Problem-Solving through Think-Alouds

Katharine Clemmer, Jeremy McCallum,
Jeff Phillips, Thomas Zachariah
Loyola Marymount University, Los Angeles, CA

Where is the problem-solving?

Our questions

- How can we capture the decision-making processes needed to solve problems?

- And, then how can we help students be conscious of their thinking during problem solving and improve it?

Analysis of the situation

- Only 28% of employers classify college graduates' problem solving as excellent.

- Most textbooks and instructors do not model the non-linear thinking and decision-making required for solving problems,

- The student population will likely changing due to The Common Core State Standards and The Next Generation Science Standards.

- The Partnership for 21st Century Skills "Are They Really Ready To Work?" (2006) Available at <http://www.p21.org/documents/FINAL_REPORT_PDF09-29-06.pdf>
- Richard Mayer, *Learning and Instruction* (2nd ed). Upper Saddle River, NJ: Merrill Prentice-Hall. (2008)

Outcomes for today

- Tool to support students in learning the problem-solving process

- Technology options as a media to implement our tool.

- Strategies for implementing our tool
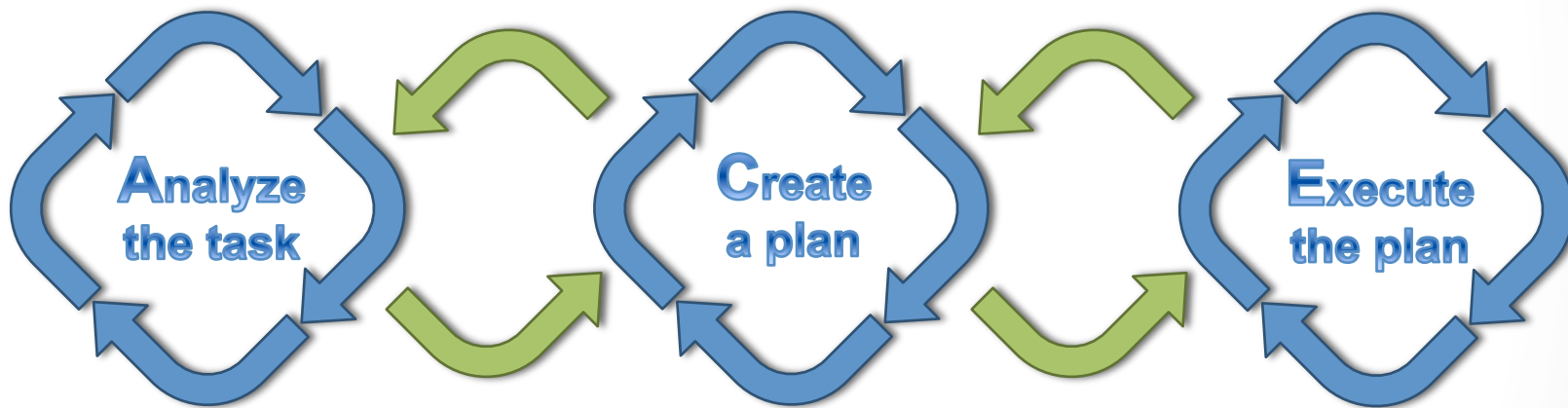
ACE 'EM Problem Solving Process

- *Analyze the task:* interpret and understand what is provided in the task.

- *Create a plan: connect the given information and goal with* models/concepts/relationships

- *Execute the plan: follow the plan until the goal is attained*

- George Pólya, *How to Solve It*, Princeton University Press (1945)

Listening to a think-aloud

In a think-aloud, a person verbalizes her thoughts while solving a problem to make the internal thought processes observable to others.

Analyze the task

Create a plan

Execute the plan

- Listen to the first five minutes
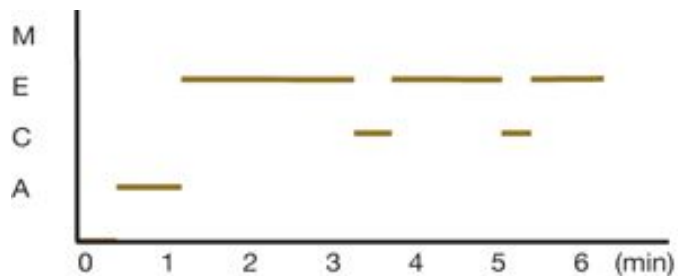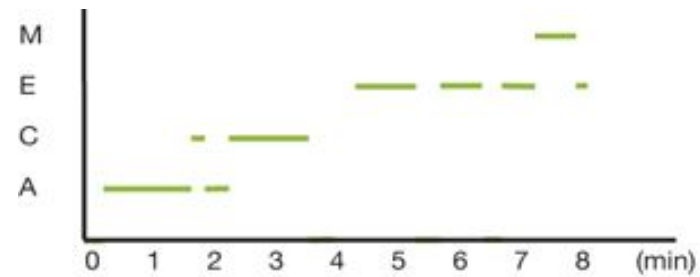- Write down times when you observe changes in the students' thought process.
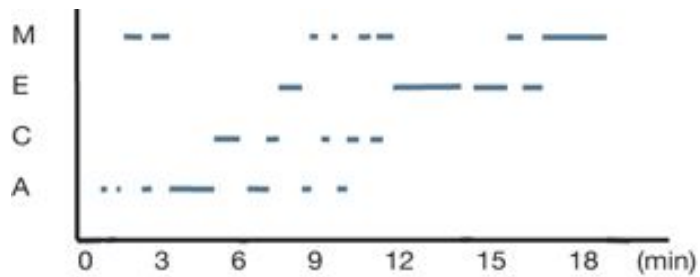
Complete picture of the problem-solving process

1. Self-monitoring embedded throughout the problem-solving process.

2. The only way to observe this process is with think-alouds.
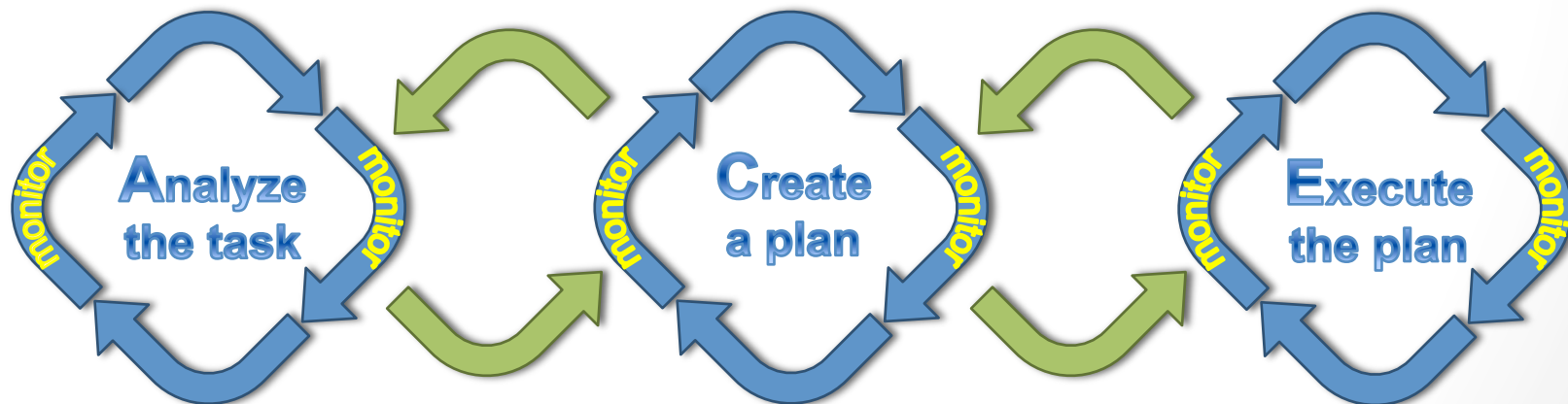
Using ACE 'EM to help students

ACE 'EM in action

- Analyze the problem independently (A only)
- In a team of 2 or 3, collectively create a plan to solve the task (C only)

All other things being equal, which lane is the fastest?

Capturing ACE 'EM

Choose someone in your group....

1. who will write and speak through problem solving process to find a solution to the task (think-aloud)

2. to write down the steps followed for problem solving during the think-aloud (ACE)

   Explain to your other students before you begin. Since they will be silent imagine them asking :
   - What are you doing now?
   - Why are you doing that?
   - I'm confused. Could you explain what you're doing?
   - Where did that come from?

3. to write down words/phrases that indicate monitoring during the think-aloud

Technology #1: smartpens

- When used with Livescribe Dot paper, a smartpen records and synchronizes pen strokes and audio to create a "pencast."

- Recorded pencasts can be transferred to a computer via a USB connection.

- From there, the recordings can be emailed or posted online.

- Pros:
  - Very portable
  - Less expensive than an iPad
  - Familiar interface (pen and paper)

Technology #2: tablets

- iPads and easy-to-use apps can record and display think-alouds.

- Videos can be shared immediately in the class or uploaded to YouTube, or other webpages.

- Apps:
  - Doceri
  - Educreations

- Pros:
  - Saves recordings in common file formats
  - Can incorporate outside images or videos
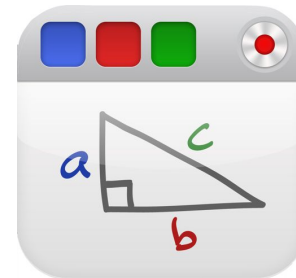
Classroom uses of ACE 'EM

- **Modeling**- Watching expert generated think-alouds

- **Apprenticing**- Watching student generated think-alouds

- **Scaffolding**- Students record think-alouds

Benefits of recording ACE 'EM

- Recording not only does helps to make the internal problem-solving process explicit for feedback, it also can shift students.

- Berardi-Coletta showed that with targeted instruction, verbalization led to more effective problem-solving.

- Verbalization helps students become aware of their thought process, thereby improving their ability to identify and correct own errors.

Berardi-Coletta, B., Dominowski, R. L., Buyer, L. S., & Rellinger, E. R. (1995). *Metacognition and problem solving: A process-oriented approach*. Journal of Experimental Psychology: Learning, Memory, and Cognition, **21**, 205-223.

Thanks!!!

- For more information on our PENS Project:
  - Visit <http://www.pensproject.com>
  - Email any of us:
    - Jeff Phillips, jphillips@lmu.edu
    - Jeremy McCallum, Jeremy.McCallum@lmu.edu
    - Katharine Clemmer, kclemmer@lmu.edu
    - Thomas Zachariah, Thomas.Zachariah@lmu.edu
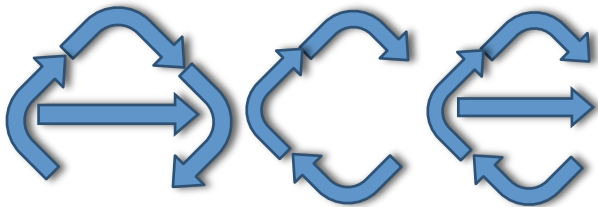
PROBLEM-SOLVING EXAMPLES WITH NARRATION FOR STUDENTS

Data

- In physics, the class average FCI normalized gains for sections that recorded think-alouds (2011 & 2012) have been higher than prior years without think-aloud activities (2008-2010): 0.55 vs 0.37.

- In organic chemistry, sections that viewed and created think-alouds, averaged 5- 15 points higher on their in-class tests than those who did not.

"At first, I really didn't enjoy making pencasts. I felt that they were very awkward and it messed me up having to say all of my thoughts out loud. However, as time went on I realized that the more I was able to talk out the problem and explain my thinking process, the more I was able to understand concepts. My highest grade on the test came when I did the most practice problems with my Pencast (who would have thought!)."

Self-monitoring

- **Checking for external consistency**- Solver compares an element of her problem solution with something outside of this solution.
  - "I guess we're not dealing with world class sprinters. I know a little track and I'm pretty sure that's pretty slow."

- **Checking for internal consistency**- Solver compares an element of her solution to something else in the same solution.
  - "hmmm… interesting… 81.25m… interesting… how to reconcile these two…"

- **Assessing readiness**- Solver evaluates whether the solution path is the correct or most efficient.
  - "Oh we don't know v_f either. So there's two variables in here. Let's see if we can find one where we just have one."

Evidence of Self-monitoring

- 2:43 "there's some question in my voice"
- 3:42 hesitates
- 4:04 I think that this would be our answer, but we haven't used the acceleration (given information)
- 4:13 "having a hard time wrapping my head around"
- 4:30 scratches out equation
- 5:23 "hmm… interesting"
- 6:00 "oh! Yeah."