Slow down to go fast?
How modeling can increase student engagement through storytelling
Sandra Erwin and Mason Converse, Harper Creek High School
Our Story

1. Our opportunity
2. Our current curriculum
3. What does the data suggest?
4. Final thoughts
1. Our Opportunity

The quest for a more student centered program
Changes toward a more student centric curriculum over time

2009
Teacher created models embedded in notes

2010
Use models to generate patterns, relationships, and construct other understandings

2011
Textbook curriculum that allowed students to construct their learning; still too teacher centric and worksheet driven.

2012
Student centered modeling construction with traditional units
Changes toward a more student centric curriculum over time

Late 2011 to present

MSU CREATE Interactions Curriculum - 9th grade Physical Science Classes

2013

2016 to present

MSU PIRE Creating Optimal Learning Moments in Science Pilot- Chemistry Classes 2017
2. Our Current Curriculum
Our current curriculum - Be good at something!!

Physical Science
1 semester - 81 mins/day
4 Units (*We only get to 2-3*)

Chemistry
1 semester, 81 min classes
5 PBL units
Key features of our PBL units

1. Start with a driving question
2. Focus on learning goals
3. Exploration of the DQ through scientific practices
4. Involve collaboration to solve problems
5. Students are scaffolded with learning technologies
6. Students create a tangible product or artifact

(Blumenfeld et al., 1991; Krajcik & Czerniak, 2013; Krajcik & Shin, 2014)
Driving questions and anchoring phenomena stimulate students to ask questions relevant to them; these questions lead to activities that allow them to test their predictions.
EXAMPLES OF UNIT DRIVING QUESTIONS

➢ “Why do some things stick together when they come out of the dryer?”

➢ “How can a small spark start a huge explosion?”

➢ “Why am I colder when I’m wet than when I’m dry?”

➢ “Why is table salt safe to eat, but the substances that form it are explosive/toxic?”
Asking relevant questions

- What do the substances charge to?
- What happens to the structures of the molecules?
- Why does the ink make the paper wrinkle like water normally does?
- Why were there no left overs when we burned the flash paper?
- What Chemicals burn easily?
- If we used a different substance to write the message, would it turn a different color once we sprayed it?
- What causes make the ink visible, and how?
Students testing their ideas

Students design and conduct an experiment to answer the question, “What is produced in a combustion reaction?“
Turn a demo into a lesson to answer a question.

A lesson from the CMA unit: “How can I optimize the amount of product formed”
Unit 1 - Electrostatics (HS-PS3-5)

- **DQ:** Why do some things stick together when they come out of the dryer?
  - Charges and how they interact
  - Particle nature of matter
  - Atomic Models and their connection with how things become charged
Unit 2 - Chemical Reactions and Energy (HS-PS1-4)

- **DQ:** How can a small spark start a huge explosion?
  - Energy Transfer and Conversion
  - Potential Energy
  - Chemical Bonds and Reactions
Unit 3 - Emergent properties due to intermolecular forces (HS-PS1-3)

- **DQ:** What Powers a Hurricane?
  - Potential Energy and Intermolecular Forces
  - Latent heat, Boiling Point, Viscosity
  - Polar vs. Non-Polar
Modeling - Gives students a chance to tell their story

Revisions of model throughout a unit provide a window into student’s processing:

- Initial model to elicit background knowledge
- Mid unit model to formatively assess new learning
- Final model as a summative and apply to a new situation
In the first picture the pie pans are just set on the machine but in the second picture, when the machine is on, the pie pans fly in the air because the belt inside the machine makes static electricity and the static makes the pans fly off the machine.
Reflection: In my first model I just drew what I saw and not what was causing the pans reaction. The first model needed explanations and reasoning. In my second model I drew what I saw and what was causing the pans to fly in the air and be brought down to the floor.
Reflection: I know that objects become charged when they bump each other, when friction is generated, and when two things pull apart. When the pie pans touched the Van de Graaff they developed the same charge. The pans flew off the Van de Graaff because they had similar charges.
Reflection: In my most recent model I showed what charge the atom was and how it had both electrons and protons and it wasn’t just a charge. My picture also showed how for a split second the pans and VDG attracted. It showed the correct way that the objects attract.
Before the pie pans start to fly off (Van de Graaff is on)

As the pans are flying off

After the pans have flown off

Energy graphs

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<th>PE</th>
<th>KE</th>
<th>Total</th>
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Showing Growth / Learning

- **Student Portfolios** -
  - Running record of specific models AND students’ reflection in Google Classroom. *(Done by the students)*
  - Simplifies how to show growth to parents, board members, administration, other teachers, etc.
Apply to something new??

1) - Negative charge
0 - Neutral charge

2) Can #2 has a stronger charge and pulls the can to the can. Can #2 has a positive charge. Can #1 is neutral. The ball bouncing from can to can.

3) Can #2 - Negative charge
Can #1 - Neutral charge
Ball - Negative charge.

4) Can #2 - Negative charge
Can #1 - Neutral charge
Ball - Neutral charge.

VDG is negative. Can #1 is negatively charged. Can #2 is neutral. The ball repelled Can #1 and pulled Can #2 negative to Can #1.
Collaborative discussion in a non-judgemental culture allows all students to engage in the sense making process; the class works as a team to piece the story together.
Student Feedback

Warm Colors
“I Like...”

Cool Colors
“Constructive Feedback”
Class “Board Meeting” to communicate and clarify thinking
Final Models

AFTER

CLOTHES IN THE DRYER!

BEFORE

The clothes are hung up to dry. The clothes get cleaned in the washer. After the clothes are cleaned, they are hung up to dry. The clothes need to be checked on, so they won't shrink or wrinkle. Not every cloth.
Final Models

Step 1: The clothes are neutral after being washed. They're moved to the dryer.

Step 2: The dryer is loaded with the clothes and is turned on.

Step 3: The clothes are transferring to the dryer. During this loading, the cotton begins to heat up.

Step 4: The socks that are in the dryer are transferring electrons. Proton 2 is negative and 1 sock positive.

Step 5: The socks are stuck together because they are now opposite charges.
Physical Science Target PE’s

- **HS-PS3-5.** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

- **HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

- **HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).

- **HS-PS1-4.** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
## Performance Expectation Overlaps

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<thead>
<tr>
<th>Unit</th>
<th>PS1-2 Chem Rxns</th>
<th>PS1-3 Structure/Electrical Forces</th>
<th>PS3-2 Energy/Particles</th>
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<tbody>
<tr>
<td>What are Stars</td>
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<td>Evaporative Cooling</td>
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<td>Combustion/Energy</td>
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<td>Salt vs Elements</td>
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<td>Conservation. of Mass</td>
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An example of revisions over time

Claim
A fireball is a star made up of various elements, primarily during fusion between hydrogen and helium.

Self Grade
• Components: 3
• Relationships: 3
• Explanations: 4
• System: 4

Evidence
• "Fingerprinting the Stars" taught us to know how different stars have different elements, but also that all stars have Hydrogen and Helium through the absorption spectra.
• The Gas Tubes/Halogen Lights Experiment helped teach us that different stars will give off different light colors because they contain different elements.
• The Article we read is where we learned about the fusion between Hydrogen and Helium and how that is how stars are formed.

Reasoning
During the "Fingerprinting the Stars" lab, we learned that every star has hydrogen and helium. As the two elements fuse together, it creates a new element and releases energy. This process continues over and over until a star is made. As the star gives off light, at a particle level, when the electron emits energy, within an element of a star, the star gives off energy as the electron jumps back to its ground state.
The Difference

Regardless or where they are...they are interested, working and **ASKING QUESTIONS**!!!
3. What does the data suggest?
First Week of Chemistry - September 2017

- The match is the kinetic push for the explosion.
- When the explosion happens, the thermal energy transfers to the atmosphere and it.

The energy of the explosion comes from the ignition. The atoms with the bond transfer its energy to the bond, and the bond breaks. And the bond breaks.

Boom
Results from 3 yrs of the PIRE pilot at our school

“Students at HC were 33% more likely to have an OLM when modeling compared to other times.”

C. Klager
MSU research data supports that student engagement has increased

- Students used their imaginations and solved problems with multiple solutions more during the PBL intervention
- Not only does PBL encourage teachers to use scientific practices, but those practices increase students’ use of creative thinking and problem-solving

(Klager, C. and Marjanen, J.)
4. Final Thoughts
THIS SCHOOL YEAR AND BEYOND

Biology embedded student centered modeling; slowly adding driving questions to frame units

Addition of MSS Earth Science course to the department

2017

2018

2020

2109

All core classes have placed student centered modeling as a main learning process
Students draw from previous understandings of DCIs as they progress from unit to unit.
Alignment Across Disciplines

- Physical Science
- SEP/CCC
- Earth and Space Science
- Life Science
Potential Pitfalls - *Not like our science classes*

- Not a “Right” or “Wrong” answer class.
  - We are constantly asking students what the data tells them

- **MUST** create a “Safe” class

- Must be able to adapt during class
  - Some pre-lab work
  - Some in the lab
  - Some post-lab work
Slow down so students can learn more.

Engaged Students
The focus on their story cuts down on disruptions and inattention, leading to more time on task.

Easy to differentiate
Students come in at various levels, but the large achievement gap is reduced.

Unit-Unit Alignment
Cross cutting concepts and science and engineering practices help students make connections between units.

Course-Course Alignment
Cross cutting concepts and science and engineering practices help students make connections between courses.
Learning through a story helps me remember the concepts better, especially at the end of a unit or course - student comment
CREDITS

Our research and participation was made possible by our amazing learning community of people from

- MSU CREATE Interactions Project
- MSU CREATE PIRE Project
- Harper Creek Community Schools, especially the students
THANKS!

Any questions?

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SCHECH # 17610