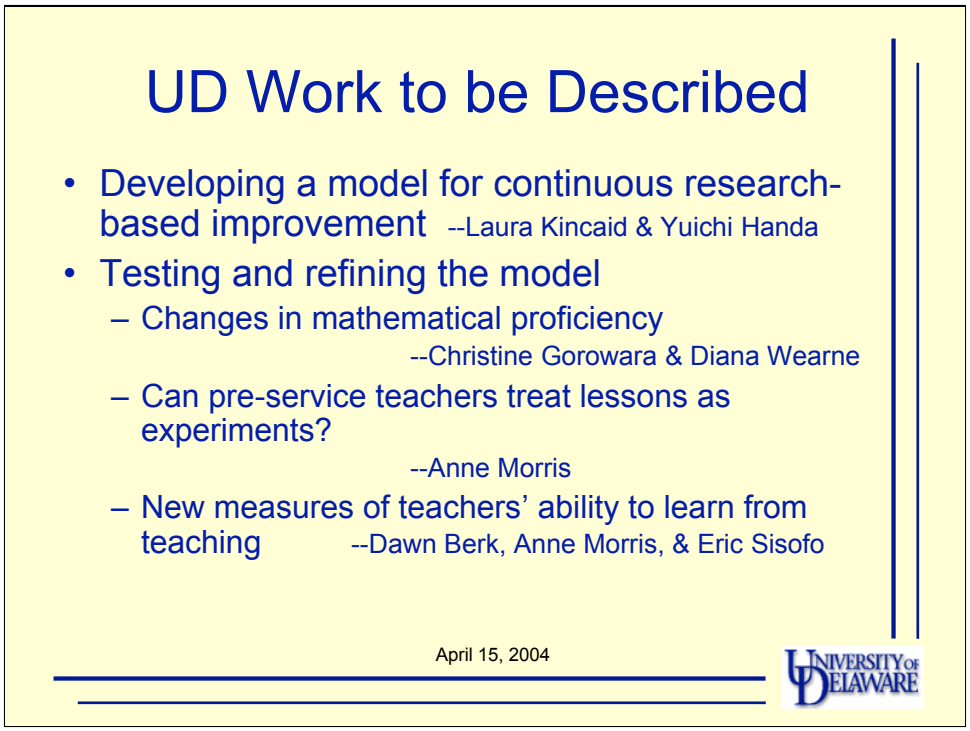
Learning to Learn to Teach

Implementing and Assessing an "Experiment" Model for the Continuous Improvement of Teaching

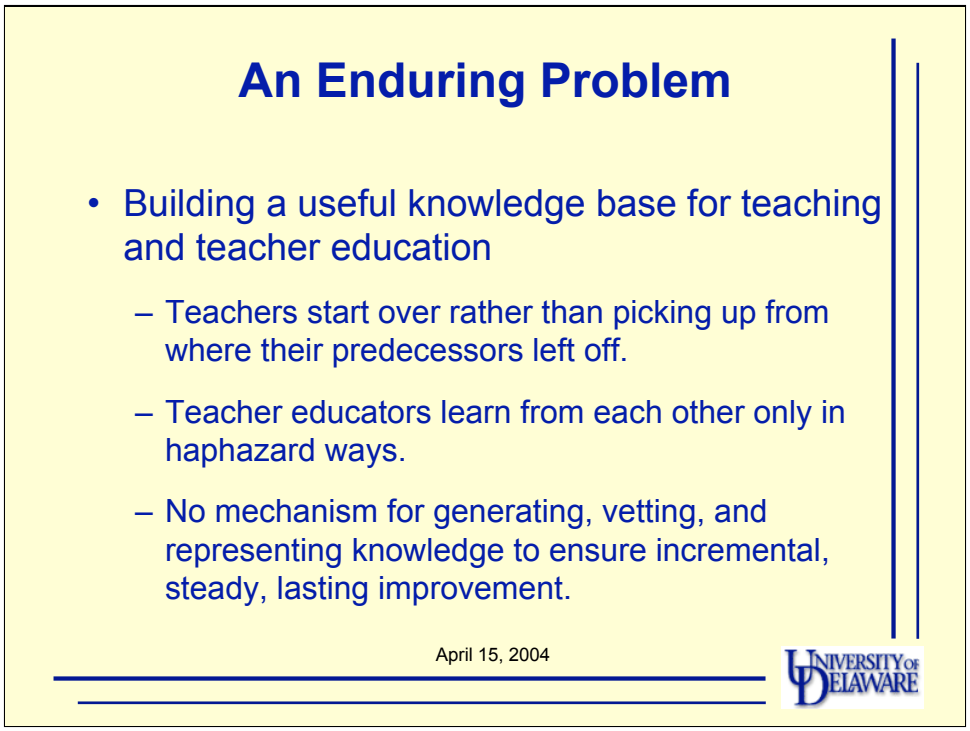
U of Delaware Mathematics Education Group

AERA – April 15, 2004

Mid-Atlantic Center funded by the National Science Foundation



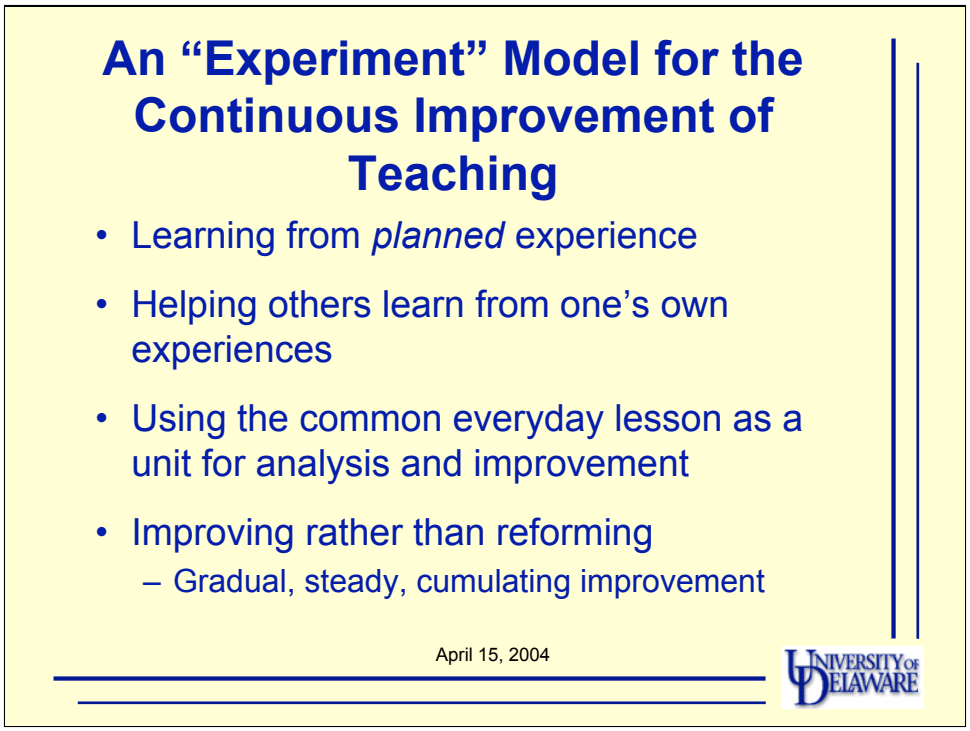
The purpose of this session is to provide an update of our work on creating and testing an "experiment" model of teacher preparation. As will become clear, the term "experiment" is not to be confused with "experimental." It was chosen to emphasize the deliberate, systematic study of teaching aimed to build, over time, a knowledge base for teaching and for preparing teachers.



One of the most significant problems in education is the absence of a knowledge base that allows teachers, and teacher educators, to build on what others have learned. Indicators of the absence of such a shared and usable knowledge base are well known.

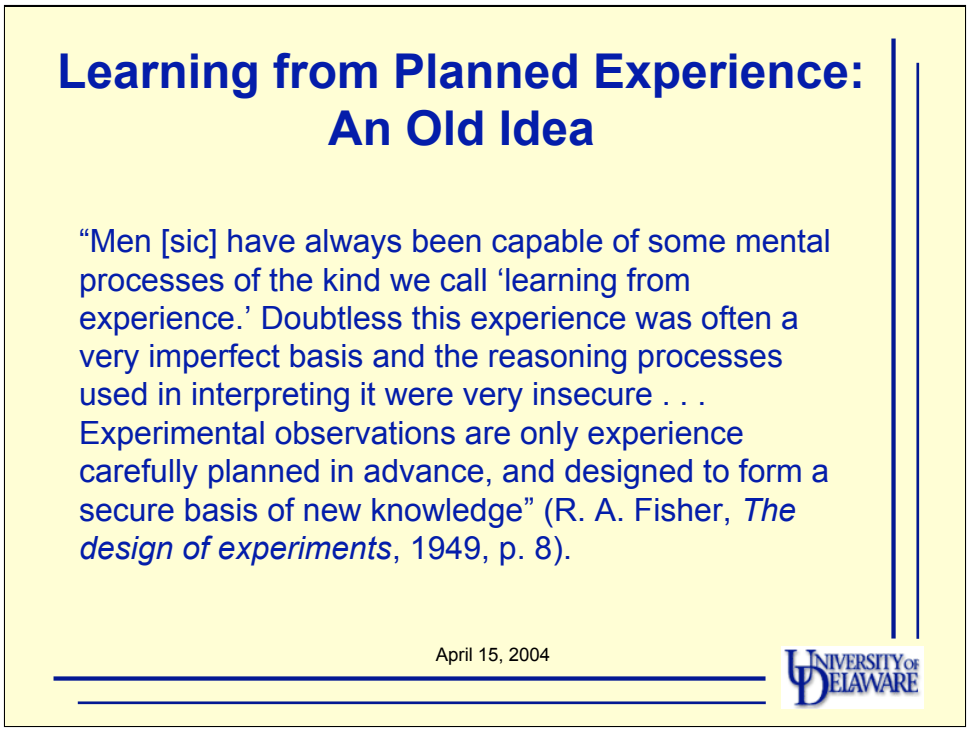
A primary reason for this enduring problem is the absence of a mechanism for generating, vetting, and representing knowledge in a way that makes it available and useful for others.

Our response to this problem is the development of a model for the continuous improvement of teaching.

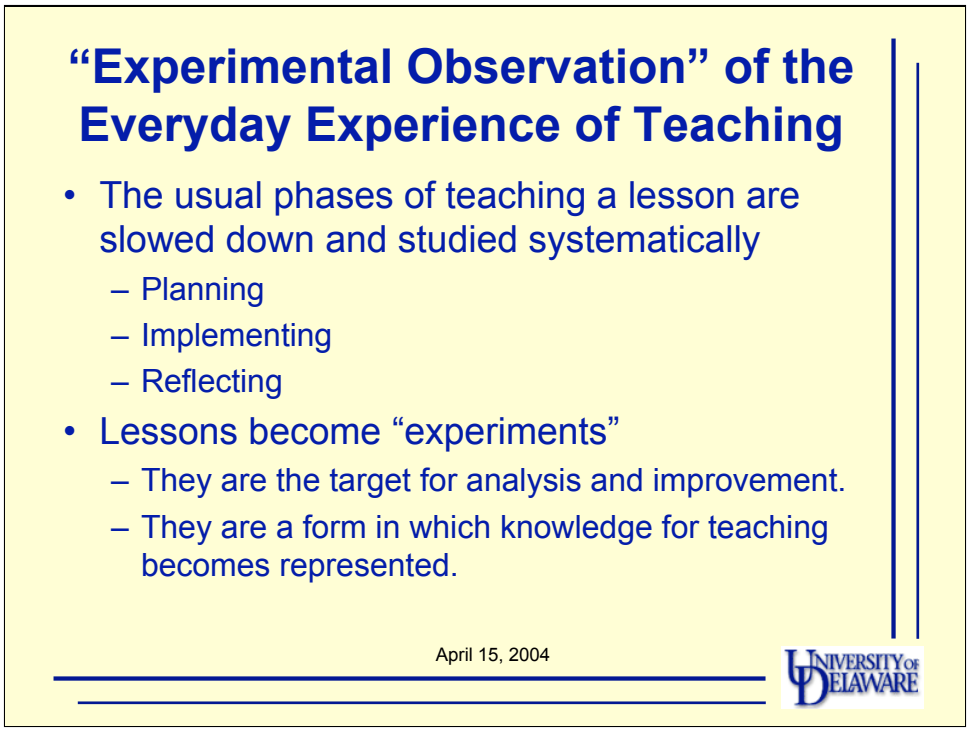


The model is based on a number of old but powerful ideas.

1. Everyone learns from experience everyday. Teachers learn from their routine experiences of teaching. But most of this learning is haphazard and fleeting. At the center of our model is the value of planning to learn in a systematic, deliberate way, especially planning to learn from teaching.
2. It is not good enough for teachers, or teacher educators, to become better skilled practitioners or to accumulate knowledge for their individual practice. Building a knowledge base means that every teacher is responsible to help others learn from each individual's experience.
3. Because teachers teach by planning and delivering daily lessons, and because lessons are large enough units to contain the important interactions in the classroom but small enough to study intensively, we focus much of our work on studying and improving lessons. The outcomes include more general principles of teaching that span individual lessons.
4. Reforms have a way of contributing to pendulum swings buffeted by the latest fads; long-term steady, lasting improvement, even though incremental, has much greater payoff in the long run.



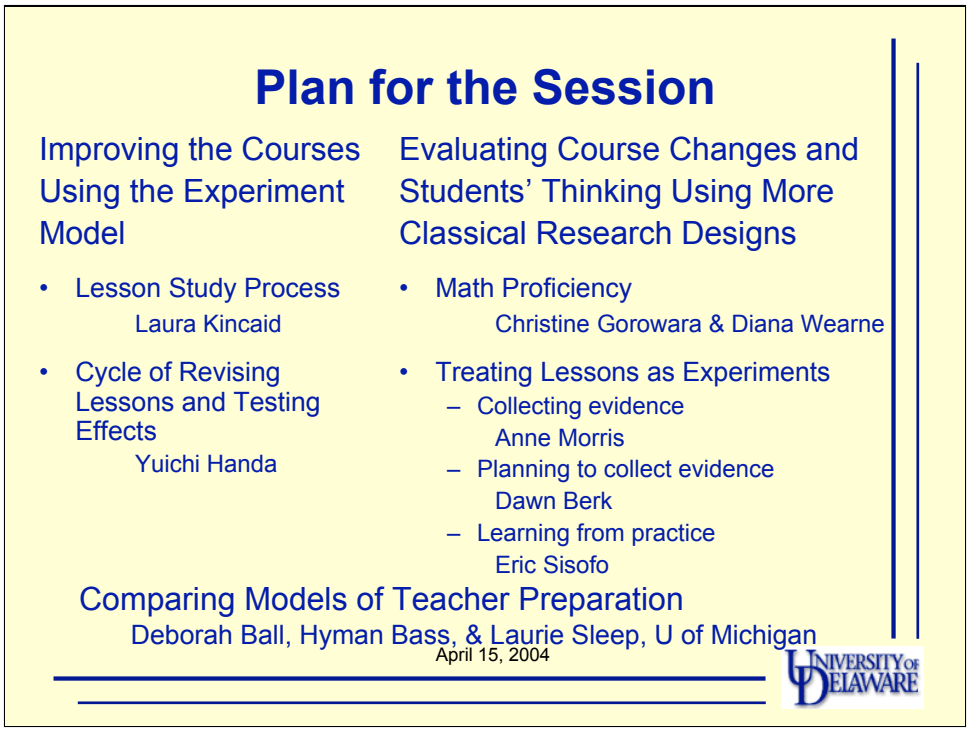
The origins of the principles or assumptions of our model are difficult to trace, but the notion of learning from planned experience has a source that links directly to the concept of treating lessons as experiments.



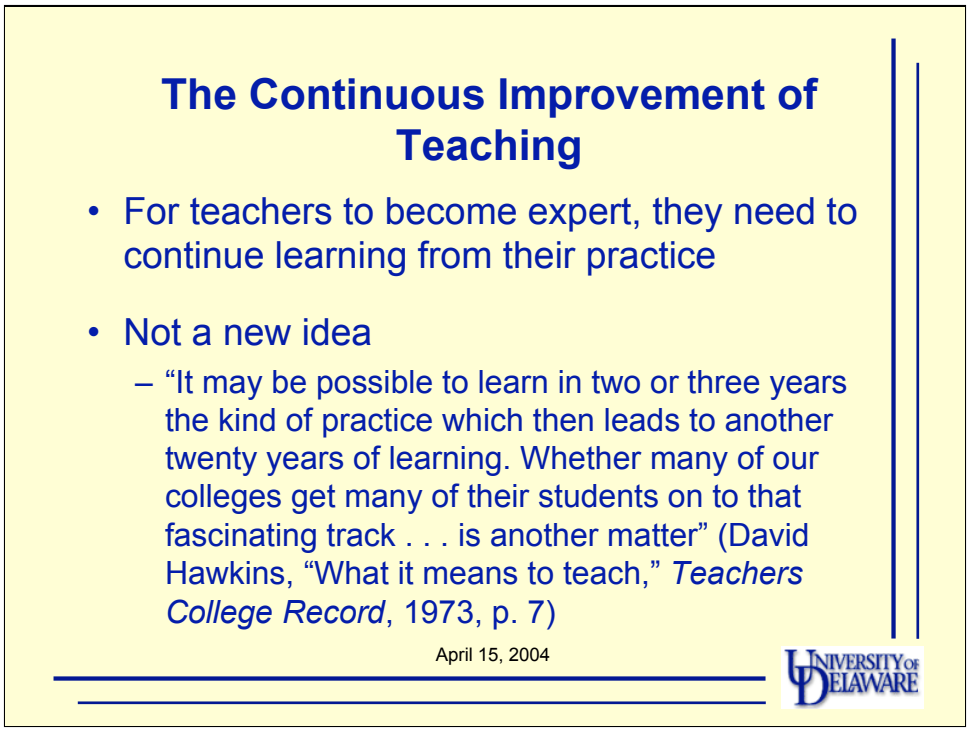
Everyday, teachers engage in the familiar routine of planning lessons, implementing them, and reflecting on how well they worked. What if we could slow down these phases of teaching and think of them as contributing to conducting careful, intentional "experiments."

The three phases of teaching could include much more than just planning a sequence of activities, implementing them with students, and making a few quick mental notes about which ones worked well. Unpacked as shown on this slide, it is possible to see how lessons could become experiments. Treating even a few lessons in this way would give teachers the chance to study teaching systematically.

The phase of teaching on which educators usually focus their attention is "implementing"—teaching the lesson. This is where the "rubber hits the road." But this also is the phase that can depend on personality traits and extemporaneous decision-making. We are especially interested in planning and reflecting--phases in which all teachers, regardless of their "natural gifts," can improve through study and hard work. In addition, it is these two phases that will produce significant aspects of a growing knowledge base for teaching.

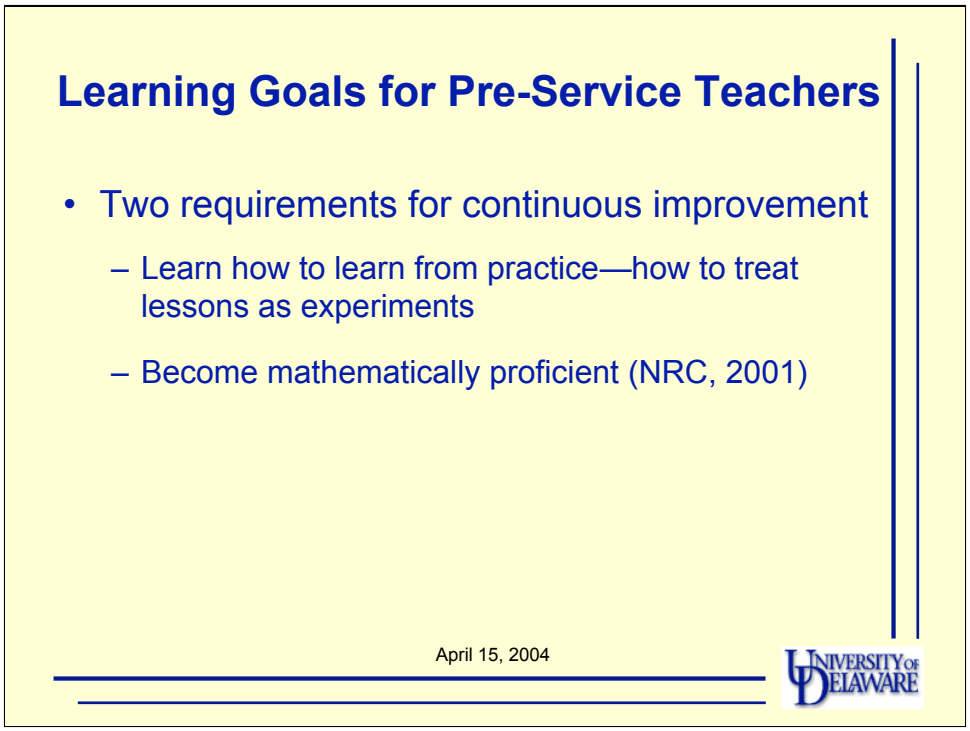


We organized the session to highlight the fact that we are developing and testing the model by engaging in two kinds of research processes. The first is a modified version of lesson study in which instructors for each of the pre-service mathematics courses engage in semester long collaborations to implement and then improve the lessons for the course. The second includes more classic research designs that, at this point in our work, are focusing on the entry abilities of pre-service teachers to engage in the individual processes necessary for treating lessons as experiments.



One assumption in our model of continuous improvement is that we cannot develop pre-service teachers into expert teachers in four years. Rather, for teachers to become expert, they need to continue learning from their practice.

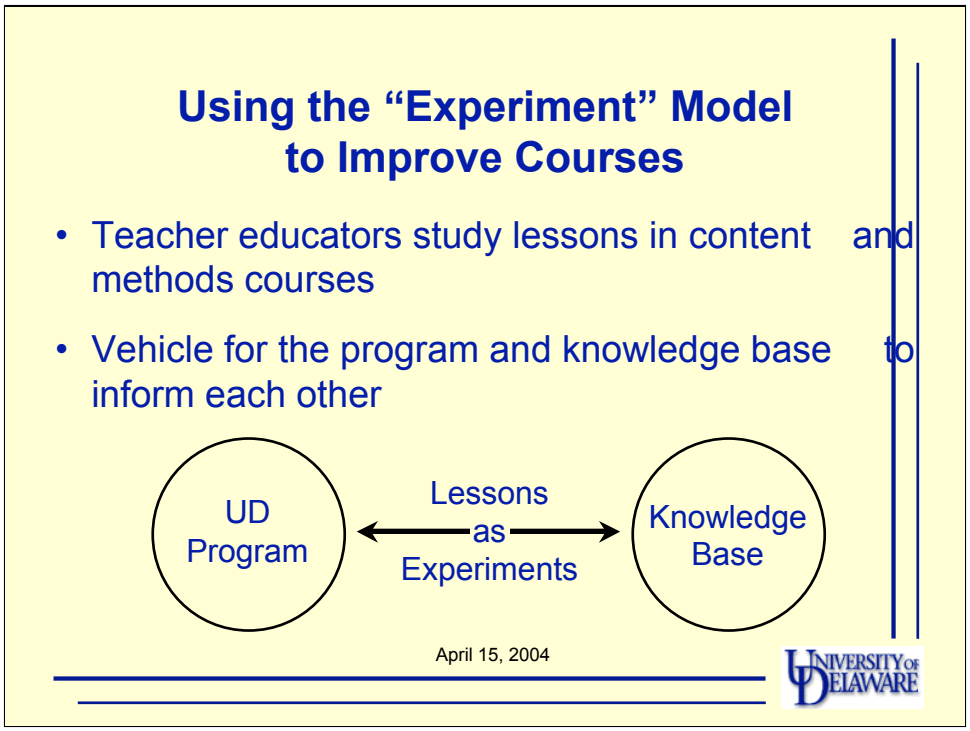
This desire to have teacher education programs develop life-long learners is another of the old ideas on which we are building (see quote).



In the UD teacher education program, there are two learning goals for pre-service teachers. These express our fundamental values. We believe they are required to continually improve one's teaching.

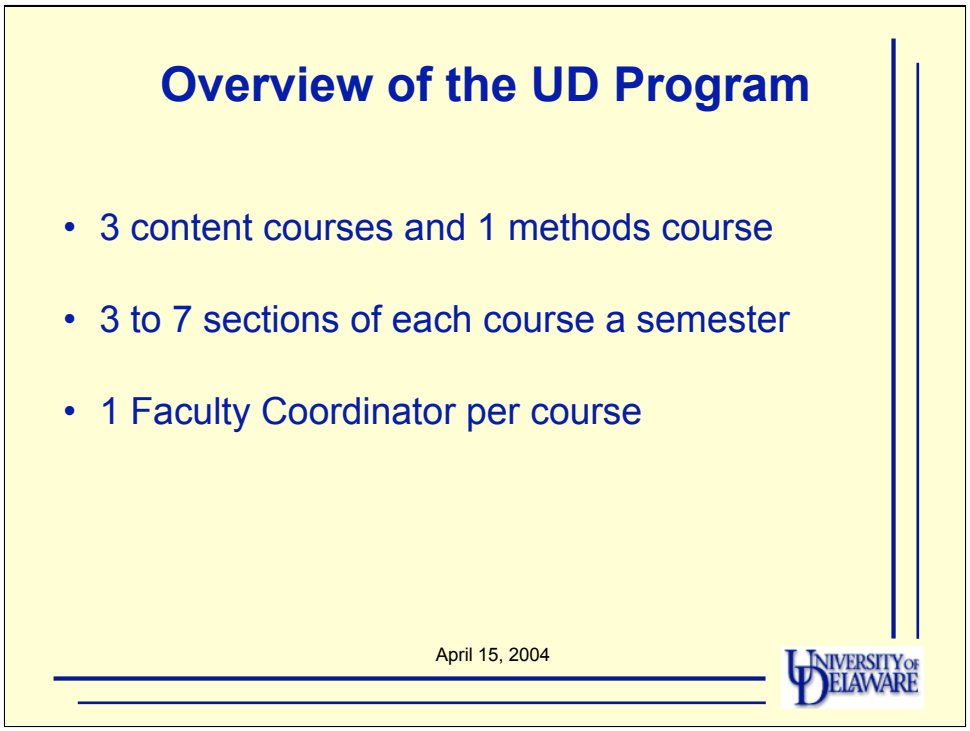
The second goal of mathematical proficiency is included because skills to learn from one's practice are not enough.

This set of goals applies to two groups of people in our program: pre-service teachers and teacher educators.



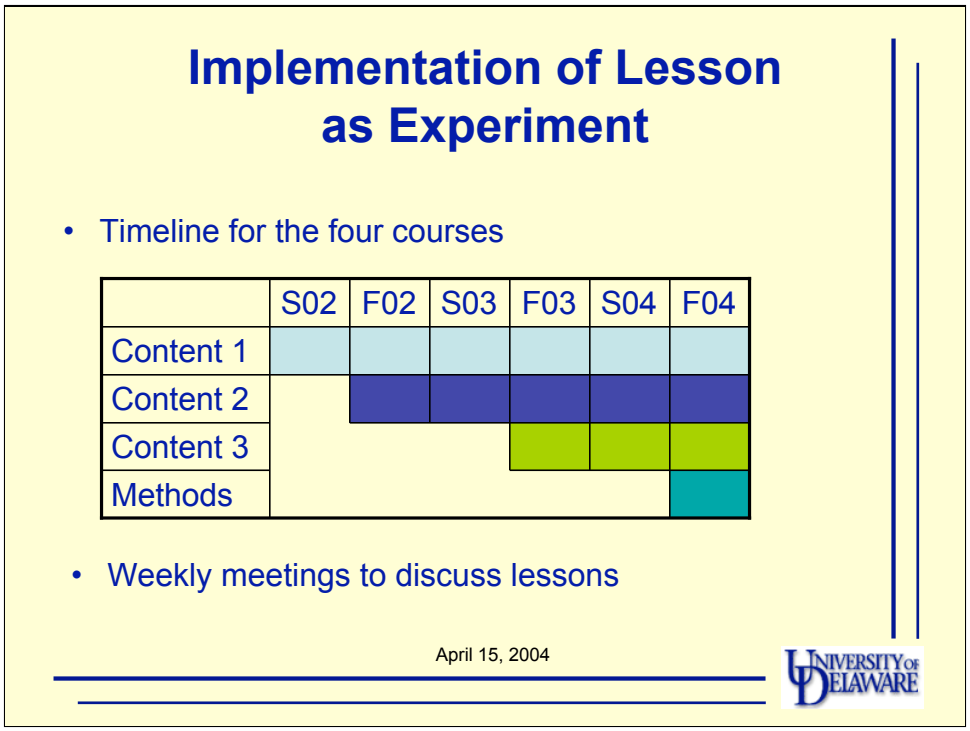
Our teacher educators have the opportunity to treat lessons as experiments when teaching mathematics content and methods courses for pre-service teachers. By doing so, lessons as experiments become a vehicle for the program and knowledge base to inform each other.

For example, a group of instructors for a particular course create a set of lessons (refer to the "UD program" circle). Then, they study these lessons by collecting data during the enactment of the lesson and analyzing it (refer to the "Lesson as Experiment" arrows). Finally, these data and the revised lessons based on the data contribute to the knowledge base on Teacher Education (refer to the "Knowledge Base" circle). These revised lessons now become the object of study for the next semester and the cycle continues. This feedback cycle allows for the gradual improvement of lessons over time.



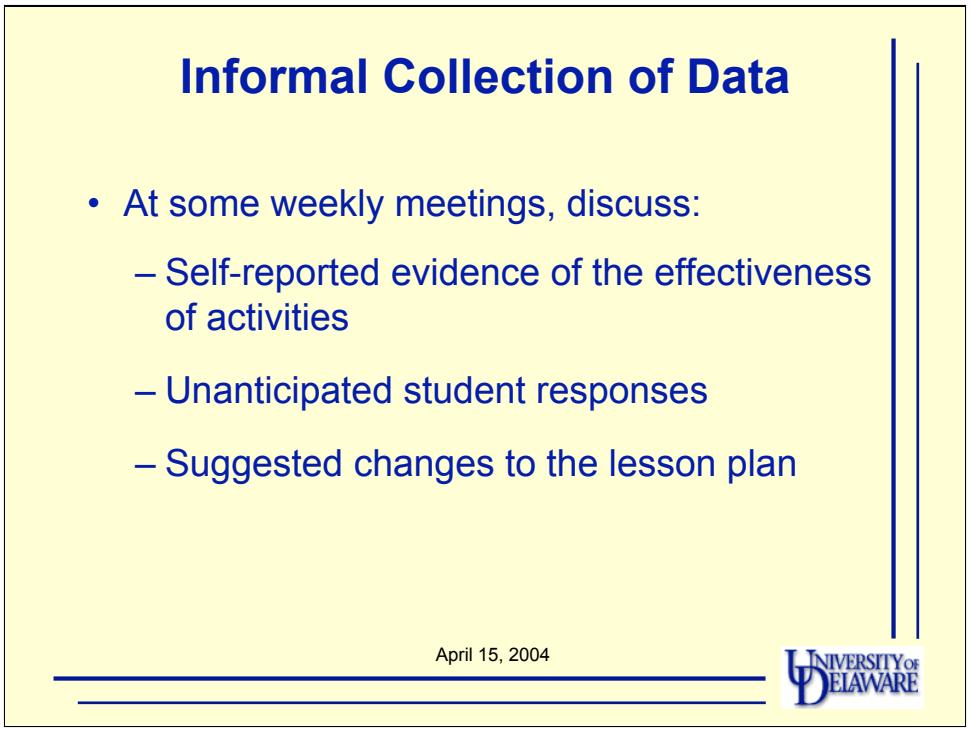
In the UD program, pre-service teachers take three mathematics content and one mathematics methods course. Most students begin this 4-course sequence their freshman year.

There is one faculty coordinator per course, and the other instructors are primarily doctoral students.

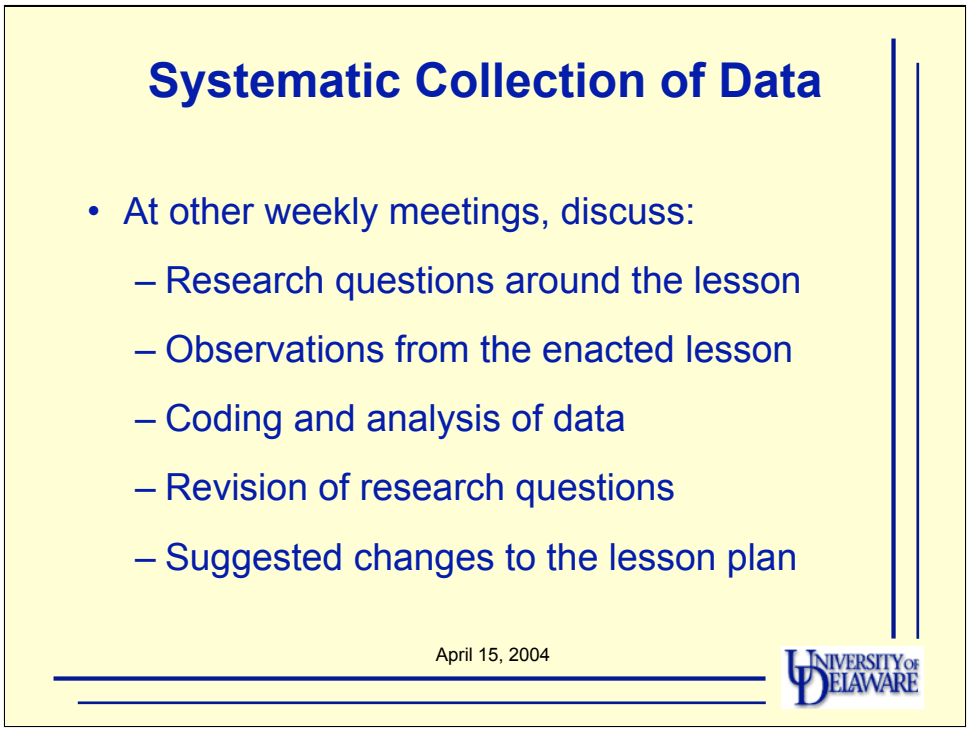


The treatment of lesson as experiment has been introduced, in sequence, across the four courses. The first content course adopted this model of continuous improvement in the Spring of 2002, and the methods course will implement this model this upcoming Fall semester.

When a course adopts this model to improve the course, the instructors meet weekly for 1-2 hours to discuss how they will study the lessons.



At some weekly meetings, the discussion centers around data that have been informally gathered. These data include instructors' impressions from teaching the same set of lessons, cross-class observations by the instructors, and feedback from students through usual class assessments.



Sometimes the collection of data is more formal.

The changes made to the lesson contain the knowledge gained through sharing information among instructors—these changes include notes for future instructors on key aspects of the lesson, anticipated pre-service teachers' responses to lesson tasks, and hypotheses regarding the learning benefits for particular activities that should be studied and revised the following semester.

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  Laura Kincaid
- Cycle of Revising Lessons and Testing Effects
  Yuichi Handa

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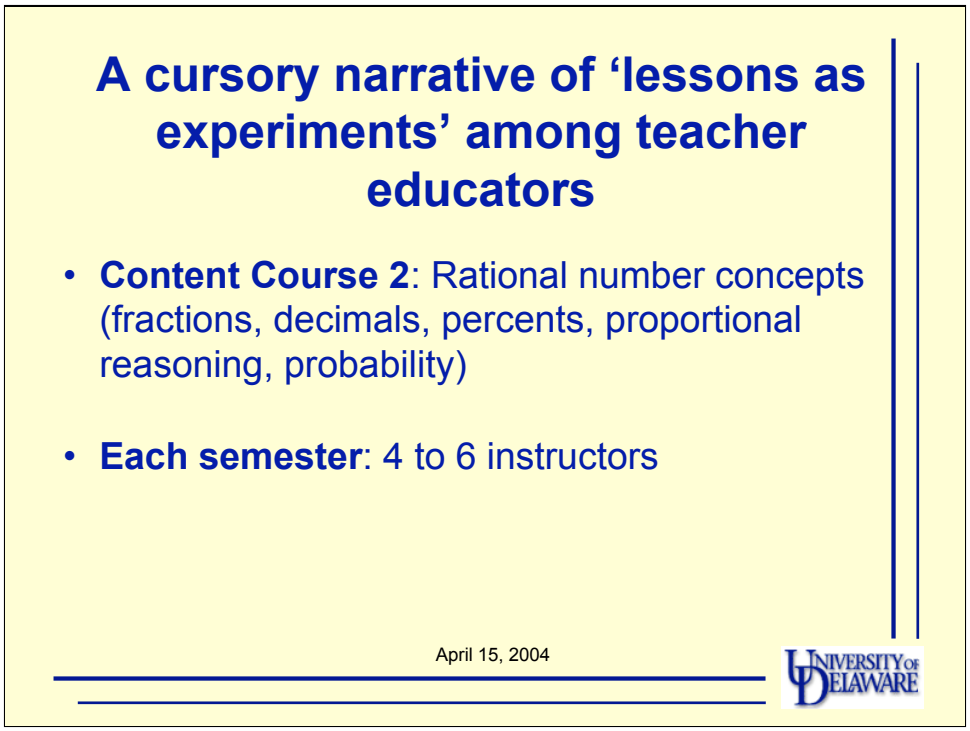
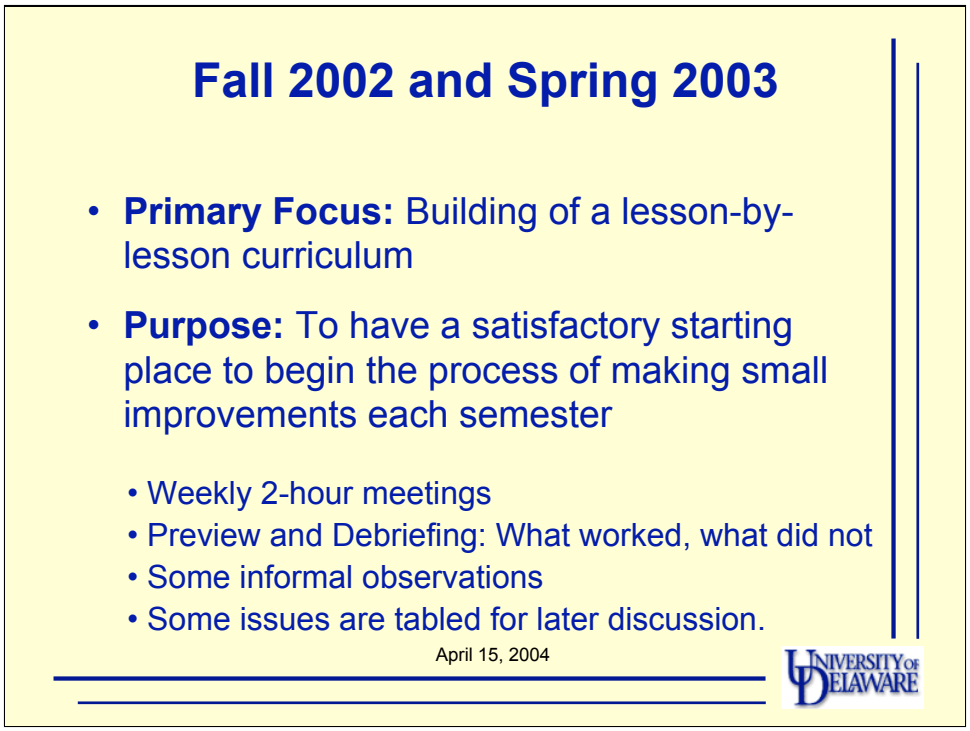
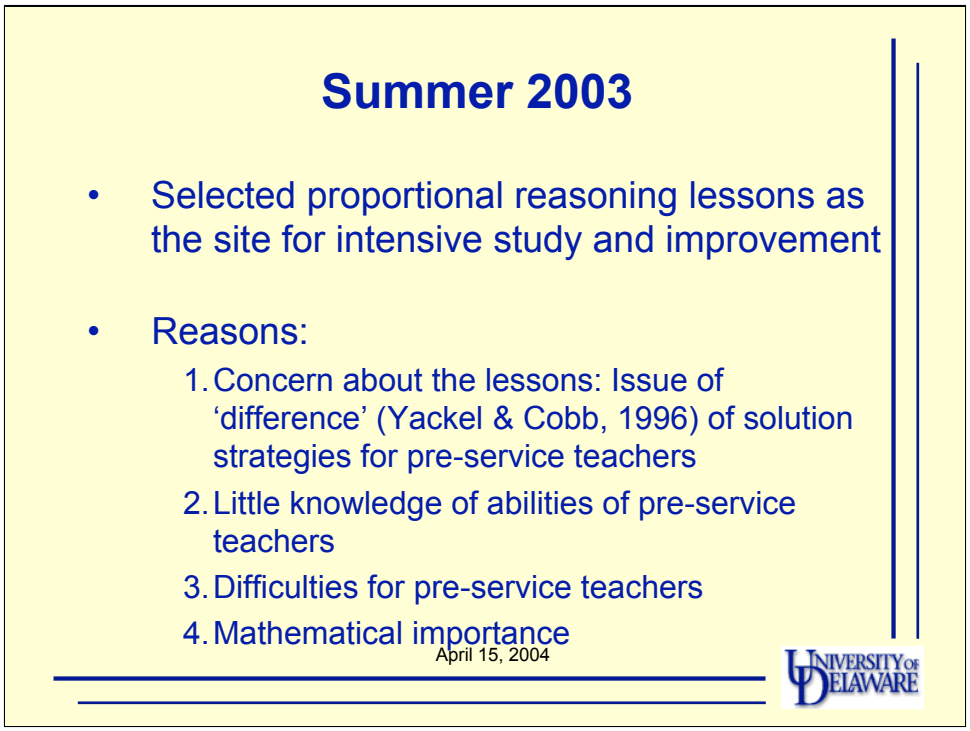
Comparing Models of Teacher Preparation
Deborah Ball, Hyman Bass, & Laurie Sleep, U of Michigan



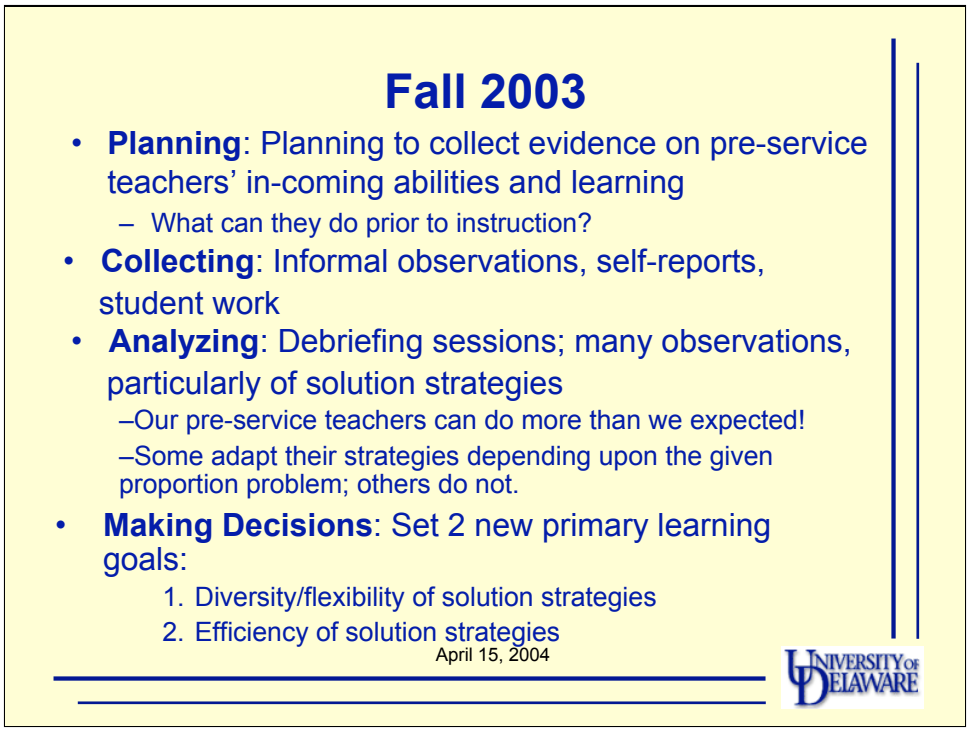
The second math content course in the 3-semester sequence focuses on rational numbers.



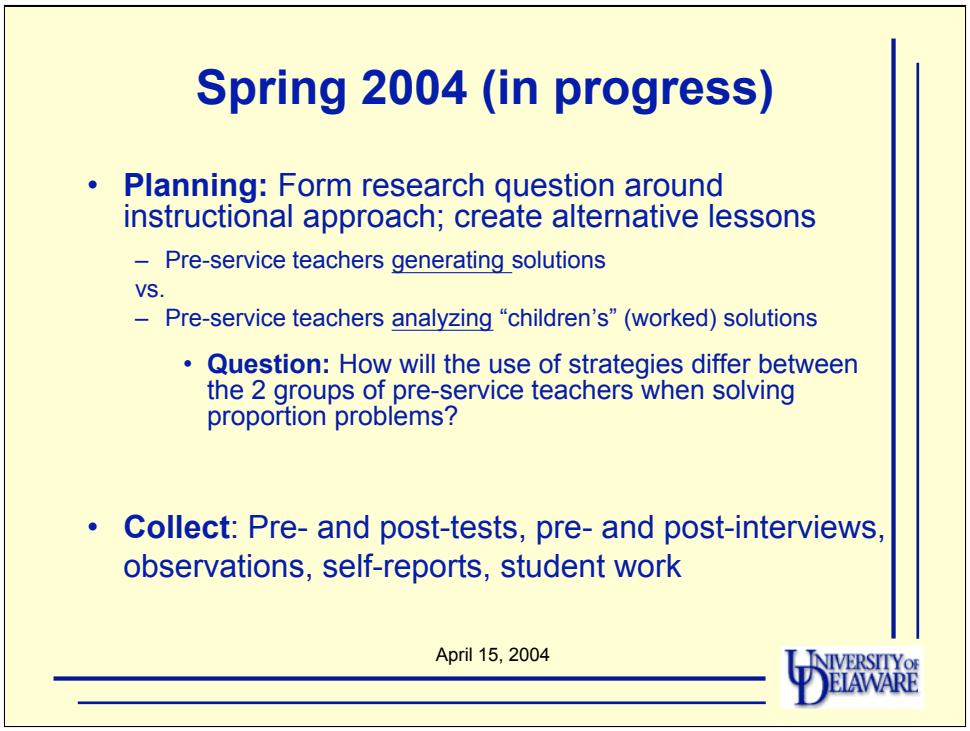
We began the course improvement process by developing a full set of daily lessons. We found this was necessary for studying teaching at the detailed level that we believe is essential for generating useful knowledge for teaching.



Once a curriculum was in place, we could begin studying a few lessons more intensively.



This academic year, we have been studying proportional reasoning by applying the continuous improvement model to our own work as teacher educators. We are emphasizing those aspects of teaching that involve careful and deliberate planning and reflecting.



Currently, we are conducting a targeted research study on the effectiveness of several proportional reasoning lessons. We have developed two different approaches to teaching these lessons and are collecting evidence on what kinds of learnings result from each approach. We will use the data to revise the lessons for next semester, perhaps selecting the more effective approach, and we will revise our hypotheses regarding links between instructional activities and pre-service teachers' learning.

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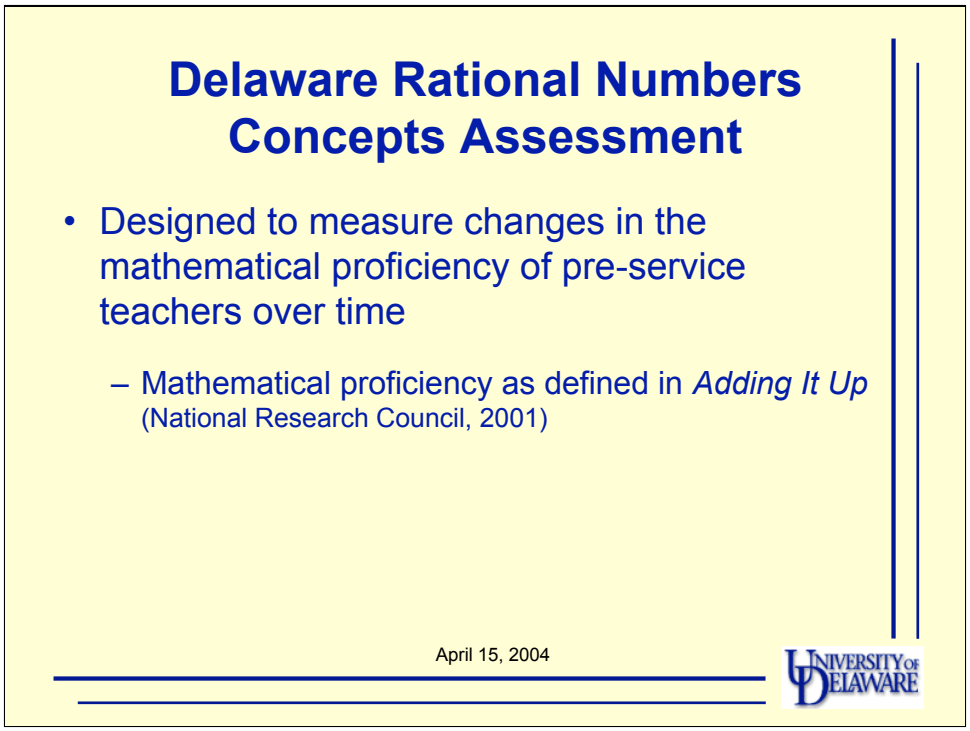
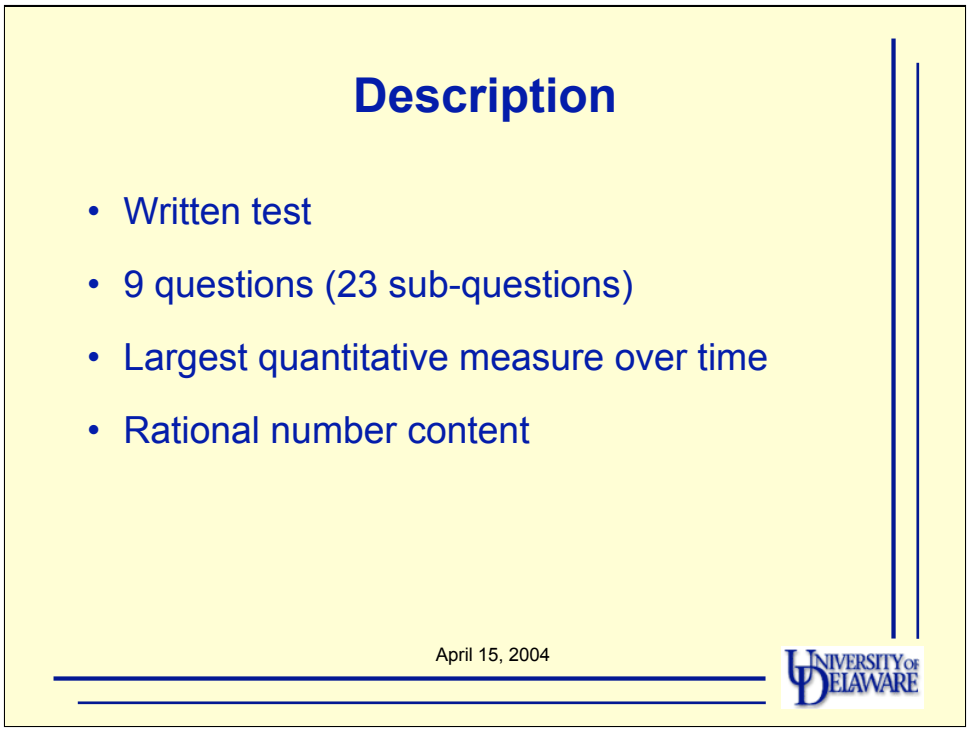
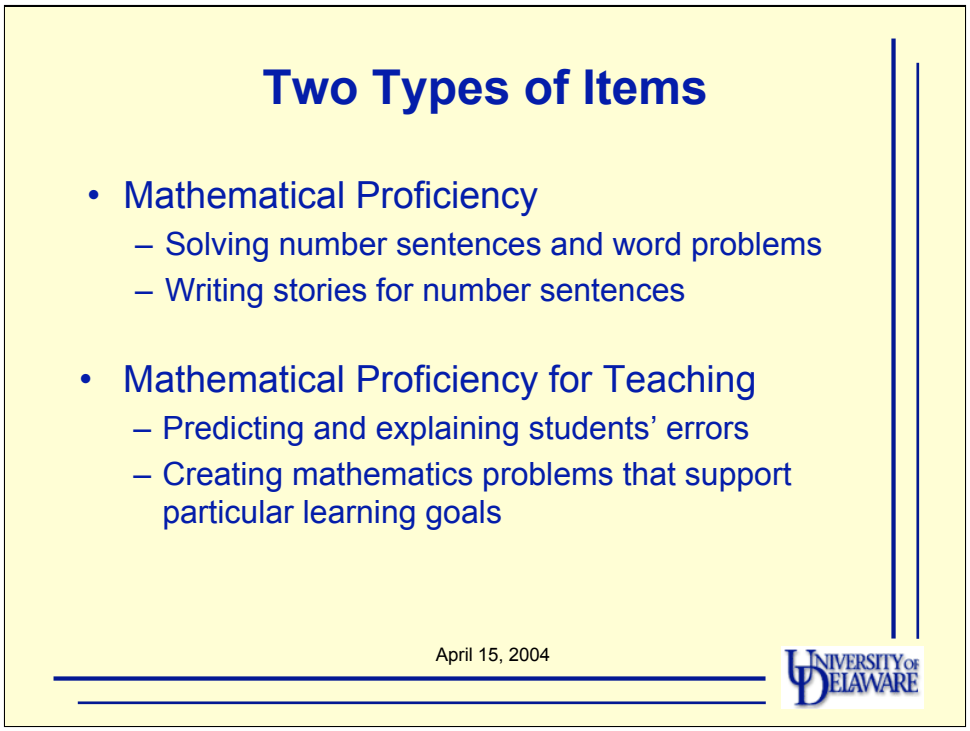


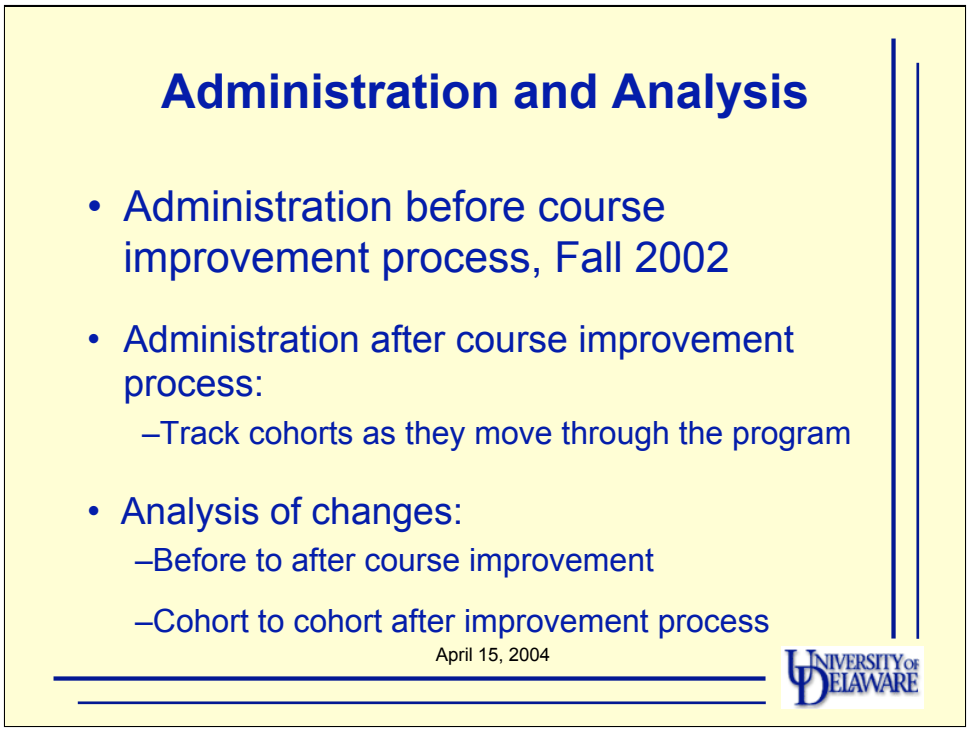
The Lesson Study process summarized on the previous slides focuses on making and measuring local improvements in a single course. We also have a large-scale assessment that measures changes over time across all four of our mathematics courses.



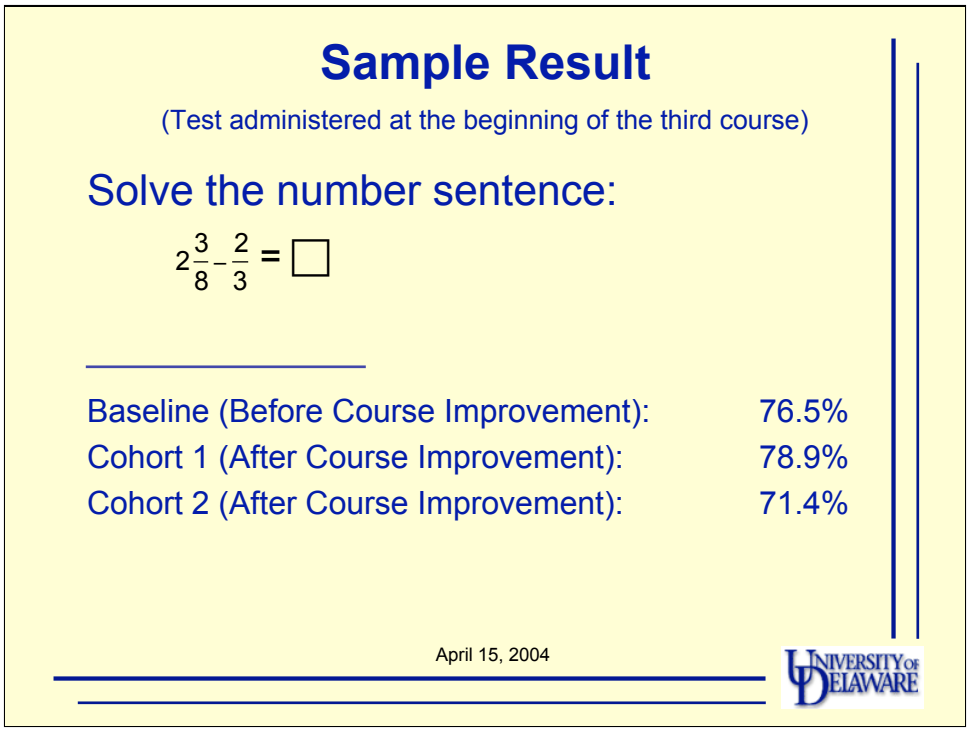
There are several reasons that our assessment focuses on rational number content. First, the literature indicates that this is an area of difficulty for pre-service teachers. Second, the focus of the second content course is rational number concepts, and rational number concepts are a part of all four courses. Third, rational number concepts are important foundationally for more advanced mathematics, such as algebra.



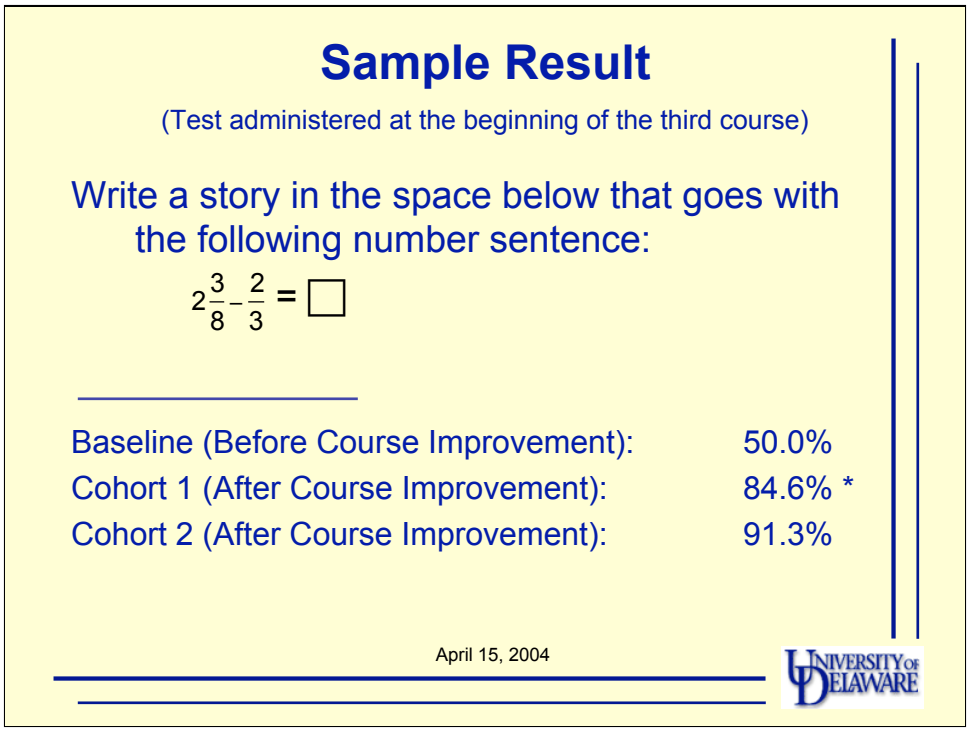
These items are presented in written form, many of them open-ended. Examples of these items, along with assessment results of those items, are given in later slides.



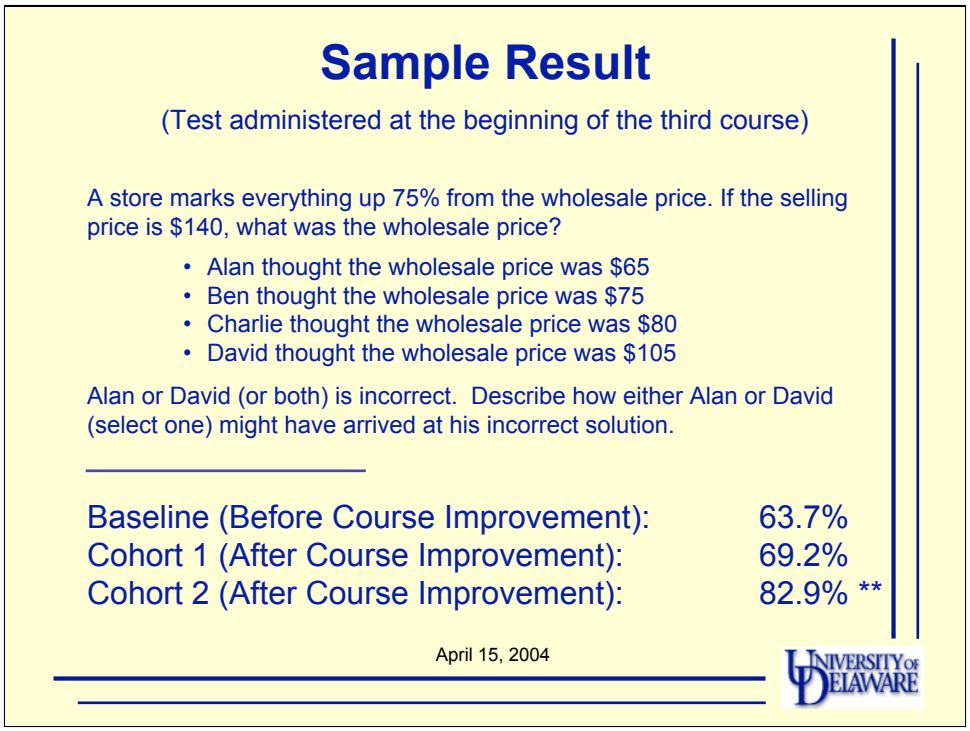
All students in all four courses were given the assessment in Fall 2002, before the course improvement process began, in order to establish a performance baseline. Students in the cohort that began the course sequence in Fall 2002 (Cohort 1) and students in the cohort that began the course sequence in Spring 2003 (Cohort 2) have been assessed at the beginning of each semester.



This is an example of a straightforward item that requires pre-service teachers to solve a number sentence. The slide shows the percentage of students who responded correctly after completing the rational numbers content course. There is no statistical difference in the percentages responding correctly.



This is an example of a item that requires pre-service teachers to write a story for a number sentence. Again, the pre-service teachers in each group were tested after completing the rational numbers content course. The difference between the Baseline and Cohort 1 is statistically significant at the 95% confidence level. The difference between Cohort 1 and Cohort 2 is not significant. It appears that the initial changes in the course positively affected pre-service teachers' learning of this skill but the later changes, which were less substantive, did not affect their learning.



This is an example of a item that requires pre-service teachers to explain student errors. Again, the pre-service teachers in each group were tested after completing the rational numbers content course. There is no difference between the Baseline and Cohort 1, but the difference between Cohort 1 and Cohort 2 is statistically significant at the 90% level of confidence. In this case, it appears that the second set of changes to the course had a greater influence on pre-service teachers' ability to explain student errors than the first set of changes. We plan to track changes in students' responses to similar items for the foreseeable future in order to understand the effects of course changes, even if minor.

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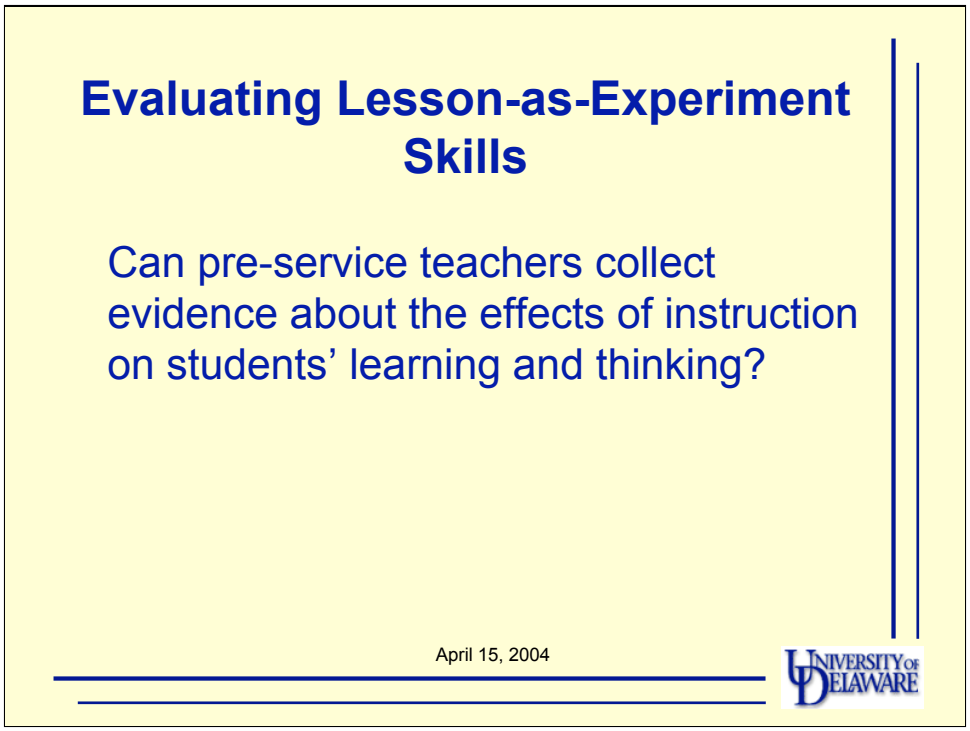
This study focused on whether beginning pre-service teachers could engage in one of the processes that we believe is critical for treating lessons as experiments—collecting evidence on the effects of instruction on students' thinking.

A more complete report of this study is available from Anne Morris.



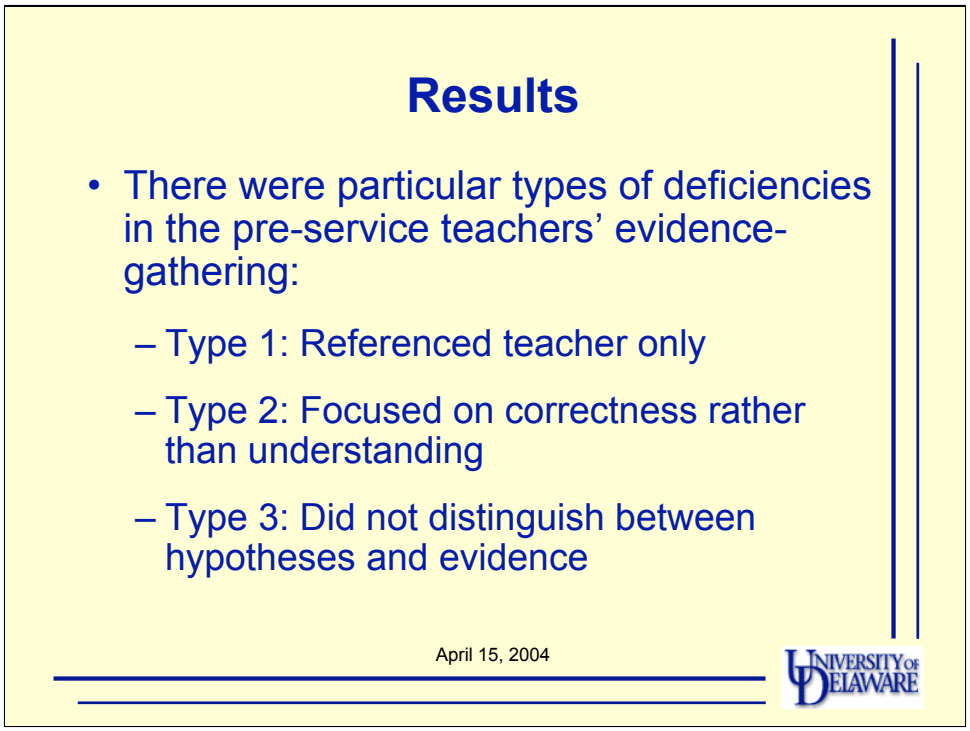
Information about the extent and nature of pre-service teachers' entry abilities to study teaching is useful for designing instructional activities in the courses that help them develop these abilities. A first question is whether beginning pre-service teachers can collect evidence about the effects of instruction on students' learning.

Research Question

What do pre-service teachers take as evidence for their hypotheses about the effects of instruction on students' learning?

Method

- 15 undergraduate pre-service elementary and middle school teachers
- All were enrolled in the first of the four courses in the mathematics teacher preparation program.
- Participants watched a videotape of a fifth grade lesson on the area of a rectangle and triangle.
- Participants were asked to form a hypothesis about what the children learned and understood by the end of the lesson, and to support their hypothesis with evidence.



Only one aspect of the findings are presented here. Consult the full paper for a complete report of the results.

Type 1: Referenced Teacher Only

- 40% of the pre-service teachers supported at least one hypothesis about students' learning with empirical evidence that referred only to the teacher's explanations.
  - "The children understand the concept behind square units. [My evidence for this is] the teacher introduces square units and starts giving examples on the board."
  - "The children understand that the height and base are not always in the same places on a triangle. [My evidence is] because the teacher said that a triangle's height must always form a right angle with the base."

Type 2: Focused on Correctness

- For one or more of the covered concepts, 87% of the pre-service teachers accepted student responses that provided little information about student understanding as evidence for understanding.
- The pre-service teachers appeared to focus on the correctness of a response rather than the connection between the content of the response and the understanding that it was supposed to show.

Type 2: Examples

- "The children understand that area is the amount of space in an object. [My evidence is] they were able to count up the squares in the teacher's examples to see how many square units were in the rectangle."
- "The children understand that they always need a right angle to have a base and height. [My evidence is] the children give the base and height [when the teacher asks for the base and height of a figure on the board where the height is drawn as a dotted line and the dimensions are indicated]."

Type 3: Did Not Distinguish Between Hypotheses and Evidence

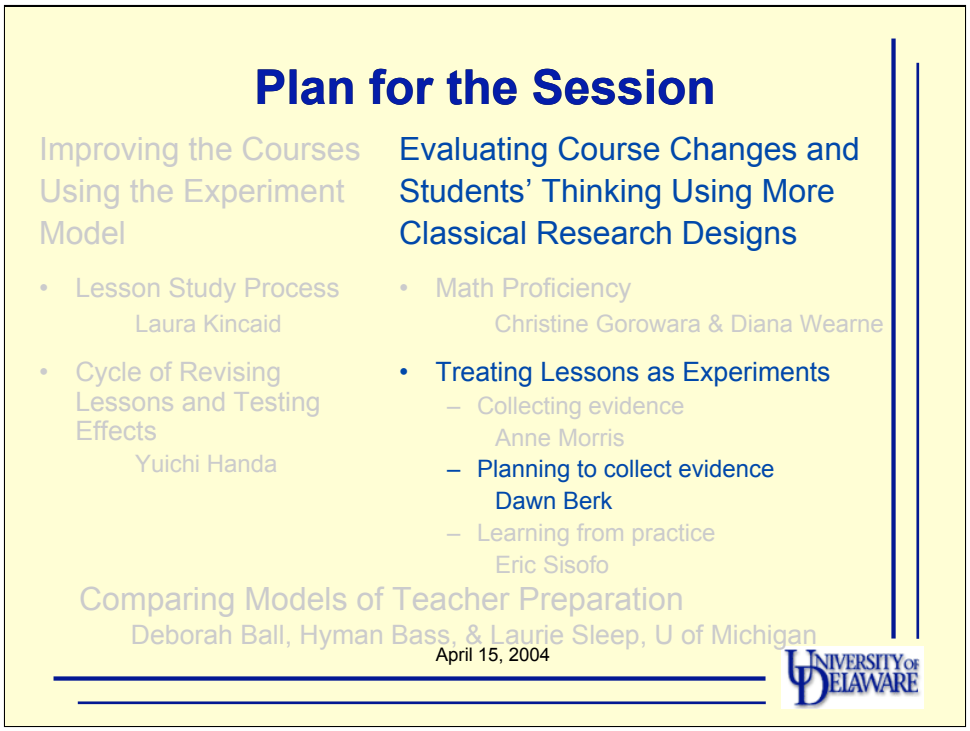
In 40% of the pre-service teachers' responses, the evidence included more hypotheses.

"The children know that they have to use a different formula when solving for the area of a rectangle/square in comparison when solving for the area of a triangle. [My evidence is] the students knew that since [this] is a rectangle/square they would need to use the formula Area = l × w. On the other hand, if the students were given [a triangle] the students knew since you can't count up the number of squares in a triangle (some are 1/2, 1/4 squares), they need to use another type of formula. When solving the area of a triangle they would use the formula Area = 1/2 × b × h. They knew that they had to use base × height because they needed to use two numbers where the lines created a right angle."

April 15, 2004

UNIVERSITY OF DELAWARE

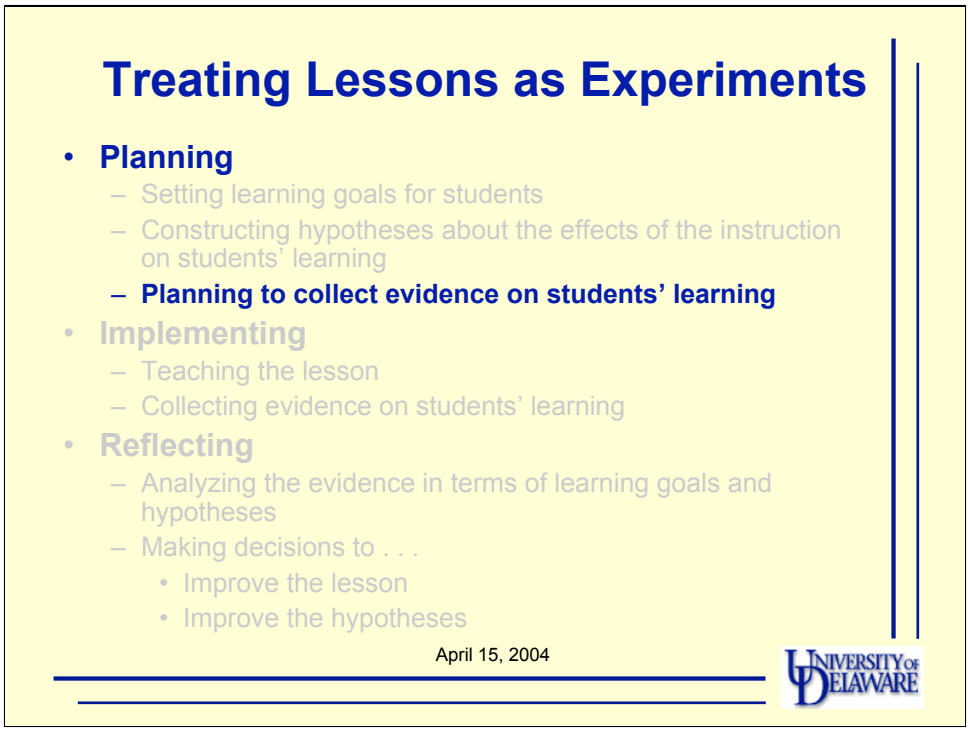
The underlined portion of this response is the only evidence provided; the rest of the comments are more hypotheses.



A forthcoming study will build on the previous study by investigating the effects of asking pre-service teachers to plan to collect evidence before viewing a videotaped lesson. Will this analysis beforehand help pre-service teachers look for different kinds of evidence (e.g., will it help them learn different kinds of things from viewing a videotaped lesson)?

Purpose of the Study

- Build on findings from study on supporting hypotheses with evidence
- Test out an important component of our model – Planning



Planning to collect evidence is another component of the more complete model of teaching in which we are situating our work.

Why investigate planning?

- Research suggests that planning matters
  (e.g., Gollwitzer 1996, 1999; Diefendorff & Lord, 2003)
- Planning might affect what pre-service teachers see in the classroom
- Planning might help pre-service teachers assume a more critical stance

Research Questions

- What kinds of evidence do pre-service teachers plan to collect, and what kinds of evidence do they actually collect?
- How does the process of planning to collect evidence…
  - Affect the nature and quality of the collected evidence?
  - Affect pre-service teachers' analysis of a lesson?
  - Affect pre-service teachers' teaching (specifically, their lesson planning)?

Participants

- 30 pre-service teachers enrolled in 2nd mathematics content course
  - Randomly selected
  - Randomly assigned to control group (n = 15) or treatment group (n = 15)
- 15 pre-service teachers enrolled in mathematics methods course
  - Randomly selected
  - Assigned to the treatment group

Method

Both groups…

- Charged to assess the effectiveness of a math lesson

Before viewing the videotape…

- Control group read the lesson plan
- Treatment group read the lesson plan and planned for what evidence to collect

Method, continued

Both groups then completed three tasks…

- Viewed videotaped lesson twice and collected evidence
- Used evidence to evaluate the effectiveness of the lesson
- Used evidence and analysis to make revisions to the lesson

Results

(Available Fall 2004)

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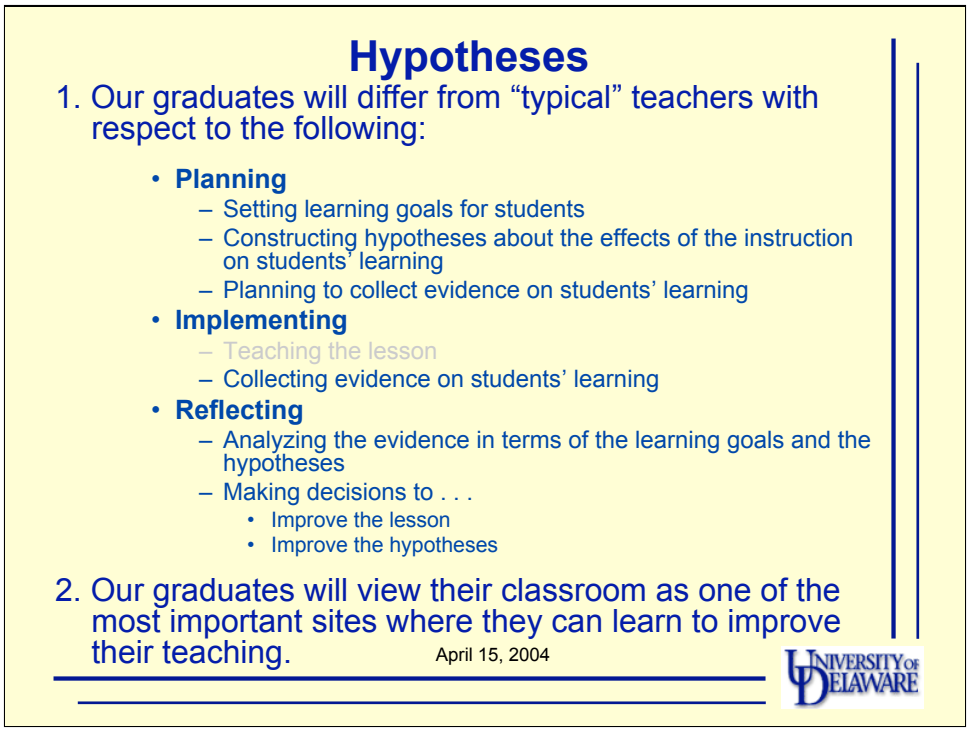


We have two primary hypotheses about how the graduates of our program will differ from non-graduates. First, our graduates will differ in the way they engage the usual phases of teaching:

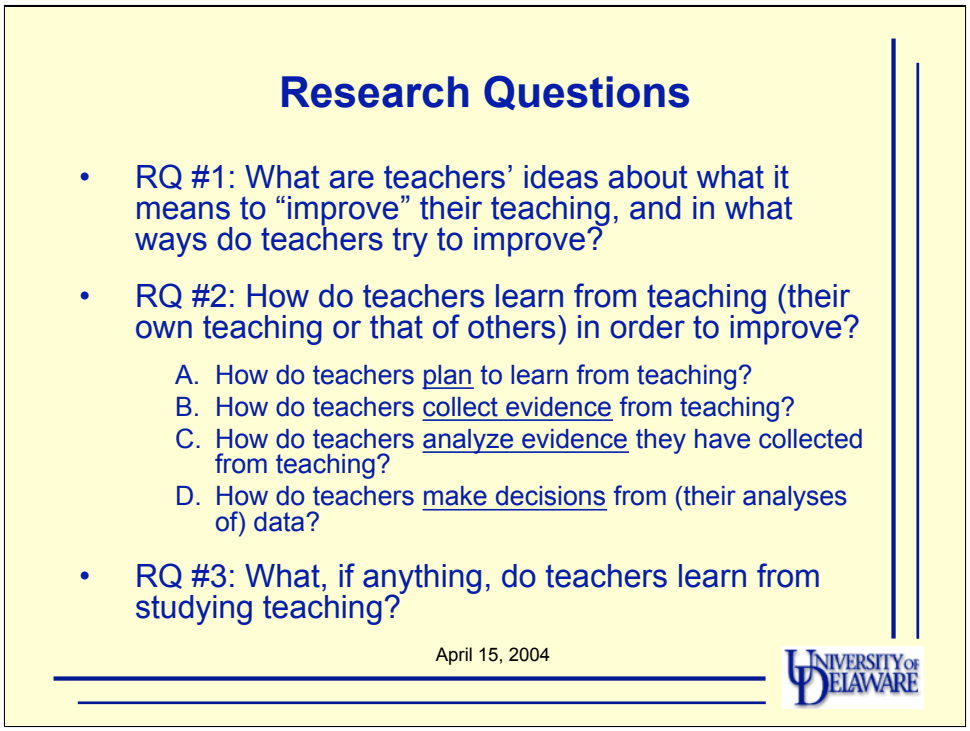
(1) How they plan to learn from teaching,

(2) How they collect evidence from teaching,

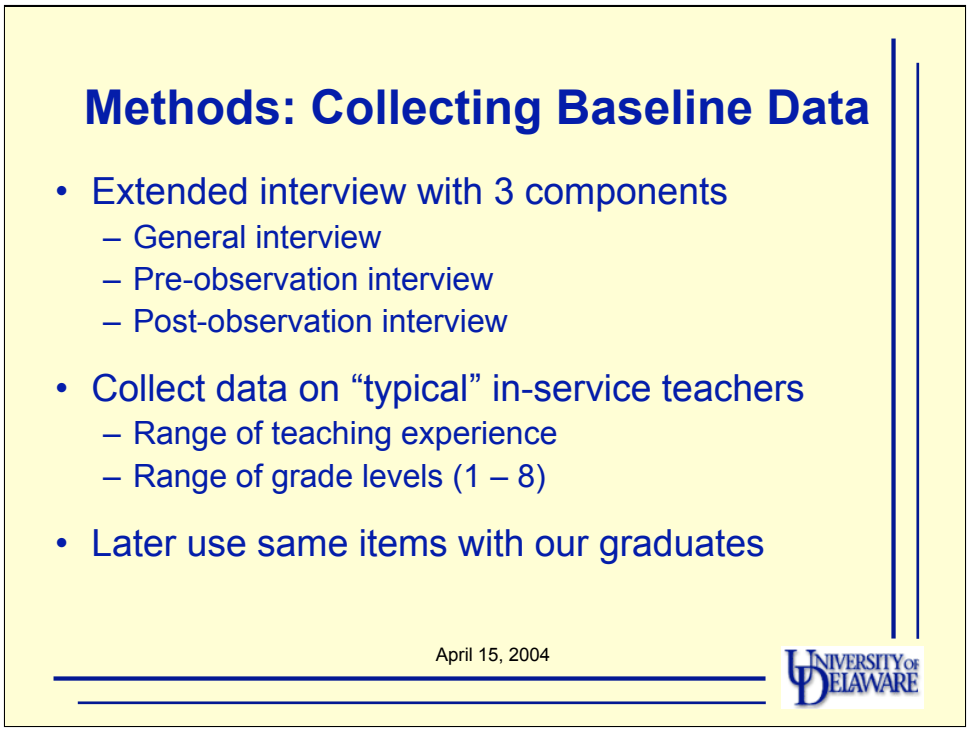
(3a) How they analyze evidence they have collected from teaching, and

(3b) How they make decisions from their analyses of data in order to improve.

Second, our graduates will, to a greater extent than non-graduates, view their classroom as one of the most important sites where they can learn to improve their teaching.



To test these hypotheses, we are conducting a study now on how non-graduates ("typical" practicing teachers) learn from their practice. We have three research questions, shown on this slide, to guide data collection. We will collect comparative data from a sample of graduates as soon as they enter the field.



We are using an extended interview format that includes a general interview and a pre- post- interview around a specific lesson. Participants have a range of teaching experience and are teaching in a range of grade levels 1 - 8. We will use the same assessment items with our graduates when they begin teaching and then run the appropriate comparisons.

Results

(Available Spring 2005)

Summary

- The UD mathematics education group is committed to developing and testing a continuous improvement model for teaching.
- This process provides a vehicle for learning how to build a knowledge base for teaching and teacher education.
- As the work proceeds, it is becoming apparent that we also are building a community that learns from its own experience—in a planned, intentional, and incremental way.