Cognitive, Affective and Behavioral Changes in K-8 Science Teaching

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Context and Research Questions

- K-8 teachers (*N*=17) enrolled in a 3-year cohort masters' program (Physical Science Initiative, PSI) at an urban, private university in a program that focused on physical science, and which also offered a middle-school physical science endorsement
- How do K-8 teachers' attitudes toward teaching physical science inquiry-based develop over time?
- If attitudes change, then are such attitudinal changes reflected in observable teaching practice?

Attitudes

- Precursor or antecedent condition of behavioral intent and subsequent behavioral change (Bagozzi & Burnkrant, 1979; Butler, 1999; McGuire, 1985; Crawley & Coe, 1990; Crawley & Koballa, 1994; Reid, 2006; Nieswandt, 2005).

- A complex theoretical construct combining three different components:
  - cognitive
  - affective and
  - behavioral

  (Bagozzi & Burnkrant, 1979; McGuire, 1985).

Attitudes

Cognitive component

- Perceptions of knowledge about an object as well as the beliefs and ideas about the object.

In our study:

- Participants' perceptions of their content knowledge in the area of physical science and inquiry-based teaching, and
- their beliefs about their physical science content knowledge and inquiry-based teaching – whether they believe that they have and can develop content knowledge and the ability to teach inquiry-based science.

Attitudes

Affective component

- Feelings about the object, whether a person likes or dislikes it.

In our study:

- All participants voluntarily enrolled in the program; assumption: they liked physical science in general and well enough to learn more about it at the beginning of the program
- But do they also like to teach it in their classes?

Attitudes

Behavioral component

- Tendency towards action with respect to the object; perceptions towards a particular behavior.

In our study:

- Participants' perceptions about teaching physical science inquiry-based as well as their self-confidence in physical science content knowledge
- If circumstances and contexts are appropriate, such perceptions result in the expected behavior – evident in participants' teaching practice (Butler, 1999; Crawley & Coe, 1990; Crawley & Koballa, 1994)

Attitude Research in Science Education

- Long history with a focused tendency toward the cognitive component (for an overview of research see Reid, 2006; Nieswandt, 2005).
- Our study goes beyond this research by
  - providing a more in-depth look at all three components of attitudes
- Thus, offering an opportunity to detect perceptual similarities and discrepancies across these components while tying these perceptions to behavioral intent and subsequent classroom practices.

Research Questions

1. **Do K-8 teachers' beliefs about their physical science content knowledge and their self-competency of teaching physical science inquiry-based (*cognitive component of attitudes*) align with their feelings of liking to teach physical science using inquiry-based practices (*affective component of attitudes*)? How do these beliefs change over time?**

2. **Does K-8 teachers' intended behavior to teach physical science using inquiry-based practices (*behavioral component of attitudes*) result in observable changes in teaching practices during the 3-year PSI program?**

Overview of Measures and Time Periods

Measure	Time Period				
	T1 (2008)	T2 (2009)	T3 (2010)	T4 (2011)	T5 (2012)
Interviews	X	X	X	X	X
Attitude Scales	X		X	X	X
HCOP	X	X	X	X	X
Focus Group				X	

Attitude Scales

- *Interest in Becoming a Science Teacher* (Nieswandt, Barret, & McEneaney, 2010, 2013)
- *Attitudes in Teaching Science (ATS)* (Race, 2001; Race, 2003) – **4 scales**
- *Personal Science Teaching Efficacy Belief (PSTEB) scale* – **part of Science Teaching Efficiency Belief Instrument, STEBI** (Riggs & Enochs, 1990) – **1 scale**
- **All attitude items were rated on a Likert-type scale (5 = Strongly Agree, 1 = Strongly Disagree)**

Attitude Scales

ATS – Four scales

Perceptions toward

- Use of Best Practice Instructional Strategies
- Teaching and their Individual Learning
- Moving Away from Traditional Methods
- Confidence in Teaching Physical Science
- Using Inquiry-based Practices

Interviews

- Semi-structured, individual, face-to-face
- Interview guide adopted from Richardson and Simmons (1994) focusing on
  - teaching philosophy
  - ideal and real teaching practice and constraints of implementation
  - teaching strategies (ideal and real)
  - philosophy about learning
  - views about the nature of science
  - teachers' self-concept about teaching and being a teacher (e.g., classroom teacher, science teacher, and/or teacher of science)
- Frist interview: Demographic questions, questions about previous careers, reasons for enrolling in the PSI program and future goals
- Follow-up interviews: Questions about the PSI courses (likes/dislikes and reasons for such affects), and transfer of knowledge and skills into teaching practice.

Focus Group

- One-time end of program focus group conducted by the external evaluator
- Two groups of PSI teachers (9 in the first group; 6 in the second)
- Use of open-ended, broad-based questions
- Used a written moderator's guide and followed methodology recommended by Krueger & Casey (2009)

Teacher Practice and Behavior

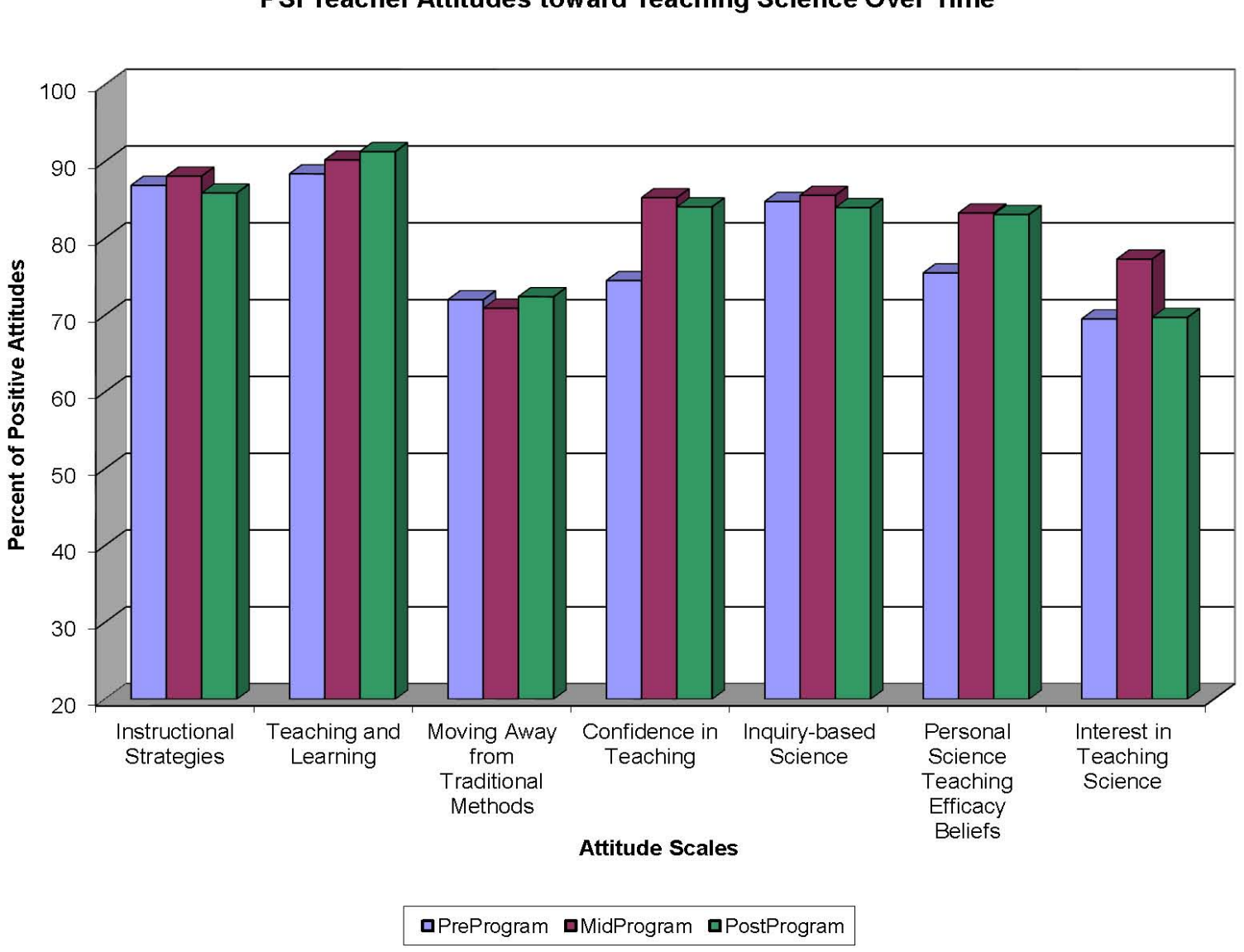
- **Actual classroom behavior observed with Horizons Classroom Observation Protocol (HCOP, 2005)**
- **Specific-section ratings**
  - Contextual background
  - Lesson description, instructional materials and classroom instruction
  - Design and implementation
  - Science content
  - Classroom culture
- **Overall Ratings**
  1. Ineffective Instruction
  2. Elements of Effective Instruction
  3. Beginning Stages of Effective Instruction
  4. Accomplished, Effective Instruction
  5. Exemplary Instruction

Change in Attitudes toward Teaching Science (Baseline to End-of-Program, EP)

Significant increase in positive attitudes towards:

- Confidence in Teaching Physical Science
  Baseline = 26.36 (SD = 4.94) vs. EP = 29.43 (SD = 3.73) $p < .03$

- Personal Science Teaching Efficacy Beliefs (PSTEB)
  Baseline = 49.07 (SD = 8.84) vs. EP = 54.00 (SD = 8.09) $p < .02$


PSI Teacher Attitudes toward Teaching Science Over Time
Percent of Positive Attitudes
100
90
80
70
60
50
40
30
20
Instructional Strategies
Teaching and Learning
Moving Away from Traditional Methods
Confidence in Teaching
Inquiry-based Science
Personal Science Teaching Efficacy Beliefs
Interest in Teaching Science
Attitude Scales
PreProgram
MidProgram
PostProgram

Results – Attitude Scales

- Participants' beliefs about their physical science content knowledge (*cognitive component of beliefs*) are aligned with their confidence in teaching science (*affective component*) – RQ1
  - Viewed themselves as capable and able to teach physical science
- Perceptions about using inquiry-based practices (and moving away from traditional teaching methods; *behavioral component*) did not change significantly over time

Overview of Ratings of Quality of Observed Lessons over Time

Level	Time point and number of teachers observed			
	T1 (2008) n=8	T2 (2009) n=12	T3 (2010) n=11	T4 (2011) n=15
1	0	2	0	1
2	1	1	1	1
3	6	7	6	8
4	1	2	2	1
5	0	0	2	4

Results – Observations

Classroom observation data showed:

- Participants' quality of teaching practice (HCOP level) increased as their involvement in the program progressed over time
- Participants' actual teaching practice aligned with their confidence in teaching inquiry-based (*affective component*)
- With respect to RQ 2 we concluded that at the end of the program *intended* behavior resulted in an observable change in teaching practice.

Results – Interview Data

- Supported classroom observation results and provided more insight into participants' increased confidence in teaching science and revealed PSI teachers' confidence in their scientific knowledge (*cognitive and affective component*)

Examples: *Teachers*

- Felt strongly about being prepared to answer their students' questions about scientific phenomena
- Showed strong efforts to integrate more current scientific topics in their teaching (e.g., tsunami and earthquake in Japan, oil spill in the Gulf of Mexico)
- Made enthusiastic attempts to make science more relevant for their students through projects such as reducing waste in the classroom or participating in NASA Space Shuttle programs

Results – Interview Data

End of PSI program: All teachers

- **Stressed that they increased their science content knowledge and felt very positive, proud and confident about their acquired knowledge (*cognitive and affective component*).**
- **Felt secure in making changes in their teaching practice by teaching more inquiry-based lessons (*behavioral component*).**

Results – Focus Group

Teachers credited the program with helping them:

- Increase their individual confidence in their ability to teach science and physical science particularly
- Make changes (self-reported) to their classroom practices
- With how they think about the nature of science and scientific inquiry
- Revise their approach to teaching science in their classrooms

Results – Focus Group

As to changes in classroom instructional practices, teachers reported:

- Asking students more questions
- Viewing science less rigidly than they have done in the past
- Incorporating scientific inquiry into their classroom lessons

→ changes in all three attitudinal components

Conclusions

- Results support three dimensions of attitudes
- Demonstrate importance of investigating all three components of attitudes to develop an understanding of possible discrepancies between teachers' actual teaching practice and their expressed attitudes about their teaching practice
- May help to understand why majority of science teachers do not implement reform-based teaching approaches (Roehrig & Kruse 2005; Rowell 2004; Hofstein, Eilks, & Bybee, 2011).

Conclusions

- Insight into complex processes of actual teaching practice and teachers' expressed attitudes about their teaching practice which teachers may or may not view as discrepant
- Development of professional development programs focusing on particular components of attitudes – professional learning trajectories. For example,
  - Strengthening efficacy beliefs while also increasing science content knowledge
  - Provide science teachers with the skills to analyze their own beliefs about their teaching and teaching practices

Overall Conclusions

- Teacher need to be motivated to implement new teaching approaches – through alignment with their values, goals and beliefs about science teaching and views of themselves as science teachers
- Teachers need to believe that they have the skills and resources to implement such teaching – in PSI inquiry-based physical science teaching – and knowledge about the ways in which science affects and is affected by society