School Earthquake Safety Initiative

Curriculum Pitch for Classrooms

Version 1.1
Last Modified on 10/1/2016 by Robert Whitney

The process of integrating the Next Generation Science Standards and Common Core practices into existing high school physics curricula requires thoughtful collaboration and considerable time for the classroom teacher. With that in mind, the Earthquake Engineering Design Lessons have been attentively aligned with the 2016 Draft California Science Framework to emphasize 'Three Dimensional Learning' and matched with relevant NGSS evidence statements and Common Core Math and Language Arts standards.

Lesson design employs the '5-E' instructional model in a natural way. Engagement with the observed phenomenon leads to further exploration through student-developed modeling. Direct instruction from the university facilitators at appropriate intervals provide engineering context and reinforce the instructional scaffolding. Periodic revision to the initial student models occurs throughout the EEDL, providing formative feedback, as students control and monitor their deepening understanding through the completion of 'Stronger and Clearer' activities. Student groups will communicate their final results meeting Common Core English Language Arts literacy objectives.

The initial focus leading the lessons is the phenomenon: the structural failure of a scaled balsa wood building secured to a portable shake table and subjected to a simulated earthquake. Following this attention-grabbing demonstration, students will create and revise models of their observations with the goal of making their thinking 'visible'. Modelling is an essential component of NGSS activities. Further explanation and justification of modelling is found in the NGSS Appendix F:

> *The Science and Engineering Practices encourage students to use models to make their thinking visible and revise their thinking as new knowledge is discovered. Models include diagrams, physical replicas, mathematical representations, analogies, and computer simulations. Although models do not correspond exactly to the real world, they bring certain features into focus while obscuring others. All models contain approximations and assumptions that limit the range of validity and predictive power, so it is important for students to recognize their limitations.*
>
> *In science, models are used to represent a system (or parts of a system) under study, to aid in the development of questions and explanations, to generate data that can be used to make predictions, and to communicate ideas to others. Students can be expected to evaluate and refine models through an iterative cycle of comparing their predictions with the real world and then adjusting them to gain insights into the phenomenon being modeled. As such, models are based upon evidence. When new evidence is uncovered that the models can't explain, models are modified.*
>
> *In engineering, models may be used to analyze a system to see where or under what conditions flaws might develop, or to test possible solutions to a problem. Models can also be used to visualize and refine a design, to communicate a design's features to others, and as prototypes for testing design performance.*

Research shows that improved student learning involves designing NGSS lessons with several ideas in mind, all of which are supported by modelling. For example, bridging prior knowledge to new experiences is a key component of the process. Therefore, student direction with their initial models should be influenced by local context, such as proximity to faults or their perceptions of historic earthquakes. Other vital considerations to the lessons are: (1) student models should predict, explain,

and be well labelled; (2) Cross Cutting Concepts should be explicitly discussed in all classroom lessons; (3) generating 'Claim-Evidence-Reason' statements are essential when students are predicting or summarizing research; (4) mindful that Performance Expectations are what students should know and do, and from which the Evidence Statement naturally reflect. The goal of measurable student success in NGSS designed lessons is exemplified with the structure of knowledge chart below.

TABLE 6.1 Cognitive Activity and Structure of Knowledge

Organized Cognitive Activity	Structure of Knowledge	
	Fragmented	Meaningful
Problem Representation	Surface features and shallow understanding	Underlying principles and relevant concepts
Strategy Use	Undirected trial-and-error problem solving	Efficient, informative, and goal oriented
Self-Monitoring	Minimal and sporadic	Ongoing and flexible
Explanation	Single statement of fact of description of superficial factors	Principled and coherent

Table reproduced from 'How People Learn' John D. Bransford, Ann L. Brown, Rodney R. Cocking, Commission on Behavioral and Social Sciences and Education National Research Council, 1999.

Our four Earthquake Engineering Design Lessons support most aspects of the current California Science framework with NGSS as well as meeting several Common Core standards in math and English Language Arts. Appropriate references and appendices are provided below.

Appendix G – NGSS Crosscutting Concepts (CCC) (noted in curriculum mapping)

1. **Patterns**. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
2. **Cause and effect**: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
3. **Scale, proportion, and quantity**. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. **Systems and system models**. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. **Energy and matter**: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
6. **Structure and function**. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

7. **Stability and change**. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

NGSS Science and Engineering Practices (noted in curriculum mapping)

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Key Common Core (CC) English Language Arts (ELA) Literacy Ideas and Detail
(addressed in group presentation communicating results)

CCSS.ELA-LITERACY.RST.11-12.7

Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CCSS.ELA-LITERACY.RST.11-12.8

Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

CCSS.ELA-LITERACY.RST.11-12.9

Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Common Core Math 'Modeling Cycle' Components (addressed during design and construction lessons)

- Identifying variables in the situation and selecting those that represent essential features
- Formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables
- Analyzing and performing operations on these relationships to draw conclusions
- Interpreting the results of the mathematics in terms of the original situation
- Validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable
- Reporting on the conclusions and the reasoning behind them