ACHIEVING THE VISION

Quality Science Instruction

- Aligned Assessments
- Science Instruction Support Infrastructure
- School Improvement
- Research and High Leverage Practices
- Materials, Equipment and Supplies
- Model Programs & Resources
- Professional Development
- Teacher Prep/Certification

Desired Student Outcomes
CURRENT STANDARDS

• Approved in 2006
• K-7 Grade Level Content Expectations (GLCEs) and High School Content Expectations (HSCEs)
• Followed by Companion Documents and topic-based mapping tools for support
A RESEARCH-BASED TRANSITION

PRIMAR Y ISSUES:
• Incorporation of practices from the field
• No cross-cutting practices or integration
• Lack of understanding of learner needs

LEAD TO TRANSITION:
• Effort to restructure standards based on research findings and current landscape
DEVELOPMENT EFFORT

• Michigan was one of 26 lead states involved in the development effort
• Several parties involved in science education in Michigan became partners in development and implementation
• Since publication, this has become the default resource and focus for Michigan science educators
Asking Questions and Defining Problems
Developing and Using Models
Planning and Carrying Out Investigations
Analyzing and Interpreting Data
Using Mathematics and Computational Thinking
Constructing Explanations and Designing Solutions
Engaging in Argument from Evidence
Obtaining, Evaluating, and Communicating Information
FOUNDATIONAL PRACTICES OF SCIENCE AND ENGINEERING
FOUNDATIONAL PRACTICES OF SCIENCE AND ENGINEERING
<table>
<thead>
<tr>
<th>Patterns</th>
<th>Physical Science</th>
<th>Earth Science</th>
<th>Life Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause and Effect</td>
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<tr>
<td>Scale, Proportion, and Quantity</td>
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<tr>
<td>Systems and System Models</td>
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<tr>
<td>Energy and Matter</td>
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<tr>
<td>Structure and Function</td>
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<td>Stability and Change</td>
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<td>Engineering and Design</td>
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<tr>
<td>Cross-disciplinary Integration</td>
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<tr>
<td>Mathematics and Language Arts</td>
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</tbody>
</table>
WHEN (AND HOW) DO WE START?
How do three different types of painkillers affect the heart rate of the xenopus tadpole?

Ibuprofen Data Table

<table>
<thead>
<tr>
<th>Trials</th>
<th>Culture Water</th>
<th>Ibuprofen</th>
<th>Qualitative Data/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>126 bpm</td>
<td>102 bpm</td>
<td>Very high heart rate</td>
</tr>
<tr>
<td>2</td>
<td>102 bpm</td>
<td>114 bpm</td>
<td>Great visual of heart beating</td>
</tr>
<tr>
<td>3</td>
<td>84 bpm</td>
<td>84 bpm</td>
<td>Could see blood flowing, hard to see heart</td>
</tr>
<tr>
<td>4</td>
<td>84 bpm</td>
<td>84 bpm</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>72 bpm</td>
<td>78 bpm</td>
<td>Lower heart rate</td>
</tr>
<tr>
<td>6</td>
<td>90 bpm</td>
<td>84 bpm</td>
<td>Could see lungs great</td>
</tr>
<tr>
<td>7</td>
<td>90 bpm</td>
<td>90 bpm</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>84 bpm</td>
<td>90 bpm</td>
<td>Could see blood flowing</td>
</tr>
<tr>
<td>9</td>
<td>84 bpm</td>
<td>96 bpm</td>
<td>Great visual of heart</td>
</tr>
<tr>
<td>10</td>
<td>90 bpm</td>
<td>90 bpm</td>
<td>No change</td>
</tr>
<tr>
<td>Average</td>
<td>90.6</td>
<td>91.2</td>
<td></td>
</tr>
</tbody>
</table>

WHAT DO WE SEE FROM STUDENTS?
**Claim**: I claim that when introduced to the xenopus tadpole, these painkillers will most likely make the heart rate go up, or it will stay the same, but rarely go down.

**Evidence**: Almost all of my trials support my claim; they all either stayed the same, or went up. For the example 24/30 trials either went up or stayed the same, and the average of all the trials is 87.2 in water, and 91.8 when the painkiller is introduced.

**Reasoning**: I did ten trials for each type of medicine, so my investigation was a fair test, and I looked for all potential sources of error, and if there was one, I restarted, so I am strongly confident in my investigation. I had also known from second hand research that these medicines had no known stimulants or depressants, so it wouldn't make much of a difference.

**Predictions**

**Sources of Error**

**Confidence in results**

**Future questions to investigate**

**CONNECTING SCIENTIFIC PRACTICES WITH MATH AND ELA SKILLS**
HOW DO WE ENGAGE LEARNERS AND DEEPEN UNDERSTANDING?

Driving Question:
What is the water like in our river?
Driving Question: What is the water like in our river?

- Where does the water in our river come from?
- What happens when it rains?
- How does the water get to the river?
- Who depends on the water?
- Is the water different through the river?
- What is in the water in our river?
- What lives in the river?
- Is our river different from others?
- Can we drink the water?

How do we engage learners and deepen understanding?
Standards Comparison: Structure and Properties of Matter

Students who demonstrate understanding can:

**Current**

a. **Classify** substances by their chemical properties (flammability, pH, and reactivity).

b. **Identify** the smallest component that makes up an element.

c. **Describe** how the elements within the Periodic Table are organized by similar properties into families (highly reactive metals, less reactive metals, highly reactive nonmetals, and some almost completely non-reactive gases).

d. **Illustrate** the structure of molecules using models or drawings (water, carbon dioxide, table salt).

e. **Describe** examples of physical and chemical properties of elements and compounds (boiling point, density, color, conductivity, reactivity).

**Proposed:**

1. **Develop models to describe** the atomic composition of simple molecules and extended structures.

2. **Analyze and interpret data** on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

3. **Gather and make sense of information to describe** that synthetic materials come from natural resources and impact society.

4. **Develop a model that predicts and describes** changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

5. **Develop and use a model to describe** how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

6. **Undertake a design project to construct, test, and modify a device** that either releases or absorbs thermal energy by chemical processes.*
A REVIEW OF STANDARDS...

MDE / Wayne RESA contract with SRI International:
• External, independent content comparison review
• Michigan Science Standards (GLCE and HSCE) to Next Generation Science Standards

Methodology:
• Crosswalk framework
• Content analysis for similarities and differences
<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Rationales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan should consider the adoption of the NGSS performance expectations in</td>
<td>The value added by the adoption of the NGSS includes access to current science concepts that are</td>
</tr>
<tr>
<td>order to improve science education in all grades.</td>
<td>required to prepare students for college and careers.</td>
</tr>
<tr>
<td>The NGSS Science and Engineering Practices and Crosscutting Concepts should be</td>
<td>The NGSS Science and Engineering Practices and Crosscutting Concepts are embedded across the NGSS</td>
</tr>
<tr>
<td>implemented to enhance current science education instruction for grades K-12.</td>
<td>performance expectations and provide coherence across grades and all science disciplines.</td>
</tr>
<tr>
<td>The NGSS performance expectations for the Disciplinary Core Ideas in Engineering,</td>
<td>Implementation of the NGSS performance expectations in new content areas such as Engineering,</td>
</tr>
<tr>
<td>Technology and Application of Science contain new content that should be</td>
<td>Technology and the Application of Science will prepare students for solving future and current</td>
</tr>
<tr>
<td>included in science instruction across all grades.</td>
<td>societal problems.</td>
</tr>
<tr>
<td>The NGSS performance expectations provide explicit connections to Common Core</td>
<td>The NGSS linkages to the Common Core Standards for Mathematics and English Language Arts connect</td>
</tr>
<tr>
<td>Mathematics and English Language Arts Standards that should be integrated into</td>
<td>consistent performance expectations across core content areas.</td>
</tr>
<tr>
<td>science instruction.</td>
<td></td>
</tr>
<tr>
<td>NGSS Professional Development Resources that support instruction in new content</td>
<td>On-going, high quality professional development that includes current science concepts is essential to</td>
</tr>
<tr>
<td>areas are available through participation in the NGSS Network and should be</td>
<td>improvements in science instruction.</td>
</tr>
<tr>
<td>leveraged to support Michigan science teachers.</td>
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</tbody>
</table>
MICHIGAN SCIENCE STANDARDS

For Adoption:

• **Student Performance Expectations** (and relevant NGSS coding), including Michigan specific expectations where appropriate

• **Front matter describing** *Crosscutting Concepts* (organizational frame), *Science and Engineering Practices* (integrated into performance expectations), and *Disciplinary Core Ideas*

Not for Adoption

• Guidance Materials on Instruction and Assessment

• Ancillary Materials (Appendices, Models, Crosswalks, etc.)

WHY?:

• Offer greater flexibility for local implementation in Michigan’s school districts and public school academies
1. Organized by grade level or band and content strand
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2. Performance expectations include coding, and MI-specific alternatives
PROPOSED SCIENCE STANDARDS & GUIDANCE

1. Organized by grade level or band and content strand

2. Performance expectations include coding, and MI-specific alternatives

3. Guidance organized in same manner, but includes relevant Science and Engineering Practice, Disciplinary Core Ideas, and Crosscutting Concepts)
**PROPOSED SCIENCE STANDARDS & GUIDANCE**

1. Organized by grade level or band and content strand

2. Performance expectations include coding, and MI-specific alternatives

3. Guidance organized in same manner, but includes relevant Science and Engineering Practice, Disciplinary Core Ideas, and Crosscutting Concepts

4. Guidance also includes relevant assessment boundaries, contexts, and related standards
NEXT STEPS - ASSESSMENT

State and Local Assessments

Formative Assessments
SCIENCE ASSESSMENT
TIMELINE

- **2015-6**: Transition M-Step with GLCE / HSCE Content
- **2016-7**: Field Test science/engin Items
- **2017-8**: Initial Items for new science/engin standards
- **2018-9**: Full Implementation science/engin stds
- **2019-20**:
CLAS**ROOM AND SCHOOL ASSESSMENTS FOR SCIENCE

**Common local assessments**

**Analysis of student artifacts**

**Performance assessment**
NEXT STEPS - SCHOOL POLICY

Resources for Learning

Instructional Practice
TRANSITION TIMELINE

**Teacher Preparation**
- Incorporate Engineering
- Change Science Content Courses
- Redesign Science Methods Courses
- Restructure Elementary Education
- Re-align Supports
- Modify Certification / Credential Requirements
- Provide Guidance / Coordinate PD / Educator Prep

**School Districts**
- Realignment to address K-5 Science
- Restructure Secondary Staff
- Address Teacher Placement and Content-based PD

**Teachers**
- Incorporate Practices and Engineering
- Action Research on Practice

2014-5
- 2015-6
- 2016-7
- 2017-8
- 2018-9
- 2019-20
- 2020-1
- 2021-2