Anatomy of a Tone:  
A Highly Functional Web-based Interactive Learning Module

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Abstract: Northeastern University’s Education Technology Advisory Committee (ETAC) consists of faculty who are specialists in bridging the gap between content development and instructional design. “Why does the note ‘A’ sound different on a flute compared to a violin?” is an interactive learning module that tackles the elusive concept of musical timbre. This is an example of an Embedded Learning Module (ELMO) that recently received a NSF (National Science Foundation) grant to explore a variety of methods to break down the barriers to teaching science to artists. Issues of planning, design, effective project management, interdisciplinary methodology and the integration of media are discussed, and the finished project presented. Anatomy of a Tone demonstrates an effective collaboration between students in Northeastern’s flagship multimedia studies program, faculty mentors, experiential learning and successful integration of content development and instructional design, the result of a 20-week long planning, design and implementation project. Anatomy of a Tone may be viewed at: http://elmo.neu.edu/elmo_html/demos/beta music.html.

Planning, Implementation and Design

The Multimedia Studies program is a state-of-the-art dual major combining skills in music technology, animation, graphic design and digital imaging at Northeastern University in Boston. Students attend for five years, and work on the job (called “co-op”) for up to eighteen months prior to graduating. As seniors, these students must complete a 20-week long experiential capstone program in order to satisfy their graduation requirements. Anatomy of a Tone is an interactive learning module based on current research in educational technology and learning behavior. It seeks to teach a complex and abstract concept via a series of integrative text-sound-image steps that allow the user (learner) to fuse difficult concepts in a manner that is extremely difficult to do in a lecture based setting. It is the process of student self-discovery that is investigated in this project.

Students, or any successful instructional designer, must collaborate with experts in the field they are illustrating. In order to understand the concept of timbre, the instructional designer is challenged to illustrate supportive scientific concepts such as wave properties, vibration, amplitude, wavelength and frequency.
Interactive Functionality

Two of the most effective interactive pages of *Anatomy of a Tone* are the “Frequency as Pitch” and “Qualities of Timbre” modules.

**Frequency as Pitch**

This module shows an image of a piano keyboard that is, to many, the familiar and comfortable interface to musical pitch. When a user clicks on a key of the keyboard, simultaneously the pitch is heard (as a sine tone), its music notation is shown, a picture of its wavelength depicted, and its exact frequency in Hertz is demonstrated. Through interaction with this module, the four concepts of tone, music notation, wavelength, and frequency in Hertz are integrated in a manner highly effective to learning.

**Qualities of Timbre**

This module allows a user to turn on and off the first eight harmonics of a 100 Hz tone and adjust the relative amplitudes of each harmonic individually and at their own discretion. This web-based additive synthesizer allows the user to hear real-time manipulation of timbre, illustrating the previous concepts through a combination of visual and aural media.

**Evaluation and Assessment**

In order to check on the comprehension of the user/learner, a summation page and interactive quiz are provide, in addition to a glossary of terms.