SEEd Swap Workshop

2017

6th Grade

The Center for
Science and Mathematics Education
THE UNIVERSITY OF UTAH

July 31st-August 4th | 8:30am-3:00pm
Granite Technical Institute
Welcome to the 2017 SEEd Swap Teacher Workshop

It’s an exciting time for the world of science instruction; advances in cognitive and pedagogical research are reshaping the way we think about engaging students in science and engineering. The state of Utah has reflected these improvements in the new 6-8th grade SEEd (Science and Engineering Education) Standards, which will be implemented across the state during the 2017-2018 school year. While this change is exciting, it also poses significant challenges. The SEEd standards are built on Disciplinary Core Ideas, as were the previous standards. The new components include the explicit integration of Science and Engineering Practices into every single standard, and the framing of ideas within Crosscutting Concepts to allow instructors to help students organize their thoughts. These three components, called ‘dimensions,’ when anchored to instruction that allows students to explore phenomena they encounter in the world, allows students to act as sense-makers and science/engineering practitioners.

In order to provide 6-8th grade teachers with professional learning support to successfully implement the new standards, the Center for Science and Mathematics Education (CSME) is offering a week-long workshop focusing on the content that has ‘swapped,’ or is new to each grade – the “SEEd Swap.”

**USBE Credit:**
80% documented attendance, taken 2x daily by your instructor, as well as an accurate CACTUS ID number on record, are required to earn 3 USBE credits.

**Supply Stipend**
A $150 check will be issued to each attendee who
Completed the pre-assessment by the July 29th deadline
Attend 100% of the workshop
Complete the post-assessment between noon on Aug. 4 and midnight Aug. 8th.

**Curricular Resources**
The majority of the resources found in this book will be available online at the Center for Science and Mathematics Education website: https://csme.utah.edu/resources/k12curriculum/
Megan Black

Megan Black is an elementary science curriculum specialist in Granite School District. She taught science for twelve years working with students in grades 4 - 9, but most often 6th grade. Megan was on the 6th grade SEEd standards writing committee and has been involved with developing the 6th Grade SEEd OER textbook. She is interested in developing curriculum and instructional strategies that engage students as scientists as they explore and figure out the natural world around them.

Sarah Braden, Post Doc Fellow

Sarah K. Braden started her career in education as a high school biology, physics, and English as a Second Language (ESL) teacher. Dr. Braden is currently an Assistant Professor of English Language Learner education in The School of Teacher Education and Leadership at Utah State University. Her research centers on understanding language socialization phenomena and promoting equity the sciences.

Ben Breinholt, Professional Educator at Granite School District

I am a Utah native and have lived in the Salt Lake area primarily. I worked over twenty-five years as an outside sales representative in the private sector before I was inspired to go back to school to become a school teacher. I have been a sixth-grade teacher for the past eleven years at West Valley Elementary. Through the opportunities provided by Granite School District I have received my ESL and Math Endorsements, a Master of Education, and most recently my STEM Endorsement. I feel extremely fortunate to be a teacher and love working with kids and my colleagues.

Brad Carroll, Professor Emeritus - Physics, Weber State University

Brad Carroll began his career as a high school math and physics teacher in Bakersfield, California. After receiving his Ph.D. in astrophysics from the University of Colorado, Brad spent time as a postdoc at the University of Rochester before joining the Physics Dept. at Weber State University in 1985. At WSU, Brad collaborated with faculty in the Dept. of Chemistry to develop a unique physical science course for elementary education majors. He also co-authored An Introduction to Modern Astrophysics, the standard undergraduate astrophysics text. Brad retired in 2015 after 30 years at WSU, 10 of them as chair of the Physics Department. In retirement, he continues to teach with the Physics Department and Honors Program, and is working on the third edition of his astrophysics text.
Jordan Gerton, Director of CSME and Associate Professor of Physics

I received my Bachelor’s degree in Engineering Physics from the University of Arizona and my Master’s and Doctorate degrees in Physics from Rice University. I have had a number of formative experiences over the years that have stoked my passion for math and science education and have driven me to leadership roles in these areas. Math and Science are among the most important and impactful human pursuits, and I am committed to helping students of all ages and backgrounds develop a passion for and proficiency in these enabling disciplines.

Holly Godsey

Dr. Holly Godsey is the Director of Student Success and Teacher Development at the CSME and an Associate Professor (Lecturer) in the Department of Geology and Geophysics. She has a BS and PhD in Geology from the University of Utah and an MS in Oceanography (Marine Geology and Geochemistry) from the University of Michigan. Since 2004, she has been involved with several science education projects that connect faculty, graduate and undergraduate students to K-12 teachers and students to inspire, empower and educate learners from across generations and disciplines.

Maura Hanenberger

Maura Hahnenberger is an Assistant Professor in the Geosciences Department at Salt Lake Community College. At SLCC she teaches and advises in the Atmospheric Sciences and Geography programs in both face to face and online settings. Maura is the founder of the WaterGirls outreach program which provides middle school girls with field experiences conducting water science. She also serves on the boards of the SLCC Chapter of the Utah Women in Higher Education Network, Utah Chapter of the American Meteorological Society, and the Earth Science Women’s Network.

Emily Harward, 7th & 8th Grade Science & Biology Teacher at Granite Schools

Emily was lucky to grow up in the Salt Lake Valley, with opportunities to spend time exploring nature. She graduated from the University of Utah in 2004, and has been teaching science at Evergreen Junior High in Granite District ever since. For Emily, the most rewarding part of teaching is developing lessons and activities that provide a pathway for students to develop their own understanding and make sense of the world they live in.
Patrice Kurnarth

Patrice received her B.S. in Biology from Ithaca College and worked in academia for a few years at Yale University and UC Berkeley. She earned her Ph.D. in Biology from the University of Utah in 2016. During her doctoral thesis, Patrice worked with middle school science teachers in the Salt Lake valley for two years as part of a GK-12 graduate school fellowship funded by the National Science Foundation. This experience was truly transformative for Patrice because she learned about pedagogical theory and experienced first-hand the set-backs and successes of teaching.

Jaleigh Mecham, 6th grade teacher at Granite School District

My name is Jaeleigh Mecham. I graduated from the University of Utah in 2013 with a bachelor’s degree in Elementary Education with a minor in Spanish Teaching. I have endorsements in Early Childhood, ESL, and STEM. I have been at Fox Hills Elementary for 4 years. In my spare time I love to be active outdoors! Hiking, biking, and camping are some of my favorites.

Candace Penrod, District Science Supervisor at SLC School District

Candace’s teaching career began in California in elementary education. Upon moving to Utah, she transitioned to secondary science teaching, followed by several years as instructional coach. She is currently the District Science Supervisor for Salt Lake City School District. Candace obtained a Master in Education from the University of Utah in 2009 and a Master of Science in Earth Science Teaching from the University of Utah. Candace is passionate about K-12 science education and continually seeks for opportunities to improve science teaching and student learning at all levels.

Scott Roskelley, Science Assement Specialist at Utah State Board of Education

Scott was born and raised in Chicago, Illinois and from a young age loved science. He holds degrees in wildlife biology, marine biology, teaching and learning, and educational administration. Never expecting to work in education, Scott fell into teaching in 2001 as he entered the alternative route to licensure in Utah. Scott worked for 15 years in the Jordan School District, mostly teaching middle school. Now as the state science assessment specialist, he is responsible for working with Utah teachers to develop the new end-of-year assessment for the new SEEd standards.
James Ruff

I am an evolutionary biologist studying basic evolutionary topics including sexual selection, and the forces maintaining genetic diversity in populations; furthermore, I apply evolutionary principles and techniques to questions concerning nutrition, toxicology, and pharmaceutical safety assessment. I am passionate about science education and prefer to focus on the process of science relative to the ‘fruits’ of the process. In this vein, I incorporate study designs, data analysis and writing into each of my courses. I have been a teaching fellow at both elementary and middle schools in SLCSD.

Holly Vancouwenberghe

Hi! My name is Holly VanCouwenberghe and I am a 6th grade teacher at Hillsdale Elementary School. I am entering my 13th year of teaching, and have taught 4th grade, 5th grade, and 6th grade, but I have been mostly in 6th. I have a bachelor’s degree in Elementary Education, Master’s in Educational Psychology, and endorsements in Early Childhood Education, English Language Learning, and STEM.

Sara Yearsley

Sara is an Earth Science teacher as Weber school district.

Tamara Young, Academic Advisor in the Department of Physics & Astronomy

Tamara’s interest in physics began in high school. As an undergraduate at Utah State University, Tamara’s studies focused on nuclear and particle physics. Tamara taught science and math for several years in the public education system. After grad school, Tamara again taught science and math in the public education system. For the last couple years, Tamara has taught astronomy at SLCC, participated in course curriculum development with CSME, and taught a computational astronomy course for Master’s students in Physics Teaching. Tamara is the academic advisor in the Department of Physics & Astronomy at the University of Utah. She also engages in public outreach and education, and loves to talk about physics.
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| 8:30-10:30 | 8:30-9:15 - Overview  
9:15-10:30 - Modeled Lesson - Experience as a Student | Dr. Sarah Braden’s Magnetism and Modeling lesson  
Emily Harward  
CCC:  
SEP: | 6.2.3 Molecules/Particle Motion  
Emily Harward  
CCC:  
SEP: | 6.3 Energy Flow (Water Cycle, Weather, Greenhouse Effect)  
Candace Penrod  
CCC:  
SEP: | 6.4.2 Interactions Between Organisms and Environment  
Ben Breinholt  
CCC:  
SEP: |
| 10:30-10:45 | BREAK                                     | BREAK   | BREAK                                        | BREAK                                        | BREAK                                       |
| 10:45-12:00 | Introduction to 3D Instruction                | Processing and Planning  
Molecules and Particle Motion  
Tamara Young | Community Resource Fair/Panel | Basic Ecological Principles  
Dr. James Ruff |                |
| 12:00-1:00 | LUNCH: USBE ASSESSMENT | LUNCH   | LUNCH                                        | LUNCH                                        | LUNCH                                       |
| 1:00-2:30 | Modeled Lesson: Moon Phases from a Phenomenological Perspective (60 min lesson, 30 min discussion)  
Megan Black & Emily Harward  
Holly Vancouwenberghe  
CCC:  
SEP: | 6.2.1/2 Molecules and States of Matter/Density | 6.2.3/4 Emphasis on Engineering  
Emily Harward  
CCC:  
SEP: | 6.4.1 Ecosystem resources  
Emily Harward  
CCC:  
SEP: | 6.4.5 Biodiversity  
Jaleigh Mecham  
CCC:  
SEP: |
| 2:30-3:00 | Guest Lecture: Megan Black  
What are structural ways that people plan/integrate science in their 6th grade classrooms? |        |                                               |                                               |                |
Introductory Writing Prompt:
Your Finest Moment

Describe a classroom experience that you facilitated that allowed a student to:

- learn content
- act like a scientist
- feel empowered

How, specifically, did you structure that students’ experience to allow them to do and feel those things?
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<td>Ideas, Feelings, &amp; Actions</td>
<td>Ideas, Feelings, &amp; Actions</td>
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<td>2. Participants talk to 12 other people to find out:</td>
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<td>o 1 word to describe your experience of Best/Worst Instructor/Participant</td>
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<td>Establish Norms:</td>
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<td>Safety</td>
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<td>&quot;Based on our experiences in PD, what are our norms to make this week maximally impactful?&quot;</td>
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<td>• Start and End On Time</td>
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<td></td>
<td>• Be present</td>
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<td></td>
<td>• Be yourself</td>
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<td>• What else?</td>
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<td>1. Written reflections of model lessons</td>
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<td>Sequence &amp; Reinforcement</td>
<td>every 10 minutes</td>
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<td>2:45-3:00</td>
<td>Written reflection</td>
<td>Accountability is mutual</td>
<td>Written Reflection</td>
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<td>Feedback for tomorrow</td>
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Welcome to the 2017 SEEd Swap Teacher Workshop

Why is it called the SEEd Swap?

1. The new SEEd Standards; Science and Engineering Education
2. Focus on CONTENT that has “swapped,” or is new.

*We won’t officially bring in lesson plans to trade with each other, though we will have some shared work time*

Who are we?

Participants: 6th-8th grade teachers who are motivated learners

Instructors: Classroom teachers who are already implementing 3D instruction with their students.
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<td>Modeled Lesson Reflection/Planning</td>
<td>Demonstrate and integrate 3D instruction</td>
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<td>10:30-10:45</td>
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<td>10:45-12:00</td>
<td>Expert Lecture Or Community Resource Panel</td>
<td>Support learning of new content through direct instruction</td>
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<td>12:00-1:00</td>
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<tr>
<td>1:00-3:00</td>
<td>Modeled Lesson Reflection/Planning</td>
<td>Demonstrate and integrate 3D instruction</td>
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This Week is Planned Intentionally

We respect that you, as adult learners, have:

- rich, real experience to bring to your learning
- The potential to learn from, as well as with, each other
- a need to connect your learning directly to your classroom practice

(Vella, 1994)

3 USBE Credits and $150 Supply Stipend

Both based on attendance:

Credit
- at least 80% participation (may miss up to one day)
- accurate CACTUS number

$150 Supply Stipend
- Pre- and Post-assessment
- 100% on-time attendance
- W-9 form
Please fill out and turn in your W-9 forms now.

Meet your colleagues!

Learner Prompt:
1. Writing Activity (in notebooks):
   4x4 matrix: best/worst PD instructors/participants
2. Participants talk to 12 other people to find out:
   3 answers for each quadrant
   Name
   District, grade
1 word to describe your experience of Best/Worst Instructor/Participant.

Norms for the week:

Learner prompt:
In your workbook, list (2 minutes):
What norms would have addressed the worst behaviors?
What norms would have encouraged the best behaviors?
Norms for the week:

**Start and End On Time**

**Be Present**

**Be Yourself**

**Start and End On Time**

– because everyone’s time is valuable

**Be Present**

– because everyone is busy and important

• refrain from having devices (phones, computers) on during instruction that doesn’t require it.
• if you must, be sure to step outside for:
  • restroom
  • maintenance

**Be Yourself**

– your experience is valuable and welcome.

What else do we need for the week to be successful?
Complete this 4x4 considering your previous professional development experiences.

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Utah’s SEEd Standards:

Why 3D Instruction?

Presentation Overview

• The history and evolution of classroom science instruction
• What is 3D instruction? Where did it come from?
• How Utah fits in to the national picture
• How instruction will stay the same
• How instruction will change

• How assessment will work

The History and Evolution of Classroom Science Instruction

Direct instruction

Hands-On

Inquiry

3D instruction

*This is great news!
We’ll learn why!
Direct Instruction

**Pros:**
- It’s easy
- We teachers feel smart and in control
- It works for some students

**Cons:**
- It doesn’t work for everyone: “students in classes with traditional stand-and-deliver lectures are 1.5 times more likely to fail than students in classes that use more stimulating, so-called active learning methods.”

Hands-On (1970s)

**Pros:**
- Fun and engaging for students

**Cons:**
- Students can participate without learning
- Scary for teachers

Inquiry (1990s)

**Pros:**
- Engages students in authentic scientific practices

**Cons:**
- Difficult to teach to teachers
- When done poorly, increased opportunity gap
Enter. . .
3-Dimensional Science Instruction

3D Science Instruction is Good News!

What, exactly, are the three dimensions?
Phenomena:

“are observable events in nature (or our lives) that connect to multiple disciplinary core ideas.”

Throughout a unit, students work towards explaining the science concepts behind the phenomenon in their own words.

Phenomena? Or PhenomeNOT?

What could the phenomena be?

Phenomena? Or PhenomeNOT?

What disciplinary core ideas could be taught with this phenomenon?
I’ll know it’s a phenomenon when . . .

See Phenomena Yes Test in workbook.
In pairs, determine; are these phenomena?

The glow stick contains two chemicals and a suitable dye (sensitizer, or fluorophor). This creates an exothermic reaction.

Some plants have flowers.

Pause to process:

Learner Prompt:
In your workbook, identify and reflect on the:
• Phenomena
• Content (disciplinary core ideas)
• Science and Engineering Practices
• Cross-cutting concepts

Involved in the morning’s modeled lesson.

NGSS Implementation Map

Key:
- Green: Adopted
- Orange: Local decision
- Blue: In progress
- Gray: Not implemented

The Center for Science and Mathematics Education, THE UNIVERSITY OF UTAH
3-Dimensional Science Instruction

Pros:
- No vague cognitive verbs like "know" and "understand"
- Stated what students should be able to do to demonstrate their knowledge
- Identify progressions as part of expectations

Cons:
- No road map, no curriculum
- None of us learned this way
- Standards need to be "unpacked"

The bad news: it’s hard

You might think to yourself... 

I’m a great teacher. I already teach that way!

Even excellent teachers don’t yet have much experience explicitly integrating all 3 dimensions.

I already do great stuff in my classroom. Do I have to get rid of it?

NO! Not at all!

Keep - and adapt - your favorite labs, activities, and assignments.
Long-term planning looks the same – and different.

Old: UNIT plan
A collection of activities related to the disciplinary core idea

New: Storyline
A carefully crafted series of cumulative experiences that allows students to build understanding, skills, and organize their thinking.

Confused?
Open to a Storyline Overview in your workbook.

Learner Prompt:
Write: What similarities do you see with your current planning process? What differences?
Pair: Did you have similar reactions to the Storyline overview? What is exciting about a Storyline? What is concerning?
Share: Biggest concern, biggest new idea.
Short-term planning looks the same – and different.

**Old:**
**Lesson Plan**
An activity aimed at supporting a learning objective.

**New:**
**Learning Episode**
A science experience motivated by questions from a phenomenon or previous experience – may answer questions, or create more.

Confused? Open to a Learning Episode in your workbook.

**Learner Prompt:**
Solo free write
Compare a lesson plan and a learning episode:
- Is the difference clear to you?
- Does the difference feel useful to you?
- What questions/concerns do you have?
Confused?
Open to a Learning Episode in your workbook.

Solo free write:
Compare a lesson plan and a learning episode:
- Is the difference clear to you?
- Does the difference feel useful to you?
- What questions/concerns do you have?

**We will have time to process these concerns as we model learning episodes all week.

This sounds great, but it won’t work for my kids.

It WILL work for your kids.
You are the expert on your students.
As long as students are engaged in making meaning, excellent 3D instruction can include:
- student choice
- vocab support strategies
- explicit direct instruction

Good news:
Your math/ELA colleagues are already supporting you.

Diagram on workbook pg...
Good news: you don’t have to do it all tomorrow.

Learner Prompt:

Listener for -
What did this teacher do to begin transitioning to 3D instruction?

You decide how to implement.

Don’t let this drain you.

To avoid frustration: Explore the suggested implementation guides in the back of your workbook.

Pause to Process:

Learner Prompt:

In your workbook, describe:
- your planning process
- your planning resources (including colleagues as thinking partners)
- how you’ll use both to systematically consider 3D science
More good news:
Assessment is changing with you.

Each SAGE item will be a part of a ‘cluster’ of questions, which will all:

- **Begin** with a named ‘phenomenon’
- **Name** the Science/Engineering Practice the student will engage

Example Assessment Items Are Available

Using a five-powered telescope, you can see four of Jupiter’s closest moons orbiting the planet.

A ruler on the line of the telescope is used to take measurements in inches. The animation shows the movements of the moons and Jupiter over the course of several days. Only part of the telescope view is shown. Click on the small gray arrow at the bottom left of the picture to begin the animation.

SAGE 3D Assessments

**Pause to process:**
Open to page ...... to STEM Tool #30.
Consider 3D assessment.

Write at least 3 questions for Scott Roskelley, USBE Director of Assessment, for our working lunch session.
Regarding SAGE, you should know:

- Reading load is ½ of grade-level reading expectation
- Math is 1 grade below the tested grade level
- Each cluster takes an average student 8-12 minutes to complete

SAGE is built to reflect 3D learning IN SCIENCE

- If you’re teaching 3D, you’ll do well
- DOK 1 doesn’t exist any more – it can’t any more, because 3D is automatically 2-4
- No more vocab lists – ESL strategies are ALWAYS welcome, teachers identify requisite vocab (vocab resources on pg...... of your workbook

Activity: 3D Classrooms and Assessments Look Different

Learner Prompt:
1. Separate the cards into 3 piles by color.
2. Use 2 orange cards for column titles.
3. Each partner takes a pile of cards (white, shaded), and may only touch their color.
4. Arrange the strips in a T-chart:

<table>
<thead>
<tr>
<th>Science education will involve</th>
<th>Less</th>
<th>More</th>
</tr>
</thead>
</table>

The Center for Science and Mathematics Education
THE UNIVERSITY OF UTAH
3D Classrooms and Assessments
Look Different

Consider the sorting activity.

Learner Prompt:
Write:
What differences are you most reluctant to accept?
What differences are you most excited about?
Pair:
Where are you already aligned with 3-D instruction? What will be the easiest shift for you?
Share:
Your partner’s area of strength.

There are resources to help your students succeed on SAGE.

STEM Tool #30 (pg. ....... In workbook)
This whole workshop!
Get on Scott Roskelley’s USBE listserve: https://goo.gl/HlaA17

The best news: it’s better for students.

Teacher-members of pilot programs who were specifically trained in 3-D instruction taught the ‘wrong’ content, ‘covered’ much less, and still improved growth scores and overall proficiency in SAGE.
Questions?

Let's make teaching fun again!!
6th Grade Strand 1: Moon Phases and Eclipses

Lesson Description:
In this lesson students use observations of patterns and models to make sense of the phases of the moon and to explore what causes solar and lunar eclipses.

Standard(s): 6.1.1 Develop and use a model of the Sun-Earth-Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and the Moon, and seasons. Examples of models could be physical, graphical, or conceptual.

<table>
<thead>
<tr>
<th>Practice(s)</th>
<th>Crosscutting Concept(s)</th>
<th>Disciplinary Core Idea(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and use a model to describe phenomena.</td>
<td>Patterns can be used to identify cause and effect relationships.</td>
<td>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.</td>
</tr>
<tr>
<td>Obtain information: Gather, read, synthesize information from multiple appropriate sources.</td>
<td>Cause and effect relationships may be used to predict phenomena in natural or designed systems.</td>
<td>The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. This model of the solar system can explain eclipses of the sun and the moon.</td>
</tr>
<tr>
<td>Construct an explanation using models or representations.</td>
<td>Models can be used to represent systems and their interactions.</td>
<td></td>
</tr>
</tbody>
</table>

Lesson Time Frame
This lesson will take several class periods. Suggested scheduling is as follows.

| Day 1: Engage/Explore 1 looking for moon patterns | Moon Phases and Eclipses PPT (whole class) |
| Day 2: Explore 2 develop a model to show cause of moon phases | Moon Journal (1 per student; student generated) |
| Day 4: Evaluate 1 lunar and solar eclipses | Moon Phase Calendar, current month (1 per student): [https://stardate.org/nightsky/moon](https://stardate.org/nightsky/moon) |
| Day 5: Evaluate 2 research on eclipses | Moon Images, handout (1 set per group) |
| Day 6: Evaluate moon phase explanation | Lamp, styrofoam ball (1 per group) |
| | Inflatable globe (1 per group) |
| | Computers for research (1 per partner or per student) |
# Moon Phases and Eclipses Storyline

<table>
<thead>
<tr>
<th>Driving Question</th>
<th>Anchor Phenomenon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why does the shape of the moon change?</td>
<td>The moon changes shape over time in a cyclic pattern.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phenomenon-driven question*</th>
<th>How students will make sense of phenomenon through practices</th>
<th>Conceptual understanding(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engage:</strong> Does the moon change shape in a pattern?</td>
<td>Moon phase observations. Asking questions about observed patterns.</td>
<td>The moon’s shapes, or phases of the moon, change in a predictable pattern.</td>
</tr>
<tr>
<td><strong>Explore 1:</strong> How long is one moon cycle?</td>
<td>Predictions of future moon phases. Describe the patterns on current month’s moon calendar.</td>
<td>The moon appears to get bigger, until it is full, and then smaller. It takes the moon about 1 month, or 28 days to complete 1 cycle.</td>
</tr>
<tr>
<td><strong>Explore 2:</strong> Where does the moon’s light come from?</td>
<td>Analyze visual data of photographs of moon phases.</td>
<td>The moon reflects the sun’s light.</td>
</tr>
<tr>
<td><strong>Explore 2:</strong> Why does the moon's shape change over the course of one month?</td>
<td>Develop a physical model (lamp and styrofoam ball) to demonstrate the cause of different moon phases.</td>
<td>The location of the moon in its orbit around Earth affects the phase of the moon that we see from Earth.</td>
</tr>
<tr>
<td><strong>Explain:</strong> Where is the moon in its orbit when we see the different phases?</td>
<td>Develop a conceptual model (diagram and/or writing) to describe the location of the moon when we see different phases of the moon.</td>
<td>During a full moon the Earth is between the moon and the Sun. During a new moon the moon is between the Earth and the Sun.</td>
</tr>
<tr>
<td><strong>Elaborate 1:</strong> What causes a solar and lunar eclipse?</td>
<td>Develop a physical model to demonstrate how the alignment of the Sun-Earth-Moon system can cause a solar or lunar eclipse.</td>
<td>A lunar eclipse occurs during a full moon, when the Earth blocks the sun’s light from reaching the moon. A solar eclipse occurs during a new moon, when the moon blocks the sun’s light from reaching the Earth.</td>
</tr>
<tr>
<td><strong>Elaborate 2:</strong> Why don’t we have a solar and lunar eclipse each month?</td>
<td>Obtain information about the occurrences of solar and lunar eclipses and why eclipses do not occur every month.</td>
<td>The moon’s orbit is on a different plane than the sun and Earth. It usually does not line up with the sun and Earth. Only when the Sun-Earth-Moon system is aligned will a solar or lunar eclipse occur.</td>
</tr>
<tr>
<td><strong>Evaluate:</strong> Return to Driving Question: Why does the shape of the moon change?</td>
<td>Construct an explanation for why the moon changes shape over time in a cyclic pattern.</td>
<td>The phase of the moon changes slightly each night. The moon waxes, or appears to get bigger, until it is full and then it wanes, or appears to get smaller. It takes the moon about 1 month to complete a full cycle. The moon reflects the sun’s light. Half of the moon is always lit by the sun. From Earth we see different amounts of the lit half of the moon; this causes the different moon phases. The phase of the moon that we see depends on the moon’s location in its orbit of the Earth.</td>
</tr>
</tbody>
</table>

* Note: These questions may need to be modified based on the questions students develop throughout the unit.
Moon Phases and Eclipses 5E Lesson

Engage: Does the moon change shape in a pattern?
Have students keep a moon phase journal for about 1 week. Journal entries should include the date and time of the observation, a picture of the moon, and the location of the moon in the sky. Have students share their observations in small groups and then as a class. Help students to recognize that the moon’s shape slowly changes from one night to the next. Ask students: what patterns do you notice? Encourage groups to ask questions about the changes in the moon’s shape that they observed. Record student generated questions, and guide students towards the driving question: why does the shape of the moon change?

Explore 1: Does the moon change shape in a pattern? (cont’d) and How long is one moon cycle?
Give students a blank monthly calendar for the current month. Direct students to draw pictures of the moon phases they observed and recorded in their moon journals prior to the lesson. Ask students to draw predictions of what the moon may look like in the next few days on their moon calendar. Ask students to draw pictures of what the moon may have looked like prior to their observations. As students share their predictions, ask them to explain their reasoning. Ask students to predict when a full moon (or other unobserved phase) might occur. Have them draw the moon on their calendar. Provide students with the monthly moon phase calendar for the current month and the following month so that they can evaluate their predictions. Tell students to work with a partner to identify more patterns in the moon phases now that they can see two months. Ask students how long they think it takes for the moon to make one complete cycle. Introduce the major phases (new moon, 1st quarter, full moon, 3rd quarter) and ask students to identify the amount of time it takes for the moon phase to change to the next major phase.
Have students individually write about the shapes of the moon and the pattern they follow. Writing could include both a written explanation and pictures to support their developing model of the moon’s changing shape. Students should include the rate of change and the cyclical nature of the pattern.

Explore 2: Where does the moon’s light come from? Why does the moon’s shape change over the course of one month?
Provide students with images of different moon phases.

Ask students to use the images to engage in argumentation by developing a claim about where the moon’s light comes from. Students should be able to reference at least one image as evidence to support their claim. For example, students may say that they can see how the crescent moon is lit by
the setting sun therefore they claim that the moon reflects the sun’s light. A claim evidence t-chart can be used to help students in developing and sharing their argument.

Remind students of the observations they have made about the moon and the moon phases in the previous lessons by reviewing the ideas that the moon’s shape slowly “gets bigger”, or waxes, until it is full moon, and then slowly “gets smaller”, or wanes, after the full moon, that it takes about 1 month for the moon to complete one cycle, and that the moon reflects the sun’s light.

Tell students that they will use these understandings to help them develop an explanatory model. Their model will demonstrate how movement in the Sun-Earth-Moon system causes the different phases of the moon. Provide small groups of students with a lamp (without a shade) and a styrofoam ball on a pencil. Encourage students to explore different movements that might result in different phases of the moon being seen from Earth. Groups can evaluate their model by whether or not they can see all of the moon phases and whether the moon phase changes in the predictable “getting bigger” and “getting smaller” pattern.

Some groups may need additional support to develop this model. Try to give groups time to grapple with the model before providing direct support. The following simulation may help students revise their initial models:


Some groups may need extensions to their models. Ask these groups to explain which phases of the moon can be observed during the day and why. These groups can be provided with an inflatable globe to help them develop a model and explanation. Alternatively, ask these groups to modify their model to show how the moon rotates so that we only ever see one-half of the moon from Earth.

Explain: Where is the moon in its orbit when we see the different phases?

Tell students that they will be using what they have learned so far to draw a model that shows where the moon is in its orbit during each of the phases of the moon. Provide students with the moon phase calendars, lamps and styrofoam balls to support them as they move from the 3D physical model of the moon phases to a 2D conceptual model (diagram) that demonstrates their understanding of the cause of the moon phases. Encourage students to add details to their models which may include the names of the moon phases, the direction of the moon’s orbit, the number of days between different phases, or actual dates when the phases will be observed for the current month. One way to facilitate this is to have students draw an initial model and then share these models with a small group in order to get further ideas about how to improve their models.

For students that need further support, use internet-based simulations, such as:
http://www.classzone.com/books/earth_science/terc/content/visualizations/es2503/es2503page01.cfm or create a whole class model by giving each student a styrofoam moon ball and setting up a lamp in the center of a darkened room. Walk students through the different moon phases as they revolve the moon balls around their heads. After students have had more experiences with the Earth-Moon-Sun system have them revise their initial models of the moon phases.

Elaborate 1: What causes a solar and a lunar eclipse?

Explain to students that the movement of the Sun-Earth-Moon system not only results in the cyclic pattern of the phases of the moon, but can also cause eclipses. Have students watch the following two videos. As students watch have them record observations and ask questions about what they see happening.

Lunar Eclipse: https://www.youtube.com/watch?v=lcRp1jKJmJU
Solar Eclipse:  https://www.youtube.com/watch?v=3_qo2CdcyC0
Discuss students observations and questions. Student questions do not need to be answered at this time, some may be answered when groups develop physical models, others may be answered in the next phase of the lesson.

Provide small groups of students with a lamp, styrofoam ball, and inflatable globe. Ask them to develop a model that demonstrates the cause of a solar eclipse and a lunar eclipse. As students develop their models ask them about whether everyone on Earth can see a solar or lunar eclipse at the same time and during which phases of the moon do solar and lunar eclipses occur. After discussing the models, have students record their models in their science notebooks.

Elaborate 2: Why don’t we have a solar and lunar eclipse each month?

Invite a few groups of students to share their physical models of a solar and/or lunar eclipse. Discuss when students would expect eclipses to occur by probing students about the phase of the moon during a solar and a lunar eclipse. Show students a chart of solar and lunar eclipses: http://www.timeanddate.com/eclipse/list.html. Have them look for patterns in this chart. Students may notice that solar and lunar eclipses occur only a few times per year. They may also notice that one eclipse occurs and then the next eclipse occurs a few weeks after, indicating that lunar and solar eclipses occur in the same moon phase cycle.

After sharing observations, ask students, why don’t we have a solar and a lunar eclipse each month? Allow students to describe their initial ideas about this question, then invite them to obtain information by doing further research on-line, http://earthsky.org/space/why-isnt-there-an-eclipse-every-full-moon, or in a textbook. After conducting research, students should be able to explain through writing or models that the moon is not on the same plane as the Earth and Sun system, so only rarely does the moon’s orbit cross the Earth’s orbital plane during a full or new moon.

As students finish research, they may want to continue to find more information about eclipses, such as why a lunar eclipse makes the moon appear red, how often a solar eclipse occurs in North America, or where to view the August 21, 2017 total solar eclipse.

To extend the lesson, and integrate writing, ask students to write a persuasive letter to the school principal about why the principal should fund a field trip for 6th grade students to see the August 21, 2017 total solar eclipse. In the letter, students should be able to explain how rare the occurrence is as they describe the cause of the eclipse, the projected path of the eclipse, and how often a total eclipse occurs so close to Utah.

Evaluate: Driving questions: Why does the shape of the moon change?

Have students construct an explanation for the cyclic patterns of moon phases and the causes of moon phases. The following prompt encourages students to share their understanding of both of these topics:

The third grade class has been observing the moon for one week. Maria, one of the students in the class, is confused about moon phases, and has come to you for help. Here is what she says:

“Our class is studying the moon. All week I have been drawing pictures of the moon before I go to bed at night. It is really fun. Our teacher told us that the moon changes in a cyclic pattern. I don’t understand what she means. What is the moon’s cyclic pattern? Also, I am curious, why does the shape of the moon change a little each night?”
Write a letter to Maria. In the letter answer both of her questions. Be sure to explain the pattern for how the moon changes, how long it takes for the moon to complete one cycle, and what causes the different moon phases. In your letter you can include pictures and diagrams to help Maria understand.

Through writing and diagrams in the letter students should be able to construct an explanation that aligns with the conceptual understanding for the driving question.
Moon Journal

For homework you will keep a moon phase journal for one week. In your journal be sure to record:

1. Date and time
2. Picture of the moon
3. Where the moon is in the sky

You can also record any interesting things that you notice or questions that you have.

Does the moon change shape in a pattern?

Share your moon journal with your group. Using observations from all of the moon journals:

1. Identify any patterns you see.
2. Record questions your group has about the moon.
Driving Question

Why does the shape of the moon change?

Does the moon change shape in a pattern?

On the blank calendar:

1) Draw pictures of the moon on each of the dates that you observed.
2) Draw pictures of the moon for the next week based on the patterns you have observed.
3) When do you think there will be a full moon this month? Draw a full moon on that date.

How long is one moon cycle?

Evaluate your predictions:

1) Compare the pictures that you drew to the moon phase calendar for this month.
2) Describe the pattern you see in the moon phase calendar.
3) Analyze the moon phases; about how long does it take for the moon to complete one cycle?
The Moon’s Cyclic Pattern

Construct an explanation of your current understanding of the moon phases. In your explanation:

1) Write about the phases of the moon and the patterns they follow.
2) Describe one complete moon cycle, including the time needed for the moon cycle.

You may include pictures in your written explanation.

Where does the moon’s light come from?

Analyze the images of the moon below. What patterns do you notice?

Develop a claim about where the moon’s light comes from. Support your claim with evidence from the images.
Why does the moon’s shape change over the course of a month?

Develop a model that explains the cause of the moon phases. To develop your model you will be using:

1 lamp
1 styrofoam ball on a pencil
1 moon phase calendar

Be prepared to demonstrate your model to show the Earth-Moon-Sun system during a new moon, 1st quarter moon, full moon, and 3rd quarter moon.

Where is the moon in its orbit when we see different phases?

Draw a model of the Earth-Moon-Sun system that explains why we see different phases of the moon and when we see each of the phases of the moon. You may want to use the moon phase calendar, lamp, and styrofoam ball as you draw your model. Include labels and captions to further develop your model.

What causes a solar and lunar eclipse?

As you watch the videos record observations and ask questions about eclipses.

Lunar Eclipse:
https://www.youtube.com/watch?v=lcRp1jKJmJU

Solar Eclipse:
https://www.youtube.com/watch?v=3_qo2CdcyC0

Develop a model that shows the Earth-Moon-Sun system during a lunar eclipse and a solar eclipse. You may use:

a lamp
a styrofoam ball
a globe

Draw and label your models in your science notebook.

During which moon phase does a solar eclipse occur?
During which moon phase does a lunar eclipse occur?
Why don't we have a solar and lunar eclipse every month?

Analyze the data about the occurrence of solar and lunar eclipses. What do you notice?

Solar and Lunar Eclipses Worldwide - Next 10 Years
http://www.timeanddate.com/eclipse/list.html

Obtain information from the Internet or a book in order to develop an explanation for why we don't have a solar and lunar eclipse every month. Record your explanation in your science notebook.

Why does the shape of the moon change?

Write a response to the following prompt:

The third grade class has been observing the moon for one week. Maria, one of the students in the class is confused about moon phases, and has come to you for help. Here is what she says:

"Our class is studying the moon. All week I have been drawing pictures of the moon before I go to bed at night. It is really fun. Our teacher told us that the moon changes in a cyclic pattern. I don't understand what she means. What is the moon's cyclic pattern? Also, I am curious, why does the shape of the moon change a little each night?"

Write a letter to Maria. In the letter answer both of her questions. Be sure to explain the pattern for how the moon changes, how long it takes for the moon to complete one cycle, and what causes the different moon phases. In your letter you can include pictures and diagrams to help Maria understand.
Modeling Phenomena; Strategies to Support Equitable Access to Learning

Student Science Performance

| Topic: Magnetism | Title: Modeling magnetism: the floating paper clip |

Overarching Performance Expectations (Standard) from State Standards or NGSS:

This lesson directly addresses Utah SEEEd standard 7.1.3 but could easily be extended to include standard 7.1.4 because the exploration of electromagnets and generators can be used to extend students’ models for how magnetism works.

**Standard 7.1.3** Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically charged objects) and the forces they exert.

**Standard 7.1.4** Collect and analyze data to determine the factors that affect the strength of electric and magnetic forces. Examples could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or of increasing the number or strength of magnets on the speed of an electric motor.

Lesson Performance Expectations:

- Ss will develop and revise models of magnetism anchored in a particular phenomenon (floating paper clip). Ss will then test their models’ ability to account for new phenomena (generators, electromagnets, or iron filings)
- Ss will use appropriate language (made explicit by the teacher in sentence frames) for describing their models and asking questions of peers to extend their thinking. Ss will share leadership responsibilities required for consensus modeling. Ss will participate in whole class discussions by repeating/rephrasing, adding new ideas, asking questions, providing counterevidence or a counter argument.

Students Will. . . To Construct Meaning

**Engage with a Phenomenon: Floating paper clip.**

**Gather:** Observations (drawings & notes) about how magnets interact with different objects under various conditions.

**Reason:** Hypothesize/model HOW the magnets produce the observable properties students collected/noticed at the stations by focusing on the floating paperclip phenomenon. The model must be consistent with the observable evidence!

**Communicate:** Using verbal contributions to both peer group and whole class discussions, students will describe and explain their drawings/models of magnetism & ask questions to clarify their understanding of their peers’ models.

Teacher Will. . . To Support Students

- Prep lesson with valued/appropriate language of participation made explicit to students at multiple points throughout the lesson.
- Manage students’ participation in groups using colored cards & explicit instructions for leadership roles & the process of forming consensus models.
- Circulate while students are working independently and in groups to provide feedback and ask strategic questions to push students' thinking. Also help individual Ss prepare to share their models – particularly EL students.
- Provide built in wait time by allowing sufficient time for independent work before group work.
- Use strategic talk moves to promote broader participation in whole class discussions and shift classroom culture away from valuing only once correct answer.
- Draw students’ attention to evidence, counter evidence, and additional scenarios strategically to push their thinking about their models (independent, small group, and whole class settings).
- If T wants students to model at the micro-level, will need to ask students specifically to think about and draw what is happening inside the magnet and the paperclip to allow this phenomenon to occur.
**Assessment of Student Learning**

*Proficiency will be determined based on whether or not students' models show the desired level of specificity at the macro or micro levels, whether the models are static or dynamic, whether they account for observable evidence (experientially provided in class), and whether or not students' models demonstrate increased sophistication/change over time. A simple 0/1 scoring could be set up for each of these dimensions if grades must be applied.*

<table>
<thead>
<tr>
<th>Management Strategies:</th>
<th>Materials Required:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Station labels &amp; instructions</td>
</tr>
<tr>
<td></td>
<td>- Magnets, nails, pencils, string, paper clips, tape.</td>
</tr>
<tr>
<td></td>
<td>- Paper for students to draw</td>
</tr>
<tr>
<td></td>
<td>- Chart paper for students to depict consensus models</td>
</tr>
<tr>
<td></td>
<td>- White board or chart paper to record ideas during whole class discussions.</td>
</tr>
<tr>
<td></td>
<td>- T may want a clipboard w/ a chart to keep track of notes on students’ thinking AND notes on Ss participation according to instructions for how to collaborate.</td>
</tr>
</tbody>
</table>

**Sequence of Instruction**

<table>
<thead>
<tr>
<th>Teacher Does</th>
<th>Students Do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present the phenomenon &amp; Q: How does a magnet make a paperclip float in air? Think-Pair-Share</td>
<td>Ss watch demo &amp; do Think-Pair-Share</td>
</tr>
<tr>
<td>T refrains from commenting too much on Ss ideas at this point. Make record of Ss initial ideas on the board.</td>
<td>Messing about: Ss visit different stations constructed by the teacher to make observations about how magnets interact with each other and other materials. Ss keep track of ideas with notes and pictures.</td>
</tr>
<tr>
<td><strong>Messing about:</strong></td>
<td></td>
</tr>
<tr>
<td>T circulates while students visit stations, and listens to student thinking and/or is available to answer procedural Qs. Can ask probing Qs as relevant.</td>
<td>Messing about: Ss visit different stations constructed by the teacher to make observations about how magnets interact with each other and other materials. Ss keep track of ideas with notes and pictures.</td>
</tr>
<tr>
<td><strong>Initial Modeling – Independent work time</strong></td>
<td><strong>Initial Modeling – Independent work time</strong></td>
</tr>
<tr>
<td>Circulate and ask probing Qs, help Ss who aren’t sure how to get started, visit EL students (&amp; others) to make sure they are ready to share their models with their classmates.</td>
<td>Ss generate drawings and initial answers to the anchor question. Ss plan how they will share their drawings with their peers.</td>
</tr>
<tr>
<td><strong>Initial Modeling – Sharing models</strong></td>
<td><strong>Initial Modeling – Sharing models</strong></td>
</tr>
<tr>
<td>T circulates to collect info on student thinking – what’s in the models, and to ensure Ss follow the participation framework and that no one student is dominating the conversation or “playing teacher/expert”.</td>
<td>Ss share their models in a small group using the participation &amp; explanation structure provided by the teacher.</td>
</tr>
<tr>
<td><strong>Consensus Modeling</strong></td>
<td><strong>Consensus Modeling</strong></td>
</tr>
<tr>
<td>T circulates to monitor Ss participation according to the framework AND to ask probing Qs about Ss thinking – to push Ss thinking.</td>
<td>Ss work together using the suggested participation framework to create a consensus model for the anchoring phenomenon.</td>
</tr>
<tr>
<td><strong>Sharing consensus models → building towards class consensus</strong></td>
<td><strong>Sharing consensus models</strong></td>
</tr>
<tr>
<td>T facilitates ‘science talk’ about the models. (See PPT)</td>
<td>Ss listen, present, and ask Qs following the participation framework.</td>
</tr>
<tr>
<td>Ss revise their models based on whole class discussion (2nd round of small group consensus modeling). Repeat process as above, assign different roles to students.</td>
<td></td>
</tr>
<tr>
<td>Ss test their models on a new phenomenon (e.g., electromagnets, generators, and/or behavior of iron filings (if not used in initial stations &amp; depending on T goals)) May have independent and/or small group work here. Activities can/should involve standard 7.1.4.</td>
<td></td>
</tr>
<tr>
<td>Ss revise models.</td>
<td></td>
</tr>
<tr>
<td>Ss use models to explain or make predictions of a novel scenario.</td>
<td></td>
</tr>
</tbody>
</table>
Utah’s SEEd Standards:
Why 3D Instruction?

Presentation Overview
• The history and evolution of classroom science instruction
• What is 3D instruction? Where did it come from?
• How Utah fits in to the national picture
• How instruction will stay the same
• How instruction will change
  • How assessment will work

The History and Evolution of Classroom Science Instruction
Direct instruction
  Hands-On
  Inquiry
  3D instruction
  *This is great news!
  We’ll learn why!
Direct Instruction

**Pros:**
- It's easy
- We teachers feel smart and in control
- It works for some students

**Cons:**
- It doesn't work for everyone:
  - “students in classes with traditional stand-and-deliver lectures are 1.5 times more likely to fail than students in classes that use more stimulating, so-called active learning methods.”
  - (Freeman, et al. 2014)

Hands-On (1970s)

**Pros:**
- Fun and engaging for students

**Cons:**
- Students can participate without learning
- Scary for teachers

Inquiry (1990s)

**Pros:**
- Engages students in authentic scientific practices.

**Cons:**
- Difficult to teach to teachers
- When done poorly, increased opportunity gap.
Enter...
3-Dimensional Science Instruction

3D Science Instruction is Good News!

What, exactly, are the three dimensions?
Phenomena:

“are observable events in nature (or our lives) that connect to multiple disciplinary core ideas.”

Throughout a unit, students work towards explaining the science concepts behind the **phenomenon** in their own words.

---

**Phenomena? Or PhenomeNOT?**

Students manipulate Oreos to mimic tectonic plate movement.

**What could the phenomena be?**

NOT!

---

A water bottle freezes and breaks.

**What disciplinary core ideas could be taught with this phenomenon?**

Phenomenon!
I’ll know it’s a phenomenon when . . .

See Phenomena Yes Test in workbook.
In pairs, determine; are these phenomena?

The glow stick contains two chemicals and a suitable dye (sensitizer, or fluorophor). This creates an exothermic reaction.

Pause to process:

Learner Prompt:
In your workbook, identify and reflect on the:
• Phenomena
• Content (disciplinary core ideas)
• Science and Engineering Practices
• Cross-cutting concepts

Involved in the morning’s modeled lesson.
3-Dimensional Science Instruction

Pros:
+ No vague cognitive verbs like “know” and “understand”
+ Stated what students should be able to do to demonstrate their knowledge
+ Identify progressions as part of expectations

Cons:
- No road map, no curriculum
- None of us learned this way
- Standards need to be “unpacked”

The bad news: it’s hard

You might think to yourself... I’m a great teacher. I already teach that way!

Even excellent teachers don’t yet have much experience explicitly integrating all 3 dimensions.

I already do great stuff in my classroom. Do I have to get rid of it?

NO! Not at all!
Keep - and adapt - your favorite labs, activities, and assignments.
Long-term planning looks the same – and different.

Old:
UNIT plan
A collection of activities related to the disciplinary core idea

New: Storyline
A carefully crafted series of cumulative experiences that allows students to build understanding, skills, and organize their thinking.

Confused?
Open to a Storyline Overview in your workbook.

Learner Prompt:
Write:
What similarities do you see with your current planning process?
What differences?

Pair:
Did you have similar reactions to the Storyline overview?
What is exciting about a Storyline? What is concerning?

Share:
Biggest concern, biggest new idea.
Short-term planning looks the same – and different.

**Old:**
**Lesson Plan**
An activity aimed at supporting a learning objective.

- **What Is Science?** (pages 6–12)
- **Learning Objectives**
  - Students will be able to...
  - Identify the skills and attitudes that scientists use to learn about the world.
  - Explain what scientific inquiry involves.
  - Differentiate between a scientific theory and a scientific law.

Short-term planning looks the same – and different.

**New:**
**Learning Episode**
A science experience motivated by questions from a phenomenon or previous experience – may answer questions, or create more.

Confused?
Open to a Learning Episode in your workbook.

**Learner Prompt:**
Solo free write
Compare a lesson plan and a learning episode:
- Is the difference clear to you?
- Does the difference feel useful to you?
- What questions/concerns do you have?
Confused?
Open to a Learning Episode in your workbook.
Solo free write:
Compare a lesson plan and a learning episode:
- Is the difference clear to you?
- Does the difference feel useful to you?
- What questions/concerns do you have?

**We will have time to process these concerns as we model learning episodes all week.

This sounds great, but it won’t work for my kids.

It WILL work for your kids.
You are the expert on your students.
As long as students are engaged in making meaning, excellent 3D instruction can include:
- student choice
- vocab support strategies
- explicit direct instruction

Good news:
Your math/ELA colleagues are already supporting you.
Good news: you don’t have to do it all tomorrow.

Learner Prompt:
Listen for -
What did this teacher do to begin transitioning to 3D instruction?

You decide how to implement.

Don’t let this drain you.

To avoid frustration:
Explore the suggested implementation guides in the back of your workbook.

Pause to Process:

Learner Prompt:
In your workbook, describe:
- your planning process
- your planning resources (including colleagues as thinking partners)
- how you’ll use both to systematically consider 3D science
More good news:
Assessment is changing with you.

Each SAGE item will be a part of a ‘cluster’ of questions, which will all:
- Begin with a named ‘phenomenon’
- Name the Science/Engineering Practice the student will engage

Example Assessment Items Are Available

Using a few powered telescopes, you can see four of Jupiter’s closest moons orbiting the planet.

A ruler on the lens of the telescope is used to take measurements in inches. This animation shows the movements of the moons and Jupiter over the course of several days. Only part of the telescope view is shown. Click on the small gray arrow at the bottom left of the picture to begin the animation.

SAGE 3D Assessments
Withstand Interrogation

Pause to process:
Open to page ...... to STEM Tool #30.
Consider 3D assessment.

Write at least 3 questions for Scott Roskelley, USBE Director of Assessment, for our working lunch session.
Regarding SAGE, you should know:
- Reading load is ½ of grade-level reading expectation
- Math is 1 grade below the tested grade level
- Each cluster takes an average student 8-12 minutes to complete

SAGE is built to reflect 3D learning IN SCIENCE
- If you’re teaching 3D, you’ll do well
- DOK 1 doesn’t exist any more – it can’t any more, because 3D is automatically 2-4
- No more vocab lists – ESL strategies are ALWAYS welcome, teachers identify requisite vocab (vocab resources on pg...... of your workbook

Activity: 3D Classrooms and Assessments
Learner Prompt:
1. Separate the cards into 3 piles by color.
2. Use 2 orange cards for column titles.
3. Each partner takes a pile of cards (white, shaded), and may only touch their color.
4. Arrange the strips in a T-chart:
   | Science education will involve |
   | --- | --- |
   | Less | More |
3D Classrooms and Assessments Look Different

Consider the sorting activity.

Learner Prompt:
Write:
What differences are you most reluctant to accept?
What differences are you most excited about?
Pair:
Where are you already aligned with 3-D instruction? What will be the easiest shift for you?
Share:
Your partner’s area of strength.

There are resources to help your students succeed on SAGE.

STEM Tool #30 (pg. ....... In workbook)

This whole workshop!

Get on Scott Roskelley’s USBE listserve: https://goo.gl/H1aAi7

The best news: it’s better for students.

Teacher-members of pilot programs who were specifically trained in 3-D instruction taught the ‘wrong’ content, ‘covered’ much less, and still improved growth scores and overall proficiency in SAGE.
Questions?

Let’s make teaching fun again!!
PROMOTING INTERACTION & PARTICIPATION IN 3D STEM LESSONS: A MODELING EXAMPLE

Dr. Sarah Braden
Urban Institute for Teacher Education
University of Utah
June 29, 2017

Agenda
1. Modeling: an NGSS Practice
2. Promoting Student Participation – Literature
3. Promoting Student Participation – Strategies
4. Sample/Model/Demo Lesson – Modeling Magnetism
5. Debrief
6. Resources, References & Contact Information

MODELING AS AN NGSS PRACTICE
Aspects of effective modeling instruction
(Passmore, Schwarz & Mankowski, 2017)

- Models are always FOR not OF.
  - Compare:
    - A model for explaining planetary motion.
    - A model of the solar system.

- “The essence of the Developing and Using Models practice is to figure out and use specific ideas about theoretical and actual objects and the relationships between them to account for the behavior of systems in the natural and designed world”. (Passmore, Schwarz & Mankowski, 2017, p. 113)

- All of the NGSS practices are interconnected.

Aspects of effective modeling instruction
(Kenyon, Schwarz & Hug, 2008)

- Sequence for modeling instruction
  1. Initial exploration of a phenomenon
  2. Ss construct a model
  3. Ss test the model
  4. Ss evaluate the model
  5. Ss test the model again.
  6. Ss revise the model
  7. Ss use the model to predict or explain.

PROMOTING STUDENT PARTICIPATION:
THE LITERATURE
Some reasons why students may not participate in classroom conversations

1. Not enough time provided to think before speaking!

2. Ss are uncertain of appropriate discourse structures for participating in conversations.

3. Structure & frequency of questions posed by the teacher (Zwiers, 2008)
   - Classroom culture that values transmission teaching (banking model) and IRE sequences (displaying knowledge for the teacher) (Carline, Rain-Fryer & Webb, 2011).
   - Cultural differences between students' home and school environments (Philips, 1983)

1. The teacher only validates some students' language backgrounds not all (Rymes & Anderson, 2004).

2. Peers can be domineering! (Braden, 2016)
   - Students from majority/privileged backgrounds can inadvertently (or on purpose) recreate the power dynamics that subjugate traditionally minoritized students. This can have a snowball effect in terms of the development of science expertise.

Teacher practices to promote broader participation

<table>
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<td>Teachers inadvertently create unsupportive environments for minoritized students.</td>
<td>6. Manage teacher reactions to students during all interactions and use alternative moves to draw out student thinking.</td>
</tr>
</tbody>
</table>
1. Providing sufficient wait time
   - Build “think” time into your lesson plans.
     - Use a timer, tell all students they have X min. to think about their answer before they will share.
   - Give students a heads up on who will be asked to share and when.
   - Use peer interaction before whole class discussions.*
     - Think-pair-share
     - Find your partner

2. Make academic language explicit
   - Brainstorm – how would you agree or disagree with the statements below? What exactly would you say?
     1. French fries are better than potato chips.
     2. Genetically modified foods are safe and should not be banned.
   - We must make functional academic language explicit
     - Agreeing & disagreeing
     - Suggesting
     - Informing
     - Listing
     - Comparing
     - Argumentation
     - Etc.………..

Academic Practices in 3D STEM Lessons
1. Asking questions & defining problems.
2. Developing and using models.
3. Planning & carrying out investigations.
4. Analyzing & interpreting data.
5. Using mathematics & computational thinking.
7. Engaging in argument from evidence.
8. Obtaining, evaluating & communicating information.
2. Make academic language explicit - Resources


  - Discipline specific language

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2. Make academic language explicit - Resources


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2. Make academic language explicit - Resources


---

2. Make academic language explicit - Resources

2. Make academic language explicit – 4th grade Science Example

**Content Objectives**
- SWBAT predict how an extinct organism looked and the environment it lived in based on evidence from the living things that they know about from their everyday lives (by completing a graphic organizer, working independently).
- SWBAT construct an argument for why they included particular physical features or environmental features in their fossil/organism drawings.

**Language Objective**
- SWBAT use description & justification sentence stems (e.g., I drew X because...; My evidence is...) provided on the board to verbally justify their choices for their organism drawings working in pairs and in a whole class discussion.

3. Small group tasks, alternatives to WC discussions

  - Cooperative learning
  - Think-Pair-Share (TPS)
  - Round tables, numbered heads together
  - Jigsaw
  - Concentric circles
  - Role plays & simulations
  - Acting out stories/scenarios
  - Interview grid/find someone who
  - Take a side
  - Debates

As long as students are working on developing arguments, explanations, and/or modeling, these are all NGSS-consistent ways to promote learning in small groups!

4. Questioning practices to promote speaking

- Use open-ended **HOW** and **WHY** as opposed to known answer questions.
- Ground science lessons in anchoring phenomena that Ss can directly experience.
  - Ask students how or why questions related to these phenomena!
- Additional tips for constructing open-ended questions (Zwiers, 2008)
  - Use hindsight to explain how a problem could have been avoided.
  - Explain how information/analysis of X can help future generations.
  - Explain/provide multiple solutions to a problem.
  - Change in thoughts over time.
  - Etc.…….
5. Helping students manage their participation in groups

- 10 coins in a hat
- 5 Ss, 2 post-its each
- Colored & ordered participation cards
- Assign roles, make the practices of the roles explicit (rubrics/instructions), hold students accountable through feedback on how they are occupying these roles.
- Exit slips/tasks that require reflection on HOW Ss participated in their groups

6. Managing whole class discussions

- Teacher Moves for Open-Ended Discussions (Michaels & O’Connor, 2012)
  - Repeating & Rephrasing - Who can rephrase what X said? Who can tell us what their partner said?
  - Challenge an idea with a counterexample - Does it always work that way? How does X idea fit with Y person’s idea?
  - Agree or disagree - Are you saying the same thing as X? Why or why not? Does anyone want to respond to X?
  - Add on – who can add onto the idea X is building?
  - Explaining what someone else means – Who can explain what X meant? What did you hear X say?

- Open-ended discussions are challenging! You should make the rules of the game explicit for learners through use of language objectives & scaffolding

6. Managing whole class discussions

- Teach students HOW to participate! Build a culture where having “the right” answer is NOT what is most valued.
- Valuable ways for students to contribute to the conversation – focus on evidence and explanations:
  1. Repeat/rephrase what someone else has shared
  2. Add a new idea (evidence or explanation)
  3. Ask a question about an idea
  4. Provide counter evidence or a counter argument

- When teachers hear students doing these things they can label and positively evaluate students’ contributions.
MODELING MAGNETISM: SAMPLE LESSON

Task
- Participate-ish (©) in a magnetism lesson centered on modeling.
- After participating, identify the strategies Sarah included to promote participation.
- Identify additional barriers to student participation and possible solutions.

SEEd
- Standard 7.1.3 Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically charged objects) and the forces they exert.
- Standard 7.1.4 Collect and analyze data to determine the factors that affect the strength of electric and magnetic forces. Examples could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or of increasing the number or strength of magnets on the speed of an electric motor.
Lesson Overview

- In this lesson we will develop a model for how magnetism works.
- This exploration is anchored in the demonstration and answering the following question:
  - How does a magnet make a paperclip float in the air?
- We will work through the first two steps of the modeling cycle presented earlier.

Sequence for modeling instruction

1. Initial exploration of a phenomenon
2. Ss construct a model
3. Ss test the model
4. Ss evaluate the model
5. Ss test the model again
6. Ss revise the model
7. Ss use the model to predict or explain.

Initial Thoughts (T-P-S)

- How does a magnet make a paperclip float in the air?

Messing About

- You will visit 7 stations that contain materials and questions geared to helping you collect data to construct your argument to answer our anchor question.
- At each station, play with the materials and think about the question posed at the station.
- Keep track of your thoughts by taking notes and drawing pictures.
Anchor Question Revisited – Forming initial models independently

How does a magnet make a paperclip float in the air?

1. Work independently (X min)
   - Draw a picture (this is your model) to help you answer the anchor question.
   - Get ready to share your model with your group
     - In my drawing you can see……… I included X,Y,Z because……… OR My drawing has…. because………
     - My evidence for this model is………
     - Something I observed today:
     - Something I observed somewhere outside of class:
     - Something I read:
     - Something I learned in another science class:

2. When directed by Sarah, form a rainbow group.

Anchor Question Revisited – Sharing models

Q: How does a magnet make a paperclip float in the air?

Instructions: Each person shares his/her model with the group and explains his/her reasoning & evidence for the model. Follow the sharing order!

Language for Presenting Your Model

- In my drawing you can see……… I included X,Y,Z because……… OR My drawing has…. because………
- My evidence for this model is………
- Something I observed today:
- Something I observed somewhere outside of class:
- Something I read:
- Something I learned in another science class:

Today’s Sharing Order:

Orange
Blue
Green

Language for Active Listeners

- I noticed you have X in your drawing, can you explain………
- Can you explain why you chose to depict/draw X (like Y)?
- Can you say more about X?
- Do you have evidence for X?

Develop a consensus model in small groups

Q: How does a magnet make a paperclip float in the air?

Instructions: Combine your ideas to make a consensus model. Each person will lead part of the conversation & work.

- Pink: What are the similarities and differences in our models?
  - I noticed X! have………
  - I noticed only X’s has…..
- Orange: What do we agree should be in our model?
  - I think we should include…. because………
  - I agree/disagree because………
- Yellow: Are we ready to draw? How should we start?
  - I think we should draw…. because/or example
- Blue: Is there anything missing in our drawing?
  - We need to add:……
- Green: What’s our evidence for this model?
  - Our evidence is……
### Students share their consensus models

- Teacher strategically selects presentation order.
  - Teacher may allow students to pick who will be the presenter or assign this role. Either way – give students time to practice/prepare what they will present to the class – Ss should use their own variations on the template provided for small group sharing.

- Teacher leads a science talk about the models (Use the poster re: types of participation!)
  - Make comparisons between the models
  - Encourage students to point out similarities, differences, consistencies, inconsistencies.
  - Provide counter evidence to challenge student thinking
  - Ask questions that probe students' thinking
  - Asks students to rephrase or repeat others' thinking/ideas
  - Build consensus, “who else thought XYZ”, “Do we agree or disagree with QRS idea and why?” (focus on ideas not ppl).
  - List ideas on the board to guide talk (be sure to be inclusive, as in don't hesitate to add incorrect ideas to the ongoing list of options)

### Remaining modeling sequence for this lesson.....

- Students revise their group models after science talk.
- Ss test their models on a new phenomenon (Ss can make predictions beforehand & test those predictions)
  - Behavior of iron filings → gets at structure of magnetic fields (pushes macro-level models)
  - Electromagnets → gets at relationship between electricity & magnetism (pushes macro & micro-level thinking)
  - Generators → gets at relationship between electricity & magnetism (pushes macro & micro-level thinking)

- Ss revise models as needed based on testing.
- Ss use models to explain or predict in a novel scenario.

### SEEd Revisited

- Standard 7.1.3 Construct a model using observational evidence to describe the nature of fields existing between objects that exert forces on each other even though the objects are not in contact. Emphasize the cause and effect relationship between properties of objects (such as magnets or electrically charged objects) and the forces they exert.
  
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What would a good student generated explanation for magnetism involve?
(Cheng & Brown, 2015)

1. **Elements that are not observable**
   - Does the explanation account for unobservable elements or observable phenomena?

2. **Interactions between those unobservable elements**
   - Does the explanation account for the arrangement of unseen elements or their interaction?

3. **Those unobservable elements are microscopic**
   - Are the unseen elements macroscopic or microscopic?

Students models can be categorized based on…
Static / dynamic
Macrosopic / microscopic → dynamic & microscopic

---

Assessments (not necessarily grades! 😄)

- Collect & categorize models
  - Macro-level components (presence/absence)
  - Micro-level components (presence/absence)
  - Accounts for observed evidence about how magnets work (Y/N)
  - Static v. dynamic (movement, interaction/relationships)

- Track progress of thinking in individual models & group models
  - Ss model revisions show…
    - Increased sophistication
    - Movement in thinking based on the indicators listed above
    - New models can account for new evidence/multiple phenomena

- Keep notes on how students participate in small group and whole class discussions & have students complete reflections on their participation. Can be in checklist form to streamline recording!

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Promoting Interaction & Participation in the Magnetism Lesson – Examples? Additional thoughts?

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Resources (happy to send PDFs!)

- **Modeling**

- **Talk Moves**

- **NGSS Practices & Language Learners**

- **Student thinking re: magnetism**

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Thank you!

Dr. Sarah Braden

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After 08/15/17:
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References


