Complex Cognitive Processes

Metacognition
Cognitive Study Strategies
Critical Thinking
Problem Solving
Teaching for Transfer
Creativity

• Executive processes; oversees the memory system
• Is rather late developing
• Can be improved through instruction
The “Knowing” and “Adjusting” Processes:

Adapted from Nelson & Narens (1990)

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Examples of Metacognition

- Knowing how well you are doing on your educational psychology test
- Predicting how difficult a chemistry project will be
- Understanding how much you know about makes and models of cars
- Knowing what information is important to take away from class lecture
- Knowing how well you can ski

Examples of Metacognition cont.

- Choosing one strategy over another when playing a board game
- Knowing if you have studied enough for the history exam
- Understanding and utilizing strategies that will make you a better setter in volleyball -- example
- Knowing when your performance on the trumpet was up to par
- Knowing which Trivial Pursuit categories you are strong and weak at
"Having knowledge is only part of effective learning. It also is important to use one’s knowledge strategically and to understand the strengths and limitations of one’s knowledge."

(Bruning, Schraw, Ronning, 1999; p. 102)

This is the key distinction between metacognition and cognition.

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**Metacognitive Readers**

- Readers Low in Metacognitive Abilities:
  - Lack awareness of process
  - Unconsciously incompetent
  - “Don’t know that they don’t know”
- Readers High in Metacognitive Abilities:
  - Realize there is a problem with reading
  - Don’t know how to fix the problem
  - Consciously incompetent
  - “Know they don’t know, but…”
What is the largest city in South America?

A. Buenos Aires  
B. Santiago  
C. Lima  
D. Sao Paulo

0% 100%
Accurate

Monitoring and Calibration

Calibration is the degree to which one can match their perception of their performance with their actual level of performance.

Calibration is one measure of metacognitive monitoring accuracy.

Is calibration related to performance?  
Does prior knowledge improve calibration?  
Can training and/or feedback improve calibration?
Some Conclusions:

- It appears that monitoring accuracy (calibration) is not strongly related to general ability, perhaps not related at all.
- Background knowledge (at least within the domain of probability) appears to be an essential component in the development of accurate monitoring skills.
- Strategy training appears to be an effective means by which to increase skill and monitoring accuracy.
- Distributed strategy training over time appears to be necessary to ensure the maintenance of gains in monitoring accuracy.

Summary Recommendations from Information Processing Theories of Learning

☛ Overlearn to the point of automaticity
☛ Encourage deeper processing
☛ Help guide selective attention
☛ Remember that meaning drives learning & memory
☛ Develop not only knowledge but the ability to monitor one’s learning
☛ Strategies rule!
Cognitive Study Strategies

Examples of Cognitive Strategies:
- Self-Checking
- Creating a productive physical environment
- Goal setting and planning
- Reviewing and organizing information after learning
- Summarizing during learning
- Seeking assistance
- Determining how much information to learn
Examples of Cognitive Strategies:

- Determining how new information relates to existing knowledge
- Determining how information will be used
- Identifying main ideas and important information
- Predicting
- Monitoring
- Reflecting on previous learning

3 Levels of Cognitive Study Strategies

- Basic Study Strategies
  - Highlighting/Underlining/Note Taking
  - Don’t take for granted that students know these!
- Comprehension Monitoring Strategies
  - Self-questioning/Summarizing
  - These are things you do “on-line” while learning
- Critical Thinking
  - Most important level--this is your goal!
  - What is critical thinking?
Ten Essential Critical Thinking Skills

- Distinguishing between verifiable facts and value claims
- Distinguishing between relevant and irrelevant information, claims, or reasons
- Determining the factual accuracy of a statement
- Determining the credibility of a source
- Identifying ambiguous claims or arguments

Taken from Beyer (1988)

Ten Essential Critical Thinking Skills cont.

- Identifying unstated assumptions
- Detecting bias
- Identifying logical fallacies
- Recognizing logical inconsistencies in a line of reasoning
- Determining the strength of an argument or claim

Taken from Beyer (1988)
Critical Thinking

Evaluating accuracy, credibility, worth of information and lines of reasoning
– verbal reasoning
– argument analysis
– probabilistic reasoning
– hypothesis testing

Fostering Critical Thinking

• Teach fewer topics, greater depth
• Encourage intellectual skepticism
• Model critical thinking
• Debate controversial issues
• Help students understand that critical thinking involves considerable mental effort, but it’s worth it
• Embed critical thinking skills in authentic activities
A Good Strategy User . . .

- Has a broad repertoire of strategies
- Metacognitive knowledge about why, when, and where to use strategies
- Has a broad knowledge base
- Ignores distractions
- Is automatic in the four components described above

Pressley, Borkowski, and Schneider (1987)

Conditions Affecting Use of Effective Study Strategies

- Instruction within a particular domain
- Teacher scaffolding
- Knowing numerous and varied strategies
- Knowing when & knowing why various strategies are effective
- Practice in applying strategies
- High self-efficacy (confidence) about learning

Strategies are most effective when integrated within the curriculum as opposed to being taught as a stand-alone unit
Problem Solving

General Problem-Solving Model

- Identify the problem
- Represent the problem
- Select a strategy
- Implement the strategy
- Evaluate the results
Identifying the Problem:

- People are not in the habit of problem finding
- Enough background knowledge?
- People tend to be impulsive and not reflect on the nature of the problem
- Well-Defined vs. Ill-Defined

Well versus Ill-Defined

**Ill-Defined**
- Desired goal unclear
- Information missing
- Several possible solutions

**Well-Defined**
- Goal clearly stated
- All information present
- Only one correct solution
Representing the Problem:

- Consider external representations to relieve demands upon working memory and organize information (e.g. pictures, diagrams, charts)
- Experts spend proportionately more time at this stage than novices

Selecting Strategies:

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<td>– Analogy</td>
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<td>– Working Backwards</td>
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</tbody>
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Implementing the Strategy:

- Experts utilize more strategies (strategy shifting), consider more solutions, and evaluate solutions at a deeper level
- Convergent vs. Divergent thinking

Convergent Thinking
- Focus on one solution

Divergent Thinking
- Consider novel solutions
Functional Fixedness

A condition that arises when we lose the ability to view familiar objects in a novel way

Evaluating the Results:

- The chance to improve problem-solving skills rests at this stage and is very metacognitive in nature
- Teachers who are “reflective practitioners” spend more time at this stage
- The development of self-regulatory skills is dependent upon evaluation
Improving Learner Problem Solving

- Improve background knowledge
- Build self-efficacy through practice
- Utilize social-interaction (learn strategies through others)
- Provide scaffolding (hints at critical junctures)
- Teach general strategies (e.g. draw out the problem, take your time, consider many different strategies to solve the problem, utilize background knowledge)

Transfer of Learning

- Occurs when something learned at one time and place is applied in another setting
  - Transferring to another university
    - Schedule time with advisor
    - Knowing how to register for classes
    - Where to find information--library
- Most difficult challenge for teachers!
- People often don’t realize the relevance of their prior knowledge in new situations
- Important to instill a “disposition for transfer” in your students
- Need to reduce inert knowledge
Factors Affecting Transfer

- Structured practice that promotes automated problem solving increases transfer.
- Meaningful learning leads to greater transfer than rote learning.
- Relate problem-solving skills in one domain to another by the use of analogy. Students should see material as context-free rather than context-bound.
- Give numerous worked-out examples.
- Similarity between two situations increases transfer.
- Transfer is more likely when only a short amount of time has elapsed after students have studied a topic.

Seven Characteristics of Experts

1. Experts excel only in their own domain.
2. Experts process information in large units.
3. Experts are faster than novices.
4. Experts hold more information in short-term and long-term memory.
5. Experts represent problems at deeper level.
6. Experts spend more time analyzing a problem.
7. Experts are better monitors of their performance.