Deepening Learning in High School Computer Science through Practices in the NGSS

NGSS Science and Engineering Condensed Practices
Adapted from the NRC Framework (2012) and the NGSS Appendix F (2013)

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
9. Planning and carrying out investigations to answer questions
10. Using technology and engineering tools
11. Identifying, examining, and evaluating assumptions
12. Evaluating the validity of claims, predictions, and conclusions
13. Designing and carrying out investigations
14. Using models to explore, explain, or predict phenomena
15. Using mathematics to model and analyze data
16. Evaluating the effectiveness of design solutions

Data Sources
- Exploring Computer Science, Versions 5 & 6
- Computational Thinking Practices: CS Principles and pact.sri.com/resources.html
- Next Generation Science Standards (NGSS) released 2013.
- Appendix F: Science and Engineering Practices in the NGSS
- Appendix I: Engineering Design in the NGSS
- rutgers.edu
- Deepening Learning in High School Computer Science: Using Practices in the Next Generation Science Standards

ECS Sample Lesson Annotation

Define: Practice 1: Asking Questions and Defining Problems
Define to precision of criteria and constraints, likely to limit possible solutions

Optimize: Use systematic processes to iteratively test and refine a solution

Develop Solutions: Combine parts of different solutions to create new solutions

Practice 1: Asking Questions and Defining Problems
As students work to define the design challenge, check to see if they understand the challenge and the constraints, including context, performance requirements, and limits to what a viable solution will look like.

Press students to consider correspondences and non-correspondences between their models (storyboards) and the actual web page they will build. Discuss how the storyboard serves as an abstraction (a model) of the web page.

Prompt students to look back and question their original assumptions. Emphasize that in the design process, the designer does not define and solve a problem only once, but should consider multiple solutions and iteratively improve on designs.

Findings
Representative engineering practices mapped to ECS learning objectives

Practice 1: Asking Questions and Defining Problems
- 1. Convening internet searches requires evaluating and framing questions that can be used as search terms
- 2. Questions are evaluated to determine if they can be answered using computational

Practice 2: Developing and Using Models
- 3. Students construct a model of computational thinking and evaluate the merits and limitations to find one that best fits the design criteria

Practice 3: Planning and Carrying Out Investigations
- 4. Students use various methods to find information, the practice could apply

Practice 6: Constructing Explanations and Designing Solutions
- 6. Students are aware of safe internet searches and demonstrate responsible use of the internet.

Practice 8: Obtaining, Evaluating, and Communicating Information
- 7. Students use various methods to find information, the practice could apply

Practice 9: Engaging in Argument from Evidence
- 8. Students use various methods to find information, the practice could apply

Practice 10: Obtaining, Evaluating, and Communicating Information
- 9. Students use various methods to find information, the practice could apply


1. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of cost and benefits is a critical aspect of decisions about technology.
2. Considerations of the impact of pervasive networking communication mechanisms, including privacy concerns.