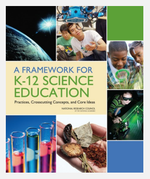
# A Quasi-experimental Study of NGSS Curriculum and PD on Three-dimensional Learning Outcomes

Susan Kowalski, Jeffrey Snowden, Lisa Carey, Betty Stennett, & Lindsey Mohan (BSCS Science Learning)
Heather Young and Catherine Stimac (Oregon Public Broadcasting)

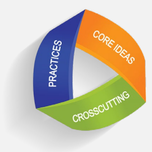
## Next Generation Science Standards (NGSS)




NGSS calls for integration of **curriculum**, **professional development**, and **assessment.**

## Curriculum Designed for NGSS

- Focuses on a central phenomenon
- Coherent storyline from the student perspective (Reiser, 2014)
- Engages students in three dimensions *simultaneously*
  - Science and engineering practices
  - Crosscutting concepts
  - Disciplinary core ideas




## Online Video-based Analysis-of-practice PD

- 50 hours of online PD
  - 2 hour weekly synchronous sessions
  - 3 hours of asynchronous work weekly in the summer
- PD spread across 5 months (summer and fall, 2018)
- Analyze their own and others' videos
- Applied the *Science Teachers Learning from Lesson Analysis,* or **STeLLA** PD model (Roth et al., 2011; Roth et al., 2019; Taylor et al. 2017)

## Distal Three-dimensional Assessment

**Performance Expectation MS-LS1-3**: Use argument supported by evidence for how the body is a system of interacting subsystems composes of groups of cells.

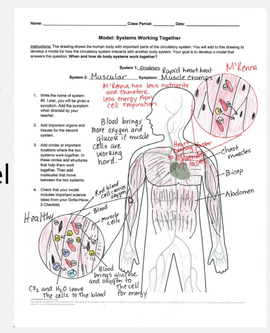
In the unit, students **develop a model explaining how body systems work together.**

On the assessment, students **use their model to and argue from evidence to explain** why some athletic students on a hiking trip in the mountains have sore muscles, and other athletic students don't.

**Phenomenon for Unit**
What's wrong with M'Kenna, and how can symptoms in one part of her body lead to symptoms elsewhere?

**Phenomenon for Assessment**
Why do some athletic students have sore muscles after hiking, and others don't?

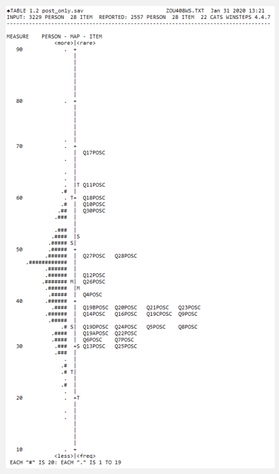
Students develop model to explain M'Kenna's symptoms.




Students apply model to explain hiking at high altitude phenomenon.

**Rasch person measures (scaled to 100 points)**
Person reliability = 0.80
Person separation = 1.98

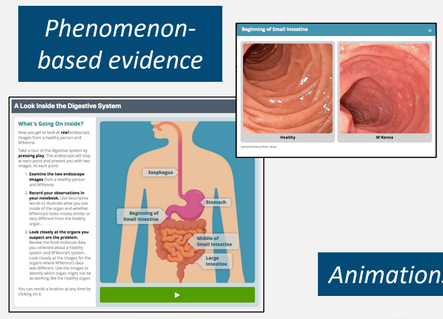
- Person separation is at low end of acceptability.
- Several items provide redundant information, particularly at low end of scale.



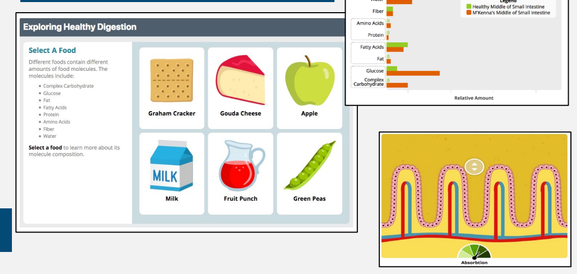

## Media-enhanced digital materials for face-to-face classroom

***A Medical Mystery***
Body Systems Unit for Middle School

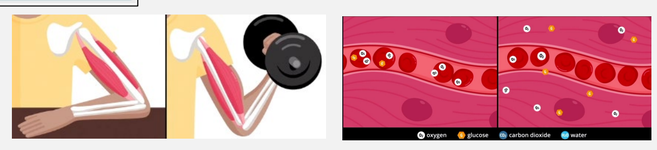
*Phenomenon-based evidence*




*Virtual tools & interactives*




*Animations*




## Research Questions

To what extent does the package of curriculum and PD

1. enhance teacher instructional practice?
2. enhance teacher three-dimensional science content knowledge? and
3. enhance student three-dimensional science achievement on a distal assessment?

## Research Design

| Comparison group | Teacher PD | Treatment group |
|---|---|---|
| Multiple classes/teacher<br>1652 students<br>Business as Usual body systems unit<br>2017-2018 school year<br>pretest/posttest | 30 teachers<br>Summer and Fall 2018<br>pretest/posttest | Multiple classes/teacher<br>1592 students<br>*A Medical Mystery* body systems unit<br>2018-2019 school year<br>pretest/posttest |

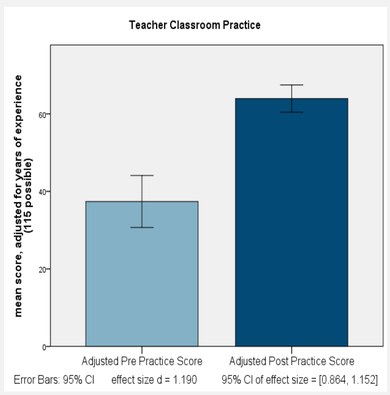
## Analytic Models

**Teacher Model**
- ANCOVA
- Post scores predicted by pre scores and years of teaching experience

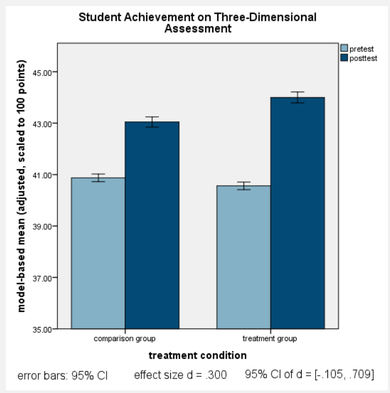
**Student Model**
- Three-level HLM
- Students nested in classes (treatment at class level)
- Classes nested in teacher
- Random slopes for treatment (average treatment effect across teachers)

## Results

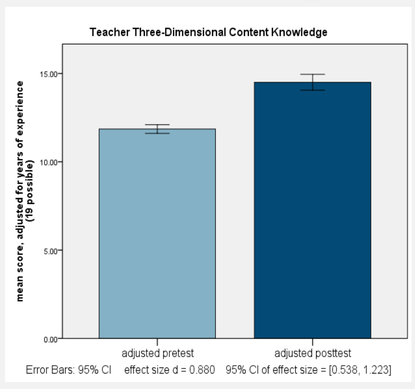
### Sizable changes in teacher practice



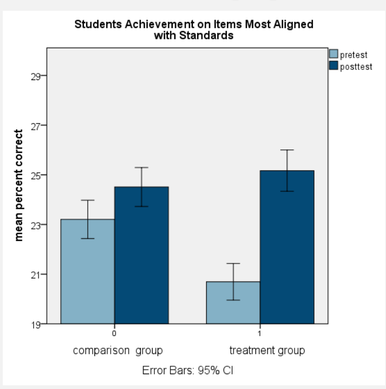

### Modest impact on students




### Modest changes in teacher content knowledge




### Student impact is greatest on most challenging items




## Proof of Concept

- This is the first study that uses a quasi-experimental design to test the theory of action outlined in *A Framework for K-12 Science Education.*
- It is **possible to "move the needle"** on students' three-dimensional learning with an **integration** of
  - curriculum
  - PD, and
  - assessment

## Challenges and Questions

- Effects were relatively small, particularly for students.
- Will a single unit ever show strong changes in three-dimensional learning?
- How will students perform after a full year of NGSS instruction? After multiple years?
- How are other researchers designing units, PD, and assessments? What improvements can be made on this model?

## Limitations

- Teacher practice measured with one video at pretest and one video at posttest. Not clear if changes in practice are durable.
- Quasi-experimental design does not rule out all possible influences on teachers and students.
  - Results may show improvement in outcomes that are to be expected on a year-to-year basis (teachers just getting better naturally over time)
- May be issues with the sensitivity of the assessment in detecting student impacts.
  - Is assessment over-aligned to instruction?
  - Are we seeing an opportunity gap?
  - Is it not sensitive enough to better reveal impacts on students?
  - Assessment with higher person separation would provide greater sensitivity.

## Implications

- We provide initial evidence in support of the theory of action outlined in *A Framework for K-12 Science Education*. More evidence is needed.
- We need additional models of high-quality assessments for NGSS
- Much research remains:
  - Additional units from other developers
  - Alternative assessment structures
  - Head-to-head comparison of units designed to address the same NGSS performance expectations

**Citations**

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