

Part I Engineering Design Learning

Part II Common Core Standards

Part III Literature-Based Engineering Design Projects and Subject Integration

Part IV Teacher Consideration, Discussion Topics and Guiding Questions References

I. Engineering Design Learning Principles

- Collaboration
- Curiosity
- Inquiry-driven science and math
- Thinking critically
 - Engineering Reasoning
- Evaluation of solution throughout design
 - Balancing criteria and constraints
 - Optimizing
- Failure as productive investigation
- Reflective Thinking
 - Evaluation of design process
 - Managing time, meeting goals, working with others

II. Common Core Standards

- Literature
 - Ask and answer question about key details in text
 - Retelling stories, including key details, and demonstrate understanding of their central message or lesson
 - Describe characters, setting, and major events using key details.
 - Explain major difference between books that tell stories and that give information.
 - Identify who is telling the story at various points in a text
 - Use illustration and details in a story to describe its characters, setting, or events
 - Identify characteristic commonly shared by folktales in stories
- Reading Informational Text
 - Ask and answer questions about key details in a text
 - Identify the main topic and retell key details of the text
 - Know and use various text features (headings, tables of contents (to locate key facts or information in a text
 - Using illustrations to build and interpret stories
- Foundational Skills
 - Demonstrate understanding of the organization and basic features of print
 - Read with sufficient accuracy and fluency to support comprehension
 - Reading with purpose and understanding
 - Reading orally with accuracy, appropriate rate, and expression on successive readings
- Writing
 - Writing informative/explanatory texts in which they name a topic, supply some facts about topic

- Writing narratives and recounting sequenced events
- Incorporating research questions
- Participate in shared research and writing projects
- With guidance and support form adults and recall information from experiences or gather information from provided sources to answer a question
- Speaking and Listening
 - Participate in collaborative conversations with diverse partners about relevant grade topics and texts with peers and adults in small and large groups
 - Ask and answer questions about key details in a text read aloud or information presented orally or through other media
 - Ask and answer questions about what a speaker says in in rder to gather addition information or clarify when something is unclear.
 - Describe people, places, things, and events with relevant details, expressing ideas and feelings clearly.
 - Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.
- Language
 - Demonstrate understanding of word relationships and nuances in word meanings
 - Words into categories (colors, clothing) to gain a sense of the concepts the categories represent
 - Define words by category and by one or more key attributes
 - Identify real-life connections between words and their use
 - Distinguish shades of meaning among verbs differing in manner and adjectives differing in intensity by defining or choosing them or by acting out the meaning.
- Mathematics
 - The K-5 standards provide students with a solid foundation in whole numbers, addition, subtraction, multiplication, division, fractions and decimals—which help young students build the foundation to successfully apply more demanding math concepts and procedures, and move into applications.
 - Learning how numbers correspond to quantities, and learning how to put numbers together and take them apart (the beginnings of addition and subtraction).
 - Focusing on fractions, negative numbers, and geometry.
 - Practicing applying mathematical ways of thinking to real world issues and challenges; they prepare students to think and reason mathematically.
 - Emphasis on mathematical modeling, the use of mathematics and statistics to analyze empirical situations, understand them better, and improve decisions.
 - When making mathematical models, technology is valuable for varying assumptions, exploring consequences, and collecting and using data purposefully.

Considerations, Discussions, and Guiding Questions

Reading with Engineering Lens

- Teacher Consideration: Reading the story first as readers and second as engineers
- Guiding Questions: What is engineering? What do engineers do? What kinds of problems do engineers solve? How do engineers solve problems? Do we solve problems like engineers sometimes?

Identifying Engineering Problems

- Guiding Questions: What are big problems in the story? What are the smaller problems in the story? Who has these problems? What if we take perspectives of other characters?
- Discussions: Can engineers help to solve these kinds of problems? (Conversation around social/emotional problems that necessitate communication for resolution)

Selecting Engineering Problems to Solve

- Teacher considerations: The whole class chooses one problem to solve versus allowing each group choose a problem to solve
- Teacher Consideration: How constrained is the problem? Does the solution have to “make sense” in story context?

Brainstorming Solutions

- Discussion: Does the solution have to be feasible in the story? Is pretend technology ok?
- Guiding Questions: Do characters need to be able to construct the design or are we acting as engineering consultants?

Sketching/Designing/Modeling/Constructing

- Teacher Consideration: Negotiating use of materials across groups and considering economic aspects of engineering problem.
- Discussion: Do materials have to be in the story context? Does the character have tools to be able to use them?
- Guiding Questions: How do we express design ideas? How would we describe this idea to the character? Is it ok if we can't get something to work? Is it ok to have other “expert” classmates help us with building?

Evaluating Designs and Models

- Teacher Considerations: Attending to students' different ideas about “what works.” Some may evaluate in terms of imagined character's ability to use the product, whereas others may focus solely on functionality in classroom. Design learning environment around productive failure.
- Guiding Questions: How does this work in the story? How might the character react to this idea?
- Discussion: Seeing failure through curious eyes – Why is it ok if something does not work the way you want it to? What do we learn from that? How does that help us figure out how to build/construct/design?

Sharing Ideas and Consulting Classmates

- Teacher Considerations: Sharing in large groups versus small groups.
- Discussions and Guiding Questions: How do we give reflective comments and questions? How do we receive comments and questions? What if my classmate has an idea that I do or

do not like? What if my solution doesn't work? How can classmates act as thoughtful consultant to help in the redesign process? Who are experts?

Redesigning

- Teacher Considerations: Balancing time and materials.
- Guiding Questions: Why do we redesign? Is it ok if we cannot get something to work? Can we still communicate our solution idea? What does Optimizing mean? How do we optimize in engineering, even when we might not have enough time or materials?

Presenting and Reflecting

- Teacher Considerations: Allowing presentations before comments and questions, limiting the number of questions and comments; providing opportunity for vocal and written reflections of the engineering design process.
- Discussion: Providing comments, questions, and recommendations to other groups that are thoughtful and constructive; reflecting on process instead of product.
- Guiding Questions: How do we evaluate an engineering design? How do we evaluate our own engineering design process? Is it ok to want to do things differently next time? What would I change about my engineering design process?

Other References:

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<http://illinoisearlylearning.org/askanexpert/beneke/sup.htm>
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- Winnett, Rockwell, Sherwood, & Williams, 1996. *Discovery science: Explorations for the early years*. Menlo Park, CA: Innovative Learning Publications.
- NSTA Preschool STEM Blog Post: <http://nstacommunities.org/blog/2010/03/01/preschool-stem/>
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- National Research Council, 2009. *Engineering in K-12 Education: Understanding the status and improving the prospects*. National Academies Press. www.nap.edu
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