Preparing novices to disrupt traditional science instruction:

Our need for a PRACTICE-BASED VISION of teaching excellence

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Novices can learn practices that make a difference for students’ participation and learning

Family resemblance in practices despite varying circumstances, topics, and students.

- Presenting a complex phenomenon
- Students talking about what they know, experiences they think are relevant
- Negotiating with students how to represent what they think they know (drawn models, list of hypotheses) and their questions
- Upcoming lessons are modified

Have learned how to do similar things—things that matter for learning and participation.

Jordyn Earth Science MS Plate Tectonics
Roberto Physical Science MS Force and Motion
Danny Biology HS Cellular Respiration
Katie Integrated Science HS Chemical Reactions
Over 1500 different teacher preparation programs in U.S.

“Teaching about teaching” varies enormously in quality; shaped by experiences, skills, and worldviews of instructors and cooperating teachers (Adams & Krockover, 1997; Smith & Gess-Newsome, 2004).

No shared vision of how to teach science or science teachers

New teacher educators are individual entrepreneurs, constantly “reinventing the wheel”

My pre-service teachers...

I want them to be very good at 4 things…

1. Planning for engagement with big science ideas
2. Eliciting student ideas and experiences
3. Supporting on-going changes in student thinking
4. Pressing for evidence-based explanations
What do the practices look like?

3

Supporting ongoing changes in student thinking

Framing the activity

Moving among the tables

Making sense as a collective
Particular type of recurring activity that teachers engage in, devoted to planning, enactment, or reflection, intended to support student learning (grain size is an issue)

1. Provides conditions for students’ intellectual work and participation
2. Prototypical sequence of interactions with learners
3. Characteristic talk, tasks, tools
4. Underlying principles that constrain/allow productive variations of practice

Informed by social practice theory (Bourdieu, 1977; Lave, 1988; Reckwitz, 2002)

What counts as a practice?
Goals for children’s science learning in U.S.

Students should be able to:

– understand, use, and interpret scientific explanations of the natural world
– generate and evaluate scientific evidence and explanations
– understand the nature and development of scientific knowledge
– participate productively in scientific practices and discourse

Taking Science to School (NRC, 2007).
What does research say about conditions that lead to rigorous and equitable learning?

1. **ANCHOR LEARNING:** Teachers anchor students’ on-going learning experiences in the press to understand complex and puzzling science phenomena.

2. **USE STUDENTS’ IDEAS AND EXPERIENCES AS RESOURCES:** Students’ everyday ideas, experiences, and questions are treated as resources within the classroom community to advance everyone’s thinking.

3. **AUTHORIZE STUDENTS TO USE SCIENCE PRACTICES FOR A PURPOSE:** Students are apprenticed into using ensembles of scientific practices to test ideas they believe are important to their developing explanations and models.

4. **FOSTER PRODUCTIVE DISCOURSE:** Teachers provide daily opportunities for students to reason through talk.

5. **SCAFFOLD TALK, WRITING, & PARTICIPATION:** Students have access to specialized tools and routines that support their attempts at science-specific forms of writing, talk, and participation in activity.

6. **MAKE THINKING VISIBLE IN ORDER TO “WORK ON IDEAS” TOGETHER:** Student thinking is regularly made public and subject to critique by the classroom community.

7. **BUILD COMPLEX AND CUMULATIVE UNDERSTANDINGS OVER TIME:** Learning experiences are sequenced to help students integrate ideas together and revise understandings of “big science ideas”.

*NO ONE OF THESE IS EFFECTIVE UNLESS COUPLED WITH OTHERS*
Core practices: Pre-service teachers need more than broad principles (i.e. “Foster productive discourse”) or curriculum to guide them.

- Practices function together to support **vision** of science teaching that is currently **uncommon** in classrooms.

1. Planning for engagement with big science ideas
2. Eliciting student ideas and experiences
3. Supporting on-going changes in student thinking
4. Pressing for evidence-based explanations
The “arc” of our tanker unit

1. Eliciting ideas
2. Planning
3. Supporting ongoing changes in student thinking
4. Pressing for evidence-based explanations

Before anything happens

Outside air molecules

Inside air molecules

(More air molecules)

Pressure inside

Cool air molecules

Out of equilibrium

Pressure outside

Critical Point

Outside air molecules

In equilibrium

Critical Point

Pressure inside

Cool air molecules

Pressure outside

Out of equilibrium

After it's steamed

Outside air molecules

Pressure outside

Out of equilibrium

Pressure is gone
Apprenticeship into practices

1. Reading about the practice set

2. Classroom video of experienced teachers

3. Modeling by instructor

4. Co-plan in groups for rehearsal

5. They rehearse, also act as “students” for peers

6. Try out practices in internship setting

7. Whole class analysis and feedback
A comparative study: The uptake of complex practice by novices

- Two groups of first year teachers (Core practices cohorts N=32, Comparison cohort N=13)
- Case studies, used observations 3X year, student artifacts, interviews
- Observed: Opportunities to Learn
  - Framing of tasks by teacher
  - Depth of participation in science practices
  - Conceptual complexity of tasks
  - Responsiveness of teacher to students’ ideas
The 4 criteria for OTL

- Framing of tasks by teacher
- Demand of task, depth of participation in science practices
- Cognitive demand of tasks, conceptual complexity
- Responsiveness of teacher to students’ ideas

Experienced science teachers, national sample

Total

Core practices group 77
Comparison group 39
116 lessons
Experienced science teachers, national sample

Total

Core practices group 77
Comparison group 39
116 lessons
Core practices group  ●  77
Comparison group  □  39

116 lessons
How can a shared vision of instructional excellence help teachers and teacher educators work together to innovate on practice?
Innovation cycles with practitioners

University Researchers

We share with teacher community: “In theory, this set of practices or this tool should work.”

Teacher Colleagues

Teachers send us principled adaptations:
- “We changed X so that more students could participate.”
- “Takes too much time.”
- “We re-invented the tool you gave us.”
Facebook, social media, speeds innovation cycles
Conclusions

- Having a vision of teaching is critical in teacher preparation

- Knowledge becomes social capital, now accumulates in our local system (tools, variations of practices, lessons), and embedded in different parts of the community (among cooperating teachers, cohorts of novices, doctoral students, program instructors).

- Teacher educators are developing shared language and pedagogies across preparation sites centered on “practice.”