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Teacher Resource Guide

2009 Oregon Science Engineering Standards

Rubrics for Assessing Engineering Standards

Resources: Lesson Plans

About This Guide

Teachers will find help to implement the new K-12 science engineering standards. This can be used as a stand-alone resource or as a supplement to teacher participation in National Engineers Month (NEM).

Our sincere gratitude goes to Rebecca Steinke for creating this guide. A science teacher at Scappoose High School, Rebecca will implement the engineering standards with her students this year and is in her third year of applying Proficiency-based instruction as a result of a BEC Proficiency workshop in 2006.

About NEM

A free service to schools, teachers can request an engineer visit through the National Engineers Month (NEM) program. As a stimulating **enrichment activity** for your classroom**,** the engineer provides a career lesson on engineering and a hands-on experiment (grade appropriate) to excite student interest in math and science, **NEM signup is October thru December and visitations occur in February**. In its 15th year, NEM is an annual program managed by the Business Education Compact (BEC).

About the BEC

25 years serving Pacific Northwest schools

With a mission to "Make Learning Real" the BEC specializes in connecting schools and businesses with innovative, hands-on learning experiences for students and teachers. Additionally the BEC provides Proficiency-Based Teaching and Learning workshops and paid internships for high school and college students. For more information visit the BEC website or contact nemsupport@becpdx.org.

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Oregon Department of Education
2009 Science Standards
Engineering Strand

Kindergarten

K.4 Engineering Design: Engineering design is used to design and build things.

K.4D.1 Create structures using natural or designed materials and simple tools.
K.4D.2 Show how components of designed structures can be disassembled and reassembled.

1st Grade

1.4 Engineering Design: Engineering design is used to design and build things to meet a need.

1.4D.1 Identify basic tools used in engineering design.
1.4D.2 Demonstrate that designed structures have parts that work together to perform a function.
1.4D.3 Show how tools are used to complete tasks every day.

2nd Grade

2.4 Engineering Design: Engineering design is a process used to design and build things to solve problems or address needs.

2.4D.1 Use tools to construct a simple designed structure out of common objects and materials.
2.4D.2 Work with a team to complete a designed structure that can be shared with others.
2.4D.3 Describe an engineering design that is used to solve a problem or address a need.

3rd Grade

3.4 Engineering Design: Engineering design is a process that uses science to solve problems or address needs or aspirations.

3.4D.1 Identify a problem that can be addressed through engineering design, propose a potential solution, and design a prototype.
3.4D.2 Describe how recent inventions have significantly changed the way people live.
3.4D.3 Give examples of inventions that enable scientists to observe things that are too small or too far away.

4th Grade

4.4 Engineering Design: Engineering design is a process of using science principles to solve problems generated by needs and aspirations.

4.4D.1 Identify a problem that can be addressed through engineering design using science principles.
4.4D.2 Design, construct and test a prototype of a possible solution to a problem using appropriate tools, materials, and resources.
4.4D.3 Explain how the solution to one problem may create other problems.

5th Grade

5.4 Engineering Design: Engineering design is a process of using science principles to make modifications in the world to meet human needs and aspirations.

5.4D.1 Using science principles describe a solution to a need or problem given criteria and constraints.
5.4D.2 Design and build a prototype of a proposed engineering solution and identify factors such as cost, safety, appearance, environmental impact, and what will happen if the solution fails.
5.4D.3 Explain that inventions may lead to other inventions and once an invention exists, people may think of novel ways of using it.

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6th Grade

6.4 Engineering Design: Engineering design is a process of identifying needs, defining problems, developing solutions, and evaluating proposed solutions.

6.4D.1 Define a problem that addresses a need and identify science principles that may be related to possible solutions.
6.4D.2 Design, construct and test a possible solution to a defined problem using appropriate tools and materials. Evaluate proposed engineering design solutions to the defined problem.
6.4D.3 Describe examples of how engineers have created inventions that address human needs and aspirations.

7th Grade

7.4 Engineering Design: Engineering design is a process of identifying needs, defining problems, identifying constraints, developing solutions, and evaluating proposed solutions.

7.4D.1 Define a problem that addresses a need and identify constraints that may be related to possible solutions.
7.4D.2 Design, construct and test a possible solution using appropriate tools and materials. Evaluate the proposed solutions to identify how design constraints are addressed.
7.4D.3 Explain how new scientific knowledge can be used to develop new technologies and how new technologies can be used to generate new scientific knowledge.

8th Grade

8.4 Engineering Design: Engineering design is a process of identifying needs, defining problems, identifying design criteria and constraints, developing solutions, and evaluating proposed solutions.

8.4D.1 Define a problem that addresses a need, and using relevant science principles investigate possible solutions given specified criteria, constraints, priorities, and trade-offs.
8.4D.2 Design, construct and test a proposed engineering design solution and collect relevant data. Evaluate a proposed design solution in terms of design and performance criteria, constraints, priorities, and trade-offs. Identify possible design improvements.
8.4D.3 Explain how creating a new technology requires considering societal goals, costs, priorities, and trade-offs.

High School

H.4 Engineering Design: Engineering design is a process of formulating problem statements, identifying criteria and constraints, proposing and testing possible solutions, incorporating modifications based on test data, and communicating the recommendations.

H.4D.1 Define a problem and specify criteria for a solution within specific constraints or limits based on science principles. Generate several possible solutions to a problem and use the concept of trade-offs to compare them in terms of criteria and constraints.
H.4D.2 Create and test or otherwise analyze at least one of the more promising solutions. Collect and process relevant data. Incorporate modifications based on data from testing or other analysis.
H.4D.3 Analyze data, identify uncertainties, and display data so that the implications for the solution being tested are clear.
H.4D.4 Recommend a proposed solution, identify its strengths and weaknesses, and describe how it is better than alternative designs. Identify further engineering that might be done to refine the recommendations.
H.4D.5 Describe how new technologies enable new lines of scientific inquiry and are largely responsible for changes in how people live and work.
H.4D.6 Evaluate ways that ethics, public opinion, and government policy influence the work of engineers and scientists, and how the results of their work impact human society and the environment.

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Proficiency Based Rubrics

Information Based Rubric ©Marzano

Grade Letter	Rubric Level	Proficiency Defined
A	4	The Student has a complete and detailed understanding of the information important to the topic.
B	3	The student has a complete understanding of the information important to the topic but not in great detail.
C	2	The student has an incomplete understanding of the topic and/or misconceptions about some of the information. However, the student maintains a basic understanding of the topic.
In Process of meeting the Standard	1	The student's understanding of the topic is so incomplete or has so many misconceptions that the student cannot be said to understand the topic.
	0	No judgment can be made

Skill or Process-Based Rubric ©Marzano

Grade Letter	Rubric Level	Proficiency Defined
A	4	The student can perform the skill or process important to the topic with no significant errors and with fluency. Additionally, the student understands the key features of the skill process.
B	3	The student can perform the skill or process important to the topic without making significant errors.
C	2	The student makes some significant errors when performing the skill or process important to the topic but still accomplishes a rough approximation of the skill or process.

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In Progress	1	The student makes so many errors in performing the skill or process important to the topic that he or she cannot actually perform the skill or process.
	0	No judgment can be made

Thinking and Reasoning Skills ©Marzano

Grade Letter	Rubric Level	Proficiency Defined
A	4	The student includes all important characteristics on which the item should be compared and/or contrasted.
B	3	The student excludes some critical elements on which the items should be compared or contrasted.
C	2	The student makes some significant errors when performing the skill or process important to the topic but still accomplishes a rough approximation of the skill or process.
In Progress	1	The student uses trivial elements to compare or contrast the items.
	0	No judgment can be made

Analyzing Relationships ©Marzano

Grade Letter	Rubric Level	Proficiency Defined
A	4	The student identifies the main pattern running through the information along with all the minor patterns.
B	3	The student identifies the main pattern running through the information.
C	2	The student addresses some of the features of the main pattern running through the information but excludes some critical aspects.
In Progress	1	The student does not address the main pattern through the information.
	0	No judgment can be made

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Experimental Inquiry ©Marzano		
Grade Letter	**Rubric Level**	**Proficiency Defined**
A	4	The student designs and conducts an experiment that adequately tests a well-articulated hypothesis. When the experiment is completed, the student fully and accurately explains the results in light of the hypothesis.
B	3	The student designs and conducts and experiment that adequately tests a well-articulated hypothesis but does not completely explain the results in light of the hypothesis.
C	2	The student designs and conducts an experiment that is related but does not adequately test the hypothesis.
In Progress	1	The student does not design and conduct an experiment or designs one that has no relationship to the hypothesis.
	0	No judgment can be made

Investigation ©Marzano		
Grade Letter	**Rubric Level**	**Proficiency Defined**
A	4	The student thoroughly and accurately identifies what is known about the subject of the investigation and presents a well-articulated solution to the confusions or contradictions associated with the situation.
B	3	The student thoroughly and accurately identifies what is known about the subject of the investigation but does not fully address the confusions or contradictions associated with the situation.
C	2	The student presents a partial description of what is known about the subject of the investigation.
In Progress	1	The student's description of what is known about the subject of the investigation is severely flawed.
	0	No judgment can be made

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Problem Solving ©Marzano		
Grade Letter	**Rubric Level**	**Proficiency Defined**
A	4	The student selects the solution that is the most effective for overcoming the obstacle or constraint and accurately explains why it is the most effective of the possible solutions.
B	3	The student selects the solution that is the most effective for overcoming the obstacle or constraint but does not completely explain why it is the most effective of the possible solutions.
C	2	The student selects a solution that overcomes the obstacle or constraint but is not the most effective solution given the options.
In Progress	1	The student selects a solution that does not overcome the obstacle or constraint.
	0	No judgment can be made

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Resources

Try Engineering Website
www.tryengineering.org

(1) Explore the career field of engineering:
http://www.tryengineering.org/become.php

- Preparation Tips
- Pre-university course selection
- Engineering Degree Fields
- Student Opportunities for Camps & Internships
- Engineering Societies
- Student Engineering Projects

(2) Engineering lesson plans:
- **PDF Listing of Lesson Plans**
  http://www.tryengineering.org/lessons/LessonPlanListing.pdf
- **Database of Individual Lesson Plans**
  http://www.tryengineering.org/lesson.php

(3) Engineering Games:
Interactive Hands on Virtual Engineering Games
http://www.tryengineering.org/play.php

- Bionic Arm Design Challenge
- Design a Parachute
- Wind Turbine Simulator
- Roller Coaster Designer
- Energy Flows
- Invention Convention
- Compound Machines
- Lever an Obelisk
- Engineer It! Blow Your Mind
- Questioneering (Trivia Game)
- Power Up
- Build a Lifeboat
- The Transformer
- West Point Bridge Designer
- Pack World
- MRI Game
- Destroy the Castle
- Simple Machines

Teach Engineering Website
www.teachengineering.org

(1) Engineering lesson plans:
- **Lesson Plans by Subject Area**
  http://teachengineering.org/browse_subjectareas.php
- **Lesson Plans by Curricular Units**
  http://teachengineering.org/browse_curricularunits.php
- **Individual Lesson Plans**
  http://teachengineering.org/browse_lessons.php
- **Engineering Activities**
  http://teachengineering.org/browse_activities.php

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(2) Engineering labs:

Interactive Hands on Virtual Engineering Labs
http://control.mines.edu/livinglabs/

- Wind Living Lab
- Fast Tracks Living Lab

Engineer Girl
www.engineergirl.org

(1) Explore the career field of engineering:
http://www.engineergirl.org/CMS/WhyBeAnEngineer.aspx

(2) Interactive Games, Sites and Resources
http://www.engineergirl.org/CMS/BecomingAnEngineer/TryThis.aspx

- Alice 2.0 (Free Computer Programming Software)
- Eureka
- Energy Quest
- Satellites: You be the Engineer

American Society for Engineering Education
www.engineeringk12.org

(1) Explore the career field of engineering:
http://www.engineeringk12.org/students/default.php

(2) Engineering lesson plans:
http://www.engineeringk12.org/educators/How_Do_I_Use_Engineering_In_My_Classroom/Individual_Lesson_Plans/default.php

- Air-Powered Car
- Paper Bridges
- Sounds and Music
- How Does an Airplane Fly
- Mousetrap
- Amazing Skyscrapers
- Machines and Tools
- Cracking Dams
- Leaning Tower
- Rocket Launch

Women in Science and Engineering
http://wise.web.arizona.edu/

Science, Technology, Engineering and Math with 8-12 Year Olds Curriculum
http://ws.web.arizona.edu/wise/pdf/FinalHandbook.pdf

- Chemical Engineering
- Mathematics
- Solar Energy
- Technology
- Flight/Aerospace Engineering
- Simple Machines
- Structures
- Properties of Water

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Society of Women Engineers
http://aspire.swe.org/

Database of Lesson Plans geared for girls in grades 5-8.
http://www.swe.org/iac/index.html

- Aeronautical
- Mechanical
- Biomedical
- Civil
- Genetic
- Aerospace
- Materials
- Chemical
- Electrical

Design Squad—PBS Program featuring Engineering by Kids, Lesson Plans and Activities
http://pbskids.org/designsquad/parentseducators/getting_started.html
http://pbskids.org/designsquad/parentseducators/activities.html (21 Hands-On Engineering Lesson Plans)

National Engineers Week Foundation
www.eweek.org

(1) Hands-On Activities Featured
http://www.eweek.org/site/DiscoverE/activities/index.shtml

- Dance-Pad Mania
- Put a lid on it!
- Kicking Machine
- Ups and Downs in Design

(2) Archived Featured Activities
http://www.eweek.org/site/DiscoverE/activities/archive.shtml

- Build a Better Bunny Copter
- Resistance is Futile
- Zoom Glue
- Radioactive Ping Pong Balls
- Hearing the Light
- Slime
- Kinetic Sculpture
- Ups and Downs in Design
- Make a Timer
- Air-Powered Bottle Rocket
- The Microprocessor
- + More

National Engineers Week—Intel Archived Lesson Plans

- **Database of Intel Archived Lesson Plans for Engineering, Search by Grade Level.**
  http://www.businesseducationlinks.org/nem/activities/index.htm
- **Grades: K-2 Lesson Plans Engineering**
  http://www.businesseducationlinks.org/nem/activities/K-2/index.htm
- **Grades: 3-4 Lesson Plans Engineering**
  http://www.businesseducationlinks.org/nem/activities/3-4/index.htm
- **Grades: 5-8 Lesson Plans Engineering**
  http://www.businesseducationlinks.org/nem/activities/5-8/index.htm
- **Grades: 9-12 Lesson Plans Engineering**
  http://www.businesseducationlinks.org/nem/activities/9-12/index.htm

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