

Effect of a Concentrated In-Service Elementary Teacher Force and Motion Workshop

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Thesis Committee

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Students enter introductory university physics classes with less than adequate tools for describing the world in which they live.

Why Elementary School Teachers?

- Research shows that
 - children begin developing physics resources at an early age
 - elementary teachers have not traditionally been trained to guide science resource development
- National and State Teaching Standards have science goals for students as early as kindergarten

Why a Workshop Format?

- Teachers are jealous of their time
- Workshop environment can be less threatening than course work
- Curriculum materials are available to fit this format

What Goals Should This Workshop Have?

- Improve content knowledge
- Work on epistemology
 - Teachers should understand how their teaching and *attitude* affects student learning
- Improve teacher Self-Efficacy
 - We'd like our teachers to believe their teaching can have a positive impact on student learning
 - We'd like them to believe that they are capable of teaching science effectively

Workshop Content

Hands-on, inquiry-based curriculum

- Computer based lab work with motion sensors
- Non-technical work with stopwatch, meter stick, and other aids
- Primarily from *Explorations in Physics*, supplemented with material from *Inquiry Into Physical Science* and other sources

Workshop Content

Explicit work on epistemology

- Epistemological resources -- Hammer & Elby
- "Talking" science -- Lemke
- Epistemic Games and Frames -- Tuminaro
- "Stop I can't Fit Anything More Into My Head" -- Olenick

Diagnostics

- Force and Motion Conceptual Evaluation (FMCE)
- Maryland Physics Expectations Survey (MPEX) – modified for workshop setting
- Science Teaching Efficacy Belief Instrument (STEBI)

The FMCE - Thornton and Sokoloff

- 47 question, research-based, multiple-choice assessment instrument designed to probe conceptual understanding of Newtonian mechanics
- Rubric suggested by Thornton, only 33 questions scored
- Velocity, Acceleration, Newton's first and second laws, Newton's third law, and Energy clusters
- Originally intended for use in undergraduate and high school classes – but appropriate here

The FMCE – Example Questions



30. They are both moving at the same speed when they collide. Which choice describes the forces?
31. The car is moving much faster than the heavier truck when they collide. Which choice describes the forces?
32. The heavier truck is standing still when the car hits it. Which choice describes the forces?

Questions 30-34 refer to collisions between a car and trucks. For each description of a collision (30-34) below, choose the one answer from the possibilities A through J that best describes the forces between the car and the truck.

- A. The truck exerts a greater amount of force on the car than the car exerts on the truck.
- B. The car exerts a greater amount of force on the truck than the truck exerts on the car.
- C. Neither exerts a force on the other; the car gets smashed simply because it is in the way of the truck.
- D. The truck exerts a force on the car but the car doesn't exert a force on the truck.
- E. The truck exerts the same amount of force on the car as the car exerts on the truck.
- F. Not enough information is given to pick one of the answers above.
- J. None of the answers above describes the situation correctly.

*In questions 30 through 32 the truck is **much heavier** than the car.*

MPEX – University of Maryland

- 29 question Likert scale test, but scoring reduced to favorable, unfavorable, and neutral scores.
 - Six clusters, but only five used in this study: Independence, Coherence, Concepts, Reality-link, Math-link
 - Survey modified to fit workshop format – five questions dropped, wording changed slightly on others

Modified MPEX – Example Questions

12/13 My *learning* in this workshop is primarily determined by how familiar I am with the material. Insight or creativity has little to do with it

My grade in this course is primarily determined by how familiar I am with the material. Insight or creativity has little to do with it. Independence

24/26 *When I prepare classroom activities*, I explicitly think about the concepts that underlie the problem.

When I solve most exam or homework problems, I explicitly think about the concepts that underlie the problem. Concepts

STEBI – Riggs and Enochs

- 25 question Likert scale test, again reduced to favorable, unfavorable, and neutral scores
- Two scales, Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE)
- STOE may be a measure of external locus of control, not expectancy, and is considered less reliable than PSTE

STEBI – Sample Questions

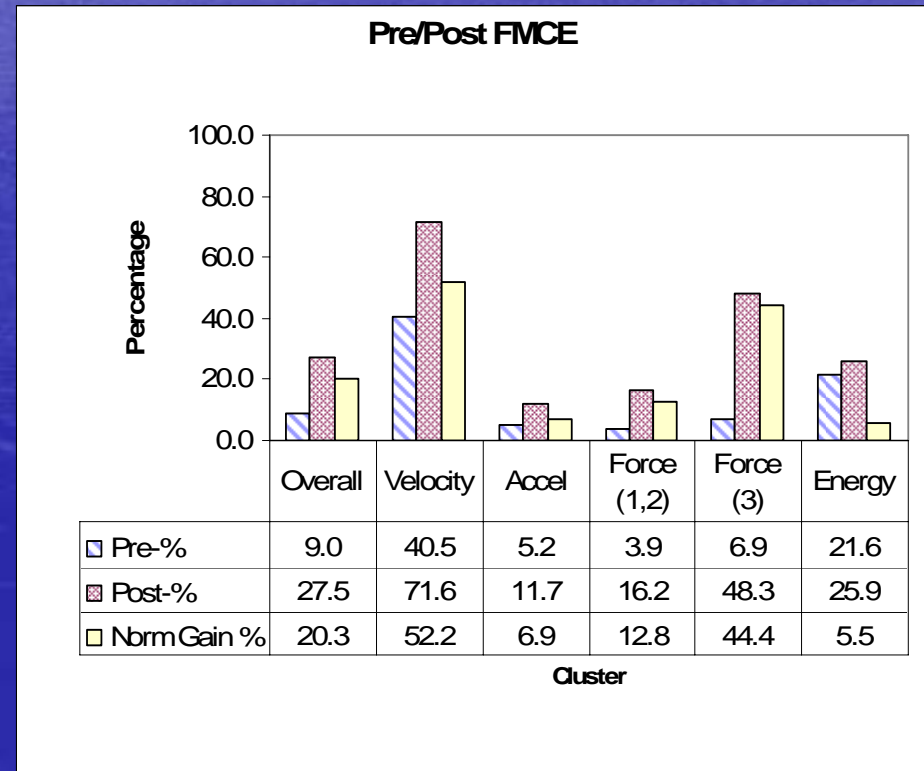
- 2. I am continually finding better ways to teach science. PSTE
- 3. Even when I try very hard, I don't teach science as well as I do most subjects. PSTE
- 10. The low science achievement of some students cannot generally be blamed on their teachers. STOE
- 15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching. STOE
- 25. Even teachers with good science teaching abilities cannot help some kids learn science. STOE

Workshop Setting

- Two locations, James Bean School in Sidney and Zippel Elementary School in Presque Isle
- 29 Elementary Teachers
 - 2 to 30 years of experience
 - 26 female, 3 male
 - Kindergarten through Grade 5
- Five days in both locations
 - Monday to Friday in Presque Isle
 - Thurs & Fri, Mon thru Wed in Sidney (Split)

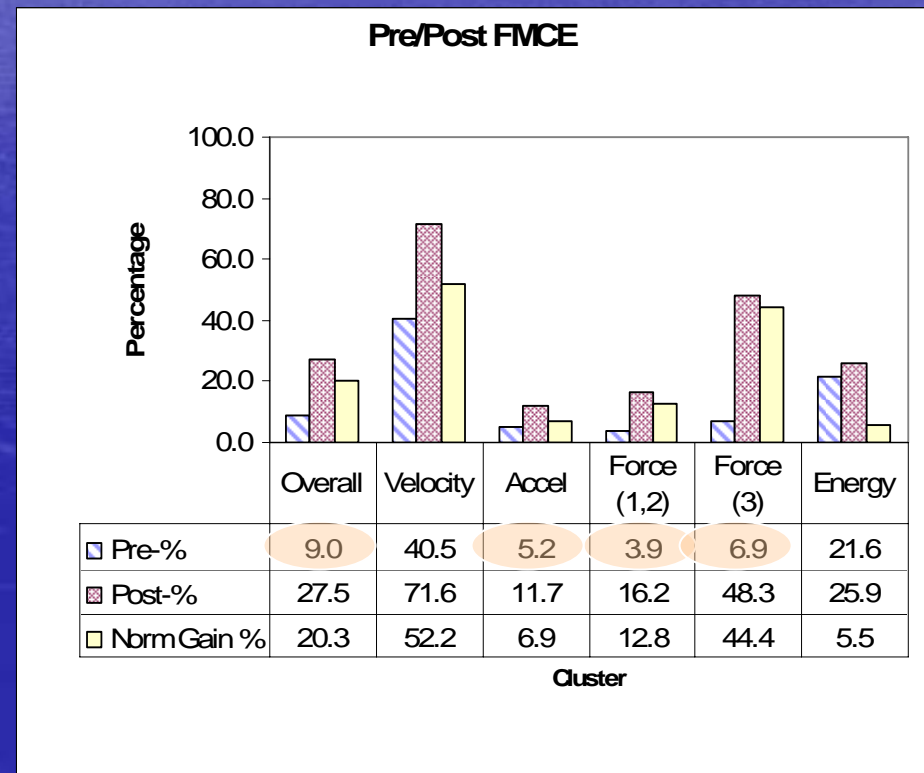
Content Knowledge Results: FMCE

- Statistically significant improvement
- Nice gain overall
- Impressive results in Velocity and F 3
- But ...



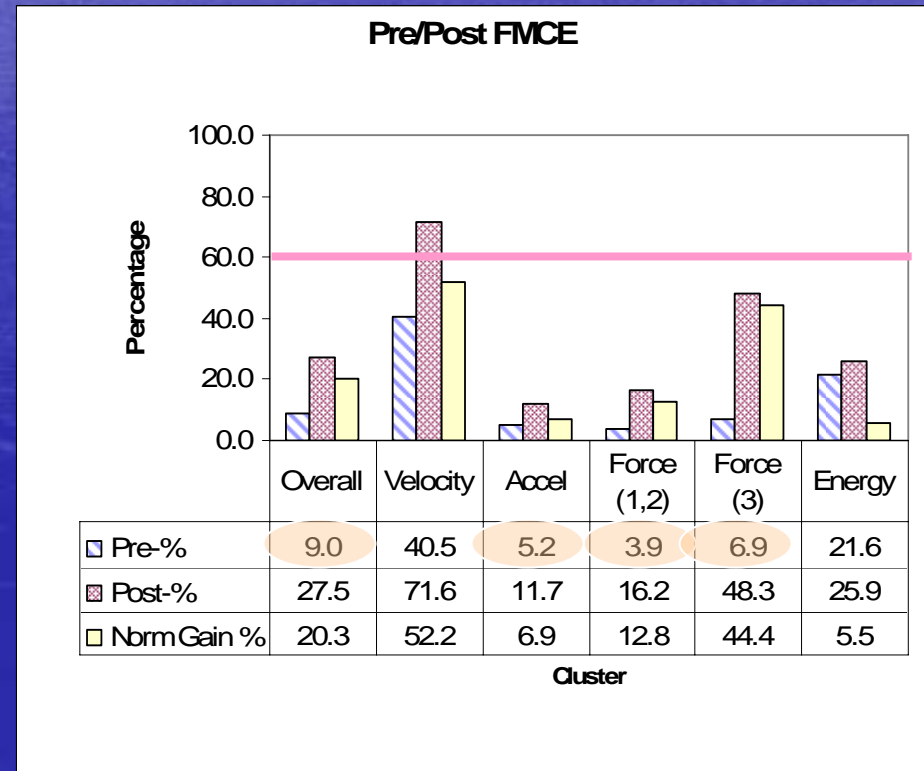
Content Knowledge Results: FMCE

- Very low pretest scores



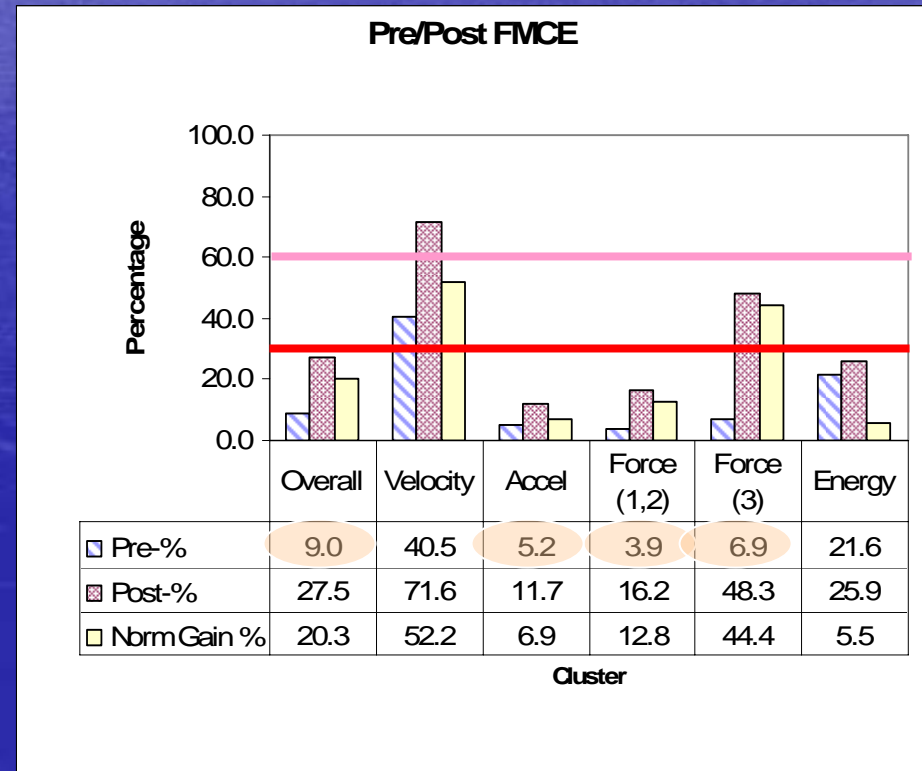
Content Knowledge Results: FMCE

- Very low pretest scores
- Most post-test scores below 60%, threshold for minimal mastery

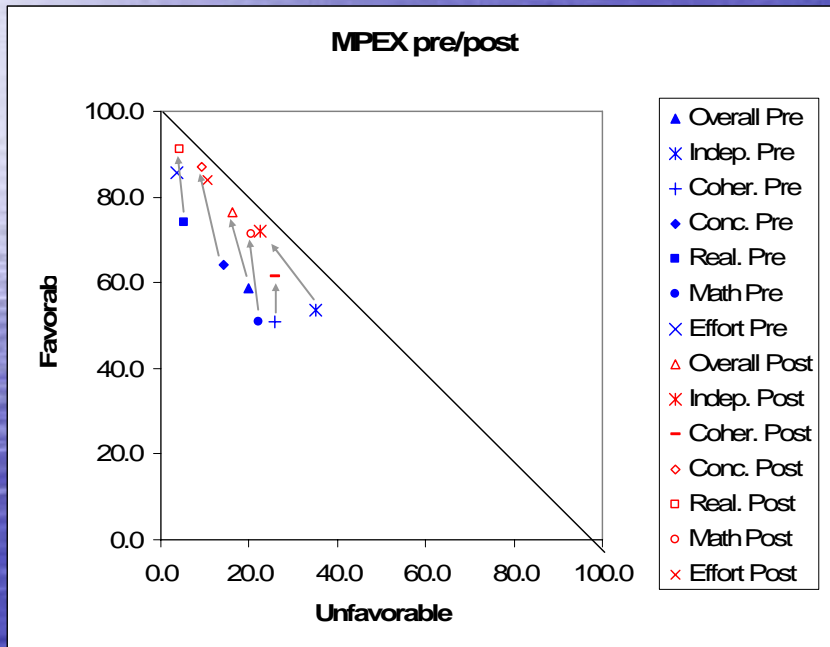


Content Knowledge Results: FMCE

- Very low pretest scores
- Most post-test scores below 60%, threshold for minimal mastery
- Most even below 30%

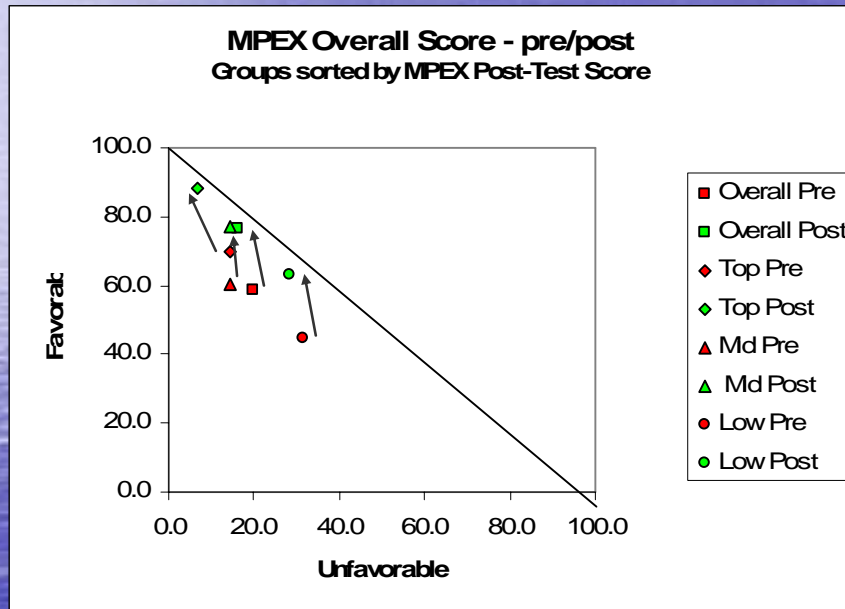


Attitudes and Expectations Results: MPEX



- Clear and statistically significant improvement, overall and in each cluster (except Effort)

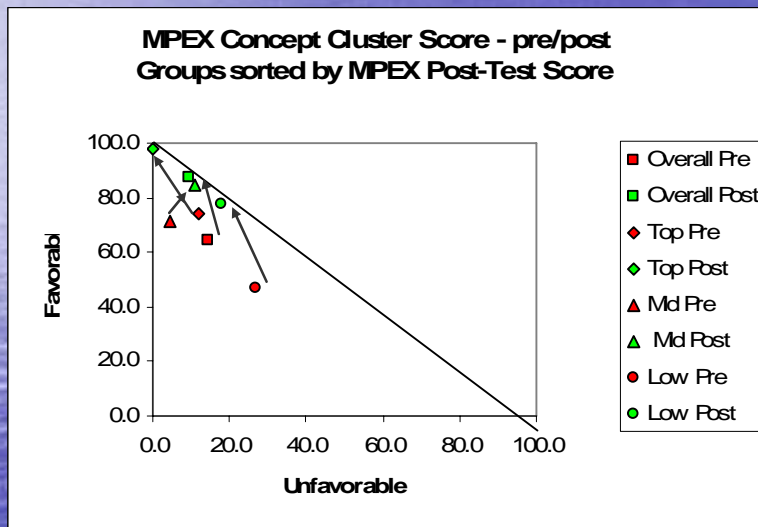
Attitudes and Expectations Results: MPEX - Overall



Overall scores tell a slightly different story when split into groups

	Normalized Gain			
	Overall	Top	Mid	Low
Favorable	0.42	0.61	0.42	0.33
Unfavorable	-0.08	-0.52	0.00	-0.10
	N=28	N=10	N=9	N=9

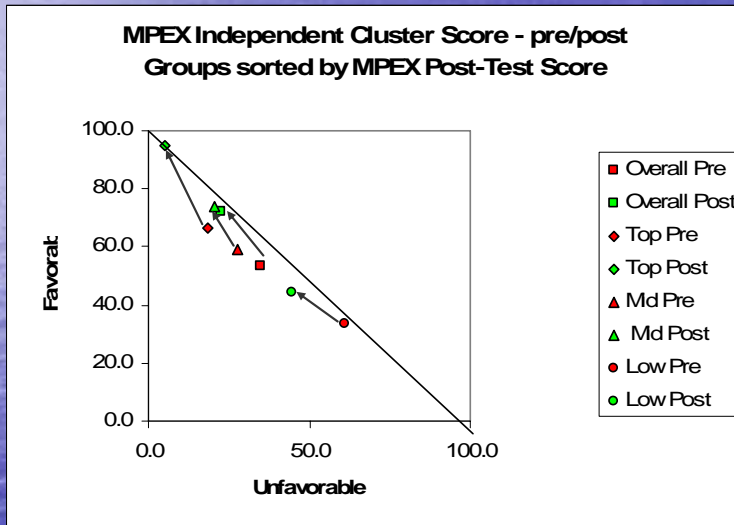
Attitudes and Expectations Results: MPEX - Concept Cluster



Concept cluster a big success

	Normalized Gain			
	Overall	Top	Mid	Low
Favorable	0.64	0.92	0.46	0.58
Unfavorable	-0.35	-1.00	0.07	-0.33
	N=28	N=10	N=9	N=9

Attitudes and Expectations Results: MPEX - Independence Cluster



Independence cluster a success, but note end position for low group

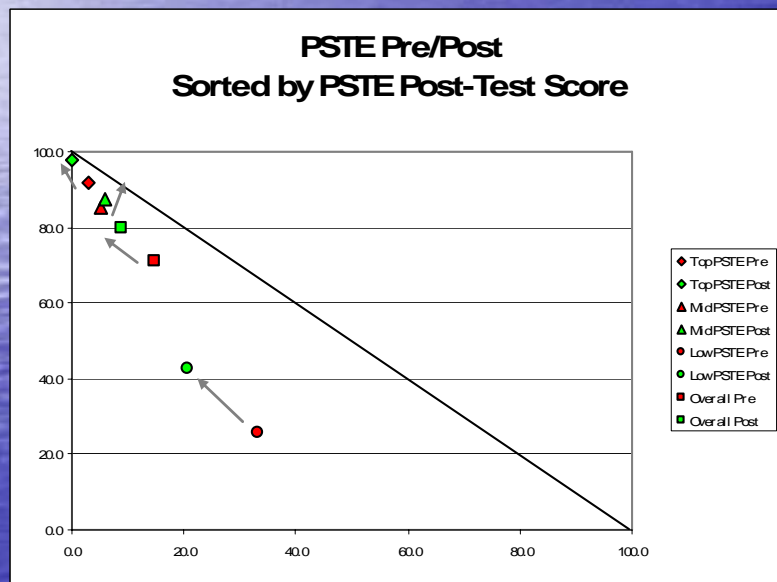
	Normalized Gain			
	Overall	Top	Mid	Low
Favorable	0.40	0.85	0.36	0.17
Unfavorable	-0.36	-0.73	-0.27	-0.27
	N=28	N=10	N=9	N=9

Attitudes and Expectations Results: Individual MPEX questions

Scores with each question are given in # favorable/# unfavorable. Overall score; Top group; Low group N=28 Overall, N=10 Top, N=9 Low

7. In this workshop, I do not expect to understand physics equations in an intuitive sense; they must just be taken as givens
12/11 – 19/6; 7/0 – 10/0; 1/8 – 2/5
16. Only very few specially qualified people are capable of really understanding physics
17/7 – 22/4; 9/1 – 10/0; 2/5 – 4/4
11. Knowledge in physics consists of many pieces of information each of which applies primarily to a specific situation
6/13 – 15/7; 3/5 – 8/1; 0/6 – 4/4
15. The derivations or proofs of equations has little to do with solving problems or with the skills I need to successfully understand physics
15/5 – 15/10; 6/1 – 6/3; 5/1 – 2/5
18. The most crucial thing in solving a physics problem is finding the right equation to use
8/8 – 22/3; 4/3 – 9/0; 1/4 – 5/2
10. A good understanding of physics is necessary for me to achieve my career goals.
5/9 – 5/15; 3/1 – 3/3; 1/5 – 1/6

Attitudes and Expectations Results: STEBI - PSTE



Scores greatly improved ... but note the low scores at low end

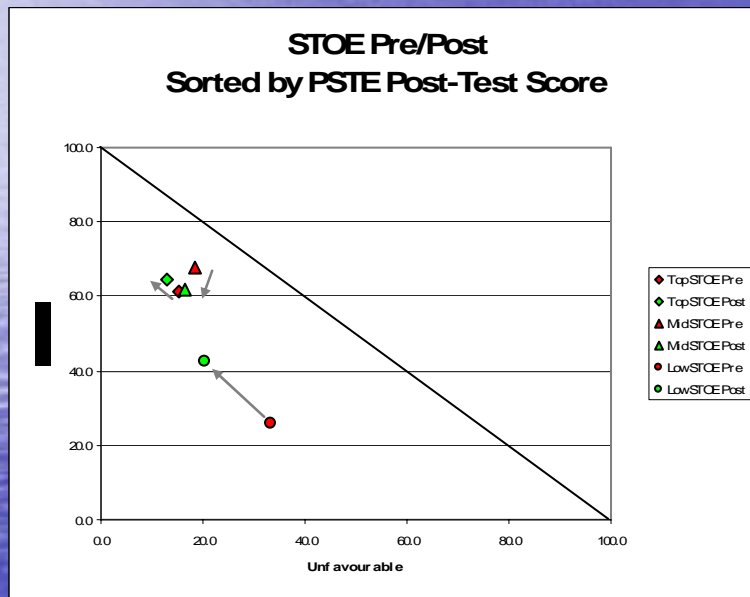
PSTE Normalized Gain

	Overall	High	Mid	Low
Favorable	0.31	0.75	0.12	0.23
Unfavorable	-0.39	-1.00	0.17	-0.38
	N=29	N=11	N=9	N=9

Favorable

Unfavorable

Attitudes and Expectations Results: STEBI - STOAE



STEBI - STOAE scores,
but may be measure
of locus of control

STOAE Normalized Gain

	Overall	High	Mid	Low
Favorable	0.03	0.08	-0.17	0.20
Unfavorable	-0.05	-0.15	-0.10	0.07
	N=29	N=11	N=9	N=9

Attitudes and Expectations Results: Individual STEBI questions

Scores with each question are given in # favorable/# unfavorable. Overall score; Top group; Low group N=29 Overall, N=11 Top, N=9 Low

5. I know the steps necessary to teach science concepts effectively.
16/6 – 21/0; 6/0 – 11/0; 2/5 – 4/0
6. I am not very effective in monitoring science experiments.
22/5 – 25/1; 9/0 – 11/0; 3/5 – 5/1
8. I generally teach science ineffectively.
24/0 – 20/5; 9/0 – 11/0; 4/0 – 2/3
10. The low science achievement of some students cannot generally be blamed on their teachers.
7/13 – 9/17; 1/7 – 3/7; 3/1 – 3/5
25. Even teachers with good science teaching abilities cannot help some kids learn science.
13/9 – 13/12; 5/3 – 5/4; 4/3 – 5/2

Conclusions

- Content Knowledge – Although gains are significant, most participants did not complete this workshop with adequate understanding of content as measured by the FMCE
- Attitudes and Expectations – Most participants started with high scores on MPEX and STEBI – PSTE, and improved
 - Small group at bottom of MPEX/STEBI scoring with troublesome scores

Study Implications

- Intensive full week workshop did not produce desired content knowledge results
 - Too much, too fast ... more time needed to internalize content
 - Short courses and workshops may not achieve intended results
 - May need to look for alternate ways to present material and/or teach science in elementary schools

Study Implications

- Significant improvement in participant expectations and attitudes
 - Across the board improvement in MPEX and STEBI-PSTE
 - Small amount of time spent, large improvement
 - Workshop and/or short course aimed at teacher efficacy can be successful

Study Implications

- Caution – This group of teachers was self-selected ... may not be representative of general population
- Sample size is small – but results are consistent with other research
- Content knowledge gains may be localized, and gains may not last over time

Nutshell

- Short professional development workshops may significantly improve affect and awareness of appropriate pedagogy

BUT

they may not have a strong effect on conceptual content understanding

- More time in workshop – and perhaps time in between lessons for assimilation – may be needed to improve content knowledge



QUESTIONS???