

National Study of Education in Undergraduate Science: 2006-2012 – What Was Learned



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The National Study of Education in Undergraduate Science (NSEUS)

Multiyear national study goal: investigate the impact of undergraduate course reform on

- Student short-term learning outcomes for all majors
- Student long term outcomes of a specific major - inservice elementary teachers of science.

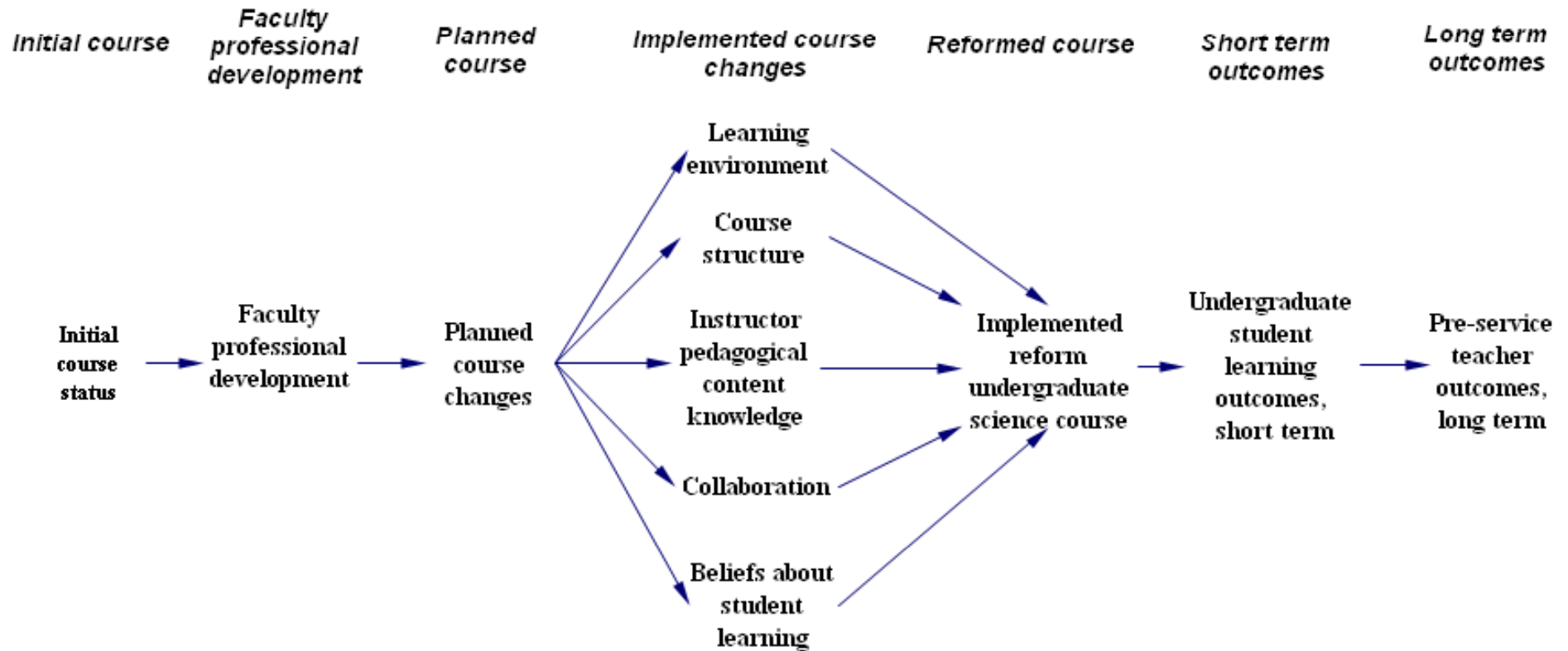
Research Question: How do undergraduate entry-level science courses, differing in level of reform, affect student learning outcomes?



Research Sub-Questions

- Does faculty professional development change undergraduate science faculty teaching practice?
- How do science teaching/learning course characteristics differ between courses?
- How do these differences relate to the learning outcomes of undergraduate students?
- How do the differing levels of course reform relate to the short term learning outcomes of undergraduate students and long term outcomes for graduated in-service K-6 teachers in their own school classrooms?

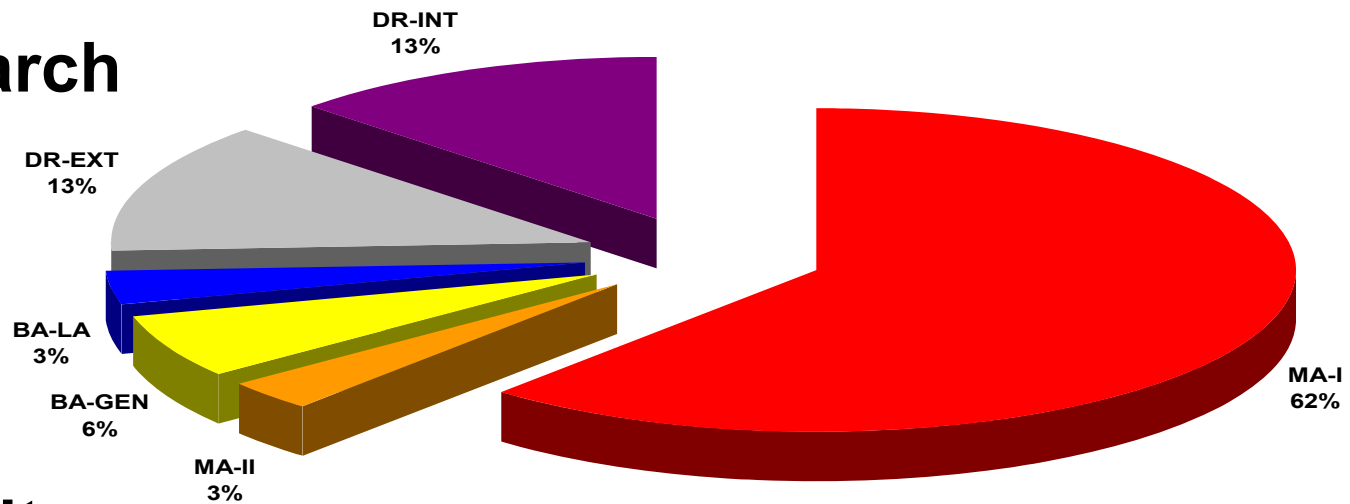
NSEUS Research Model



NSEUS National Study Sample

Description of Institutions (Study Sample N=20)

- 62% MA
- 26% Research
- 12% other
- 26% Minority

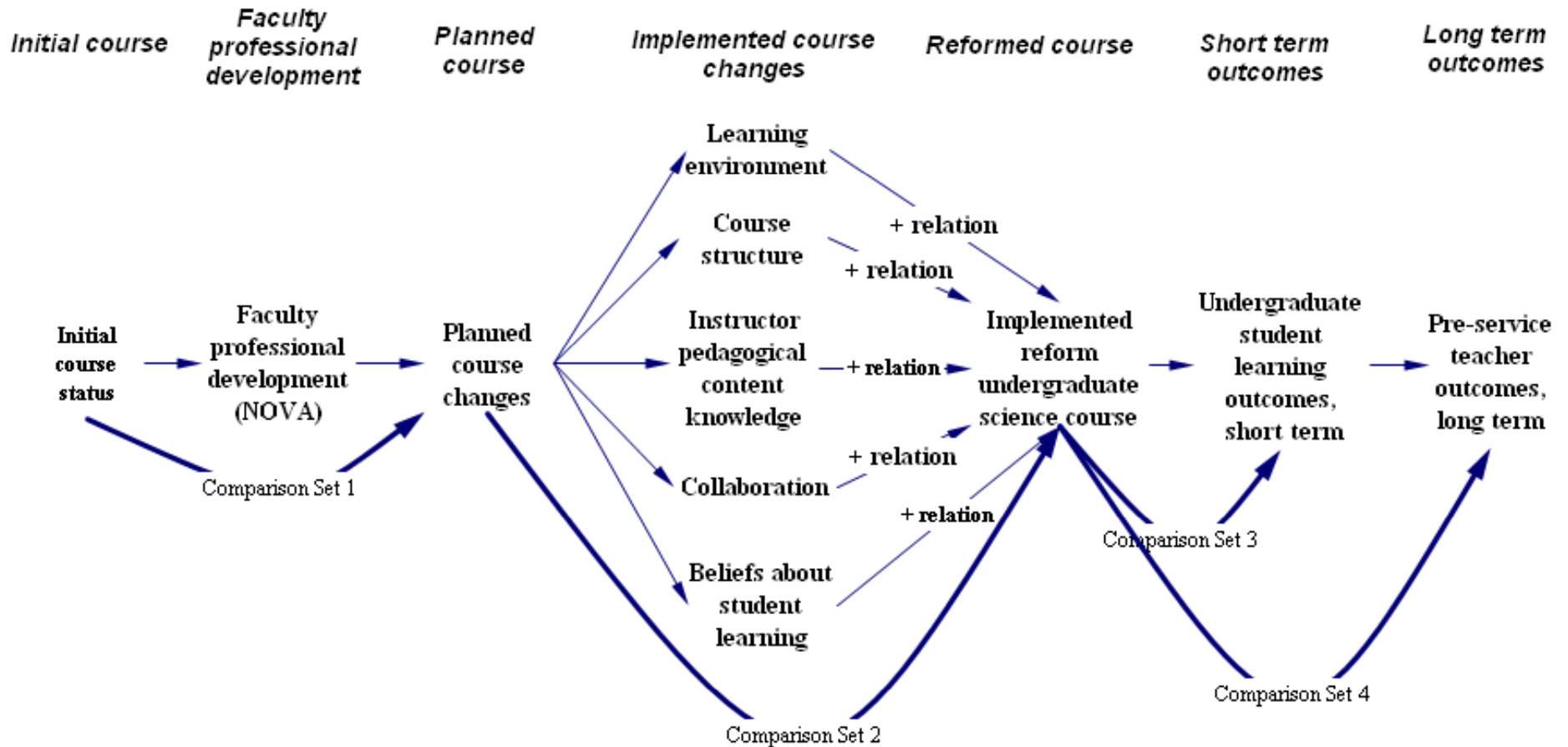


Data Collection

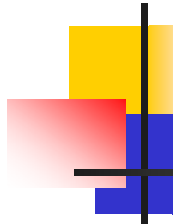


- Faculty, undergraduate students, and in-service teachers
- Multiple site visits with university campus and elementary classroom observations
- Content analysis of course materials
- Student ratings of classroom environment, attitudes toward science, efficacy, and science achievement outcome measures
- Interviews and focus groups with faculty, students and graduated in-service teachers

Research Model Comparisons



Comparison Set 1



Initial course

*Faculty
professional
development*

*Planned
course*



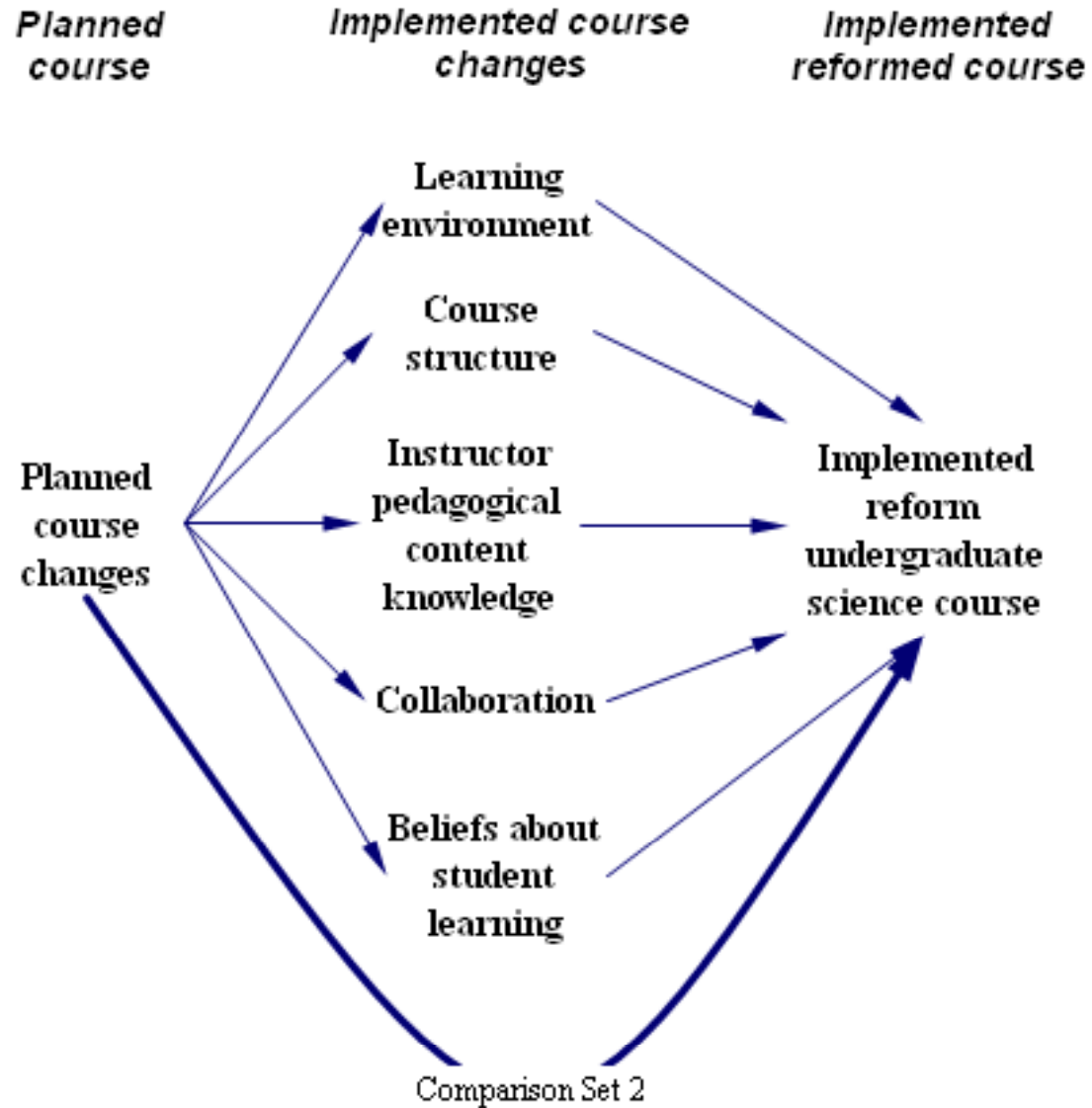
Summary Findings

Comparison Set 1: Pre-Post Faculty Professional Development Course Descriptions

Analysis of NOVA funding proposals found differences in five overarching elements (themes) in course descriptions that differed pre-post

- Learning environment
- Course structure
- Pedagogical content knowledge
- Collaboration
- Beliefs about teaching, and student learning

Comparison Set 2



Summary Findings

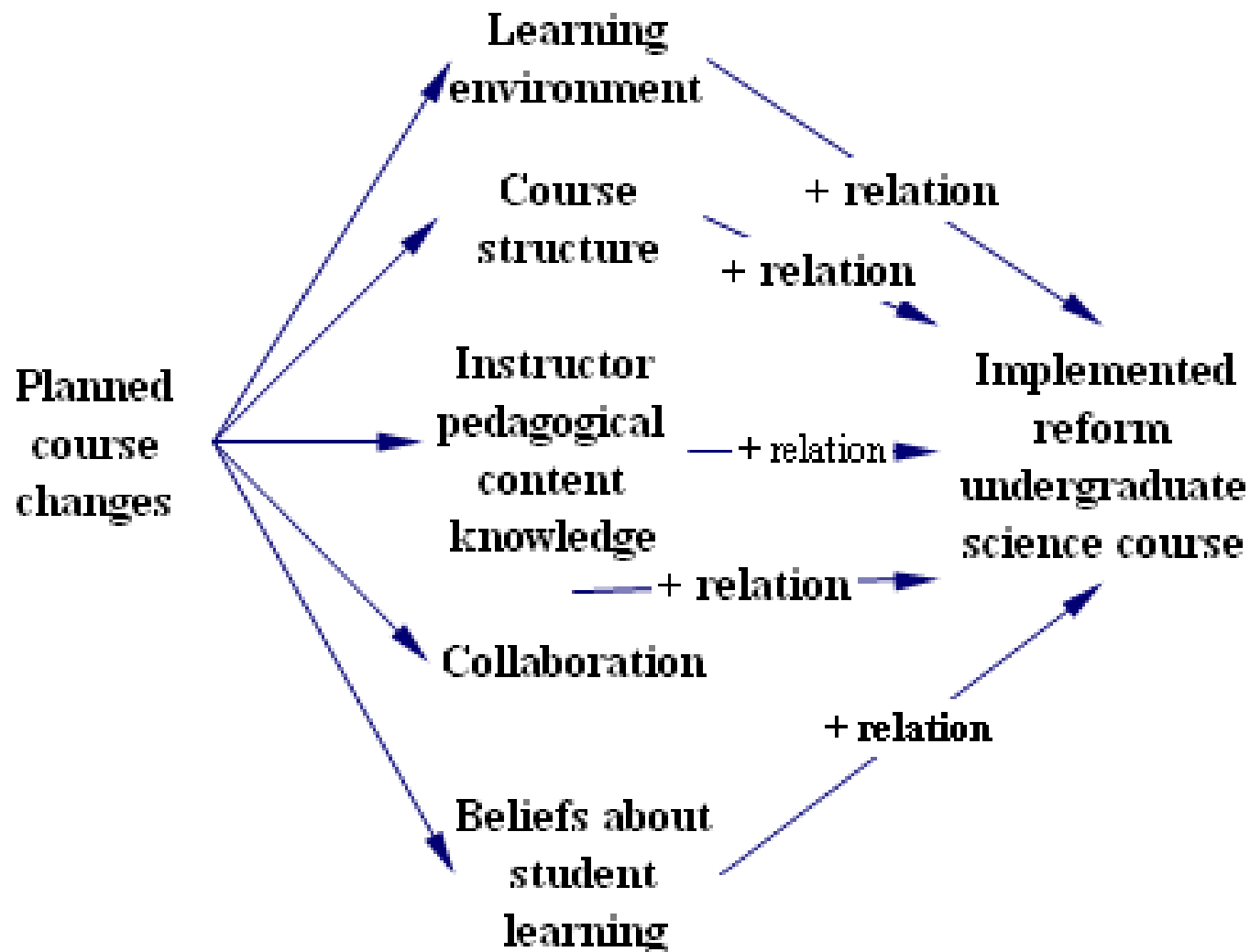
Comparison Set 2: National Survey of NOVA Population (N=103) of Reformed Courses

- Courses, once reformed, continued to be offered long term.
- Reform clones within and outside of department in $\frac{1}{2}$ of institutions
- Collaborative (tenacious) teams played vital role in developing and sustaining reformed courses
- Common characteristics in the courses were related to national science standards.
- Inquiry-based instructional methods and learning goals dominated course descriptions

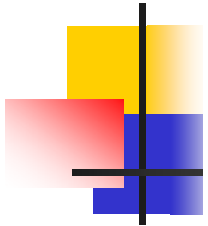
Planned course

Implemented course changes

Implemented reformed course



Comparison Set 3



Reformed course

*Short term
outcomes*

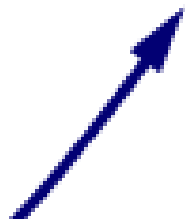
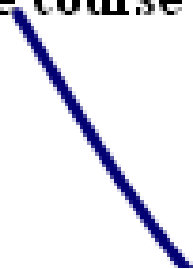
*Long term
outcomes*

**Implemented
reform
undergraduate
science course**

**Undergraduate
student
learning
outcomes**

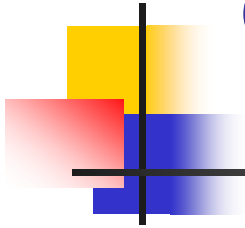
**Pre-service
teacher
outcomes**

Comparison Set 3



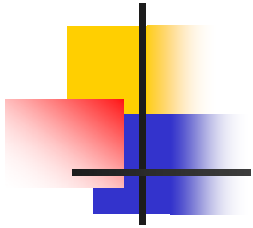
Summary Findings

Comparison Set 3



- Students experiencing higher levels of reform in their undergraduate science course;
- rated and described their classroom learning environment significantly higher
 - had higher achievement on the SCA content test
 - demonstrated higher level thinking
 - demonstrated lower levels of misconceptions about the science concept(s) tested
 - demonstrated attitudes towards science that did not differ between courses.

Comparison Set 4



Reformed course

*Short term
outcomes*

*Long term
outcomes*

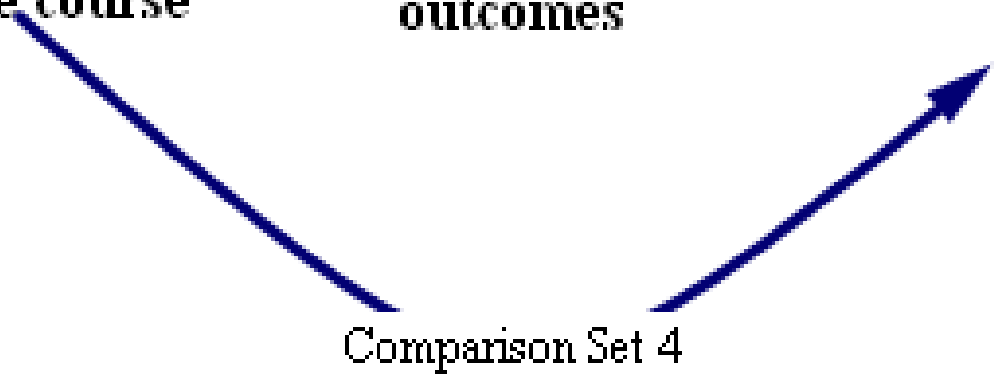
**Implemented
reform
undergraduate
science course**



**Undergraduate
student
learning
outcomes**



**Pre-service
teacher
outcomes**



Comparison Set 4

Summary Findings

Comparison Set 4



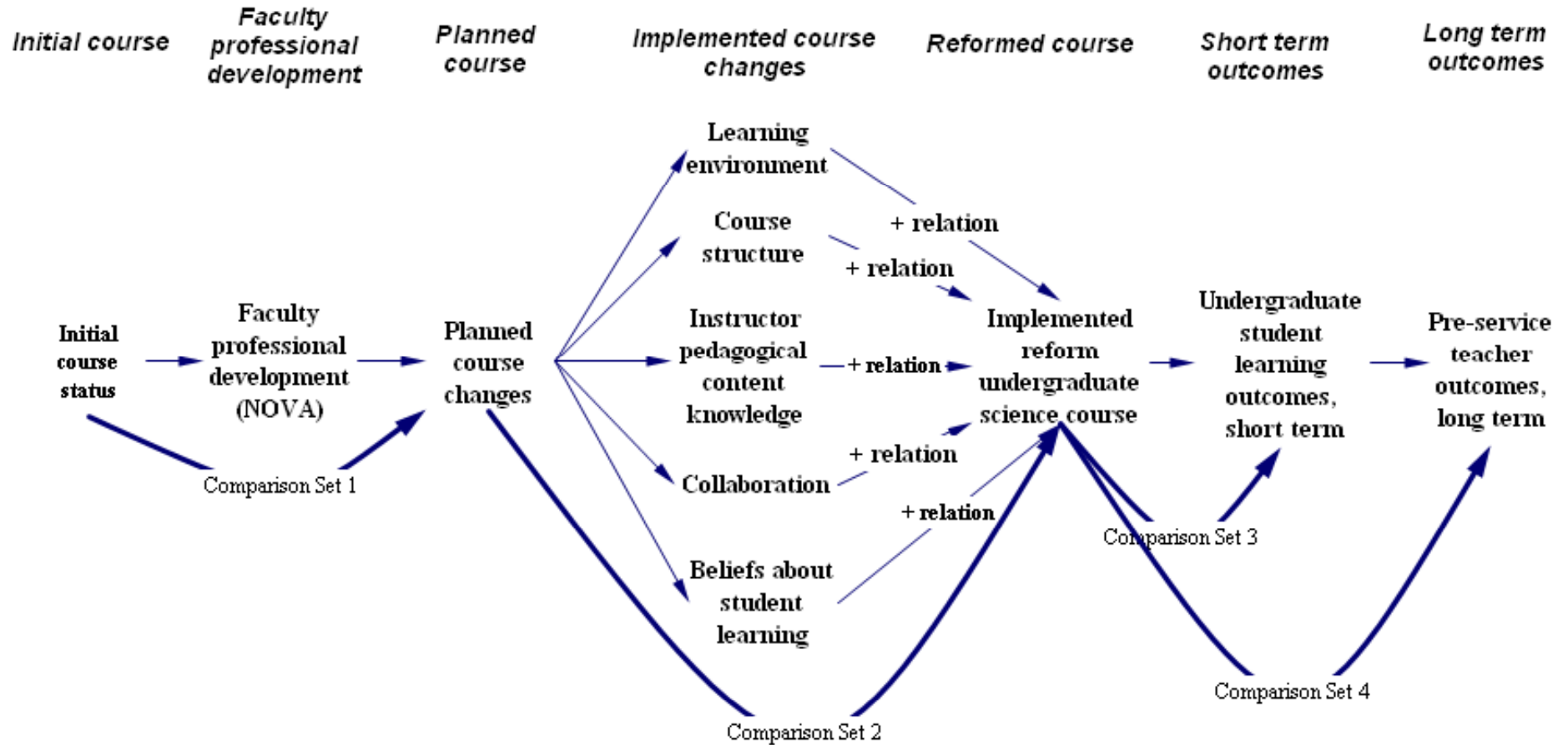
The of level of reform experienced on teaching performance is complex. Elementary teachers who had experienced higher levels of reform

- differed in their observed teaching of science in elementary classrooms only in specific settings.
- differed in their science pedagogical content knowledge.

Reform course graduates exhibited greater

- depth of science content knowledge on the concepts taught;
- knowledge of how students think about science and modify teaching to match students' learning needs;
- knowledge of science pedagogy.

Research Model Comparisons



NSEUS Study Answered These Questions



- What is an effective reform course?
- What elements are effective in science course reform?
- What is inquiry teaching at the undergraduate level?
- How many reform elements do you have to implement at the undergraduate level to show better than average achievement gain? What PCK is needed for faculty to be effective in undergraduate classes?
- What quality of reform element application is needed at the undergraduate level to show better than average achievement gain?



Conclusions

- Reformed science courses have significantly higher positive classroom learning environments.
- Reformed course faculty are more likely to engage students using inquiry with a higher level of PCK.
- Collaborative faculty teams develop and sustain course reform over time.
- Successful reform ideas are adopted by other faculty.



Conclusions (cont.)

- Students experiencing higher levels of reform had higher science achievement and demonstrated higher level thinking.
- Undergraduate students' ideas about the nature and process of science differed among individuals but not classes.
- Graduates of reform courses used a higher level of science PCK in teaching science in elementary schools.



What We Learned

- The Research Model supports the effectiveness of the reform process studied leading to positive student learning outcomes. It forms a model or theory of undergraduate course reform.
- Reform efforts are sustainable with dedicated collaborative faculty & administrative support.
- A significantly high level of reform both in quality and quantity is required to observe greater than expected gains in student outcomes.
- Faculty professional development activities that reflect reform profoundly affect the short and long term learning outcomes undergraduate students.
- Undergraduate science course experiences (context) affect how students understand science on both affective and cognitive levels.



NSEUS

National Study of Education in Undergraduate Science

<http://nseus.org>

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