Teaching Physics and Related STEM Subjects Using Electric Guitars

www.guitarbuilding.org

ATE Due-0903336

"Blues had a baby, and named it Rock and Roll"

Muddy Waters

STEM Revolution

Science

Technology

Engineering

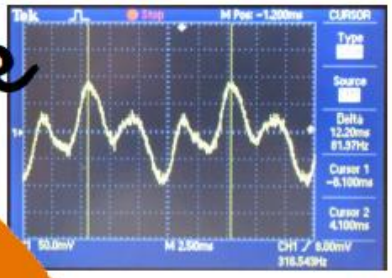
Math

$$v=\sqrt{t/\mu} \qquad v=\lambda f$$

$$\lambda=2L$$

$$f=\frac{\sqrt{t/\mu}}{2L}$$

v = velocity
T = tension force
μ = mass/length
λ = wavelength
f = frequency
L = string length



Innovative, Relevant, Dynamic STEM Education

NSF - ATE DUE 0903336

STEM Basics

"It's a long way to the top if you want to Rock and Roll" – AC/DC

- Science
  - Physics (wave motion, sound, electricity/ magnetism, frequencies)
  - Chemistry (finishes)
- Technology
  - CNC, Laser, Electronics, Woodworking, Tool usage (power and hand)
- Engineering
  - Design, analysis (CG), material properties, Ergonomics, IE
- Math
  - Geometry, algebra, logarithms, calculus

So Why does it work?

- Easy to implement
  - Multiple levels of integration—full class participation to after-school club
- It is Gender neutral
  - We are even experimenting with nail polish painting!
- Students already have interest (easily recognizable)
- High success rate for completed guitars
  - At college level success rate is 99% (1% just stopped showing up)

So Why does it work?

- PBL— Students work collaboratively, solve problems throughout the build.
- Increased student confidence—"Oh yeah, I built that!"
- Increases community interest and involvement.
  - This program will generate a lot of publicity for your class.
- Relatively low cost to get started (under $1500 in tools / equipment for a lab) and is a sustainable program through guitar sales (funding is available for teachers completing the workshops)

How we use this in classes at Sinclair Community College

- Physics and Math dept's uses guitars and string tension gauges in classes
- 2 types of class options in MET
  - No-prerequisite class in exploring manufacturing and guitar building (students customize a pre-made guitar) over 50% are non-ET majors
  - Mini capstone -Our MET program has a end of year one capstone in design and fabrication

How we use this in Physics Classes at New Philadelphia High School

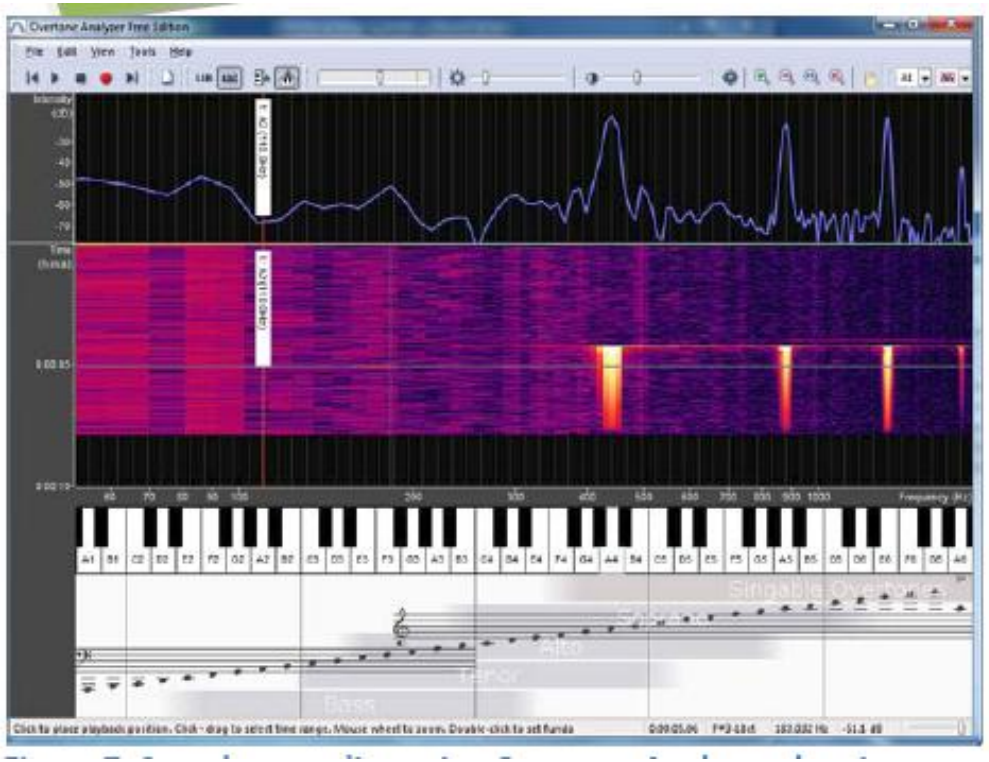
- Interested students build guitars during activity period/after school.
- Learning activities implemented in Physics and Physical Science Curriculum
- Student research group with D'Addario Guitar Strings and Purdue University

How we use this in Physics Classes at New Philadelphia High School

- Students did preliminary tests on various paints (such as model paint and nail polish) for swirl dipping

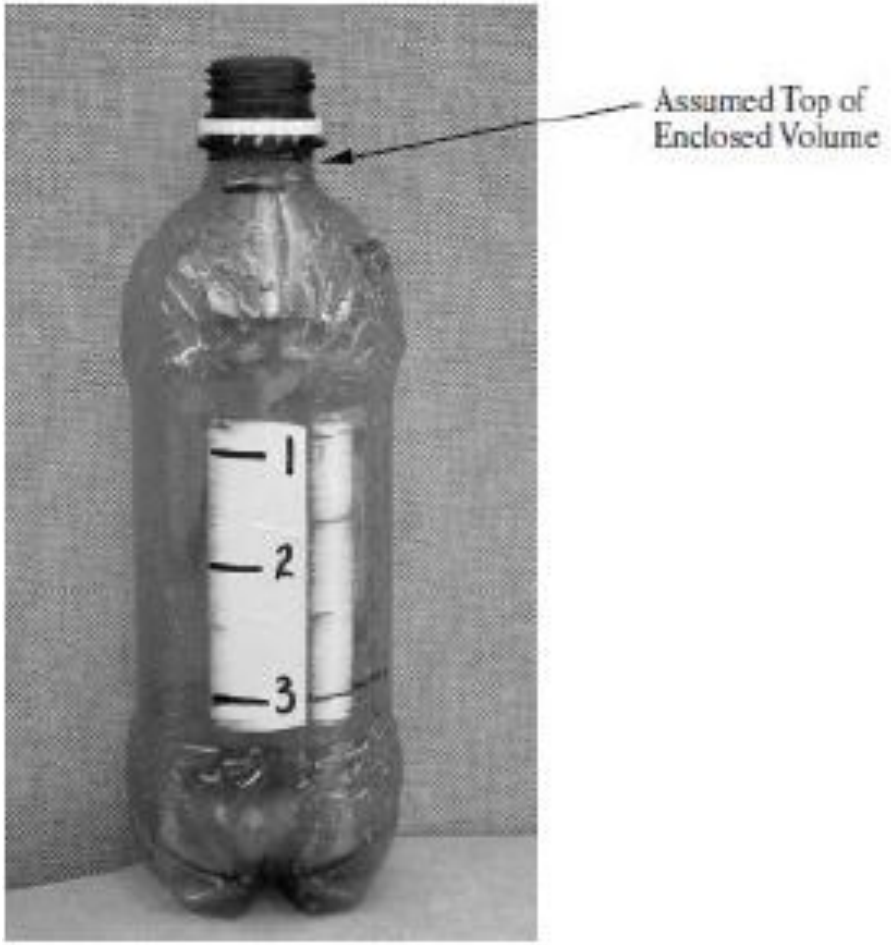
Sample of Science Lessons

- Decibel Scale
- Big Ben Sound Demo
- Dancing Laser Demo
- Intro Wave Behavior
- Standing Waves on a String
- Standing Waves on a Guitar String
- Determining String Tension using Measured Frequencies
- Pickups and Faraday's Law of Induction



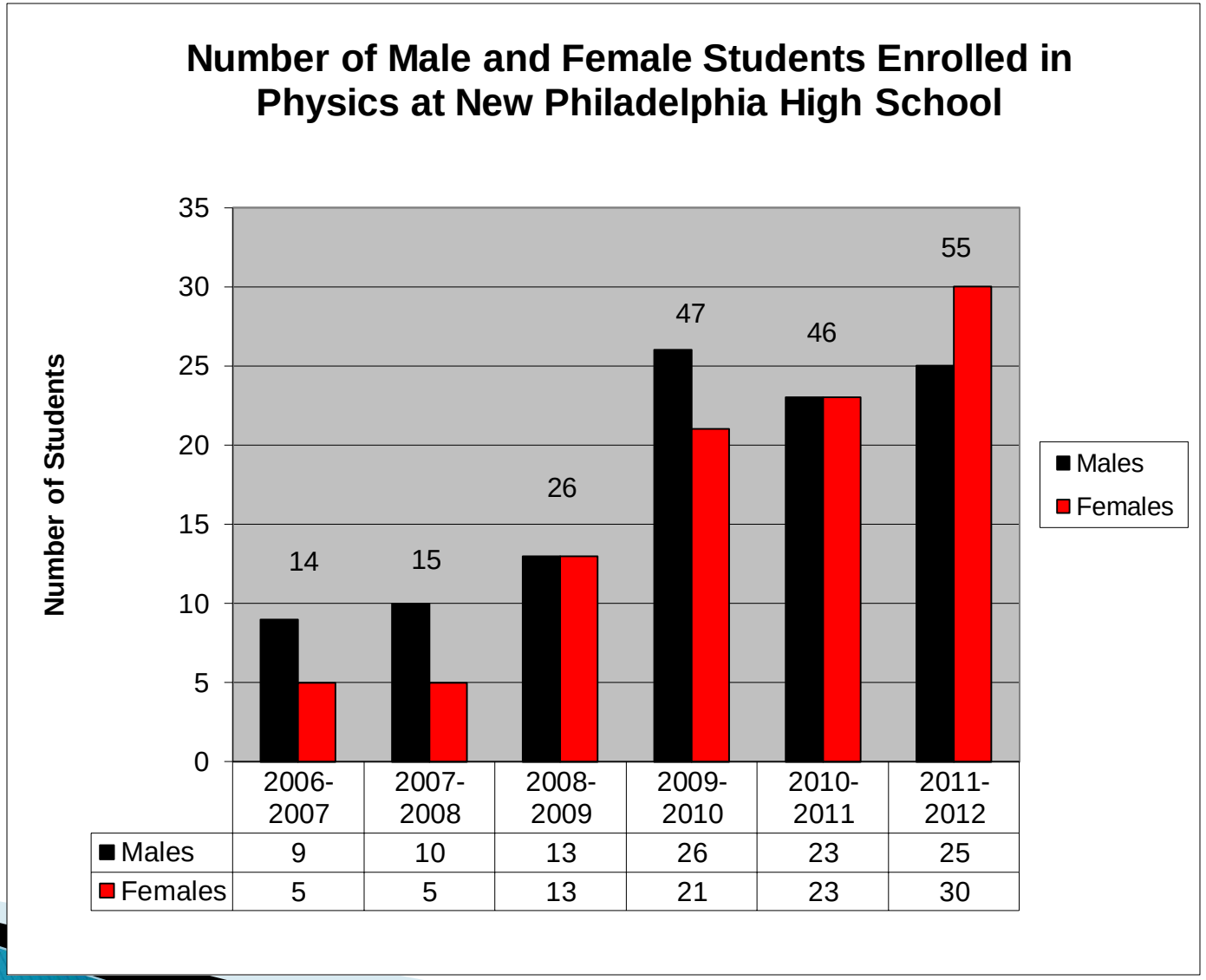
Sample of Science Lessons

- Using a Pop Bottle as a Helmholz Resonator
- Spectrum Analysis: Overtone Analyzer
- Understanding Musical Scales
- Investigation of Guitars Using a Spectrum Analyzer
- Independent Project
- Chemistry of Swirl Dipping I, II, and III
- **Stay tuned for more lessons!**



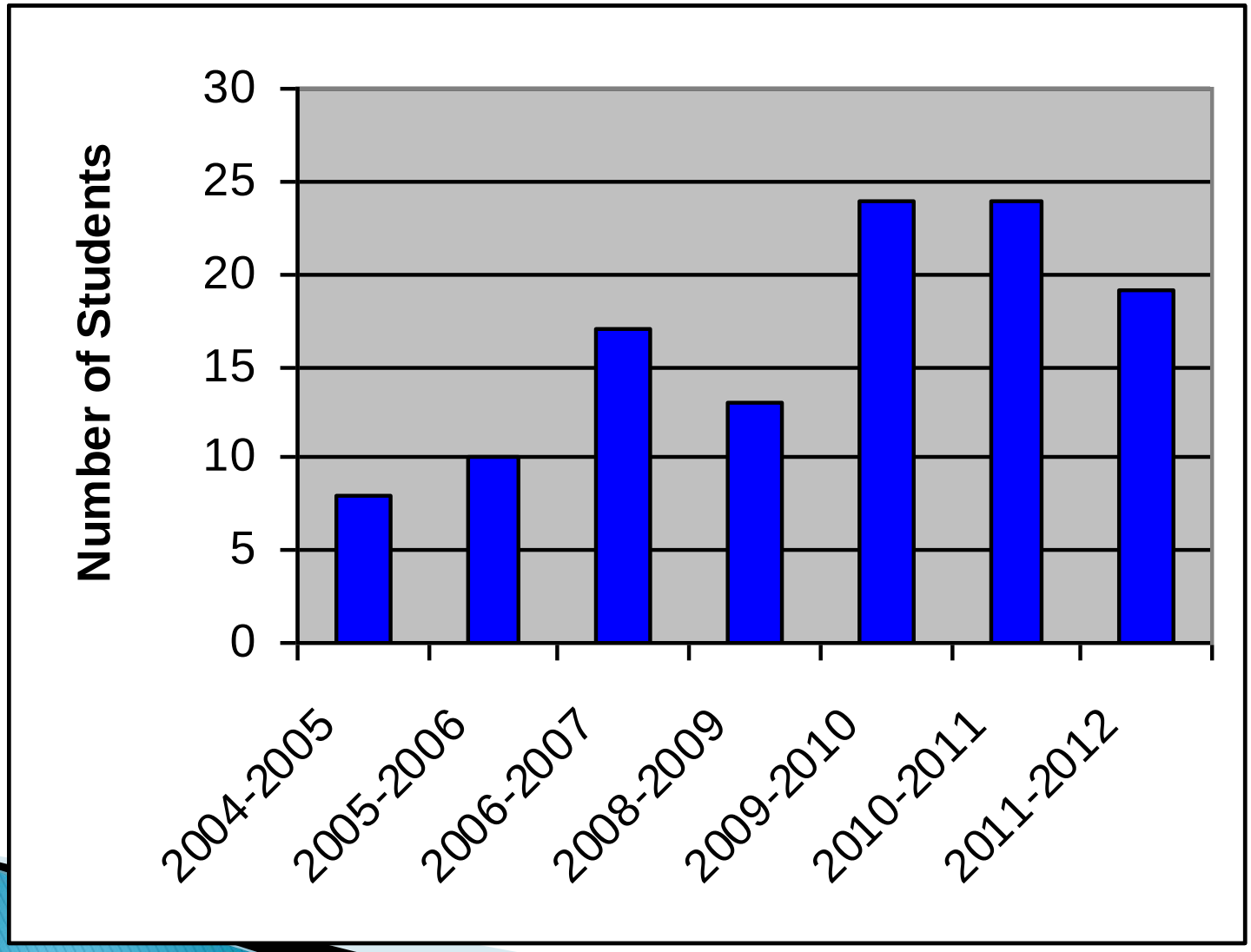
Results of Implementation

- Increased overall student interest in physics
- Increased number of female students



	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Males	9	10	13	26	23	25
Females	5	5	13	21	23	30

Student Enrollment in a Tech Class at Southern Wells High School



Results of Implementation

- Increased community interest and involvement with physics
- Local music stores, parents, luthiers, and music teachers are involved!

How to Integrate: the first step

- Attend a training workshop on STEM applied guitar fabrication (2012 dates)
  - June 18–22 College of the Redwoods, Eureka, CA
  - June 18–22 Butler County Community College, Butler, PA
  - June 25–29 Ventura Community College, Ventura, CA
  - July 9–13 Purdue University West Lafayette, IN

Team partner applications (one Technology faculty one Math or Science Faculty @www.guitarbuilding.org

Registration is available Now!

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Dynamic, Relevant, Innovative STEM Education

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Guitars in the Classroom? Absolutely.

This National Science Foundation STEM Guitar Project provides innovative professional development to high school and community college faculty in collaborative design and rapid manufacturing.

Faculty teams will take part in an intense five day guitar design/build project. Each faculty member will build his/her own custom electric guitar and will engage in student centered learning activities that relate the guitar design to specific math, science and engineering topics. Participants will leave this weeklong experience with their custom-made guitars, curriculum modules that can be immediately integrated into the faculty teams school curriculum, and much more.

Who are we?

Like Scot Rabe, Steve Brown and 19 others like this.

Curriculum and Resources

Guitar Kit

How to get involved

- Look for integration opportunities in your curriculum
  - Check out our Guitar design and Manufacture workbook for STEM activities ready for classroom use
  - You choose the level of applied learning
    - Use the curriculum as a stand alone item in the classroom
    - Integrate through Building guitars
    - Become a supply chain partner
- We sell complete or hardware only kits of the guitars to schools.
  - if you do not have Mfg capabilities but still want to get involved!
  - $175 for the guitar kit
  - $135 for the hardware only

How to get involved

- Attend a training workshop on STEM applied guitar fabrication
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  - **June 18-22** Butler County Community College, Butler,PA
  - **June 25- 29** Ventura College, Ventura, CA
  - **July 9-13** Purdue University West Lafayette, IN
  - Seattle area will have summer workshops Edmonds Community College / EMP
  - Aug 13-17. Richland HS, Richland, WA
  - **Team partner applications (one Technology faculty, one Math and/or Science Faculty @ www.guitarbuilding.org**

Registration is available Now!

Contacting us directly

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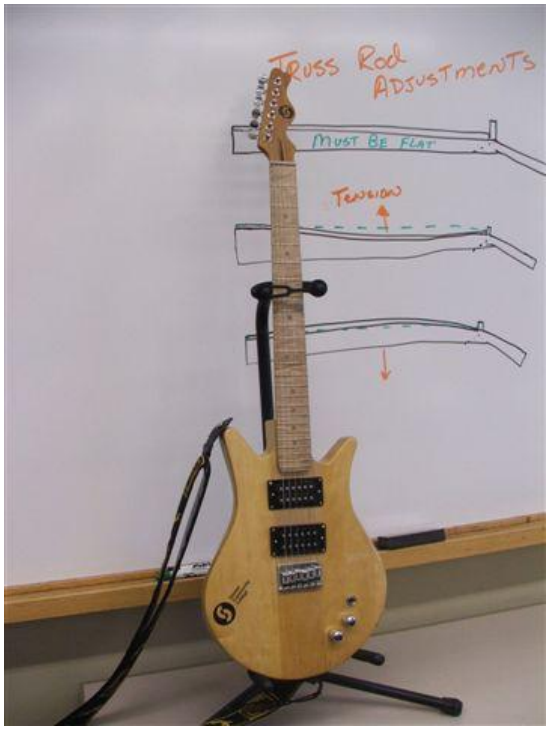
- Tom Singer
  - Thomas.singer@sinclair.edu

Educational and Corporate Project partners

For more information, curriculum and videos

Guitarbuilding.org



He never ever learned to read or write so well, but he could play his guitar like he was ringing a bell.

– Chuck Berry, Johnny B. Goode

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New Philadelphia Guitar Photos

Sinclair Collab N FAB Guitar LAB Photos