MySci User Guide

Welcome to MySci, building the next generation of scientists

MySci was launched in 2005 by Washington University in St. Louis with generous funding from the Monsanto Fund. MySci’s mission is to empower schools to cultivate curiosity-driven education, by providing educators with teaching strategies, interactive learning modules, and ongoing support, with the goal of transforming classrooms into learning labs.

The MySci program has a history of collaborative partnerships with community organizations directly involved in science education in the St. Louis area. The Missouri Botanical Garden, the Saint Louis Zoo, and the Saint Louis Science Center all partnered in the development of the original MySci units for grades K-2. Educators from these organizations, as well as area school districts, were part of the development teams for the new instructional materials that now span grades K-5.

MySci is dedicated to instilling a love for science in students. With MySci’s innovative instructional materials, teachers can improve student learning through hands-on, investigative resources and support.
HISTORY AND PHILOSOPHY

Our goals in developing the MySci units were three-fold:

1. To provide an engaging and assessable set of instructional units aligned with the Framework for K-12 Science Education and the Next Generation Science Standards. Each unit emphasizes the scientific and engineering practices, focuses on a core disciplinary idea appropriate for the grade level, and encourages students to make connections about the crosscutting concepts that unify the study of science and engineering. The learning progressions are intentional and enable students to build on prior knowledge.

2. To encourage and model best practices in instruction. The units use the 5E (Engage, Explore, Explain, Elaborate and Evaluate) Learning Cycle as the instructional model for its lesson plans. This perspective assumes students are actively engaged in the learning experience. In addition, each unit:
   - integrates science, engineering, literacy, and mathematics,
   - encourages student dialogue and collaboration,
   - encourages the use of multiple methods for formative assessments,
   - uses a project-based approach to encourage students to apply their knowledge to real world problems.

3. To provide a forum for teachers to share and interact in order to continually improve the project. The MySci units are available online in a blog format to encourage all teachers to share their creative adaptations, additions and recommendations. Instructional materials can be fluid, living documents that, unlike textbooks, can be continually improved and adapted based on user feedback. Please join the MySci team, adding your expertise and insights, by sharing with others via the website at http://www.schoolpartnership.wustl.edu/programs-services/mysci/. Note that this link takes you to curriculum. You need to go to the specific unit to comment.
USING THE CURRICULUM

The curriculum is comprised of 25 units, arranged by grade level and core science area. MySci incorporates several key features into each unit to foster best practices in instruction and student success:

FLOW CHART
On the second page of every curriculum guide, there is a flow chart. This gives the teacher an overview of the entire unit, the design challenge and a quick view of the essential questions for each lesson. It is important to note that a single lesson may take several days to complete.

The design challenge is a chance for students to consider a real-world situation that scientists and engineers might encounter. Students will get an authentic opportunity to apply the Science and Engineering Practices to a real-world problem. The Engineering Design Cycle (provided later in this document) is a road map for students to use as they complete these open-ended challenges.

TEACHER PREP LIST
The third page of the curriculum contains information the teacher needs in order to be ready to teach each lesson. It describes both the materials included in the kit and the materials the teacher needs to gather for the lesson. It also tells what needs to be copied or prepared in advance of the lesson.

TEACHING TIPS
In the sidebar of the lesson pages are teaching tips that contain content information, management suggestions, and how to respond to common student ideas.

FORMATIVE ASSESSMENTS, RUBRICS AND ACTIVITY SHEETS
Several of the lessons begin with the students drawing pictures or writing their understandings of concepts covered in this unit. These early assessments give insight to a student’s understanding or
misunderstanding of a concept. There are also formative probes included in many of the lessons. Throughout the unit are opportunities for oral presentations and demonstrations by students, in pairs or groups, and formal probes and activity sheets for assessing understanding. This provides multiple opportunities for students to collect and analyze data and apply their learning. All of these instruments, when consistently used in conjunction with the student science notebooks, can help the teacher know and describe how the students’ understanding has grown and changed over the course of the MySci unit.

SCIENCE NOTEBOOKS
Student writing can be used to provide insight into their understanding. A science notebook can serve as an important conversation among students, teacher and the world around them, as students share their thinking. We have noticed that when the science notebook and activity pages are put together in one folder, the students use the notebook in a fashion that represents how scientist and engineers use notebooks.

STANDARDS PAGE (LOCATED IN THE MIDDLE OF THE CURRICULUM GUIDE)
These units are based on the Next Generation Science Standards (NGSS), with consideration of the Missouri Grade Level Expectations (GLEs). Both are listed on the standards pages of the curriculum. Included with the NGSS Standards are the three dimensions of learning, which are:

1. Science and Engineering Practices
2. Crosscutting Concepts
3. Disciplinary Core Ideas

MySci has embedded the three dimensions within each lesson, where applicable.

VISUAL RESOURCES
The following pages feature visual representations of the Engineering Design Cycle, the Cross-Cutting Concepts, the Science and Engineering Practices, and the Scientific Method used in the curriculum. Also included are visuals to represent the various components of the scientific process used in the curriculum. We recommend that teachers post these documents in their classrooms as visual reminders for themselves and for students.
Engineering Design Cycle

1. Identify Need/Problem
2. Research & Brainstorm
3. Choose Best Ideas
4. Construct Prototype
5. Test & Evaluate
6. Communicate
7. Redesign
CROSSCUTTING CONCEPTS

Patterns
(Patterns)

Cause and Effect
(Cause and Effect)

How is it shaped?
How does it work?
(Structure and Function)

How much or how big?
(Scale, Proportion and Quantity)

What changes?
What stays the same?
(Stability and Change of Systems)

Systems and Models
(Systems and Models)

Energy and Matter in Systems
(Energy and Matter in Systems)

For more information on the Next Generation Science Standards, visit http://www.nextgenscience.org/.
SCIENCE AND ENGINEERING PRACTICES

Ask Questions, Define Problems
(Asking Questions and Defining Problems)

Make a Model, Use It to Test
(Developing and Using Models)

Investigate: What will you do? How will you do it?
(Planning and Carrying Out Investigations)

Make a Claim, Find Evidence and Back It Up with Science
(Engaging in Argument from Evidence)

Use Math in Your Thinking
(Using Mathematics and Computational Thinking)

Information: Get It, Evaluate It and Share It
(Obtaining, Evaluating and Communicating Information)

Data: Analyze It and Interpret It
(Analyzing and Interpreting Data)

What is happening and why? Develop a solution.
(Constructing Explanations and Designing Solutions)

For more information on the Next Generation Science Standards, visit http://www.nextgenscience.org/
SCIENTIFIC METHOD

**QUESTION**
- Ends in a question mark
- Wonders about something
- Asks for help or more information
- Clears up misunderstandings
- Can be tested by something we can do or see

**HYPOTHESIS**
- Makes a detailed prediction about what might happen

**DATA**
- Carefully observes what happens
- Draws or writes what happened
- Makes sure to include name, date, time, amounts or other important factors

**GRAPH/DRAW**
- Draws or writes what happened in a way that others can clearly understand
- Includes dates, times and amounts
- Includes title

**CONCLUSION**
- Answers the question
- Uses data
ASK A QUESTION
What do you want to know about the world?
Why do you want to know it?
How can science help you answer the question?

DO YOUR RESEARCH
See if anyone has asked your question before.
Research similar questions.
Ask others for advice.

FORM A HYPOTHESIS
What do you think is the answer to your question?
Why do you think it’s the answer?
Can your prediction be tested?

TEST YOUR HYPOTHESIS
Design an experiment.
Perform your experiment carefully.
Record your data.

ANALYZE YOUR DATA
Make a chart or graph.
Compare your data to others.
See if your data fits your hypothesis.

DRAW CONCLUSIONS
What did you learn from the experiment?
What is the relationship between the variables?
What questions do you have now?
TESTABLE QUESTION

How does changing **IV** affect the **DV**?

Any question that can be the starting point for a scientific investigation:

- Identifies what will be tested or measured
- Will generate quantifiable data
- Has a control or comparison inherent in the question

**EXAMPLE**

How does the **amount of carbon dioxide** affect **atmospheric temperature**?

HYPOTHESIS

If the **IV** changes in a particular way, then the **DV** will change in a particular way because of a scientific principle.

As the **IV** changes in a particular way, the **DV** changes in a particular way because of a scientific principle.

An idea or explanation that can be tested through experimentation.

**EXAMPLE**

If the **amount of carbon dioxide** increases, then the **temperature of the atmosphere** will increase.
INDEPENDENT VARIABLE
- Changed by the scientist
- Cause of the change
- Only one changed per experiment

DEPENDENT VARIABLE
- Measured in an experiment
- Affected during the experiment
- “Depends” on the other variable

CONTROLLED VARIABLE
- Constant
- Unchanged
- Improves validity of results
- Allows scientist to know what caused the effect
IMPORTANCE OF MULTIPLE TRIALS

- Unusual data (outliers) affects results less when averaged with more consistent data
- Data from multiple trials can be compared to ensure the validity of the investigation
- Results from trials should be similar but not necessarily identical; i.e., a pattern is evident)
- Multiple trials produce more valid results/accurate results

EXAMPLE

<table>
<thead>
<tr>
<th>Surface of the Ramp</th>
<th>Distance the Car Traveled (cm)</th>
<th>Average Distance (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
</tr>
<tr>
<td>sand paper</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>wax paper</td>
<td>92</td>
<td>98</td>
</tr>
<tr>
<td>paint</td>
<td>63</td>
<td>82</td>
</tr>
</tbody>
</table>

outlier
QUALITATIVE DATA

- Deals with descriptions
- Data can be observed but not measured
- Examples: color, texture, smell, taste, appearance
- Quality

QUALITATIVE DATA:
- robust aroma
- frothy appearance
- strong taste
- orange mug

EXAMPLE -- LATTE

QUANTITATIVE DATA:
- 12 ounces
- temperature 150 degrees fahrenheit
- serving cup 7” in height
- cost $4.95
**DATA TABLES**

**TITLE**
- **Clearly state the purpose of the experiment**

**ROWS AND COLUMNS**
- **Use descriptive headings with units**
- **Indicate what information should be observed and recorded relative to the independent variable**
- **Indicate what information should be observed and recorded to measure the dependent variable**

**ORGANIZATION**
- **Allow for collection and analysis of data**
- **Another scientist could use it**

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<table>
<thead>
<tr>
<th>Independent Variable (unit)</th>
<th>Dependent Variable (unit)</th>
<th>Derived Quantity (unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**EXAMPLE**

<table>
<thead>
<tr>
<th>Substance</th>
<th>pH</th>
<th></th>
<th></th>
<th>Average pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
<td>Trial 3</td>
<td></td>
</tr>
<tr>
<td>lemon juice</td>
<td>2.4</td>
<td>2.0</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>baking soda</td>
<td>8.4</td>
<td>8.3</td>
<td>8.7</td>
<td>8.5</td>
</tr>
<tr>
<td>orange juice</td>
<td>3.5</td>
<td>4.0</td>
<td>3.4</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Title: Independent Variable vs Dependent Variable or Effect of IV on DV

- Is the scale appropriate with equal intervals?
- Are data plotted correctly?
- Is the type of graph appropriate for the data?
CONCLUSION

When you do this to the $\text{IV}$ then this happens to the $\text{DV}$. This is supported by particular data from the experiment.

- Answer testable question
- Include data from your data table or graph.
- Shows relationship between independent and dependent variable.
The mission of MySci is to build the next generation of scientists and STEM professionals. For this reason, we make several resources available to all educators in the St. Louis region:

- Free STEM equipment loaner service: https://schoolpartnership.wustl.edu/programs-services/stem-materials-services/

For those in school districts that partner with MySci, educators have access to additional resources for each unit. These resources include:

- pre and post assessments and scoring guides for each unit
- short professional development videos for lessons with complex teacher directions
- student performance checklists for Kindergarten and 1st grade
- suggested book titles for additional reading
- suggested items in our STEM Materials Lending service to extend or expand on the activities in the unit
- free online resources aligned with the unit, including alignment with Readworks and Discovery Ed.

If your school is a MySci partner, you can access these resources from our website, http://schoolpartnership.wustl.edu/instructional-materials/. Additional resources are available on the page for each unit. Your district leaders will supply you with the password for partner resources.

We at the Institute for School Partnership would like to thank you for collaborating with us to deliver interactive science experiences and creative curriculum to students. Please reach out with any questions or feedback concerning the MySci program. We look forward to continuing to build connections that foster excellence in teaching and learning across the region!