Self-Regulated Learning in Serious Digital Games

About Me . . .

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- My research involves the study of metacognition and self-regulation in classroom-based and computer-based settings
- Love to travel, run, and eat lots of pizza, ice cream, and sweets!
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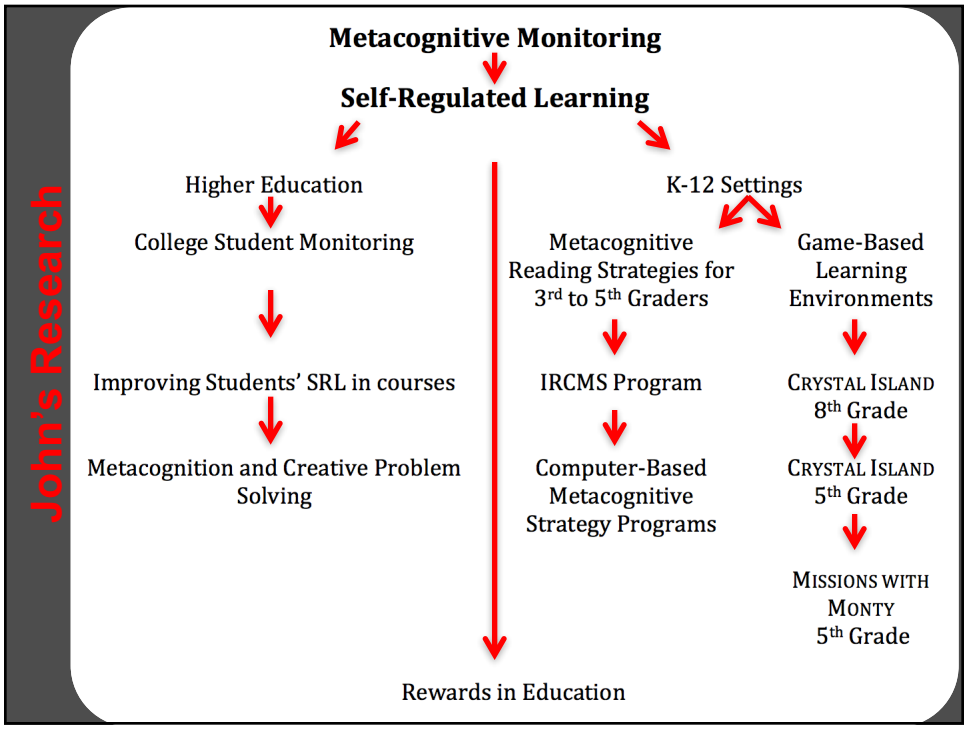


Things to consider . . .

- Educational bias
- Please ask questions

Game Design Sketch Competition

- In small groups develop a serious game proposal idea for the following topic:
  "Comprehension Monitoring with Informational Science Text for Upper Elementary Students"
- Use the guidelines from the website
- Submit your proposal in class on Nov. 1st
- John will review them and announce one recipient as the winner and then share ideas for our current proposal on this topic

What do you think?

"One of the most consistent findings when the educational technology research literature is carefully reviewed is that ***there are few if any improvements in learning outcomes specifically attributable to the technology alone***. That is, when technologies such as online presentation and discussion of teaching case studies by teacher education students are compared with traditional approaches (e.g., the same students reading and discussing teaching case studies in the classroom), there seldom are learning benefits attributable to the technology itself (e.g., see Clark, 1994, 2001, 2003; Salomon, 1984)."

Bruning, Schraw, & Norby (2011)

Self-Regulated Learning

The ability to control all aspects of one's learning, from advance planning to how one evaluates performance afterward

"Effective regulation of one's own learning in the pursuit of personal goals" *Nietfeld, Shores, & Hoffmann, 2014*

3 Core Components

- **Strategy use**
  - **Selectively choosing then evaluating strategies**
- **Metacognitive awareness**
  - **Knowledge about cognition/Regulation of cognition**
- **Motivational control**
  - **Goals, self-efficacy, effort, emotional regulation, affect**

Two Ways of Considering SRL in Game Contexts

1. How SRL skills impact behavior and performance in games
2. How to create games to support SRL skill development

Effective SRL in Games Emphasizes:

COGNITION

A focus on important information in the face of interference
Creation of a well integrated and rich knowledge base

METACOGNITION

Accurate monitoring and control of learning
Flexibility in applying strategies
Learning through scaffolding

MOTIVATION

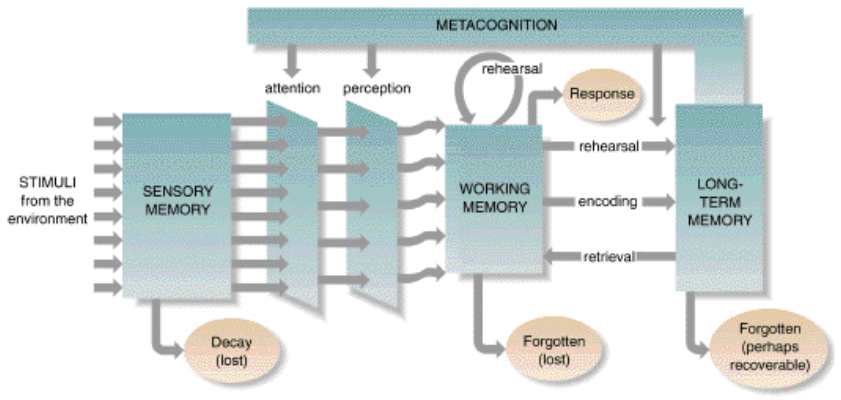
Intrinsic motivation to learn
Mastery and performance approach goal orientations
Confidence in the face of challenges

Cognitive Processing & Strategy Use

Effective SRL in Games Emphasizes . . .

. . . a focus on important information in the face of interference.

Information Processing Model



Eggen/Kauchak
Educational Psychology: Windows on Classrooms 4e

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What Information Processing work has taught us . . .

- Cognitive resources are limited
- Automaticity allows for more efficient use of cognitive resources
- Meaning drives memory

Sperling's Sensory Memory Tasks

Sensory Memory

- A memory buffer holding sensory input
  - *Function*: Gather information from the environment
  - *Capacity*: large
  - *Duration*: short
  - *Getting it in*: sensation

  - Iconic Memory (visual)
    - ~0.5 seconds (video camera)
  - - Echoic Memory (auditory)
    - ~ 2 seconds (tape recorder)

Selective Attention

Strategically allocating our limited resources to important information

Implications for Serious Games:

- Recognize capacity limitations and rate of decay of new information so as not to overload learners
- Cue learners to focus their selective attention to what is most important (e.g. using tools, taking notes, employing effective strategies)

Seductive Details Can Impair Reading Comprehension

Seductive details are details that readers find interesting but are irrelevant to the main ideas of the text. College students read essays on lightning with either seductive details included or not (Lehman et al., 2007). Those in the seductive details condition recalled fewer main ideas and scored lower on measures of deeper processing from resultant essays.

Example of seductive details from Crystal Island – Uncharted Discovery

What is this quote referring to?

"My problem is that I have been persecuted by an integer. For seven years this number has followed me around, has intruded in my most private data, and has assaulted me from the pages of our most public journals. This number assumes a variety of disguises, being sometimes a little larger and sometimes a little smaller than usual, but never changing so much as to be unrecognizable. The persistence with which this number plagues me is far more than a random accident. There is, to quote a famous senator, a design behind it, some pattern governing its appearances. Either there really is something unusual about the number or else I am suffering from delusions of persecution."

George Miller's comment on the magic number 7 capacity limit of working memory

Working Memory

7 + or - 2

Old -- Short Term Memory

New -- Bottleneck

Scratchpad

Workbench

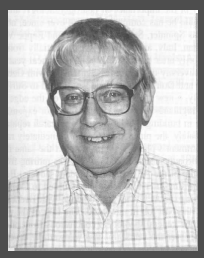
Working memory and reasoning?

- Some have argued that working memory is the key predictor of intelligence or for performance on intelligence/reasoning tests (Kyllonen & Christal, 1990)
- Current theories focus on the effectiveness of processing information while blocking out interference as the best indication of one's working memory ability

Daneman and Carpenter Task

Why do WM capacity measures so successfully predict performance across a range of cognitive abilities?

Baddeley's Theory of Working Memory



Executive Control System
Functions:
Selecting Information Planning
Transfer Information to LTM

Articulatory Loop
Functions:
Auditory Rehearsal
Articulation Processes

Visual-Spatial Sketch Pad
Functions:
Visual Rehearsal
Spatial Comparisons

Cognitive Load Theory

Refers to the level of demands placed upon WM in a given learning environment – common to research in educational technology

Cognitive Load Theory

- Load can be:
  - intrinsic (inherent properties of the to-be-learned information)
  - extraneous (how the to-be-learned information is presented)
  - germane (cognitive load that is relevant to learning and creation of schemas)
- The goal of instructional design is to not exceed WM limits and to maximize germane load

Example of Types of Cognitive Load

- Learners with same prior knowledge (thus similar amounts of intrinsic load) are presented with a problem in 2 separate conditions – Condition A intended to increase germane load by providing a worked example; Condition B no worked example
- Average perceived mental effort rating for Condition A = 8 (out of 9) and Con B = 6
- Learners in Condition A perform higher on a posttest than those in Condition B
- We can assume the worked example presented germane cognitive load that led to learning outcomes

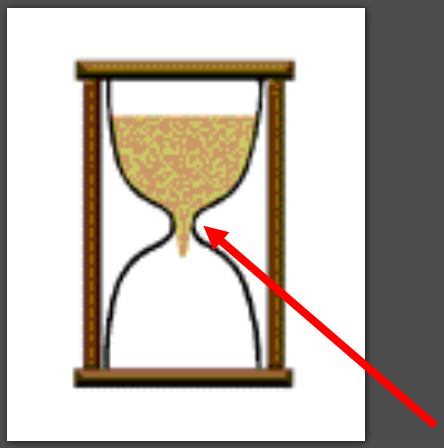
Implications for Serious Games:

- **Utilize multiple modalities to distribute cognitive load.**
- **Consider issues of split attention/multi-tasking**
- **Emphasize the use of external representations or tools**
  - **Relieve pressure on bottleneck so that learners can work on individual pieces of the problem**
  - **Notes**
  - **Models**

Effective SRL in Games Emphasizes . . .

. . . the creation a well integrated and rich knowledge base.

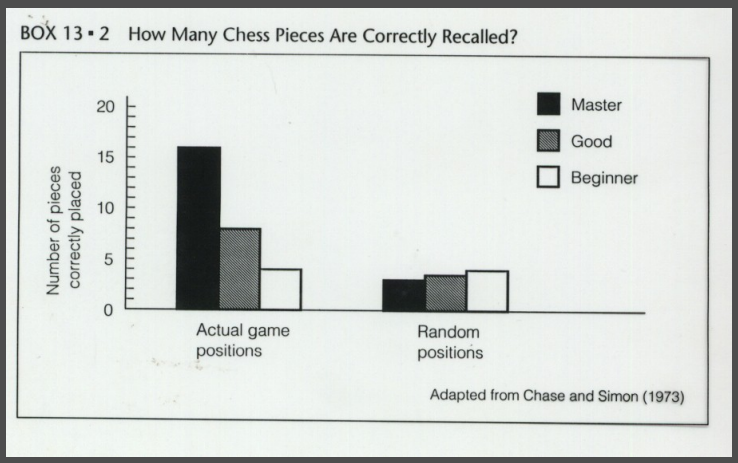
2 Ways to "Beat the Bottleneck"



- Background knowledge and experience – automaticity
- Organizational strategies – mnemonics, chunking

Automaticity

Overlearning information or operations to the point where they can be used with little mental effort



Expertise Reversal Effect:

- Employing cognitive load reduction techniques is not always appropriate
- Learner expertise plays a role in the effectiveness of cognitive load reduction
- Generally, as factors are added to multimedia presentations to reduce cognitive load by adding instructional guidance, students with high levels of expertise on the topic can find this redundant
- Thus, these students are suffering from the *redundancy effect* and experiencing unnecessary extraneous load.

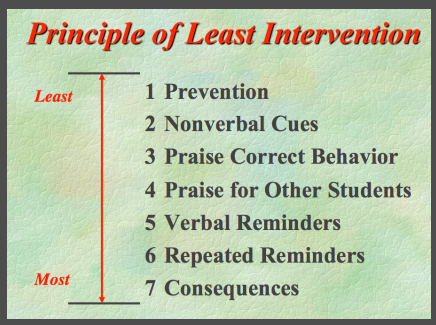
(Kalyuga, Ayres, Chandler, & Sweller, 2003)

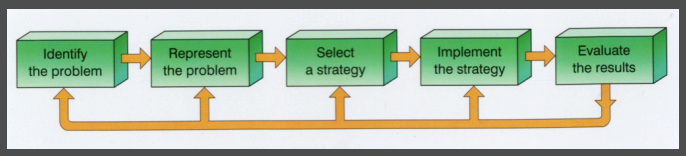
Evidence for the Expertise Reversal Effect:

Kalyuga, Chandler, & Sweller (1998)

- Participants were electrical trade workers and had differing levels of expertise in the area of electrical engineering.
- The workers were presented with either diagram-only instruction, or diagram + integrated text.
- The workers with higher expertise in the area of electrical engineering benefitted more from the diagram-only presentation than those with the same level of expertise that received the diagram + integrated text presentation.
- However, the workers with lower expertise levels benefitted more from the diagram + integrated text presentation.
- The redundancy of the material placed extraneous cognitive load on the “experts”, but helped the “novices” further understand the material

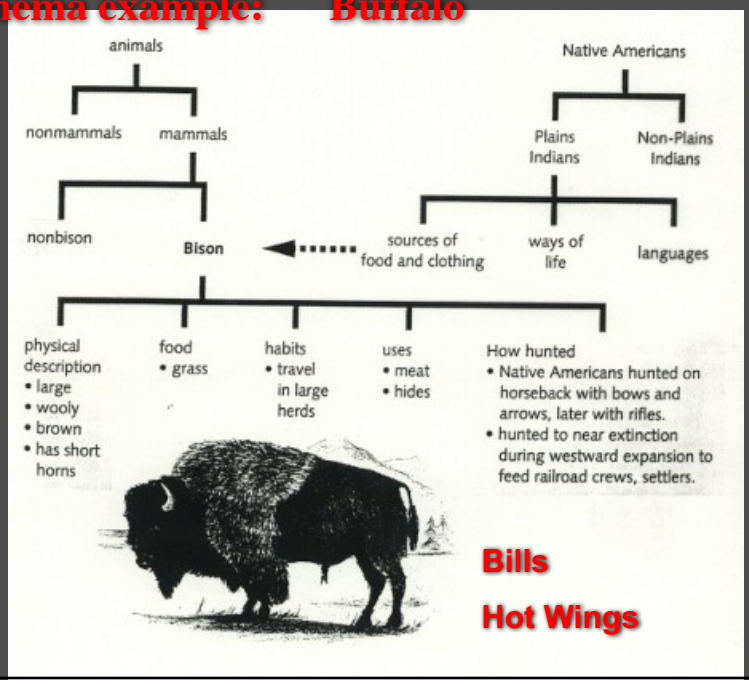
Encourage Mental Models





Mental Model for learning?

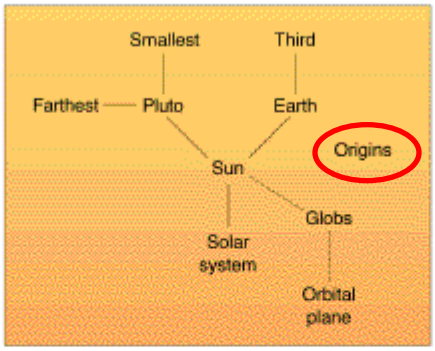
Schema example: Buffalo

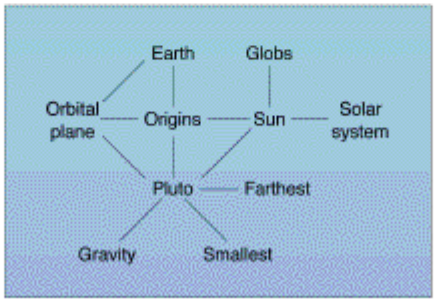


Bills

Hot Wings

Schemata





Inert Knowledge

Context **and** ***Experience***
shape Schemas

The two boys ran until they came to the driveway. "See I told you today was good for skipping school," said Mark. "Mom is never home on Thursday," he added. Tall hedges hid the house from the road so the pair strolled across the finely landscaped yard. "I never knew your place was so big," said Pete. "Yeah, but its nicer now than it used to be since Dad had the new stone siding put on and added the fireplace."

There were front and back doors and a side door which led to the garage which was empty except for three parked 10-speed bikes. They went in the side door, Mark explaining that it was always open in case his younger sister got home earlier than their mother.

Pete wanted to see the house so Mark started with the living room. It, like the rest of the downstairs, was newly painted. Mark turned on the stereo, the noise of which worried Pete. "Don't worry, the nearest house is a quarter of a mile away," Mark shouted. Pete felt more comfortable observing that no houses could be seen in any direction beyond the huge yard.

Saturday night

Every Saturday night, four good friends get together. When Jerry, Mike, and Pat arrived, Karen was sitting in her living room writing some notes. She quickly gathered the cards and stood up to greet her friends at the door. They followed her into the living room but as usual they couldn't agree on exactly what to play. Karen's recorder filled the room with soft and pleasant music. Early in the evening, Mike noticed Pat's hand and the many diamonds. As the night progressed the tempo of play increased. Finally, a lull in the activities occurred. Taking advantage of this, Jerry pondered the arrangement in front of him. Mike interrupted Jerry's reverie and said, "Let's hear the score." They listened carefully and commented on their performance. When the comments were all heard, exhausted but happy, Karen's friends went home.

(Anderson, Reynolds, Schallert, & Goetz, 1977)

Tony

Tony slowly got up from the mat, planning his escape. He hesitated a moment and thought. Things were not going well. What bothered him most was being held, especially since the charge against him had been weak. He considered his present situation. The lock that held him was strong but he thought he could break it. He knew, however, that his timing would have to be perfect. Tony was aware that it was because of his early roughness that he had been penalized so severely--much too severely from his point of view. The situation was becoming frustrating; the pressure had been grinding on him for too long. He was being ridden unmercifully. Tony was getting angry now. He felt he was ready to make his move. He knew that his success or failure would depend on what he did in the next few seconds.

Hocked gems

With the hocked gems financing him, our hero bravely defied all scornful laughter that tried to prevent his scheme. Your eyes deceive, he had said. An egg, not a table, correctly typifies this unexplored planet. Now three sturdy sisters sought proof. Forging along, sometimes through calm vastness, yet more often through turbulent peaks and valleys, days became weeks as the many doubters spread fearful rumors about the edge. At last, from nowhere welcome winged creatures appeared, signifying momentous success. (Dooling & Lachman, 1971)

A simple procedure

Tell me what this procedure is

The procedure is actually quite simple. First you arrange things into different groups. Of course, one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to the lack of facilities that is the next step, otherwise you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run this may not seem important but complications can easily arise. A mistake can be expensive as well. At first the whole procedure will seem complicated. Soon, however, it will become just another facet of life. It is difficult to foresee any end to the necessity for this task in the immediate future, but then one never can tell. After the procedure is completed one arranges the materials into different groups again. Then they can be put into their appropriate places. Eventually they will be used once more and the whole cycle will then have to be repeated. However, that is a part of life.

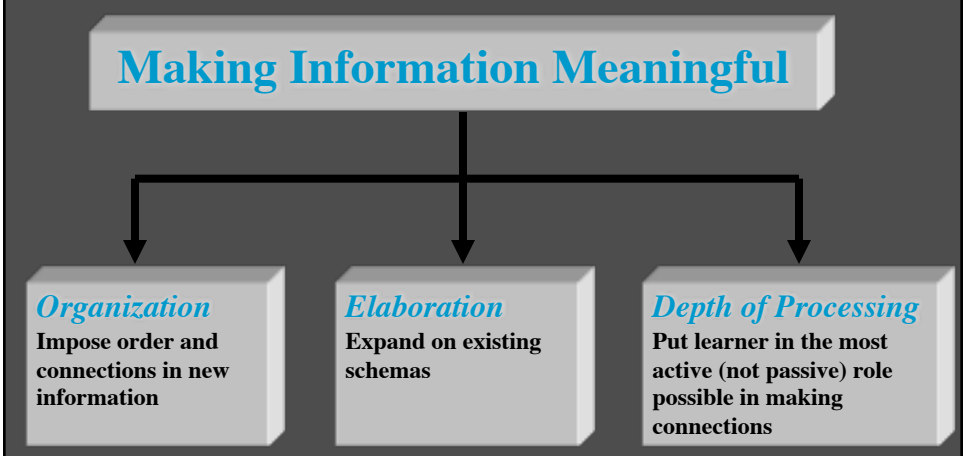
Schema Representation Guidelines

This project is intended to give you the opportunity to visually express what factors will be the most important for effective instruction in your future profession. Your goal should be to create a representation that answers what factors will make you a successful _____ (teacher, engineer, counselor, psychologist, etc.). What you include in your project or what your representation looks like is largely up to you. The goal of the project is for you to reflect on what you have learned in this class (and other similar classes) and produce a representation of an organized "mental model" for your future profession.

Two means of encoding:

– **Maintenance rehearsal** — repeating information over and over

– **Elaboration** — associating information to be learned with existing knowledge.



Organizing Information

Try using:

- Hierarchies—show progression from broad to specific
- Sequences/outlines—shows linear progression of information.
- Matrices—shows relationships between elements
- Models—unified representation, shows how parts are related
- Concept maps

Elaboration

Connecting new information to information you already know (background knowledge)-external connections

- Analogies—recognizing similarities "It's like….."
  - Examples / "illustrations"
  - Stories
- Activating prior knowledge—"what do we already know about…."
- Special cases– Mnemonics—Generated connections (use when there is no background knowledge)

Depth of Processing

- Finding similarities and differences and generalizing:
  - "How are these alike?"
  - "How are they different?"
  - "What pattern do you see?"
- Explaining:
  - "Why?" (e.g., "Why do you suppose Mercury is so hot on one side and so cold on the other?")
- Providing evidence:
  - "How do you know?"
    - Example: "How do you know that people's perceptions vary?"
  - Evidence:
    - Some people saw the young woman in the picture, whereas others saw the older woman.
- Hypothesizing:
  - "What would happen if?"
    - Example: "What would happen if Mercury rotated on its axis as does the Earth?"
    - Hypothesis: The temperature wouldn't vary so much. It would be very warm on all parts of the planet.

Summary Suggestions for Integrated Knowledge Base:

- Encode Visually and Verbally
- Block out Interference
- Build Interconnected Schemata
- Focus on Organization, Elaboration, & Depth of Processing
- Learn in Depth
- Learn in Many Contexts
- Use Mnemonics for Factual Lower Level Knowledge
- Utilize Strategic Deliberate Practice

Strategic Practice

- Focus on improving specific skills/procedures
- Automaticity frees up needed resources
- Which is more effective --massed or distributed practice?

Distributed!

Implications for Serious Games:

- The automation of basic skills free cognitive resources for higher level thinking
- Assist in the development of mental models that evolve in the game environment. This requires an emphasis on explicitly drawing connections between new knowledge and existing background knowledge.
- The context of the game (rules, goals, etc.) may change the way in which learners gain content knowledge