

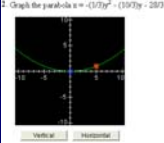
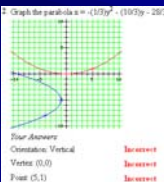
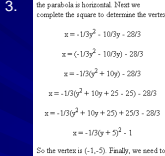
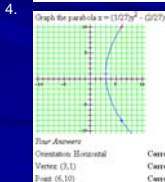
Measuring Transfer and Conceptual Learning Using Online Procedural Tools or Data-Mining an Online Homework System

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Why Use Online Homework?

- For the student
 - Multiple attempts
 - Immediate feedback
- For the teacher
 - Automatic grading
 - No shuffling papers

Our Online Homework

1. 
2. 
3. 
4. 

A Business Model

- Amazon.com found a way to order and ship lots of different books more easily.
- We have ways to provide problems and solutions to our students more easily.
- Amazon.com then studied how people used the site to do a better job selling books online.
- We need to do similar work to do a better job teaching math.

What Are They Learning?

- Procedural Knowledge
 - Rote memorization of procedures for solving specific problem types
- Conceptual Knowledge
 - Trying to understand why things work
 - Building different models of ideas

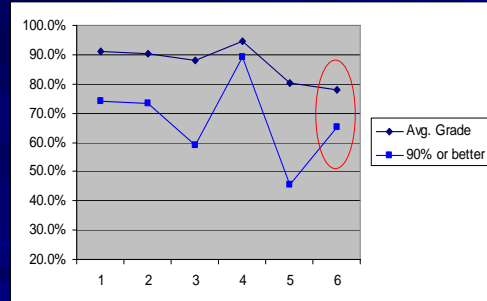
Recognizing Conceptual Learning

- Traditionally measured with clinical interviews
 - Provides rich data
 - Time consuming
- Can we recognize conceptual learning from online results?
 - Data is less rich
 - But there is a lot more of it

Recognizing Conceptual Learning

- Recognize when class grapples with new concepts
 - Criterion: Divergence between % of A's and average score.
- Recognize whether students are learning conceptually
 - Criterion Acceleration through related assignments

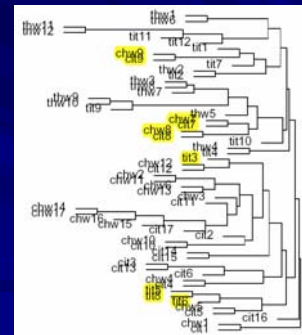
Performance on Trig Assignments



Transfer of Learning

- How can we tell if students are transferring concepts to later work?
- Criterion: Assessments in different courses (taught in different semesters) that are more closely correlated than assessments in the same course demonstrate transfer.
- This criterion is hard to satisfy.

Trig and Calculus 2

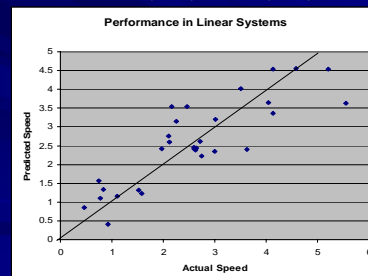


Transfer to Other Disciplines

- Best measure of transfer is speed of learning new material.
- Compare work of electrical engineering students in differential equations to the speed with which they mastered online assignments 2-4 semesters later in linear systems.
- Use stepwise linear regression to build a predictive model

Final Model

$$\text{ite total} = 0.16601 - 1.61483(\text{itm2}) - 2.38427(\text{itm3}) + 2.74966(\text{itm4}) + 2.23541(\text{itm15}) + 0.25721(\text{hwml7})$$



Testing The Model

- The model is statistically significant (p-value less than 4×10^{-6})
- The model appears suitable for predicting future success
 - Explains over 65% of variation
 - F-statistic exceeds critical value (95% conf. level) by a factor of over 5.
- Key variable is acceleration of learning in differential equations

Summary

- Can detect conceptual learning from procedural work given sufficient data
- Conceptual learning as measured can be correlated to successful transfer.

Future Research

- Can we develop accepted measures of transfer?
- Can we develop accepted measures of conceptual knowledge that can be readily evaluated?
- Can we get real time feedback on how well the class is learning?

Acknowledgements

- I'd like to thank all the colleagues and students who worked with these online tools.
- I'd like to particularly thank my collaborators: J. Bergner, E. Lawrence, G. Neumann, and E. Verbych.
- This work supported by NSF Grants REC-0087788 and DUE-0206943