemen and five ladies. [Eight years later], I had 62 students and 50% girls and guys equally...My numbers really increased [after year three] when I implemented the guitar program.”

Few of her students “had experience with hand tools, soldering, electronics. So this was a really good experience for my ‘academic’ students to gain more hands-on, real-world skills,” she maintains.

“That’s part of the intangibles that this project brings: confidence in actually making something, something I think we’ve lost in high school. We no longer make things,” contends Tom Singer, professor of Mechanical Engineering Technology at Sinclair Community College in Dayton, Ohio, and the project’s principal investigator. “Having hands-on, kinesthetic-based learning is really important to capture a variety of students because not all students learn just from lecture and lab, or from reading it in the book, or watching the video. They actually want to learn using their hands.”

In addition, says French, “there is a lot of problem solving [involved, like] diagnosing a wiring problem, such as ‘Why is the jack buzzing? Is there a missing ground? Is there a crossed wire?’”

The National STEM Guitar Project hosts Guitar Building Institutes around the country to give educators the chance to build a solid-body electric guitar and use it to teach science, technology, engineering, and math (STEM). Thirty-two states now have at least one program that has implemented the STEM Guitar Project, notes Singer, adding, “We’ve got all levels of academic involvement,



Teachers participating in the National STEM Guitar Project’s institutes build a solid-body electric guitar and use it to teach STEM and other subjects.

from middle schools all the way up to universities.”

David Parker, physics teacher at Noble High School in North Berwick, Maine, implemented the program three years ago. “The guitar program was important because it helped us reach out to students who didn’t think of themselves as STEM candidates at first. We had a lot of students who were not necessarily excited about physics, but really liked music. I knew I could get them interested by building a guitar and teaching them about how a guitar makes sound,” he explains.

Teachers need not be guitar players to attend the institutes. Dawn Nguyen—a homeschool instructor for EarthSchool of Maine and a participant this past summer—says, “I contacted Tom Singer immediately to see if a non-guitar-playing, homeschool educator would be eligible to participate in the institute. Happily, I was accepted to the program.”

During the institute, “we went from Tom’s kits [of materials for building the guitars] to pretty wonderfully finished guitars in about 35 to 40 hours,” reports Bruce Gamage, eighth-grade science teacher at Oceanside High School-West in Thomaston, Maine. “We even received a \$300 stipend for the workshop,” he adds.

“Participants in our institutes get financial support through the NSF as part of the implementation plan,” Singer notes.

The project’s curriculum, available free at www.guitarbuilding.org, supports the *Next Generation Science Standards* and *Common Core State Standards*, and features “plug-and-play modular learning activities [teachers] can use for any type of course, whether it’s science-based, engineering-based—even in English you could use some of our curriculum,” observes Singer. “Part of what we provide is a writing curriculum,” he adds. “My students actually have to do a research paper as part of the class itself, researching the importation of wood products.”

French and other members of the grant team “have designed learning activities for particular disciplines,” and “invite teacher-participants at the workshops to develop their own lesson plans” for publication on the website, she notes.

Several activities, including those related to “the chemistry of swirl finishes, allow us to integrate the science, engineering, and artistic aspects,” she relates. “We’ve experimented with different paints; water quality affects how we can apply the paint to the surface of the guitar.”

Arts integration also can occur with 3D modeling. “We have participants sketch their headstock design in a 3D modeling software, such as Inventor or [others]. And then they either print out the paper and cut the headstock out manually, or they use a [computer numerical control] router to electronically cut out their headstock,” French explains.

“Creating a guitar from wood is like sculpting a work of art; as the process continues, the guitar comes to life from the wood,” Nguyen contends. “Students will benefit from not only the math and science topics covered, but [also] by the confidence and creativity that is evoked during the project.”

Costs and Benefits

Teachers implementing the program have their schools purchase the project kits, which contain materials for building the guitars. “Most schools have students pay at least partially for the guitar kits. One teacher in Indiana had his students do a fundraiser,” French explains.

“We also have school districts that fund the guitars themselves, and then the districts own the guitars until the students graduate...then the students get to take the guitar with them. [It’s a] graduation incentive,” Singer remarks.

Gamage says his school received a grant from the Perloff Family Foundation for startup funds. “We will supply the kits for students who can’t afford them, and hope to auction the finished instruments to raise funds for next year’s guitar program.”

The institute also offers participants “a graduate credit option through the University of Wyoming,” says French. Teachers can earn “three credit hours for a total of \$150...They have to do some additional work, including designing lesson plans.”

“There’s a huge amount of support out there” for teachers interested in implementing the program, Parker maintains. “All teachers have to do is decide they want to do it. The curriculum, kits, and funding models are there [for them].” ●