Ambitious Science Teaching: Modeling to Learn
Welcome!

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“Ambitious teaching deliberately aims to support students of all backgrounds to deeply understand science ideas, participate in the activities of the discipline, and solve authentic problems.”
Disclaimer

I’m no expert!
Intellectual Engagement

1. Planning for engagement with important science ideas
2. Eliciting students’ ideas
3. Supporting ongoing changes in thinking
4. Pressing for evidence-based explanations

Attention to Equity
Intellectual Engagement

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Attention to Equity

Modeling
What are models?

A scientific model is a representation of a system or a phenomenon.
Original drawing of DNA by Francis Crick and conceptual model today
What are models?

- Drawings
- Diagrams
- Flow charts
- Equations
- Graphs
- Computer simulations
- Physical replicas
What are models?

✘ Drawings
✘ Diagrams
✘ Flow charts
✘ Equations
✘ Graphs
✘ Computer simulations
✘ Physical replicas

BUT
not all of these are appropriate for modeling in the classroom!
What is modeling?

“...the process by which scientists represent ideas about the natural world... and then collaboratively make changes to these representations over time in response to new evidence and understandings.”
Modeling is closely related to other scientific practices

- Asking Questions & Defining Problems
- Analyzing & Interpreting Data
- Arguing with Evidence
- Evaluating & Communicating Information
- Designing & Carrying out Investigations
- Using Mathematical Thinking

Explanation

Modeling
Modeling is closely related to other scientific practices:

- Asking Questions & Defining Problems
- Analyzing & Interpreting Data
- Arguing with Evidence
- Evaluating & Communicating Information
- Designing & Carrying out Investigations
- Using Mathematical Thinking
- Building Knowledge
More than just posterizing established ideas already found in textbooks
construct  test  evaluate  revise
“It is during these kinds of work that students see the need to learn new science ideas, to reason about how ideas and events are related, to argue about evidence, and to monitor their own thinking along the way.”
Five qualities of models make them useful for modeling in science classrooms
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1. They represent an event or phenomenon rather than things.
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2. The phenomenon should be context-rich, meaning that it is about a specific event that happens in a specific place and time under specific conditions
Five qualities of models make them useful for modeling in science classrooms

1. Represent an event or phenomenon rather than things
2. The phenomenon should be context-rich.
3. It helps if students’ models are pictorial, meaning that there is some visual resemblance between the representations on paper and the process or event being modeled.
What are models?

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- Diagrams
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- Equations
- Graphs
- Computer simulations
- Physical replicas
Five qualities of models make them useful for modeling in science classrooms

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2. The phenomenon should be context-rich.
3. It helps if students’ models are pictorial.
4. The representations include both observable and unobservable features
Five qualities of models make them useful for modeling in science classrooms

1. Represent an event or phenomenon rather than things.
2. The phenomenon should be context-rich.
3. It helps if students’ models are pictorial.
4. The representations include both observable and unobservable features.
5. They are revisable.
Questions?
What does modeling look like in the classroom?
Kindergarten consensus model of forces and motion on playground slide
AP Chemistry model by a pair of students on heat transfer
Third grade sound unit

Teacher planning:
- Prioritize the science ideas in the curriculum
- Select an anchoring event: Singer breaking glass
- Create model and explanation yourself
- Line up activities and readings with what's needed in the final explanation

Day 1
- Ellicit ideas about anchoring event
- Students hypothesise, draw initial models

Days 2 and 3
- Ideas: Sound as waves
- Activity: Soccer ball experiment

Days 4 and 5
- Ideas: How does force relate to volume?
- Activity: Tuning fork activity

Day 6
Student revise models and add to explanations: critique models of others based on new ideas, evidence

Days 7
- Ideas: Making, sensing sounds with the body
- Activity: Vocal cord and eardrum readings

Days 8 and 9
- Ideas: Sound travelling through media
- Activity: Observations of sound in air, through solids

Days 10 and 11
- Ideas: Resonance and frequency
- Activity: Video and activity with humming

Day 12
- Preparing in small groups for final explanations, revising models, commenting on models of others
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What did we notice about this unit of study?
Sophomore unit on ecosystems

Day 1
- Eliciting ideas about anchoring event
- Students hypothesize, draw initial models

Days 2 and 3
- Ideas: Biotic and abiotic factors in ecosystem
  - Activity: Carrying capacity game

Days 4 and 5
- Ideas: Trophic levels and energy flow
  - Activity: Simulation of energy transfers

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- Ideas: Nutrient cycling in an ecosystem
  - Activity: Readings on carbon and nitrogen cycles

Days 9 and 10
- Ideas: Food webs and predators
  - Activity: Making food webs for arboreal forest

Days 11 and 12
- Ideas: Birthrates of hares and lynx, how plants respond to overgrazing
  - Activity: Reading research data on plants under stress and effects on young hares

Day 13
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Teacher planning:
- Unpack the science ideas in the curriculum
- Select an anchoring event or process
- Create models and explanation yourself
- Line up activities and readings with what is needed in the final explanation.
Sophomore unit on ecosystems

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My new explanation is different from my original
hypothesis because I took away the presence of a
poacher. I added the quality of the hare's food and
how that affected reproduction rate, and I
added the flow of energy.

I revised my idea of a poacher, because human
interference is a density-independent limiting factor,
meaning that it can affect the population of hares at
anytime. It seemed unlikely that every year
poachers would start hunting and then stop.
I added food quality. I learned that when
the hare population is high, and there are more
other hares eating plants, the hare
will start to make changes in the
amount of food available. I added the
hare's reproduction rate, because I learned that
the hare gets 10% of the
amount of food available.
Questions?
My experience with modeling
Day 1

1. Model Image with Prompt
2. Watch Video
3. Individual thinking
4. Group Discussion
5. Create Group Models
6. Class Discussion & Create Class Model
7. Compile List of Questions
What are the different pushes and pulls acting on the rocket before, during, and after launch?
Consensus Model: 1st Iteration
**BEFORE**

The forces of the rocket are balanced. No forces acting on the rocket so it is stationary.

\[ \text{\( \uparrow FN \) \( \downarrow Fg \) \( \uparrow Fg \) \( \downarrow FN \)} \]

**DURING**

The rocket boosters are applying a force on the rocket that is causing it to accelerate upwards.

\[ \text{\( \uparrow \text{F\text{lift}} \) \( \downarrow \text{Fg} \) \( \uparrow \text{Fg} \) \( \downarrow \text{F\text{lift}} \)} \]

**AFTER**

No more rocket boosters so the rocket is not accelerating anymore.

MODEL: ITERATION # 2
BEFORE

Static Friction from holder thing

F

Normal Force pushing against rocket from ground

wind

fuel is stored energy

Fg

Weight-force due to gravity: pulling towards earth

DURING

bigger arrow shows more force in direction of thrust

thrust pushing against weight

Fuel is converted to kinetic energy

Fair air resistance as it shoots through the air

Fuel

Still weight Fg

AFTER

Suborbital launch:
Boosters are off-
Traveling at a constant speed for a bit
Then starts accelerating towards Earth due to gravity

Rocket release: not visible

MODEL: ITERATION #3
What went well...

✘ Picked a good video
What went well...

✘ Picked a good video
✘ Student discussion
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✘ Final iterations looked good
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What I learned...

✗ Create a model myself
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Questions?
Advice from AST Teachers

The unseen is vital
Always ask students to draw both observable and unobservable features. The exception here might be the initial models of early elementary students, where most of the features are accessible to observation or measurement.
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Have students produce representations that show how the event or processes change over time, for example in “before-during-after” panels.
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How will we draw?
Agreement about drawing conventions is important. Have a conversation about how the class should represent certain ideas, so that everyone understands each other’s drawings.
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Avoid model fatigue
Have students change the model only once or twice in the middle of the unit, not every other day. They will get “model fatigue” if you go back to the drawings too often.
Advice from AST Teachers

Multi-modal communication

✗ Writing + drawing is really important.
✗ Many English Language Learners will be particularly helped by the drawing aspects of modeling.
✗ Everyone needs help in writing full explanations.
✗ Students also need assistance in writing about *how evidence supports their explanatory models*.
✗ Give kids “practice” time for this type of writing and consider scaffolds for these activities as well.
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- ✗ Give kids “practice” time for this type of writing and consider scaffolds for these activities as well.

#### Can’t do it all
- ✗ The phenomenon cannot be the anchor for all the ideas one needs to teach in a unit of instruction.
- ✗ But it can tie together most of the major ideas.
- ✗ You will have to have some lessons that are not directly tied to the anchoring phenomenon in order to meet the demands of your curriculum and standards.
Brainstorm!

PLAN YOUR NEXT UNIT!

How can you incorporate modeling in your next unit?
THANKS!

What questions do you have?

You can find me at

× @ORandPhysics
× RhiannaORand@gcisd.net

Please fill out the review survey on Sched!
Big concept

Bring the attention of your audience over a key concept using icons or illustrations
White
Is the color of milk and fresh snow, the color produced by the combination of all the colors of the visible spectrum.

Black
Is the color of coal, ebony, and of outer space. It is the darkest color, the result of the absence of or complete absorption of light.
<table>
<thead>
<tr>
<th>Yellow</th>
<th>Blue</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the color of gold, butter and ripe lemons. In the spectrum of visible light, yellow is found between green and orange.</td>
<td>Is the colour of the clear sky and the deep sea. It is located between violet and green on the optical spectrum.</td>
<td>Is the color of blood, and because of this it has historically been associated with sacrifice, danger and courage.</td>
</tr>
</tbody>
</table>
A complex idea can be conveyed with just a single still image, namely making it possible to absorb large amounts of data quickly.
Want big impact? Use big image.
Use charts to explain your ideas
And tables to compare data

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>10</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Blue</td>
<td>30</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Orange</td>
<td>5</td>
<td>24</td>
<td>16</td>
</tr>
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</table>
89,526,124

Whoa! That’s a big number, aren’t you proud?
That’s a lot of money

185,244 users

Total success!
Our process is easy

first

second

last
Let’s review some concepts

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Is the color of gold, butter and ripe lemons. In the spectrum of visible light, yellow is found between green and orange.

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You can copy & paste graphs from Google Sheets
Android Project

Show and explain your web, app or software projects using these gadget templates.
iPhone Project

Show and explain your web, app or software projects using these gadget templates.
Show and explain your web, app or software projects using these gadget templates.
Desktop Project

Show and explain your web, app or software projects using these gadget templates.

Place your screenshot here
THANKS!

Any questions?
You can find me at
	✓ @username
	✓ user@mail.me
Credits

Special thanks to all the people who made and released these awesome resources for free:

✘ Presentation template by SlidesCarnival
✘ Photographs by Unsplash
Presentation design

This presentation uses the following typographies and colors:

✘ Titles: Sniglet
✘ Body copy: Dosis

You can download the fonts on these pages:

https://www.fontsquirrel.com/fonts/dosis
https://www.fontsquirrel.com/fonts/sniglet

✘ Gray #3d4965
✘ Dark cornflower blue #3c78d8

You don’t need to keep this slide in your presentation. It’s only here to serve you as a design guide if you need to create new slides or download the fonts to edit the presentation in PowerPoint®.
Extra resources

\[ \sqrt{2} \quad E = mc^2 \quad H_2O \]
SlidesCarnival icons are editable shapes. This means that you can:
- Resize them without losing quality.
- Change fill color and opacity.

Isn’t that nice? :) 

Examples:
Now you can use any emoji as an icon!
And of course it resizes without losing quality and you can change the color.

How? Follow Google instructions https://twitter.com/googledocs/status/730087240156643328

and many more...