Washington State Academy of Sciences
2011 Annual Symposium

# Teaching for Understanding in K-12 Science & Mathematics

Tamara Holmlund Nelson, Ph.D.
Associate Professor, Science Education, College of Education


GAISER MIDDLE SCHOOL


MESA
2005/05/21

# A Shifting Focus

**From Instructional Methods**

- to

**Teaching for Understanding**

- Or “Teaching with Learning in Mind”

# A Shifting Focus

## From "Potential Scientists"

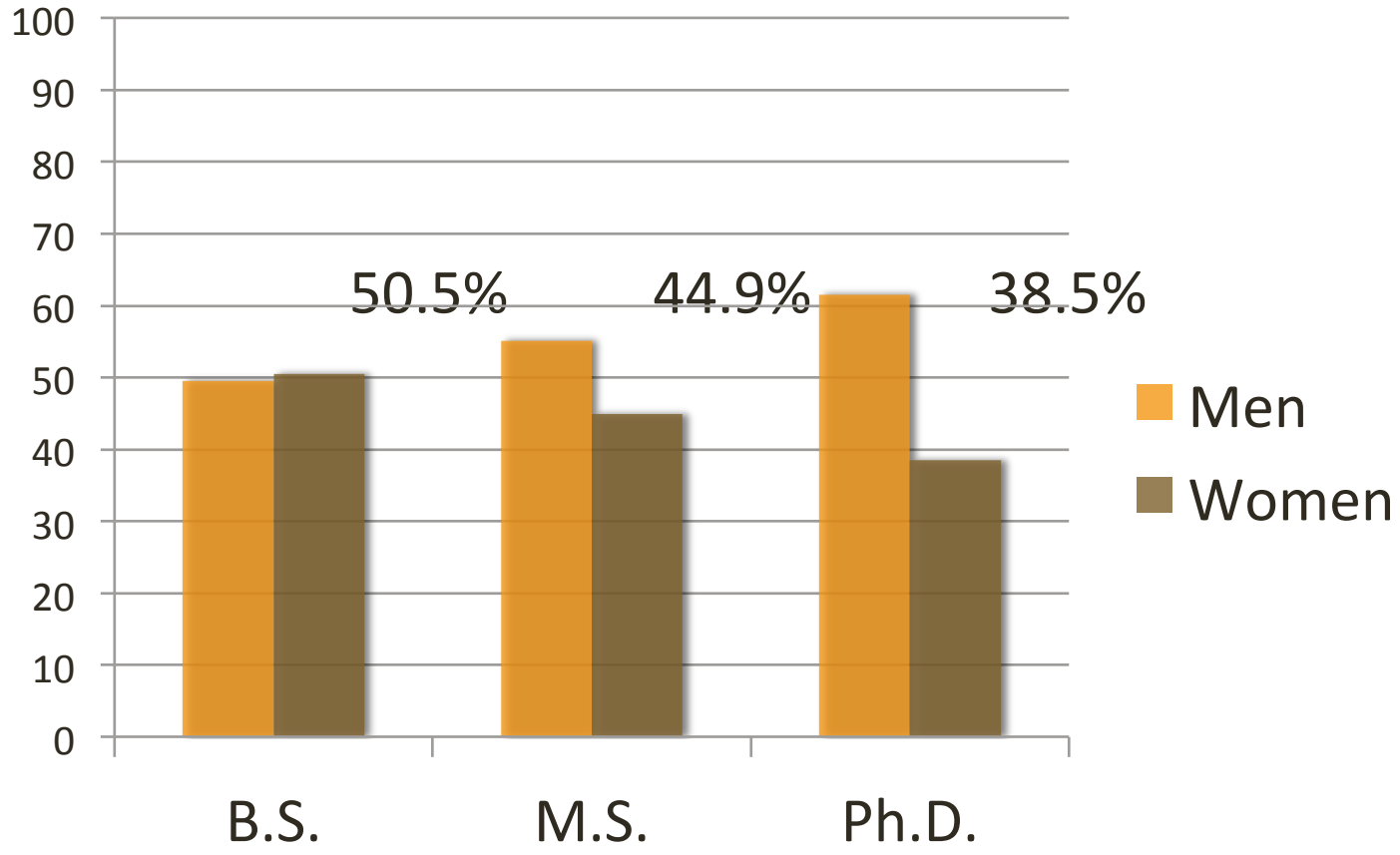
- To

## All Students

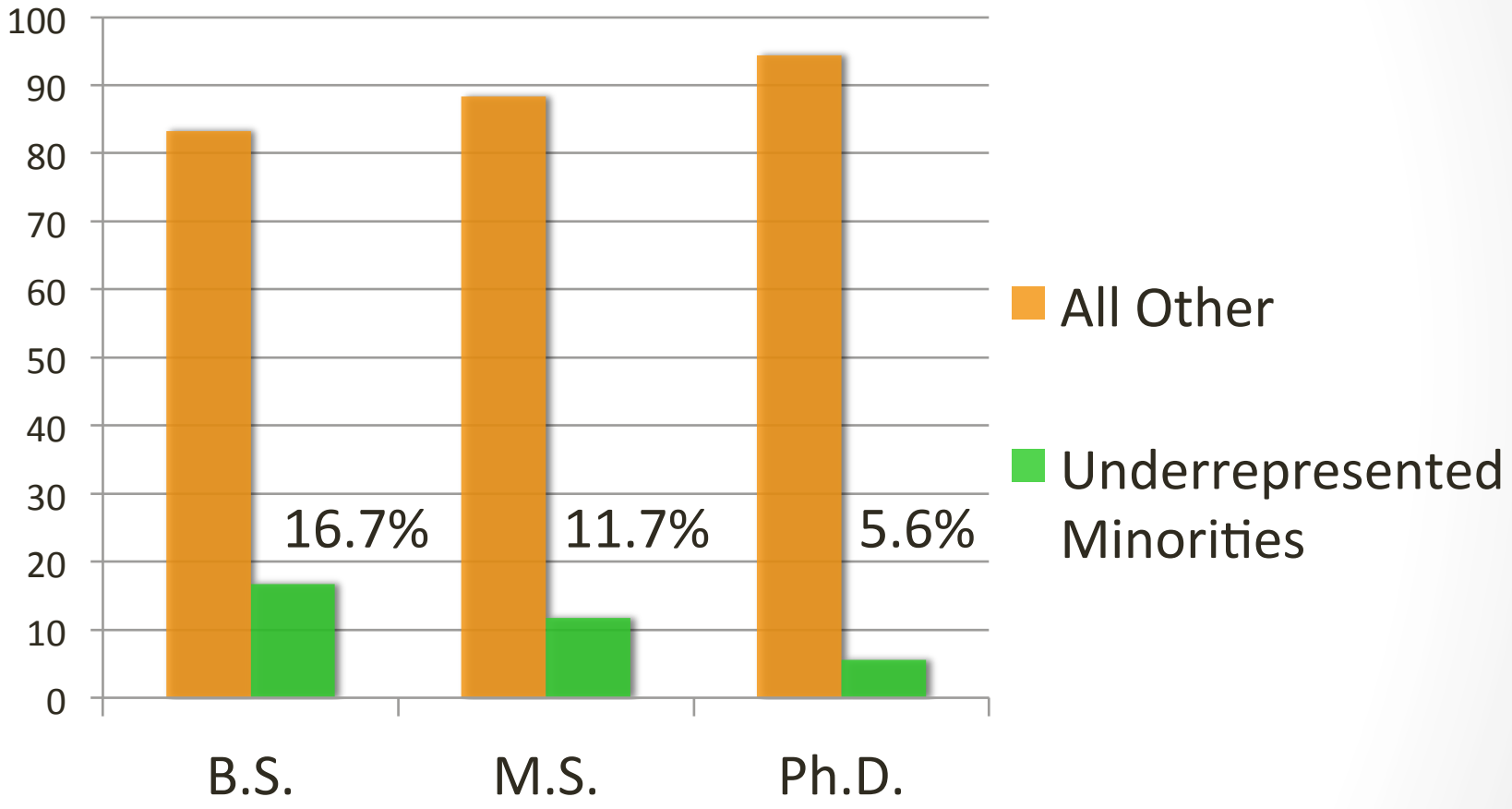
- Other Smart Kids, I Don't Know Kids, Outsiders

# Why Should We Care?

# Degrees across All Science & Engineering Fields: Men vs. Women

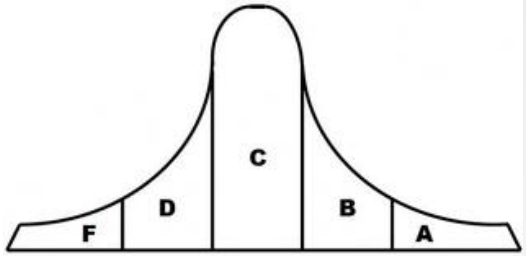


# Degrees across All Science & Engineering Fields: Highly Represented vs. Underrepresented Groups



# Why Should We Care?

"Science, like all professions, needs to reproduce itself nonbiologically. But by seeking attributes and attitudes much like their own, scientists inhibit recruitment from outside familiar channels. From this perspective, the low representation of women as well as racial and ethnic minorities in science may not be the result of social discrimination per se . . . but of too narrow a vision of what kinds of attributes, behaviors and lifestyles the 'true' scientist displays." (Tobias, 1990, p. 11)




**Content**
- Transmitted by

**Teacher**
- More or less creatively to

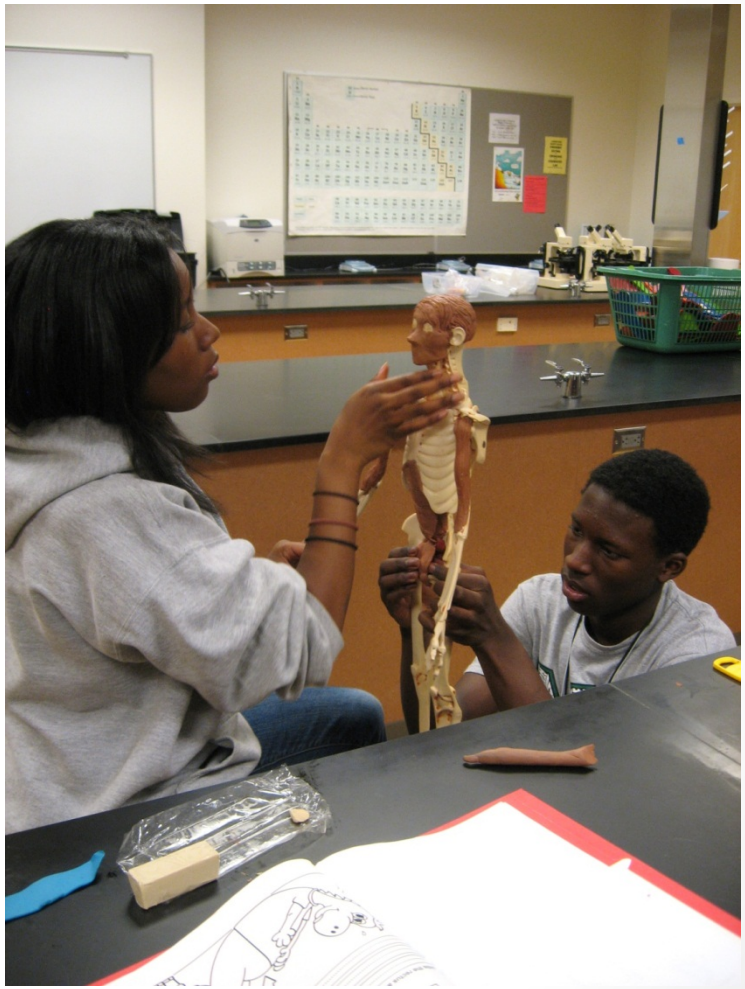
**Student**
- Who has to make sense of it

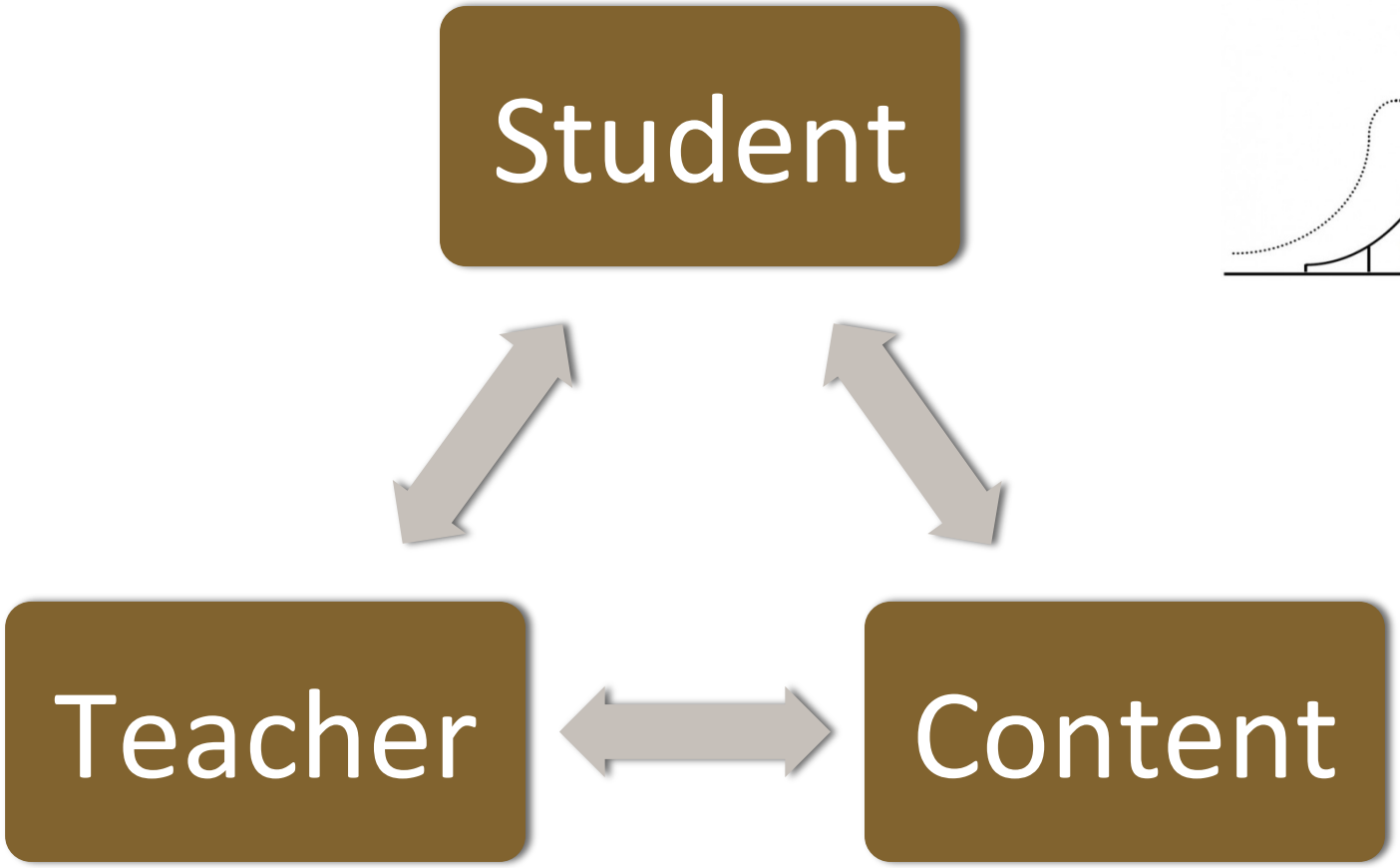
# Transmission Model of Learning

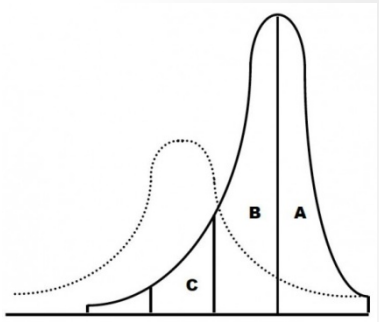
# What “understandings” are we hoping for?

**We have to change the game of school from "Get the Right Answers" to "Work with Others to Investigate Interesting Questions."**

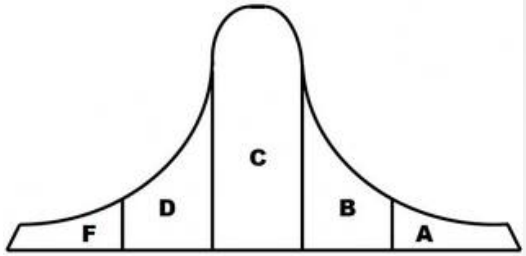
(Ackerly, R. 2011)






# Teaching for Understanding




**Content**
- Transmitted by

**Teacher**
- More or less creatively to

**Student**
- Who has to make sense of it

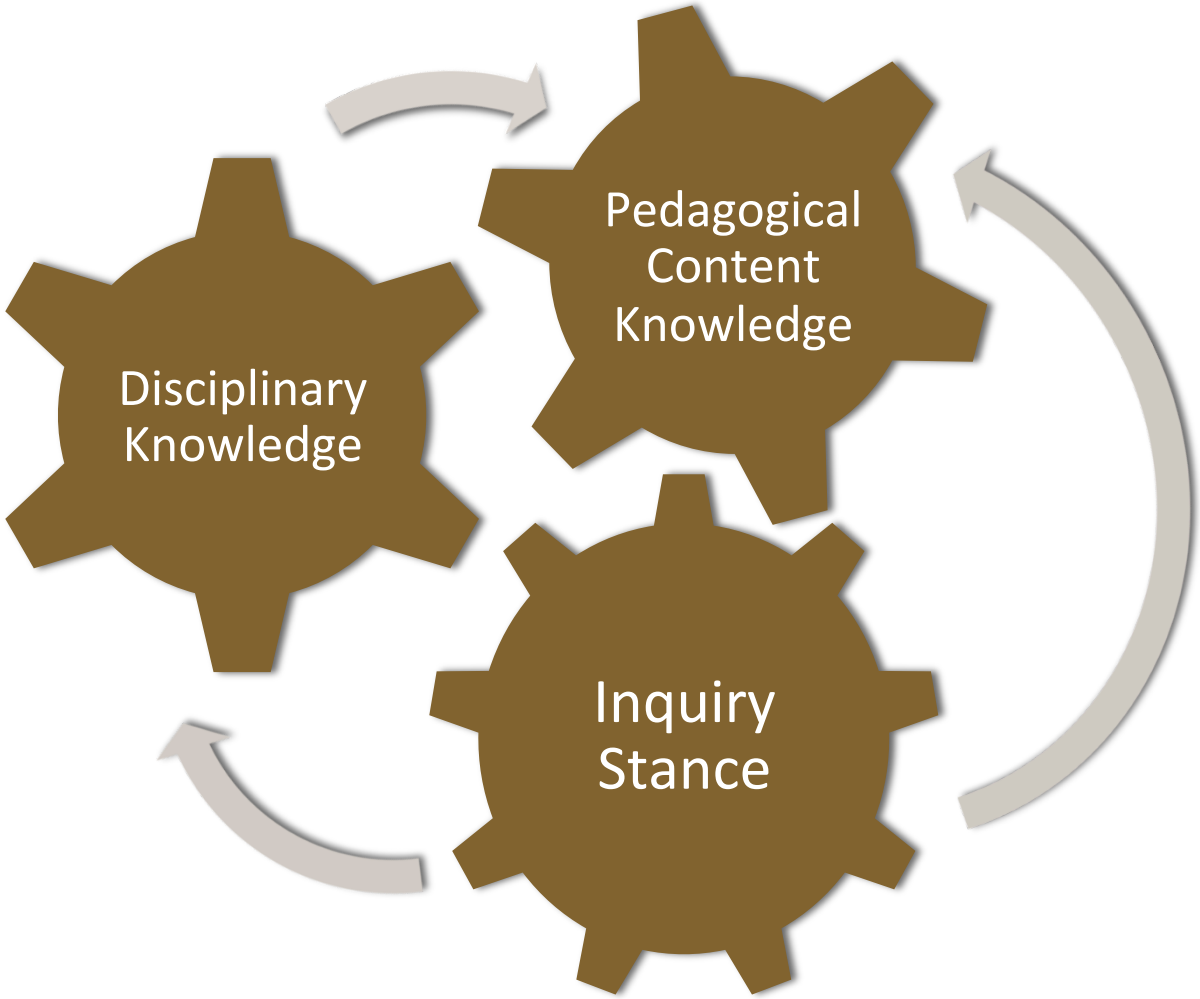
# Transmission Model of Learning

# What understandings are we hoping for?

- Scientific explanations of the natural world
- Scientific evidence and explanations
- The nature and development of scientific knowledge
- Scientific practices and discourse

# What do teachers need to know and do to "Teach for Understanding"?

# Teaching for Understanding



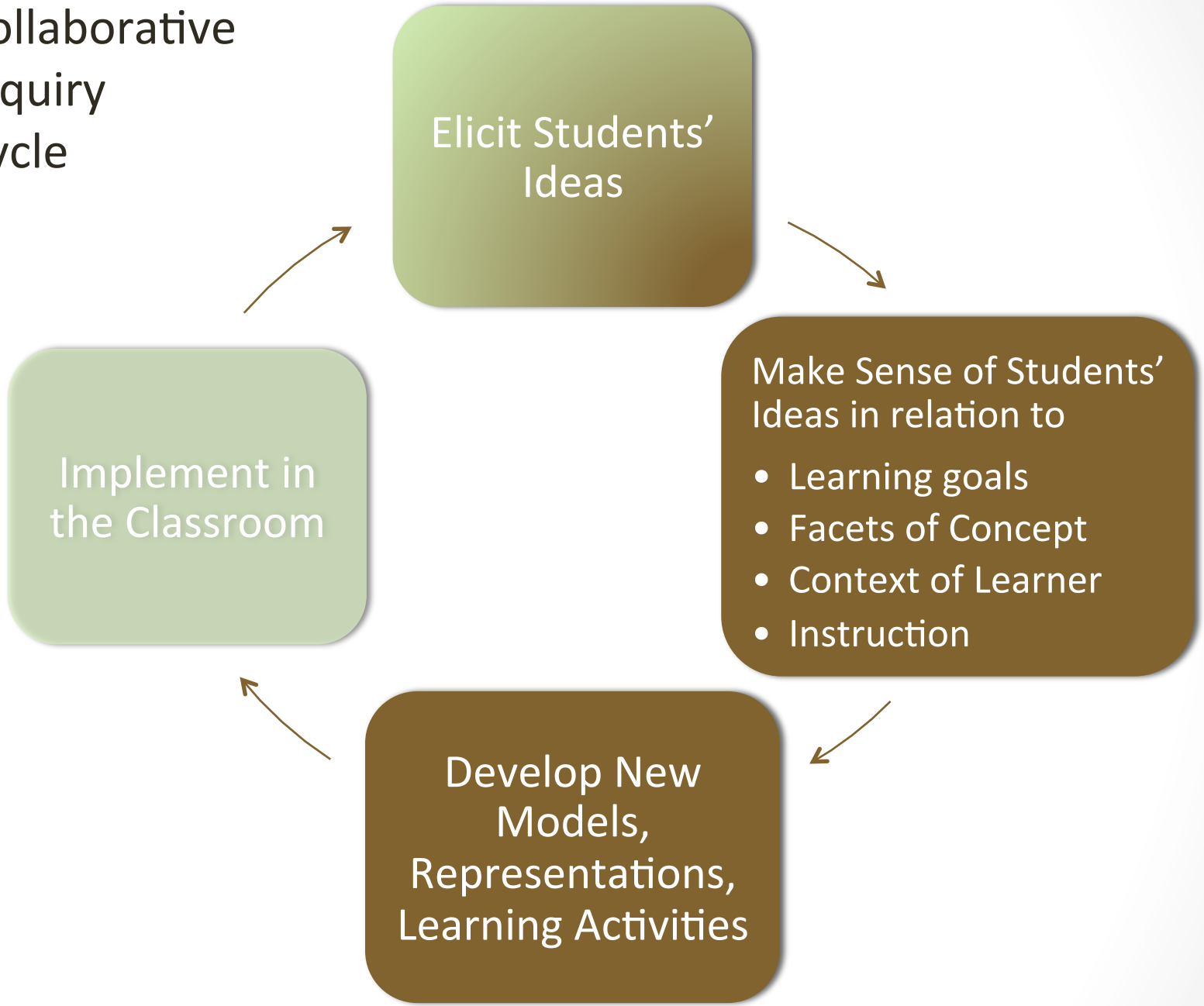
# Disciplinary Knowledge

- Substantive
- Epistemological
- Beyond “what” to “why” and “how”
- Supported by coursework, authentic experiences

# Pedagogical Content Knowledge (PCK)

- Combines disciplinary and teaching knowledge
- Translates disciplinary knowledge for diverse learners
- Supported by experience and reflection

# Collaborative Inquiry Cycle



# Making Sense of Students' Ideas

<u>Anecdotal, no student work present:</u>

Tchr 1: I think kids are understanding their labs a little bit better.

Tchr 2: I agree. Doing it this way seems like I have a lot fewer kids who are just lost. Asking me, "What do I do?" type of thing.

Not so powerful

# Sharing Data – More Powerful

- Tchr 1:  I thought this conclusion was really wordy, I'm looking at it, you can't see a difference, you see all these numbers getting whipped around in there –
- Tchr 2: That one took me a long time to grade.
- Tchr 1: I'm looking at it, I read it over, and I'm like this isn't very good, just because he wrote a lot, it's nice handwriting and he's got some numbers, **you can't tell this kid knew the soil heated up and cooled off faster than the water**. I read this, I'm like this kid didn't get it.
- Tchr 2**: I think he had all the stuff that's required**, **but** yeah, from a standpoint of wording, yeah, there's a lot of fluff in there.
- Tchr 1: When you look at it, it's pretty organized, but when you read it
- Tchr 3: We all agree that **the high and low data needs to be the total temperature change** at the bottom?

# Teaching for Understanding

Links students' understandings to:

- ✓ Learning goals (draws on Disciplinary Knowledge)
- ✓ Instructional practices (draws on PCK)
- ✓ Conceptual framework

Beyond "got it" or "didn't get it"

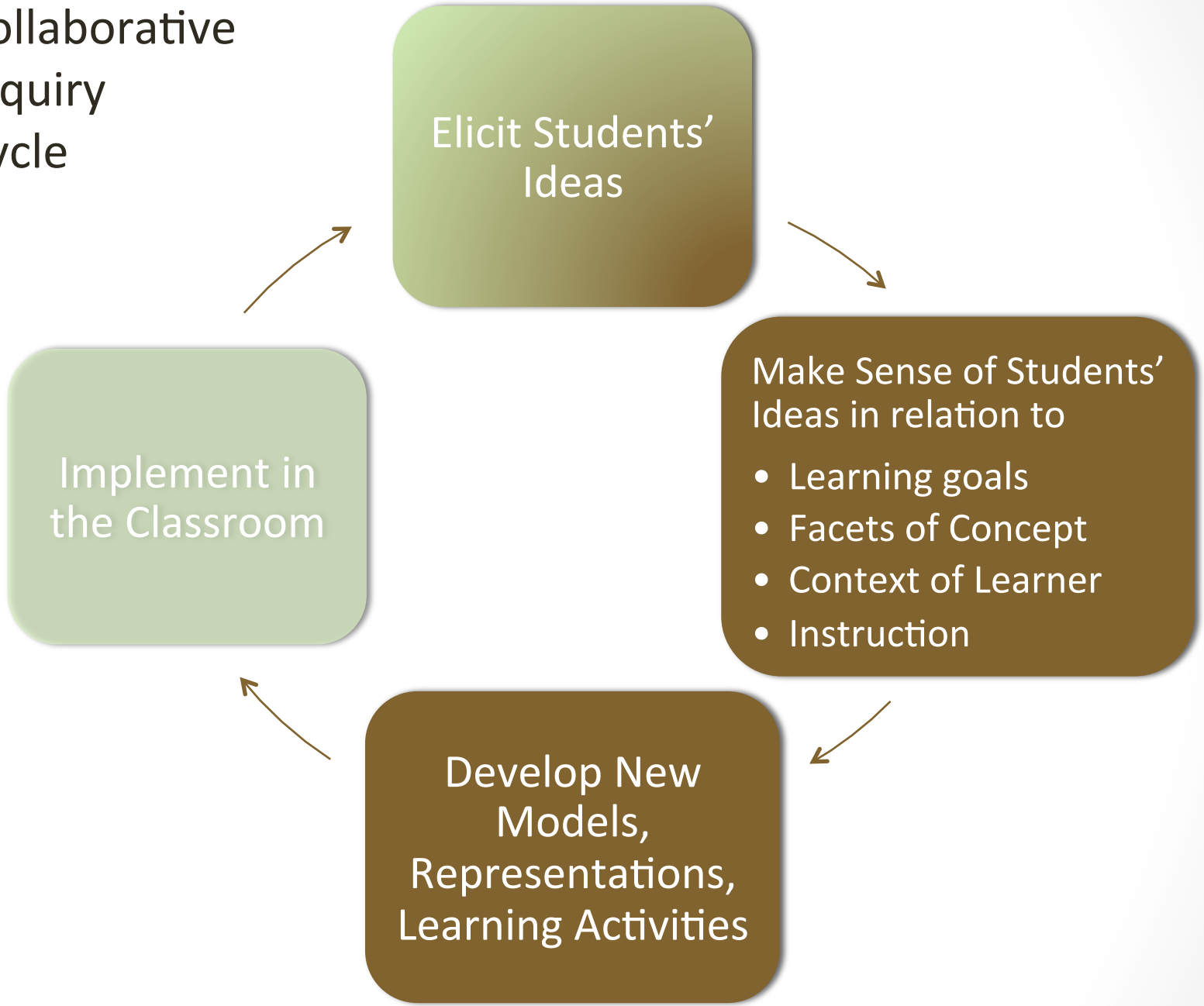
# Why Should We Care?

School science [should] be presented in an everyday context relevant to students [and] represented in an intellectually honest way . . .

[There is] disturbing evidence that traditional school science is actually discouraging bright students from choosing science-and technology-based careers. (Ryan & Aikenhead, 1992)

# What Can We Do?

# Collaborative Inquiry Cycle



## References


Ackerly, R. (retrieved September, 2011). Nine lies about academic achievement that parents and teachers often seem to believe—but don't really. http://bit.ly/jjLkL2

Aikenhead, G. S. (1998). Border crossing: Culture, school science, and assimilation of students. In D. A. Roberts & L. Ostman (Eds.), *Problems of meaning in science curriculum* (pp. 86-100). New York: Teachers College Press.

Aldridge, B. G. (1992). Project on scope, sequence, and coordination: A new synthesis for improving science education. *Journal of Science Education and Technology, 1*(1), 13-21.

American Association for the Advancement of Science. (1990). *Science for all Americans: Project 2061*. New York: Oxford University Press.

Barnett, J., & Hodson, D. (2001). Pedagogical context knowledge: Toward a fuller understanding of what good science teachers know. *Science Education, 85*, 426-453.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school*. Washington, D. C.: National Academy Press.

Costa, V. (1995). When science is "another world": Relationships between worlds of family, friends, school, and science. *Science Education, 79*(3), 313-333.

Darling-Hammond, L., Barron, B., Pearson, P. D., Schoenfeld, A., Stage, E. K., Zimmerman, T. D., et al. (Eds.). (2008). *Powerful learning: What we know about teaching for understanding*. San Francisco: Jossey-Bass.

Darling-Hammond, L., & Sykes, G. (Eds.). (1999). *Teaching as the learning profession: Handbook of policy and practice*. San Francisco: Jossey-Bass.

Donovan, M. S., & Bransford, J. D. (Eds.). (2005). *How students learn: Science in the classroom*. Washington, D. C.: National Academies Press.

## References


Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (Eds.). (2007). *Taking science to school: Learning and teaching science in grades K-8*. Washington, D. C.: National Academies Press.

Lee, E., & Luft, J. A. (2008). Experienced secondary science teachers' representation of pedagogical content knowledge. *International Journal of Science Education, 30*(10), 1343-1363.

MESA (Mathematics, Engineering, Science Achievement). http://depts.washington.edu/mesaweb/

Michaels, S., Shouse, A. W., & Schweingruber, H. A. (2007). *Ready, set, science!: Putting research to work in K-8 science classrooms*: National Academies Press.

Minstrell, J. (2001). The role of the teacher in making sense of classroom experiences and effecting better learning. In D. Klahr & S. M. Carver (Eds.), *Cognition and instruction: Twenty-five years of progress* (pp. 121-150). Mahwah, NJ: Lawrence Erlbaum Associates.

Nelson, T. H. (2009). Teachers' collaborative inquiry and professional growth: Should we be optimistic? *Science Education, 93*(3), 548-580.

Nelson, T. H., Kennedy, A., Deuel, A., & Slavit, D. (2009). The influence of standards and high-stakes test-related documents on teachers' collaborative inquiry. In D. Slavit, T. H. Nelson & A. Kennedy (Eds.), *Perspectives on supported collaborative teacher inquiry*. New York: Routledge.

Nelson, T. H., Slavit, D., & Deuel, A. F. (2012). Two dimensions of an inquiry stance toward student learning data. *Teachers College Record, 114*(8).

Otero, V. K. (2006). Moving beyond the "get it or don't" conception of formative assessment. *Journal of Teacher Education, 57*(3), 247-255.

Roberts, D. A., & Ostman, L. (Eds.). (1998). *Problems of meaning in science curriculum*. New York: Teachers College Press.

Tobias, S. (1990). *They're not dumb, they're different: Stalking the second tier*. Tucson, Arizona: Research Corporation.

Weiss, I. R., Pasley, J. D., Smith, P. S., Banilower, E. R., & Heck, D. J. (2003). *Looking inside the classroom: A study of k-12 mathematics and science education in the United States*. Chapel Hill, NC: Horizon Research.

Wineburg, S. (1997). Beyond "breadth and depth": Subject matter knowledge and assessment. *Theory into Practice, 36*(4), 255-261.