Rational Cognitive Task Analysis 3
Goals for today

• Quick review/example
  – CTA => instructional redesign
    • OLI Statistics online course (CTA1 slides)
  – CTA => automated instruction
    • algebra cognitive tutor example

• Discussion of Aleven, Klahr, & Siegler
  – What are the tasks?
  – What CTA methods used?
  – What is the output of the CTA?
  – How is (or could) CTA used to improve ed?

• Applying CTA to your own research
CTA and instructional design

- CTA yields a representation of knowledge or a “cognitive model” of student thinking
  - Model has elements: production rules, concepts, skills, schemas ... “knowledge components” (KCs)
- Cognitive model guides instructional design
  - Direct verbal instruction corresponding with KCs
  - Select activities: Examples & tasks
  - Order activities: Aid learning of then- and if-parts
  - Assess & remediate based on KCs
  - Make intermediate steps visible (reify)
Secondary point

• Another example (besides Zhu & Simon) that production systems can represent multiple solution paths
An airplane has sunk off the coast of South Africa at a depth of 12,730 feet. The military has located the airplane and are in the process of raising it to the surface. It is currently 7625 feet below the surface and is being raised at the rate of 165 feet per hour. (Hint: Consider the direction above sea level to be positive)

1. How deep was the airplane five hours ago?
2. How deep will the airplane be five hours from now?
3. When did the military start raising the airplane?
4. When will the airplane reach the surface?

To write an expression, define a variable for the time from now and use this variable to write a rule for the depth of the airplane.

**Use equations, symbolic calculator**

-7625+185H = -12790
Add 7625
185H = -6,166
Divide by 185
H = -1,033/37
Cognitive Tutors: Combining Cognitive Psychology & Intelligent tutoring systems
Cognitive Tutor Technology
Use cognitive model to individualize instruction

• Cognitive Model: A system that can solve problems in the various ways students can

If goal is solve $a(bx+c) = d$
Then rewrite as $abx + ac = d$

If goal is solve $a(bx+c) = d$
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If goal is solve $a(bx+c) = d$
Then rewrite as $bx + c = d/a$

• Model Tracing: Follows student through their individual approach to a problem -> context-sensitive instruction
Cognitive Tutor Technology
Use cognitive model to individualize instruction

• Cognitive Model: A system that can solve problems in the various ways students can

   3(2x - 5) = 9
   6x - 15 = 9
   2x - 5 = 3
   6x - 5 = 9

   If goal is solve a(bx+c) = d
   Then rewrite as abx + ac = d

   Hint message: “Distribute a across the parentheses.”
   Known? = 85% chance

   If goal is solve a(bx+c) = d
   Then rewrite as abx + c = d

   Bug message: “You need to multiply c by a also.”
   Known? = 45%

• Model Tracing: Follows student through their individual approach to a problem -> context-sensitive instruction

• Knowledge Tracing: Assesses student's knowledge growth -> individualized activity selection and pacing
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Connecting to your research

• What domain would you do a CTA in?
• How would you do it?
  – Empirical or theoretical/rational?
  – Descriptive, prescriptive?
  – Which technique?
• How might you represent your results?
• How would you use your results to redesign instruction?