Grades K-12 Science Tutorials
Northfield Public Schools

- Building Blocks for K-12 Science Teachers
- Minnesota Science Standards Overview
- Science MCA-III Test Question Design (by grade level)
- What is the Difference Between Science and Engineering?
- Scientific Inquiry Process
- Engineering Process
- The Deep Dive – Guidelines for Group Innovation
- Backward Design Process
- A Balanced and Coherent System of Assessment
- Optimal Learning Model
Northfield Public Schools

**MISSION: Why we exist**

It is the mission of the K-12 Science Department to foster life-long learning of science and engineering principles and equip our students to succeed in a highly-competitive global environment.

**VISION: What we hope to become**

We envision a K-12 Science Department in which teachers:

- Are well-versed in the standards and benchmarks assigned to their course/grade level.
- Work collaboratively and support each other.
- Deliver a guaranteed and viable curriculum in each course/grade level that provides all students with access to the same knowledge and skills regardless of the teacher to whom they are assigned.
- Stimulate creative problem solving and logical thinking.
- Inspire passion for scientific thinking.
- Monitor the learning of each student on a timely basis.

**COLLECTIVE COMMITMENTS: How we will behave to achieve our vision**

To achieve our vision, we will:

- Commit to teaching the standards and benchmarks assigned to our courses/grade levels.
- Work in PLC teams and grade level teams to learn and plan together.
- Identify and implement essential learnings, pacing schedules, formative and summative assessments, and standards of proficiency.
- Identify and implement best practice strategies.
- Deliver engaging, hands-on, inquiry-based instruction.
- Utilize real-life applications to teach science and engineering concepts.
- Accept various and differing viewpoints.
- Model safe and ethical practice.
- Use formative assessments to promptly identify student needs and make instructional changes accordingly.
MINNESOTA SCIENCE STANDARDS
Implemented 2011-2012

Physical Science
- Matter
- Motion
- Energy
- Human Interactions

Earth & Space Science
- Earth Structure & Processes
- Interdependence in Earth System
- The Universe
- Human Interactions

Life Science
- Structure & Function
- Interdependence in Living Systems
- Evolution
- Human Interactions

Adapted From Minnesota Department of Education
SCIENCE MCA-III TEST QUESTION DESIGN FOR GRADES 3-5

Test Design
The following table provides the approximate number of points by strand on the operational test for each grade. Multiple-choice (MC) items are each worth 1 point, while other item types are worth 1-3 points. Approximately 40-60 percent of the test will be comprised of multiple-choice items, and other item types will make up the remainder of the test.

Grade 5 Science MCA-III (Operational Form)

<table>
<thead>
<tr>
<th>Strand</th>
<th>Approximate Number of Points</th>
<th>Approximate Percent of Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Science and Engineering (NSE)</td>
<td>11-13</td>
<td>28</td>
</tr>
<tr>
<td>Physical Science (PS)</td>
<td>9-11</td>
<td>24</td>
</tr>
<tr>
<td>Earth and Space Science (ESS)</td>
<td>9-11</td>
<td>24</td>
</tr>
<tr>
<td>Life Science (LS)</td>
<td>9-11</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>41</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Grades 3-5 Points by Substrand

1. **Nature of Science and Engineering (11-13)**
   1. The Practice of Science (4-7)
   2. The Practice of Engineering (2-4)
   3. Interactions Among Science, Technology, Engineering, Mathematics and Society (3-6)

2. **Physical Science (9-11)**
   1. Matter (3-5)
   2. Motion (1-3)
   3. Energy (4-6)

3. **Earth and Space Science (9-11)**
   1. Earth Structure and Processes (2-4)
   2. Interdependence within the Earth System (2-4)
   3. The Universe (1-3)
   4. Human Interactions with Earth Systems (2-4)

4. **Life Science (9-11)**
   1. Structure and Functions in Living Systems (2-4)
   2. Interdependence Among Living Systems (2-4)
   3. Evolution in Living Systems (1-3)
   4. Human Interactions with Living Systems (2-4)
SCIENCE MCA-III TEST QUESTION DESIGN FOR GRADES 6-8

Test Design
The following table provides the approximate number of points by strand on the operational test for each grade. Multiple-choice (MC) items are each worth 1 point, while other item types are worth 1-3 points. Approximately 40-60 percent of the test will be comprised of multiple-choice items, and other item types will make up the remainder of the test.

Grade 8 Science MCA-III (Operational Form)

<table>
<thead>
<tr>
<th>Strand</th>
<th>Approximate Number of Points</th>
<th>Approximate Percent of Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Science and Engineering (NSE)</td>
<td>13-15</td>
<td>28</td>
</tr>
<tr>
<td>Physical Science (PS)</td>
<td>11-13</td>
<td>24</td>
</tr>
<tr>
<td>Earth and Space Science (ESS)</td>
<td>11-13</td>
<td>24</td>
</tr>
<tr>
<td>Life Science (LS)</td>
<td>11-13</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Grades 6-8 Points by Substrand

1. **Nature of Science and Engineering (13-15)**
   1. The Practice of Science (4-6)
   2. The Practice of Engineering (3-5)
   3. Interactions Among Science, Technology, Engineering, Mathematics and Society (5-7)
2. **Physical Science (11-13)**
   1. Matter (5-7)
   2. Motion (3-5)
   3. Energy (3-5)
3. **Earth and Space Science (11-13)**
   1. Earth Structure and Processes (5-7)
   2. Interdependence within the Earth System (3-5)
   3. The Universe (2-4)
   4. Human Interactions with Earth Systems (1-3)
4. **Life Science (11-13)**
   1. Structure and Functions in Living Systems (4-6)
   2. Interdependence Among Living Systems (3-5)
   3. Evolution in Living Systems (3-5)
   4. Human Interactions with Living Systems (1-3)
SCIENCE MCA-III TEST QUESTION DESIGN FOR GRADES 9-12

Test Design
The following table provides the approximate number of points by strand on the operational test for each grade. Multiple-choice (MC) items are each worth 1 point, while other item types are worth 1-3 points. Approximately 40-60 percent of the test will be comprised of multiple-choice items, and other item types will make up the remainder of the test.

Grades 9-12 Science MCA-III (Operational Form)

<table>
<thead>
<tr>
<th>Strand</th>
<th>Approximate Number of Points</th>
<th>Approximate Percent of Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of Science and Engineering (NSE)</td>
<td>24-28</td>
<td>38</td>
</tr>
<tr>
<td>Life Science (LS)</td>
<td>40-44</td>
<td>62</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>68</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Grades 9-12 Points by Substrand

1. **Nature of Science and Engineering (24-28)**
   1. The Practice of Science (8-10)
   2. The Practice of Engineering (8-10)
   3. Interactions Among Science, Technology, Engineering, Mathematics and Society (8-10)

4. **Life Science (40-44)**
   1. Structure and Functions in Living Systems (9-11)
   2. Interdependence Among Living Systems (8-10)
   3. Evolution in Living Systems (11-13)
   4. Human Interactions with Living Systems (8-10)
WHAT IS THE DIFFERENCE BETWEEN SCIENCE AND ENGINEERING?

*Scientists* investigate what is; they discover new knowledge by peering into the unknown …

*Engineers* create what has not been; they make things that have never existed before …

Joe Bordogna, National Science Foundation

<table>
<thead>
<tr>
<th>SCIENTIFIC INQUIRY</th>
<th>ENGINEERING DESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROCESS</strong></td>
<td><strong>PROCESS</strong></td>
</tr>
<tr>
<td>• Make observations and form questions.</td>
<td>• Identify and define the challenge to be solved.</td>
</tr>
<tr>
<td>• Formulate the hypothesis for your</td>
<td>• Explore what others have done and what materials are available.</td>
</tr>
<tr>
<td>experiment.</td>
<td>• Develop a variety of solutions/designs, and then choose one.</td>
</tr>
<tr>
<td>• Develop the procedure for your</td>
<td>• Create your solution/design.</td>
</tr>
<tr>
<td>experiment.</td>
<td>• Test your solution/design.</td>
</tr>
<tr>
<td>• Conduct your experiment.</td>
<td>• Evaluate your solution/design, modify it, and test it again.</td>
</tr>
<tr>
<td>• Refine hypothesis and experiment again.</td>
<td>• Use or market your final solution/design.</td>
</tr>
<tr>
<td>• Form a conclusion and communicate it.</td>
<td></td>
</tr>
<tr>
<td><strong>RESULTS</strong></td>
<td><strong>RESULTS</strong></td>
</tr>
<tr>
<td>• Facts</td>
<td>• Products</td>
</tr>
<tr>
<td>• Theories</td>
<td>• Processes</td>
</tr>
<tr>
<td><strong>GOALS</strong></td>
<td><strong>GOALS</strong></td>
</tr>
<tr>
<td>• Gain information and knowledge.</td>
<td>• Provide a solution to a challenge or problem.</td>
</tr>
<tr>
<td>• Understand and explain the natural world.</td>
<td>• Get someone to use or buy your solution.</td>
</tr>
</tbody>
</table>
The Scientific Inquiry Process

YOU ARE A SCIENTIST.

- OBSERVE
  Make observations and form questions.

- FORMULATE HYPOTHESIS
  Formulate the hypothesis for your experiment.

- DEVELOP PROCEDURE
  Develop the procedure for your experiment.

- CONDUCT
  Conduct your experiment.

- REFINE
  Refine hypothesis and experiment again.

- CONCLUDE
  Form a conclusion and communicate it.
The Engineering Process

YOU ARE AN ENGINEER.

IDENTIFY THE CHALLENGE
Identify and define the challenge to be solved, including limits and constraints.

EXPLORE
Explore what others have done and what materials are available.

DESIGN
Use your knowledge and creativity to develop a variety of solutions/designs. Choose one idea and draw or make a model of it.

CREATE
Create your solution/design.

TEST - TRY IT OUT
Test your solution/design.

MODIFY - MAKE IT BETTER
Evaluate how the solution/design worked and think of how you can improve it. Modify the design and test it again.

USE OR MARKET DESIGN
Use or market your final solution/design.
THE DEEP DIVE
Guidelines for Group Innovation

Have one conversation at a time.

Stay focused on the topic.

Encourage wild ideas.

Defer judgment.

Build on the ideas of others.

From IDEO, an innovation and design firm
BACKWARD DESIGN PROCESS

1. Identify the desired results.
   - What should students know, understand, and be able to do?
   - What are the essential learnings that all students must master?

2. Determine acceptable evidence.
   - How will we know if students have achieved the desired results and met the standards?
   - What will we accept as evidence of student understanding and proficiency?
   - How will students show us what they know?
   - What variety of formative and summative assessments will we use to measure student learning?

3. Plan your instruction.
   - What knowledge and skills will students need to achieve desired results?
   - What activities will equip students with the needed knowledge and skills?
   - What will need to be taught and coached, and how should it best be taught?
   - What materials and resources are best suited to accomplish these goals?

Adapted from Understanding by Design by Grant Wiggins and Jay McTighe
A Balanced and Coherent System of Assessment

Classroom Assessments
- Most Formative
- Weekly
- Ongoing Student and Teacher Formative Assessments
- Diagnostic and Prescriptive
- Identify Students Eligible for Support in a Pyramid of Interventions

Common Assessments
- More Formative
- Unit
- Collaboratively Developed Common Formative Assessments

District Level Assessments
- More Summative
- Monthly
- Collaboratively Developed District Benchmark Assessments
- Calibrate and Pace the Curriculum
- Identify Students Eligible for Ongoing Remedial and Programmatic Support

External Assessments
- Most Summative
- Semester
- Annual
- State Mandated Summative Assessments
- Ranks and Benchmarks Entrance and Exit Criteria

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Northfield Public Schools 8/31/11
| Locus of Control | Classroom Assessments | Common Assessments | District Level Assessments | Extern|al Assessments |
|-----------------|-----------------------|--------------------|---------------------------|-------|
| Summative/Formative | Most Formative | More Formative | More Summative | Most Summative |
| Frequency | Daily (frequent, ongoing) | Quarterly (at minimum) | Periodic (pre and post) | Annual (or longer) |
| Description of Data | Individualizes Student Data | Standards Based Data | Benchmark Data | Autopsy Data |
| Highlights | Mastery of strategies and skills | Levels of Proficiency | Groups of At-risk students | Programmatic Strengths and Weaknesses |
| Products | Descriptive Feedback | Diagnostic Feedback | Entrance and Exit Criteria | Rank order |
| Outcome | Reteaching and regrouping | Systematic Interventions | Program Support | Accountability |
OPTIMAL LEARNING MODEL ACROSS THE CURRICULUM

Below is a teaching and learning model that can serve as a reminder of how to plan lessons and units that will move students from dependent learners to independent learners.

<table>
<thead>
<tr>
<th>DEPENDENT LEARNER</th>
<th>INDEPENDENT LEARNER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>To Learners</strong></td>
<td><strong>With Learners</strong></td>
</tr>
<tr>
<td><strong>Demonstration</strong></td>
<td><strong>Shared Demonstration</strong></td>
</tr>
<tr>
<td><strong>TEACHER</strong></td>
<td><strong>TEACHER</strong></td>
</tr>
<tr>
<td>• Initiates</td>
<td>• Demonstrates</td>
</tr>
<tr>
<td>• Models</td>
<td>• Leads</td>
</tr>
<tr>
<td>• Explains</td>
<td>• Negotiates</td>
</tr>
<tr>
<td>• Thinks aloud</td>
<td>• Suggests</td>
</tr>
<tr>
<td>• Shows how to “do it”</td>
<td>• Supports</td>
</tr>
<tr>
<td></td>
<td>• Explains</td>
</tr>
<tr>
<td></td>
<td>• Responds</td>
</tr>
<tr>
<td></td>
<td>• Acknowledges</td>
</tr>
<tr>
<td><strong>STUDENT</strong></td>
<td><strong>STUDENT</strong></td>
</tr>
<tr>
<td>• Listens</td>
<td>• Listens</td>
</tr>
<tr>
<td>• Observes</td>
<td>• Interacts</td>
</tr>
<tr>
<td>• May participate on a limited basis</td>
<td>• Collaborates</td>
</tr>
<tr>
<td></td>
<td>• Responds</td>
</tr>
<tr>
<td></td>
<td>• Approximates</td>
</tr>
<tr>
<td></td>
<td>• Participates as best he can</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adapted from “Reading Essentials” by Regie Routman (Heinemann: Portsmouth, NH); @2003