PNNL-SA-47837

Ingredients of Effective and Engaging Online Learning

Presented to

Inter-Lab 2005 Conference

Frank L. Greitzer

December 14, 2005

(or... Musings of a Cognitive/e-Learning Evangelist)

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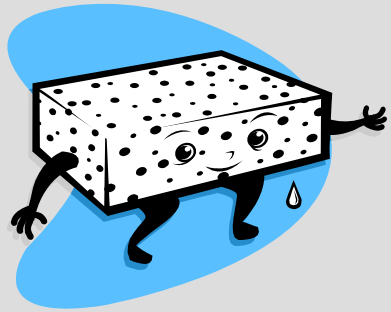
Background

- **Effectiveness**:
  - Much instruction focuses on the most elementary level of abstraction: knowledge of facts (*procedural* knowledge)

- **Engagement**:
  - Most training derives from a traditional instructional approach that places the learner in a passive role.



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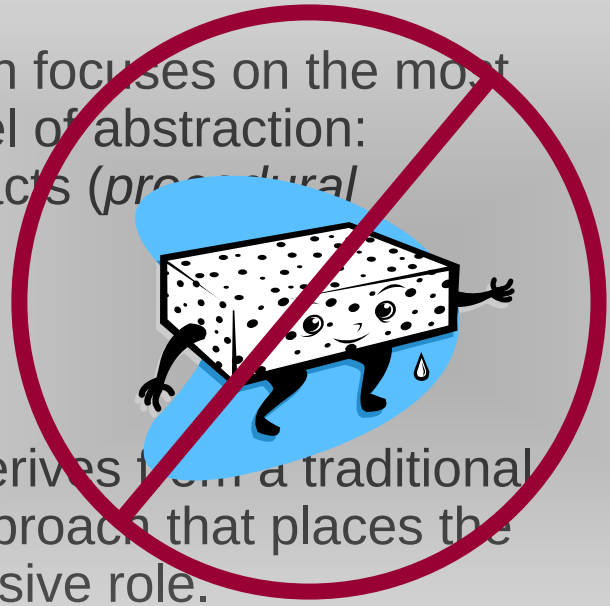

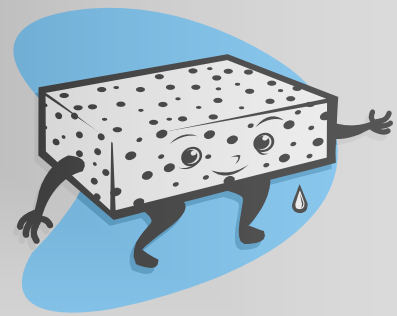

The learner is NOT a SPONGE!

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Active Learning:

Mastery of complex cognitive performance requires higher level, more abstract learning and opportunities for exercising skills in realistic situations…

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A Cognitive Approach

Effective learning environments should…

- be problem-based (scenarios)
- actively engage students in learning
  - Activating prior experience → **Relate to real world**
  - Demonstrating skills → **TELL, SHOW**
  - Applying skills → **ASK, DO**
  - Integrating skills → **Transfer to real world**

Problem: Many instructional strategies focus on more receptive/directive aspects of instruction ("TELL" and "ASK"). More attention should be directed to SHOW and DO!

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Example: “Ask” Versus “Do”

- ***Ask: Standard Multiple Choice***

What is a hazard?

(a) The item of value
(b) A threat that could adversely affect the state or condition of the target
(c) Anything that prevents an adverse event
(d) None of the above

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Example: “Ask” Versus “Do”

- ***Do: Interactive “Check on Learning”***

Scenario: Unsecured SECRET Document

Mary, a cleared staff member, was a participant in a meeting to be held in a classified conference room located in a Limited Access area. She keyed in her security code to enable access to the Limited Access area and proceeded to the conference room. Finding the door (with omni lock) ajar, she entered the room, which was empty. On the table she found an unattended SECRET document. She reported this to security.

Further investigation revealed that a meeting participant, Mark, owned the document. He had been feeling ill that morning but had come into work for this meeting to discuss the SECRET document. He had arrived a few minutes early, but suddenly felt flushed and dizzy, so he rushed to the restroom for cool water, failing to shut the conference room door as he left.

Example 1

Example 2

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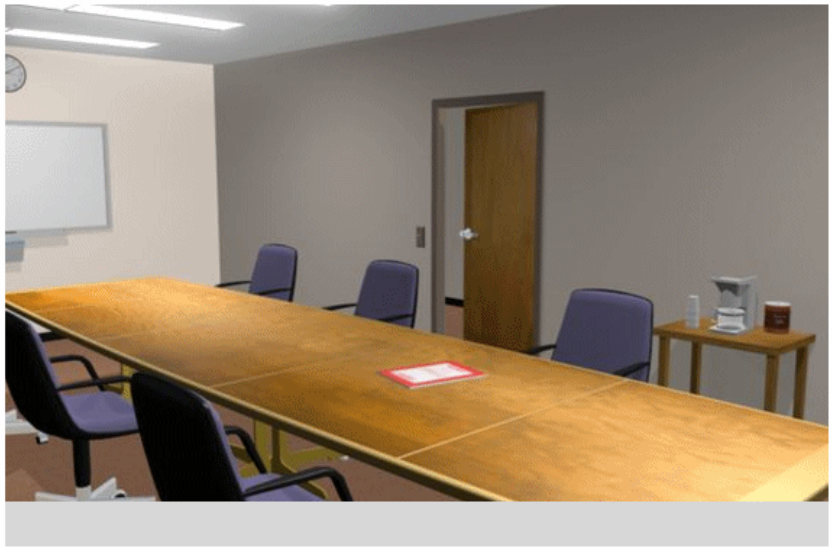
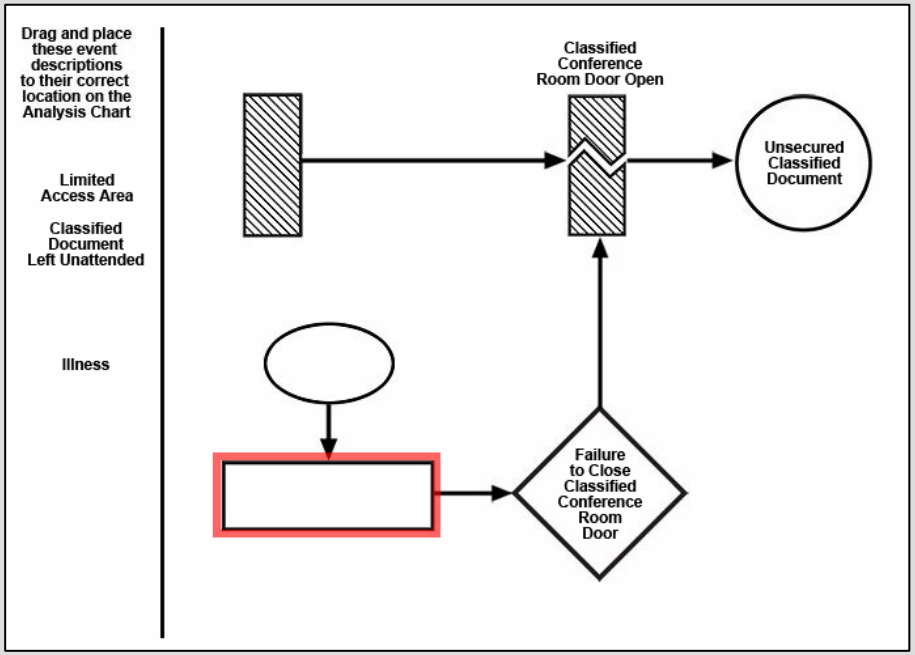
Examples of Interactive Checkpoints

Example 1 screen capture



1. In this scene, select the object that represents a Barrer:

Example 2 screen capture



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Training Approaches

- Traditional
  - Information is presented in a series of lessons, each followed by objective questions to test the learner's understanding
- Interactive, scenario-based e-Learning
  - Compel learner to organize and structure responses to problems
  - Engage learner using practical exercises that transfer to real-world activities
- Guided-discovery e-Learning
  - An innovative form of experiential learning
  - Provides coaching and support while learners work on realistic problems adapted from actual work settings (scenarios)
  - As the learner gains knowledge, skill and understanding, the level of coaching is reduced.
- Game-based e-Learning
  - Potential for reaching out to millennial youth/population
  - Challenge: to provide educational benefit

Discovery and game-based learning imposes a greater cognitive load on the learner…

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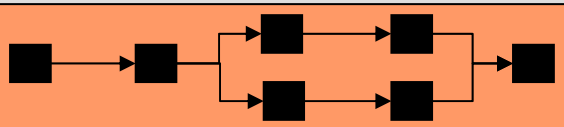
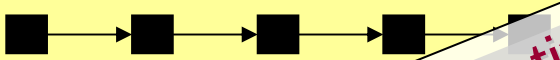
Levels of Engagement

Level 4: Game-based learning (engine drives game from an underlying model)



Level 3: Contingent scenarios (content seen depends on response)



Level 2: Linked scenarios (content seen depends on response)

Level 1: Basic scenarios (narrow, focused, independent)

Effective (and ineffective) e-learning can be developed at any of these levels of engagement.

Level 0. Traditional Computer-Based Training

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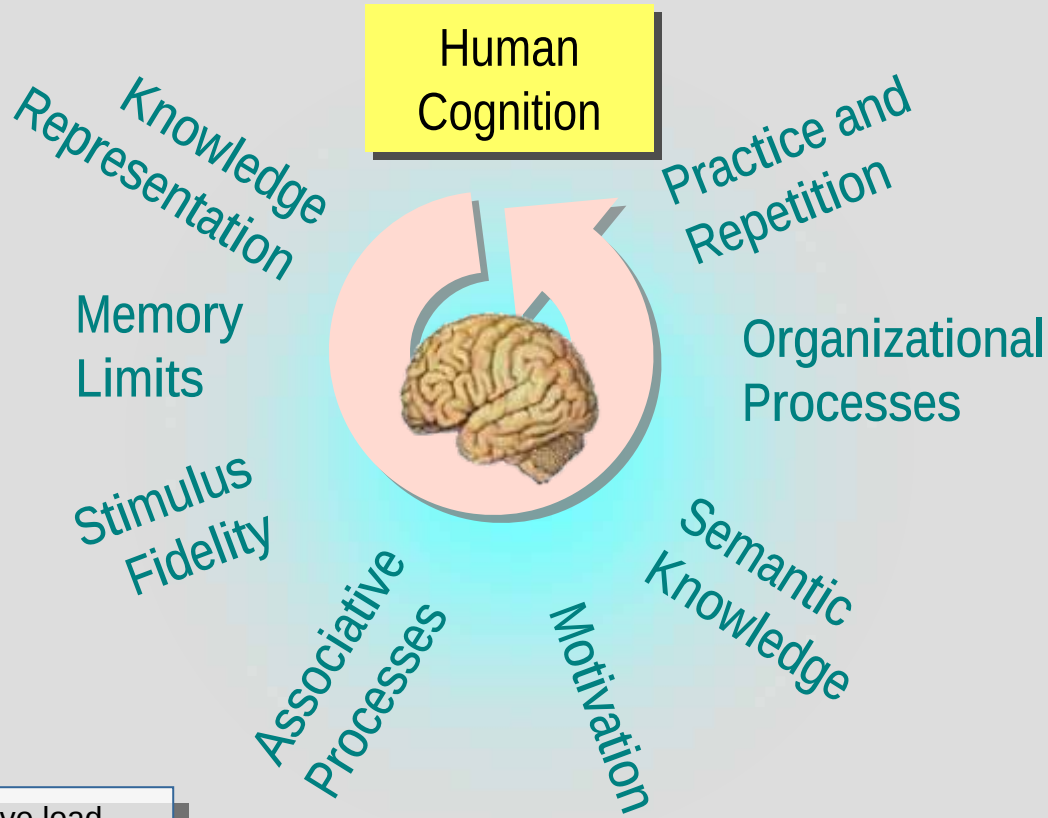
Cognitive Principles for Effective Instruction

- Stimulate semantic knowledge
- Manage the learner's cognitive load
- Immerse the learner in problem-centered activities
- Emphasize interactive experiences
- Provide frequent and varied practice
- Provide opportunity for learner to "reflect."



Challenge is to manage cognitive load
- Control difficulty
- Build from simple to complex
- Use part-task strategy
- Provide coaching

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Example Application 1: Enhancing Traditional Instruction

- Example: US Army computer based training on logistics communications equipment
- Training required for set-up, operation and maintenance of equipment
- Replaces or supplements 40 hours of classroom instruction
- Original training content followed traditional ‘page-turning’ model of instruction
- We transformed the training into an active learning approach to online instruction…

CAISI—Combat System Support Automated Information System Interface e-Learning

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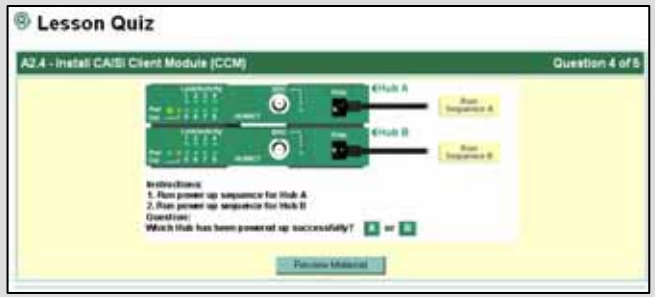
CAISI Interactive Scenario-Based e-Learning

- Training required for set-up, operation and maintenance
  - Level I (orientation): 5 modules
  - Level II (advanced): 18 modules
- Multimedia/Interactive Features
  - 257 rendered images (static or animated) constructed from 146 individual 3-D models
  - 45 movie/interactive multimedia files
  - 25 interactive “Checkpoints”
  - Integrated exercise tests major learning objectives, including troubleshooting scenarios



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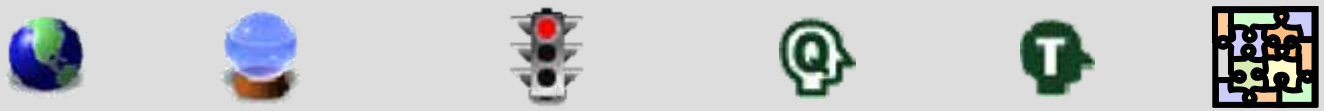
Building Blocks for Active Learning

Interaction Elements



Did You Know? | Heads-Up | Check Point | Interactive Quizzes | Module Tests | Integrated Exercises

- Allow learners to check their understanding
- Guide student practice with “worked” examples
- Re-use interaction elements to exploit familiarity/build on knowledge acquired (also used in assessments)
- Building blocks for integrated, practical scenarios

When we define learning objectives for these interaction elements, they become learning objects.

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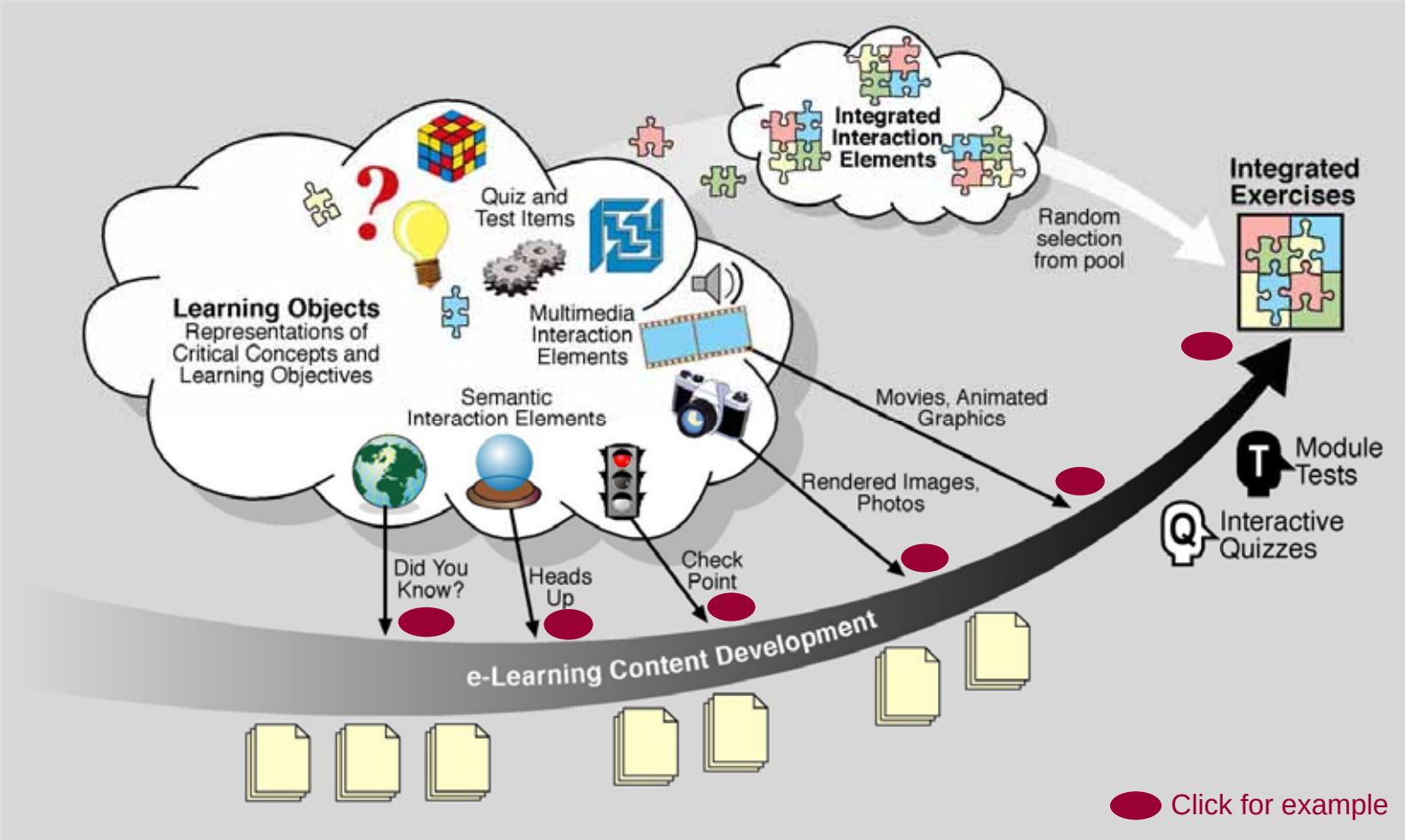
Conceptual Framework for Cognitive-based, Active e-Learning



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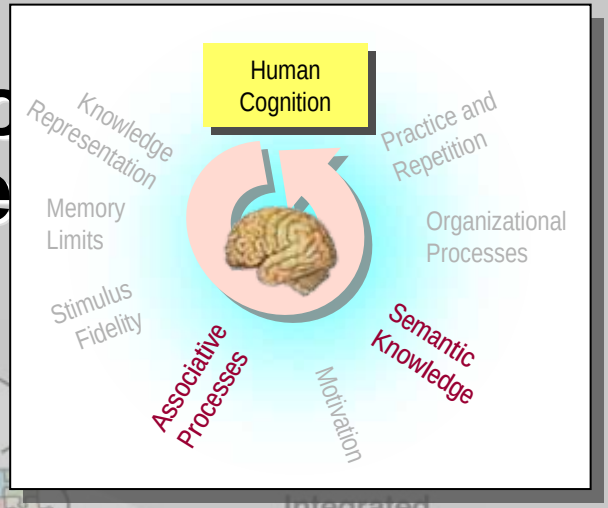
Conceptual Framewo
Cognitive-based *e*-Le



Did You Know *Interaction Elements* provide rich associations to link with semantic memory

Integrated Interaction Elements

Integrated Exercises

Random selection from pool

Learning Objects
Representations of Critical Concepts and Learning Objects

Movies, Animated Graphics

Rendered Images, Photos

Module Tests

Interactive

Did You Know?

Did You Know?

CAISI-MT was used successfully in Haiti and Bosnia in the late 1990s, and its use marked the beginning of web-based logistics. The coaxial cable used by CAISI-MT limited users to a distance of 185 meters from Mobile Subscriber Equipment (MSE). STAMIS users beyond that distance had to use field wire to establish the connection. The field wire weighed 95 pounds per mile and limited transmission to extremely slow speeds.

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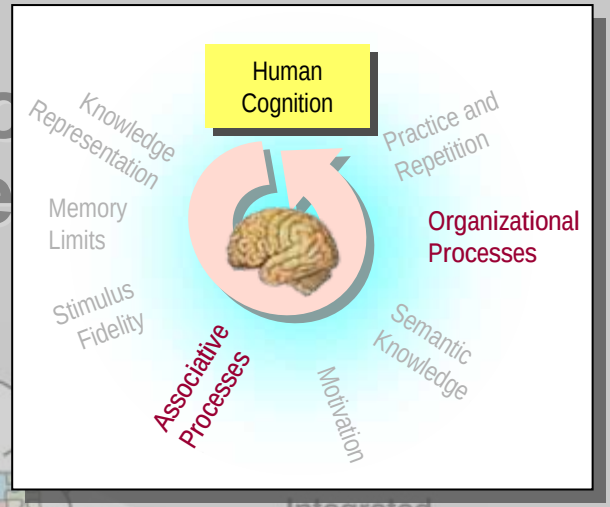
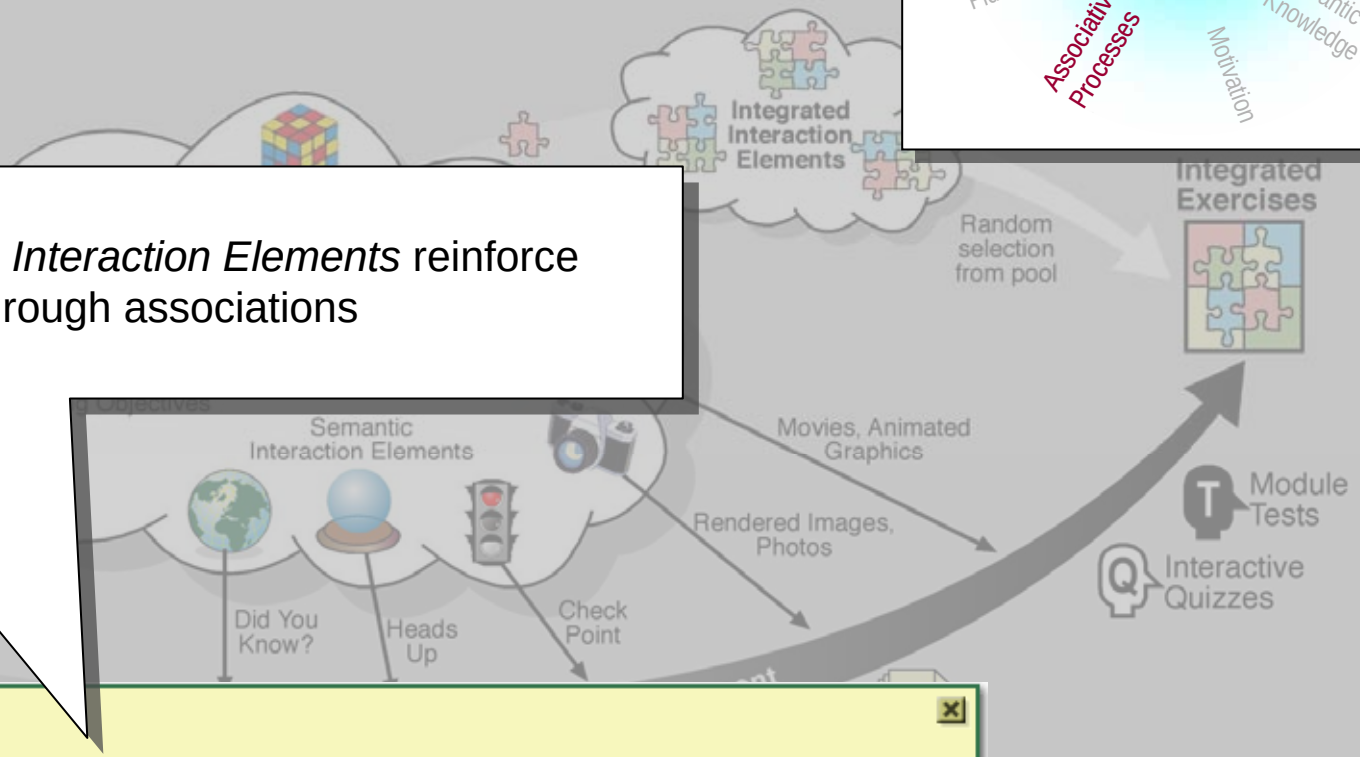
Conceptual Framewo
Cognitive-based *e*-Le





Heads Up *Interaction Elements* reinforce material through associations

Heads Up

Light Emitting Diodes (LEDs) are discussed in detail in the troubleshooting sections. It is important to know the function of each LED because LEDs indicate the operational status of each component.

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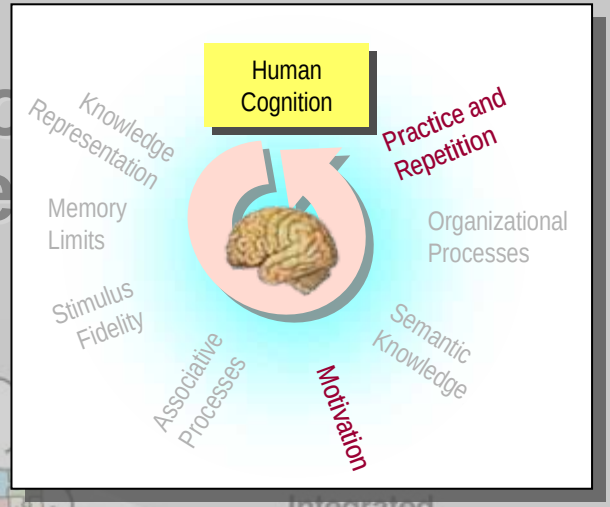
Conceptual Framewo
Cognitive-based *e*-Le



Checkpoint *Interaction Elements* encourage active construction/processing of information to help build understanding

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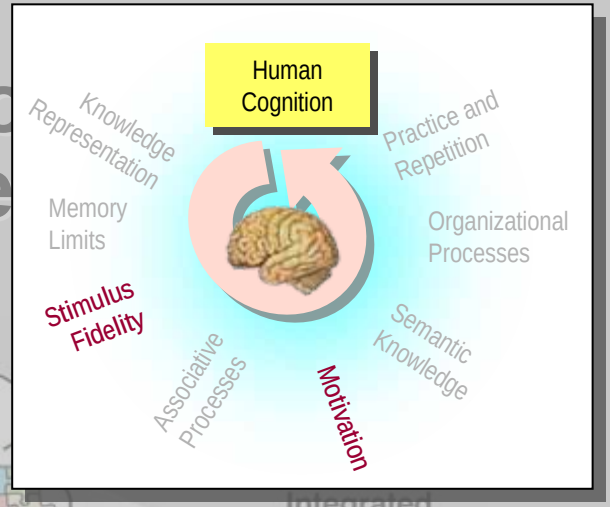
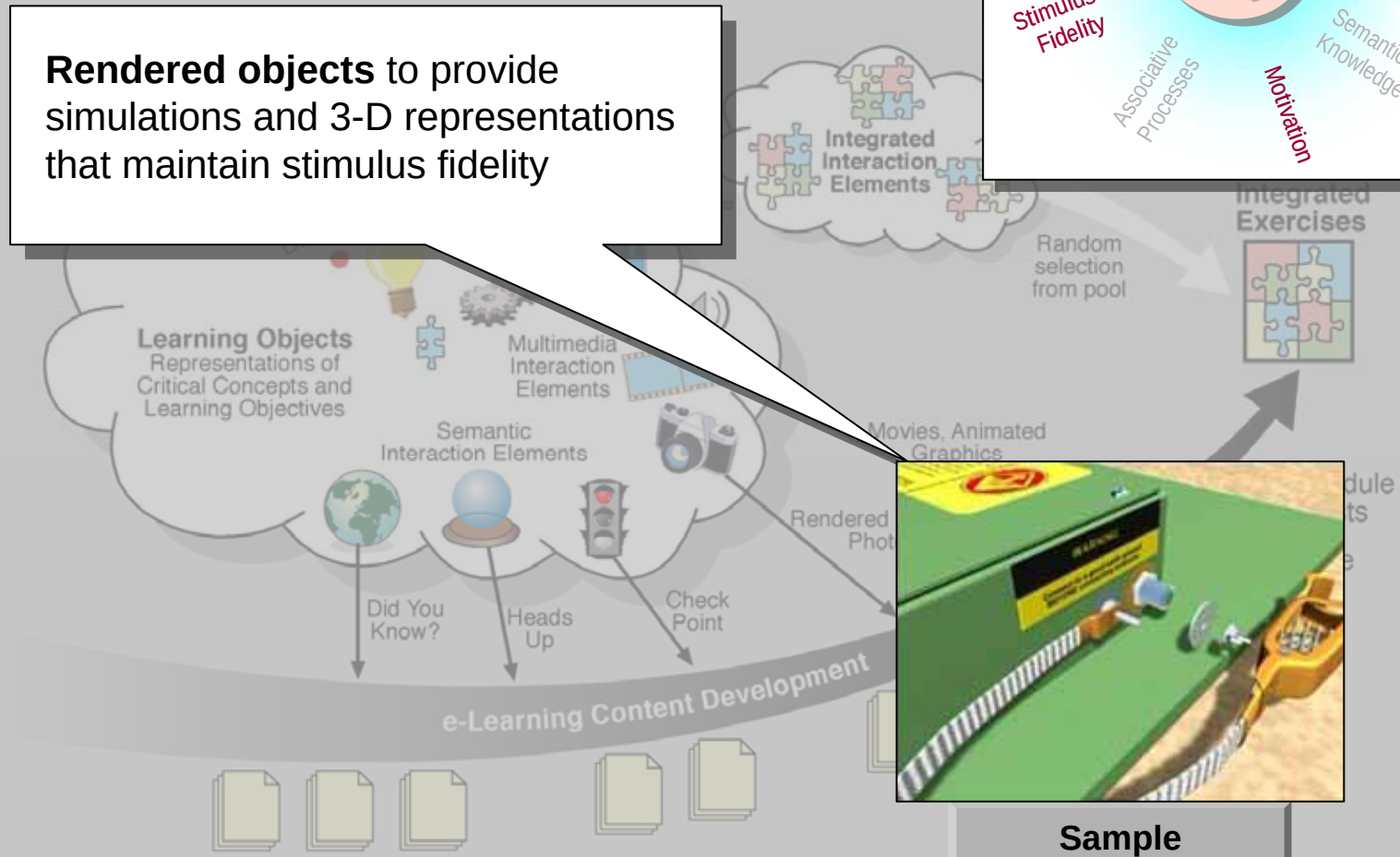
Conceptual Framewo
Cognitive-based *e*-Le

Rendered objects to provide simulations and 3-D representations that maintain stimulus fidelity





Sample Animation

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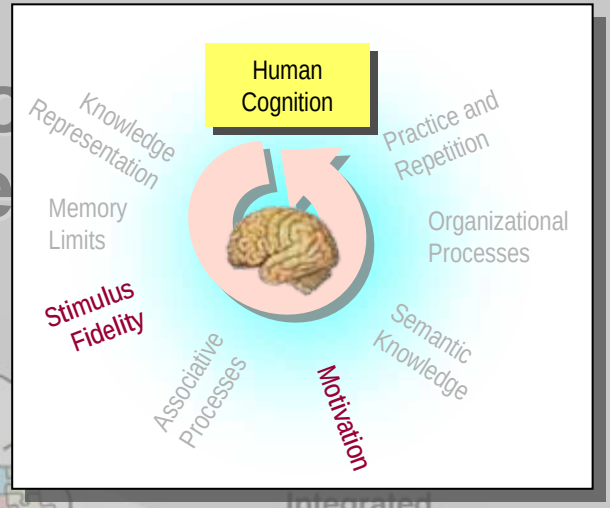
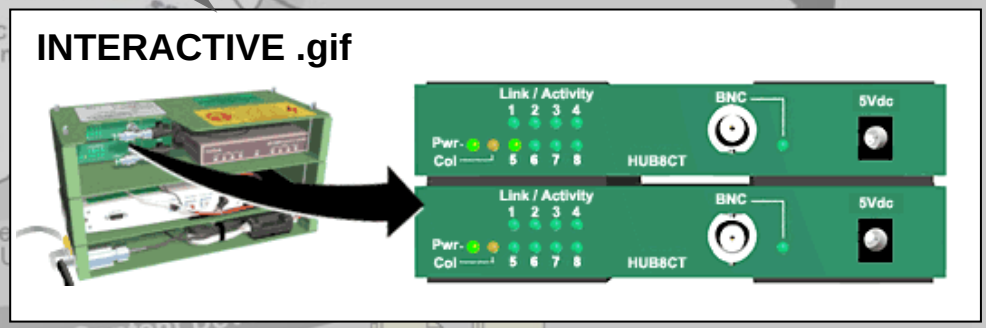
Conceptual Framewo
Cognitive-based *e*-Le



Rendered, animated graphics objects provide simulations and representations that demonstrate system states.



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Example Application 2: Guided Discovery e-Learning

Human Error Awareness and Causal Analysis Training for DOE Security Incident Inquiry Officials

- Enhanced Security Through Human Error Reduction (ESTHER) Online Causal Analysis Resources and Training
- Implemented within a game-like environment
- Context: Learner enters as a “Junior” inquiry official and performs tasks to advance to higher levels
- Training/resource material available in the learner’s virtual “office” (on bookshelves, in drawers, etc.)

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ESTHER Causal Analysis e-Learning Application

- Learner advances by completing objectives at each level
- Uses both Guided Discovery and Active e-learning approaches.

“Master” Office

“Associate” Office

“Junior” Office

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Guided Discovery Approach

- Difficulty varies by number of factors (clues) to be found in the scenario environment
- Part-task emphasis by focusing on a subset of the analysis and reporting activity
- Coaching (scaffolding) provided early and withdrawn as performance improves.

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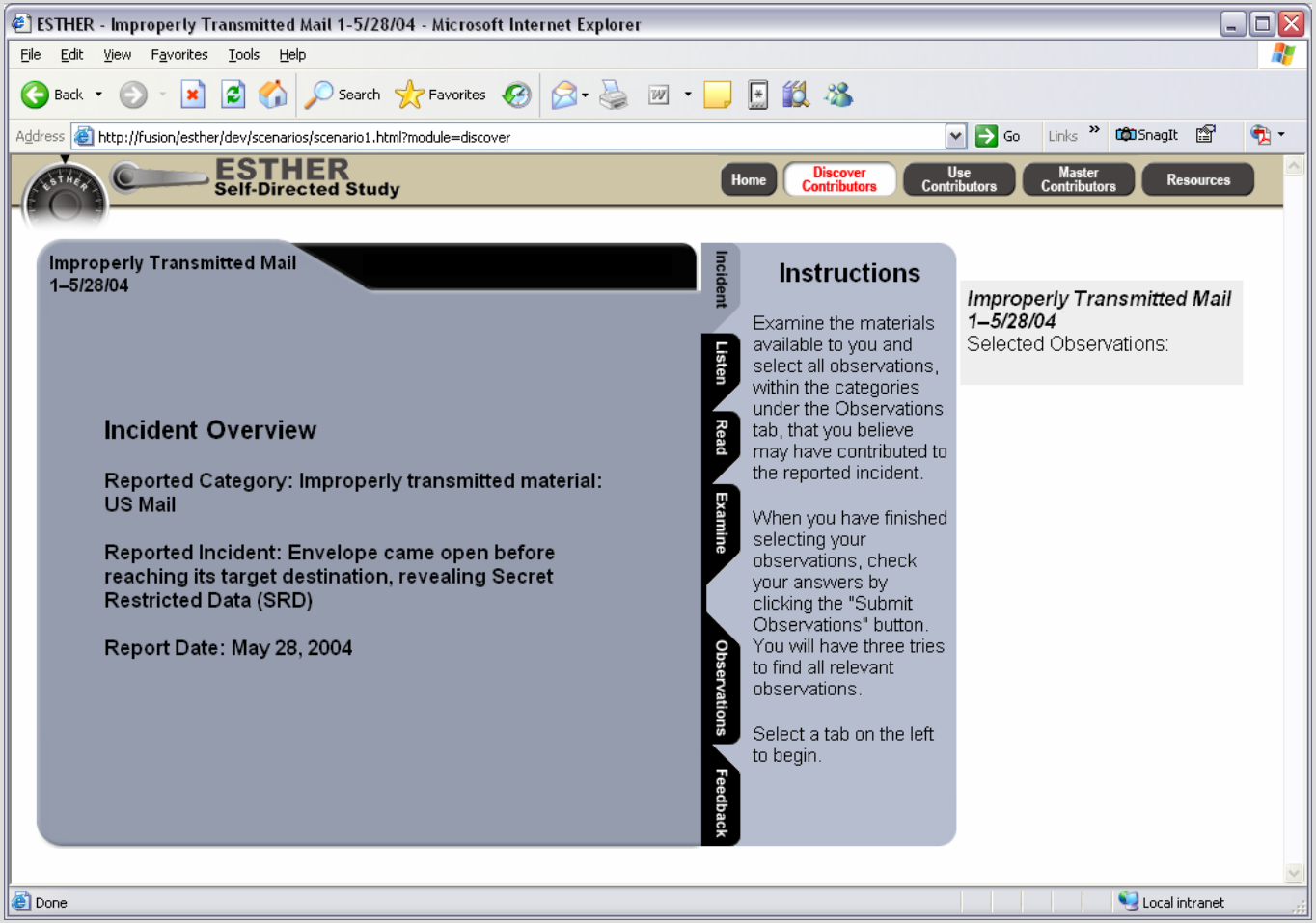
Discover Contributors Module – Incident Description

Learner "explores" evidence to discover observations that apply to the scenario…

Incident tab provides description



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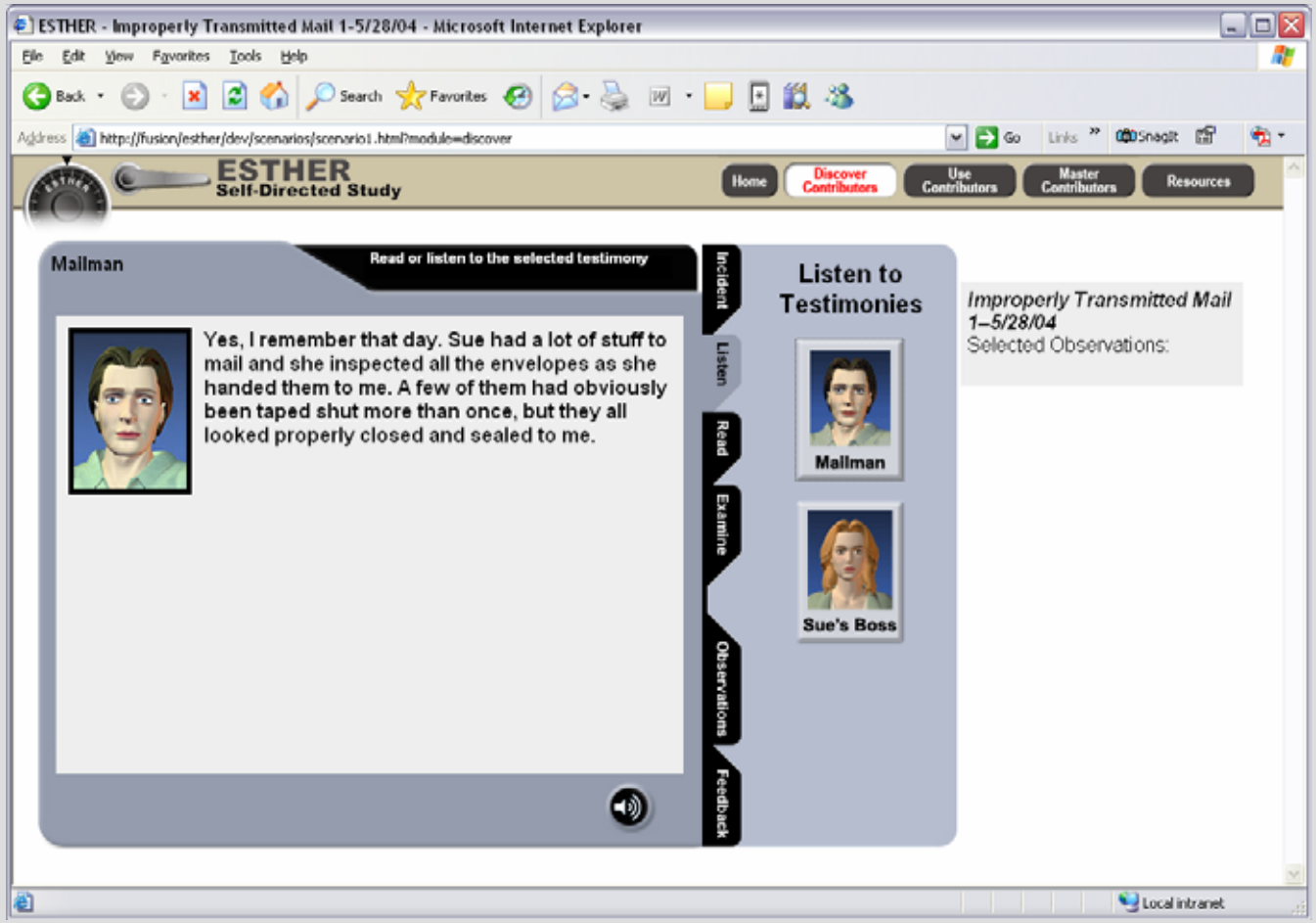
Discover Contributors Module – Testimonies

Learner "explores" evidence to discover observations that apply to the scenario…

Listen tab shows testimonies

Read tab shows documents



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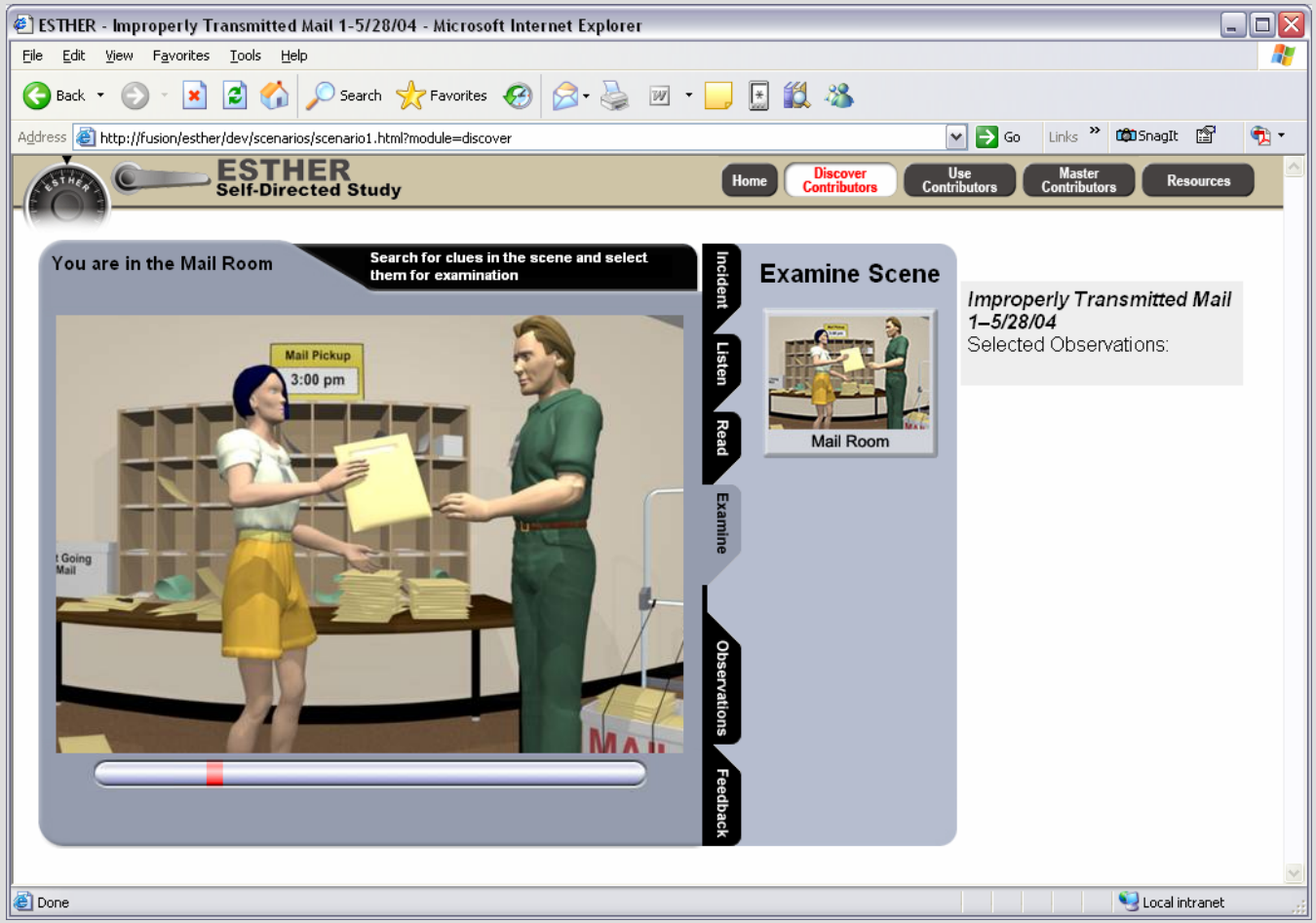
Discover Contributors Module Simulation/Animation

Learner "explores" evidence to discover observations that apply to the scenario…

Examine tab shows simulated interactive re-enactment of one or more scenes



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Discover Contributors Module – Feedback

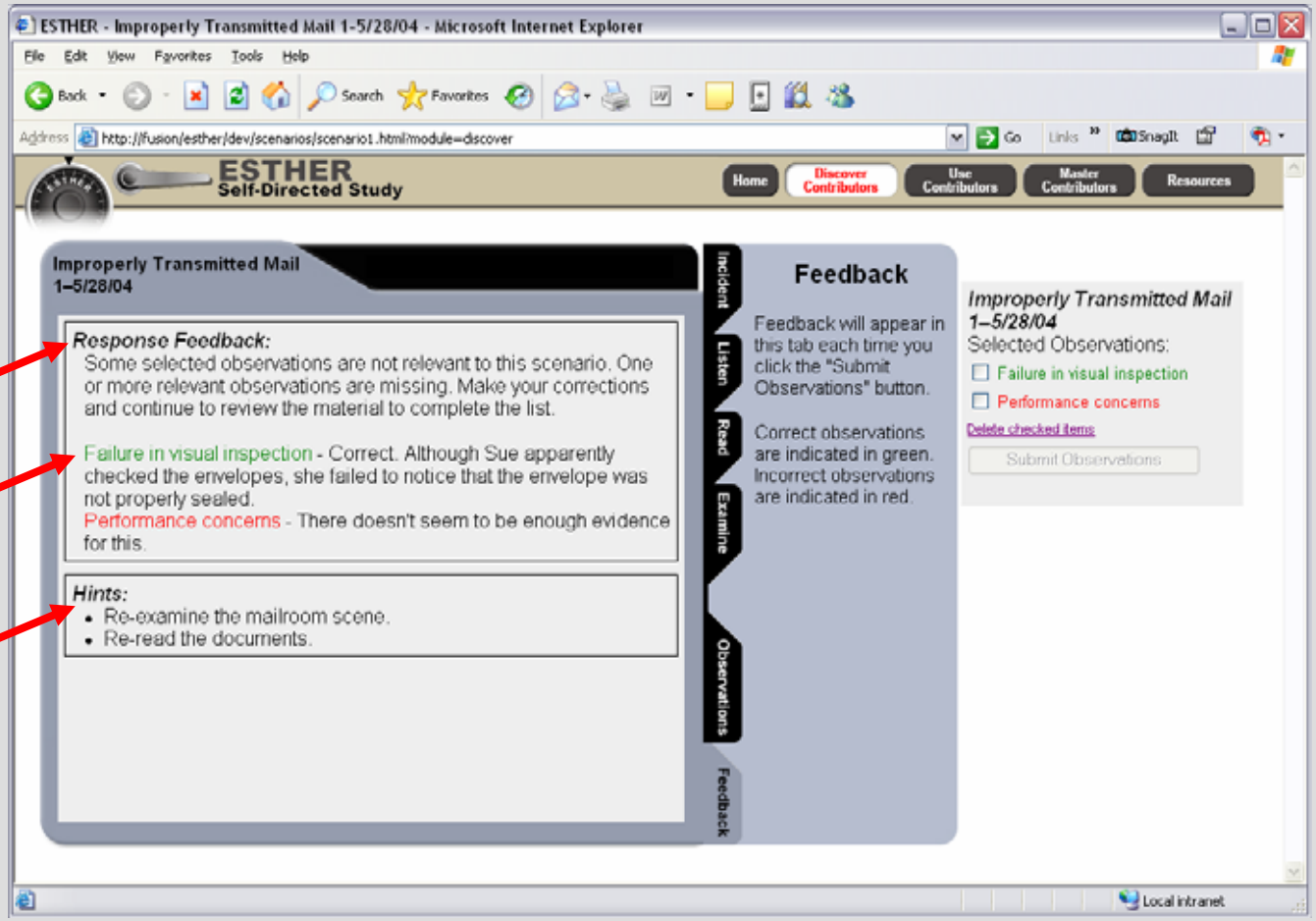
Multilevel feedback is provided after learner selects observations that apply to the scenario…

Levels of Feedback:

General

Correct/Incorrect

Hints



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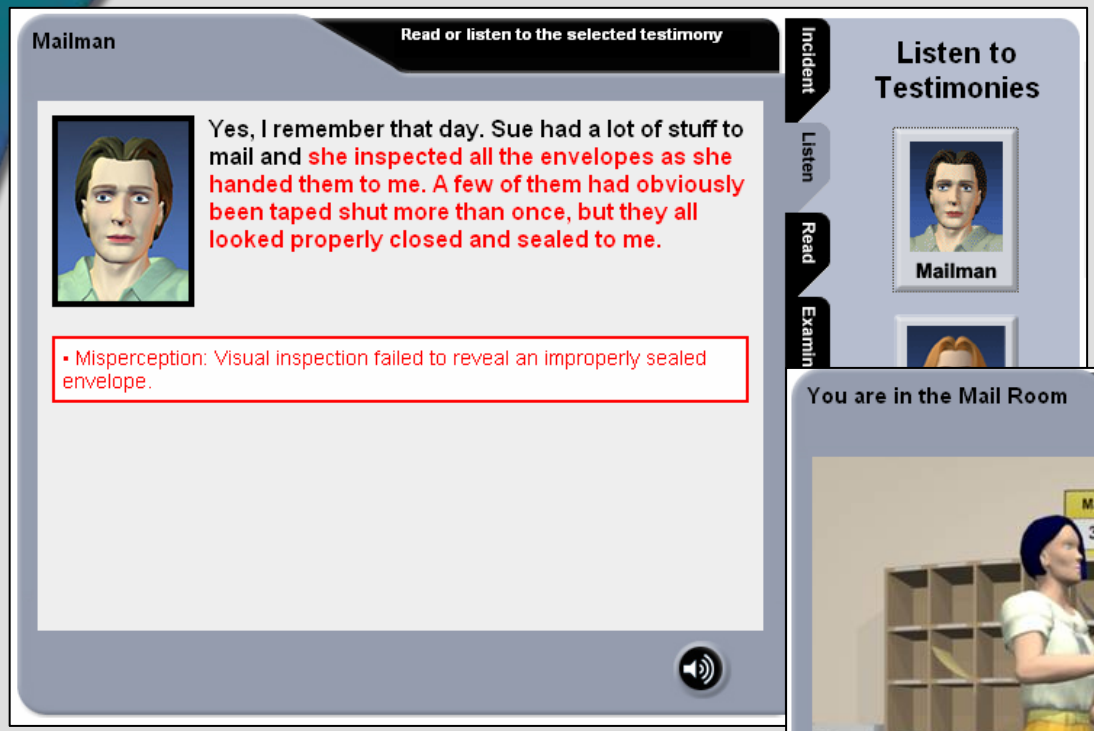
Feedback



The learner can review different tabs to see feedback highlighting relevant observations and contributors/factors.

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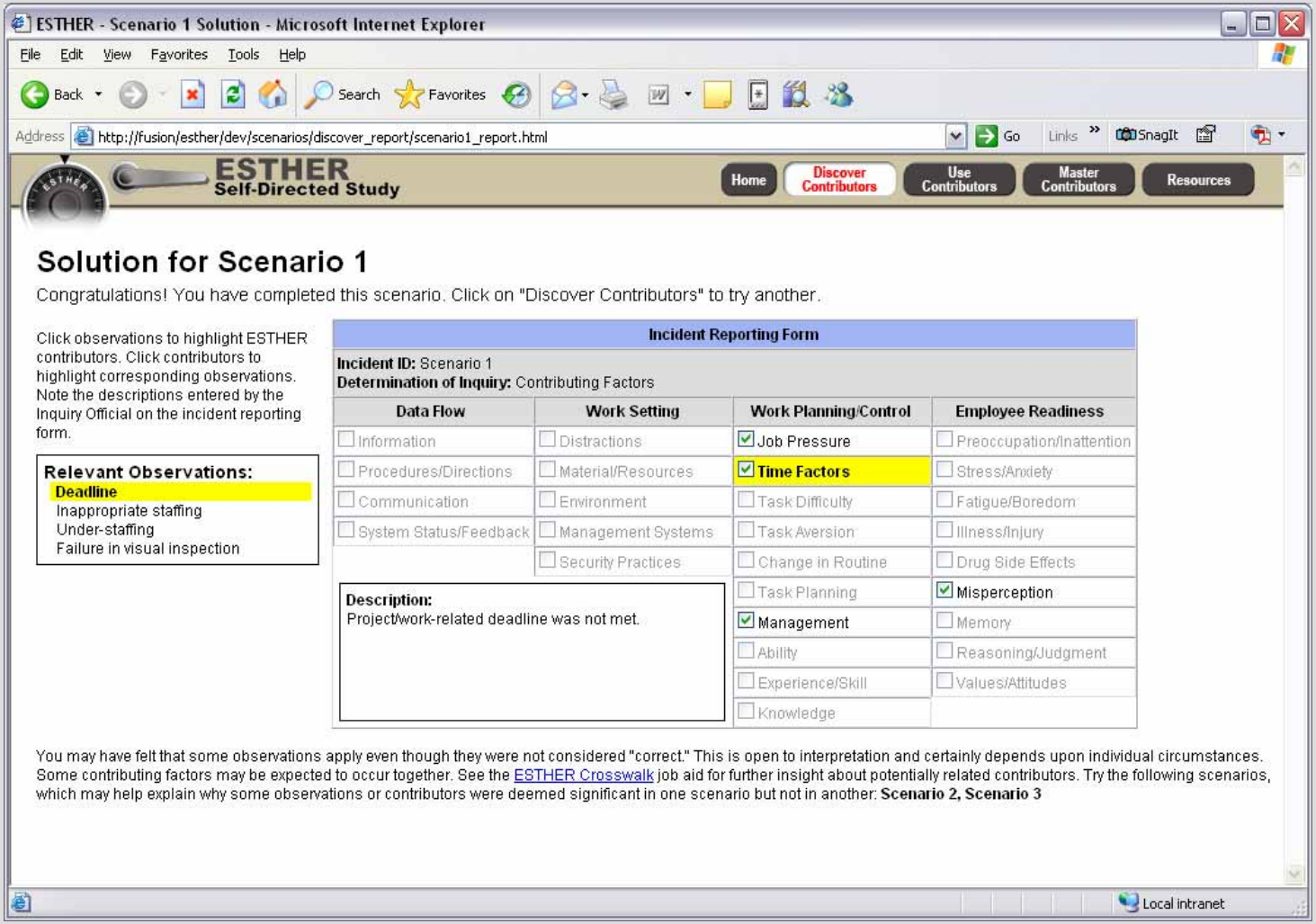
Discover Contributors Module – Higher Level Concepts

Observations are related to the ESTHER contributors on the reporting form…



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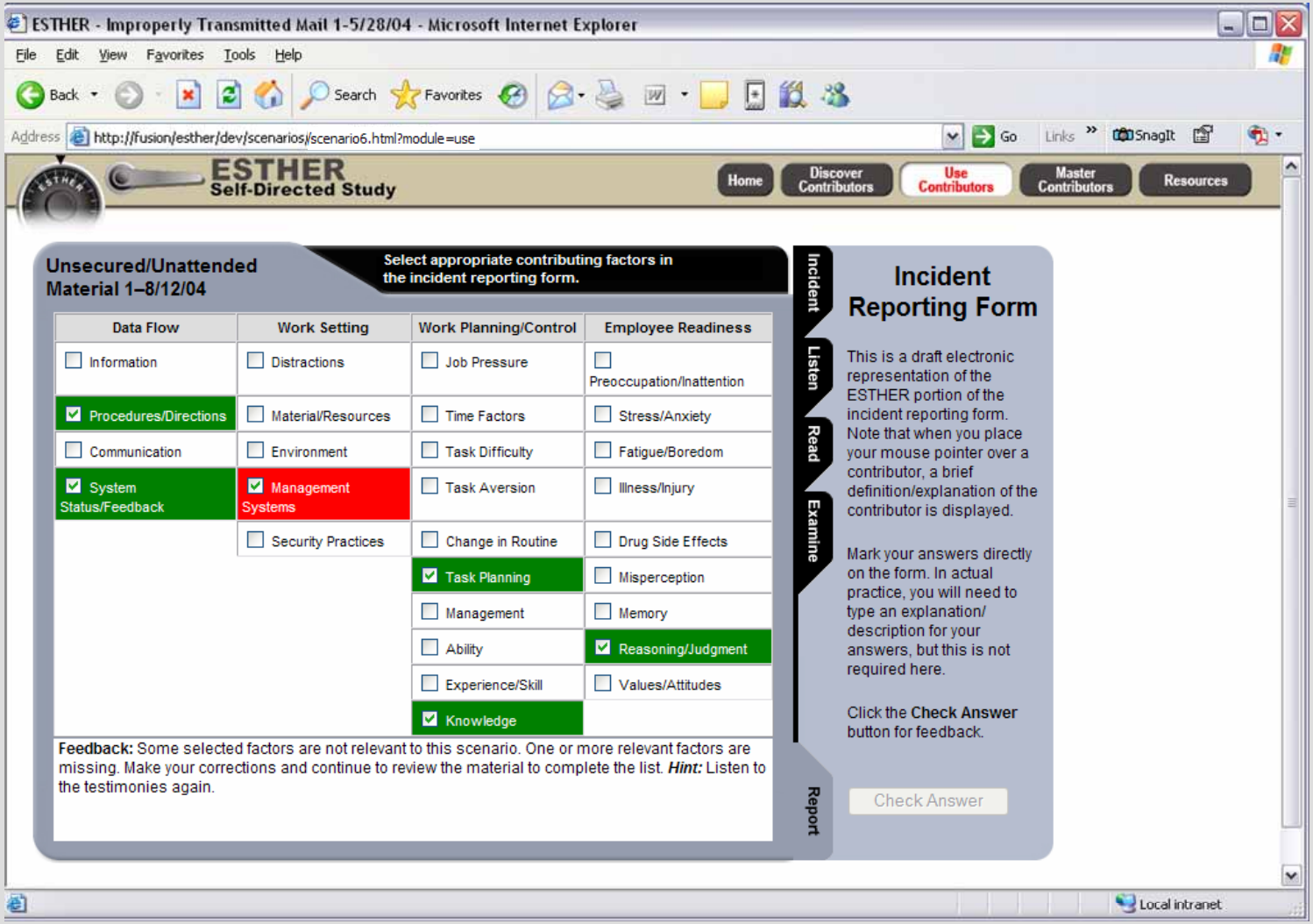
Use Contributors Module

Learner works on similar scenarios, but must respond directly using ESTHER contributors on the reporting form…



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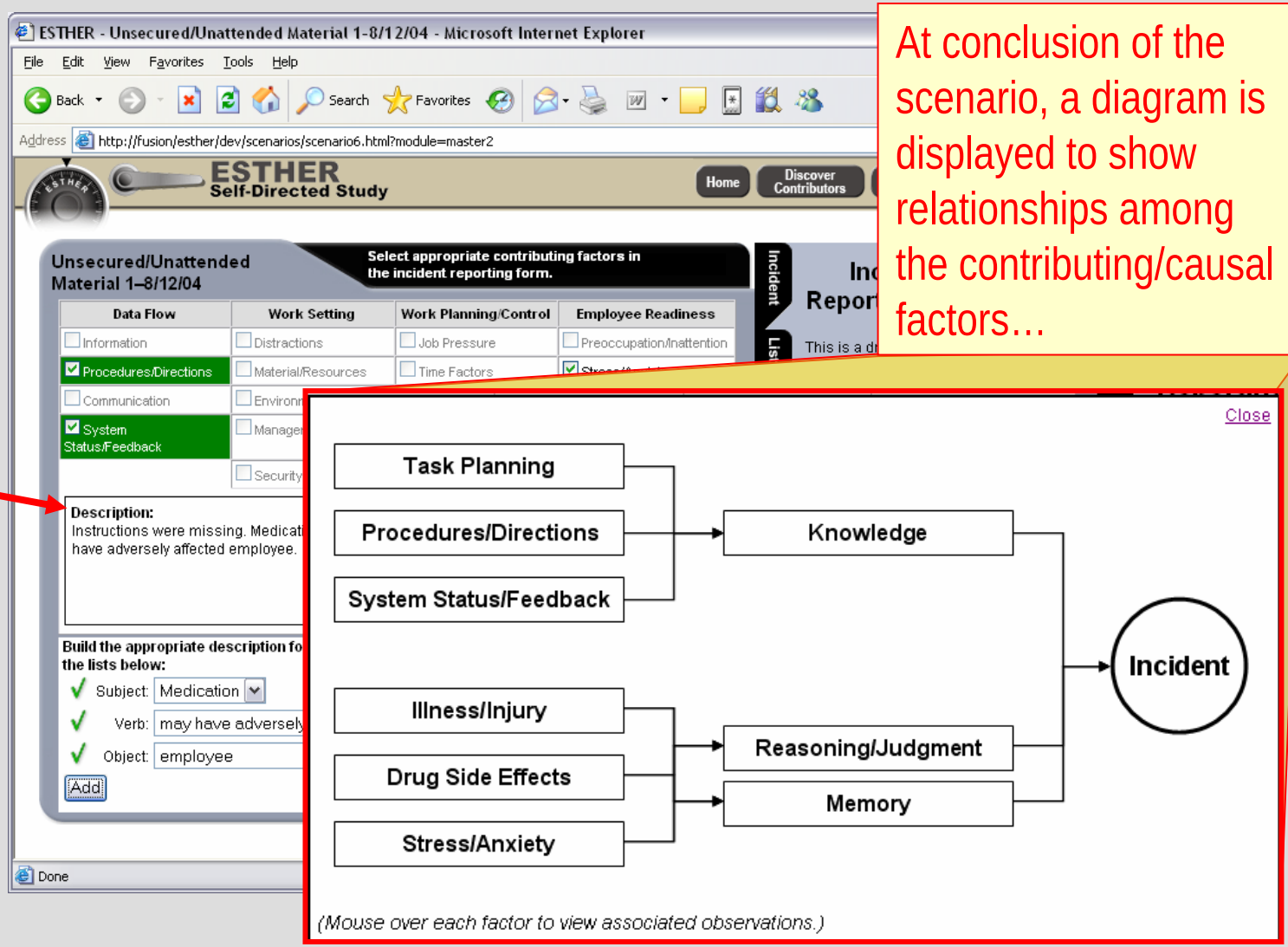
Master Contributors Module

Learner must also identify deeper causal factors and correctly describe the precursors…



At conclusion of the scenario, a diagram is displayed to show relationships among the contributing/causal factors…

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Game-Based Learning

- Typically: greater emphasis on gaming, less on learning
- Game is not motivating/engaging 'by definition' – learner must buy into the goals and context of the story that the game communicates
- Learner is not guaranteed to acquire the necessary skills by 'playing the game' – specific attention should be given to cognitive e-Learning principles in constructing scenarios
  - Careful construction of scenarios helps to match activities to learning objectives and shape learning
  - Informative feedback allows learner to reflect on performance and develop appropriate skills (vice superstitious behaviors)
  - Simulations or virtual environments should support the learning objectives—otherwise they distract from the instructional goals.

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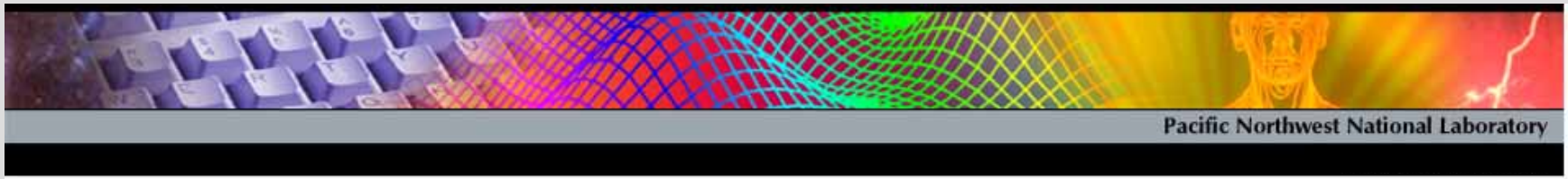
Summary and Conclusions

- Learning should be problem-based
- Learning environments should be structured to provide experiences that meet specific learning objectives
- Learning environments can/should be motivating and fun, but always should provide opportunities for learners to reflect on their experiences
- Within this broad cognitive framework for learning, there is room for an array of training approaches that includes:
  - interactive e-Learning
  - guided-discovery/scenario-based training
  - game/simulation-based training
- Cognitive principles should be applied in all forms of learning.

Contact Information



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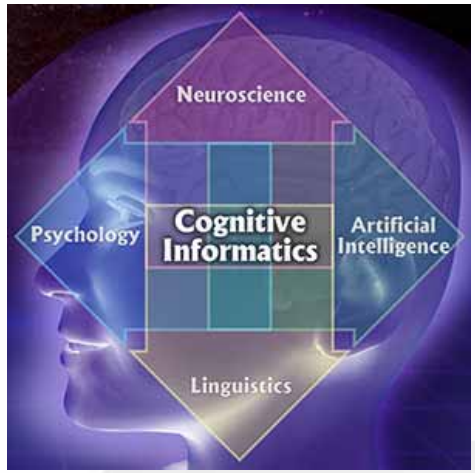

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