Investigating the relationship between scientific modeling and content knowledge development
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Results
We did not find significant gains in students’ reflection of nature and purpose of modeling. At the end of the unit, the majority of students remained at level 1 or 2.

Written assessment Question 4: Why do you think the two drawings are called models? (Nature of models)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Pretest (%)</th>
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<tbody>
<tr>
<td>2</td>
<td>Students view models as tools to support their own thinking</td>
<td>70</td>
<td>74</td>
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<tr>
<td>1</td>
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Interview Question: What’s the purpose of models?

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Reflection on the purpose and nature of models

Students’ model construction practices generally improved from level 1 to level 2

Written assessment Question 3: Draw a model for a covered and an uncovered cup to explain what happened to the water in the cup.

In the first model of the cup the student just shows the cup and water level. In the second model, there are more unobservable characteristics like the dots in the air and microscopic molecules.

Example responses in each category

Correct: 15
Incorrect: 30

Interview responses at each level

Level 1: Students do not view a model as a tool to generate new knowledge, but to see models as a means of showing others what the phenomenon looks like.
Level 2: Students view models as a means of communicating their understanding of a phenomenon rather than a tool to support their own thinking.
Level 3: Students view models as tools that can support their own thinking.

Qualitative analysis:

• Significant correlation between their gains in reflection on nature and purpose of models and on content knowledge items
• Significant correlation between students’ gains on model construction items and gains of content knowledge items, and between gains for model construction practice items and gains for items on the reflection about nature and purpose of models

Conclusions

• Content knowledge – students made considerable improvement in understanding of evaporation and condensation
• Model construction practice – some students shifted from level 1 to level 2
• Reflection on purpose and nature of models – students remained at level 1 or level 2. Students focused on models as communicative tools rather than face making tools to progress their own thinking.
• Conclusion – students’ reflection on nature and purpose of models was not strongly related to their progress in content knowledge.
• Our Explanation – the curriculum materials and assessment may not have provided enough opportunities to reflect on purpose of nature of models.

Continuing work – We are working in an iterative process to revise assessment and curriculum and test them a second time.

Content knowledge about evaporation and condensation

Students made significant improvement on the pre/post-content-oriented questions.

Written assessment Question 1: After you take a cold Coke can from a refrigerator, you notice that the outside of the can is wet. Your father says that it is wet because the can was sweating, and the Coke inside the can unfreezes. Help others, just understand it more, kind of looking at it, all of it just helped.”

Students’ model construction practices generally improved from level 1 to level 2

Written assessment Question 2: Explain what may happen to a color marker that was left uncovered for a week using one of the model you drew about open or closed cup. (new context)

Example:

Student KP has the most sophisticated understanding of nature and purpose of models among all interviewees. His evaporation model changed tremendously between pre and posttest. His content knowledge also improved tremendously between pre and posttest. His content knowledge also improved tremendously between pre and posttest. His content knowledge also improved tremendously between pre and posttest.

・A scientific model is an abstract, simplified representation of a system of phenomena that makes its central features explicit and visible, and can be used to generate explanations and predictions.

・Scientific modeling includes the elements of the modeling practice (constructing, using, evaluating and refining scientific models) and the meta-modeling knowledge that guides and motivates the practice.

・Reflection of nature and purpose of models include people’s understanding of the nature, utility, and evaluation of models, their understanding of the process of modeling, and how this understanding is used in their reasoning with models.

Learning progression of Scientific Modeling

1. Students construct models that show specific illustrations of a single phenomenon.
2. Students construct models that show several illustrations of a single phenomenon.
3. Students construct models that show several illustrations of different phenomena.

Reflection on the purpose and nature of models

We did not find significant gains in students’ reflection of nature and purpose of modeling. At the end of the unit, the majority of students remained at level 1 or 2.

Written assessment Question 4: Why do you think the two drawings are called models? (Nature of models)

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Project Overview

Research Questions

We are investigating the relationship between scientific modeling practice and the underlying content knowledge. Our research question is:

• How do students’ modeling practices and content knowledge progress when learning science through a model based unit?

Methods

Participiants:
Three teachers in three Michigan public schools piloted our unit: one urban and two suburban schools.
95 fifth grade students from those teachers’ classes.

Curriculum Material:
A 6-week unit centered around model teaching and learning of evaporation and condensation.

Data source:
Students’ post/pre written assessments.
Students’ notebooks.
Thirteen post clinical interviews at the end of the unit.

Data analysis:
An initial coding rubric based on the identified patterns within students’ responses.
Coding a small randomly selected sample of students’ responses using the initial rubric in an iterative process to revise the rubric.
Using the revised coding rubrics to code all responses.
Analyzing students’ written responses both quantitatively and qualitatively.

Learning progression of Scientific Modeling

1. Students construct models that show specific illustrations of a single phenomenon.
2. Students construct models that show several illustrations of a single phenomenon.
3. Students construct models that show several illustrations of different phenomena.

Model construction practices

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