

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)**

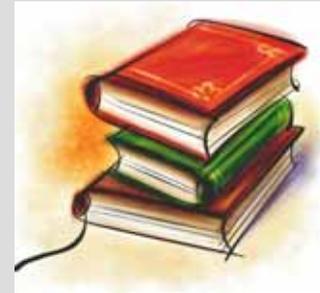
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Background

► 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.



Background

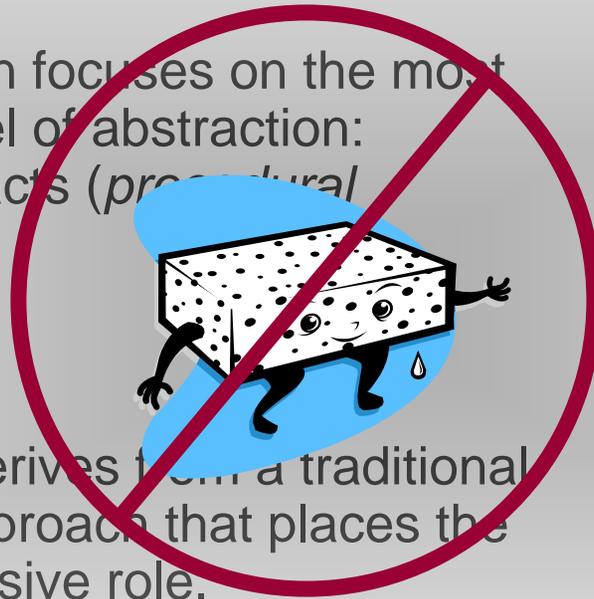
▶ Effectiveness:

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▶ Engagement:

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



The learner is NOT a SPONGE!

Active Learning:

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

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!

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

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

Examples of Interactive Checkpoints

Example 1 screen capture



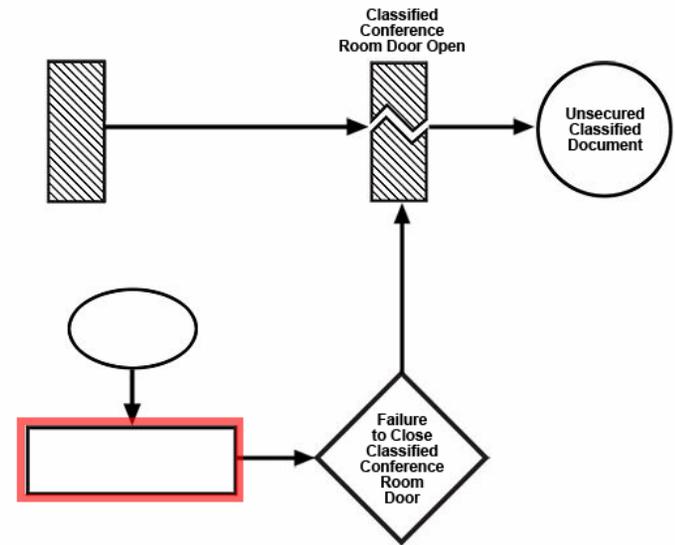
1. In this scene, select the object that represents a Barrer:

Example 2 screen capture

Drag and place these event descriptions to their correct location on the Analysis Chart

Limited Access Area
Classified Document Left Unattended

Illness



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.

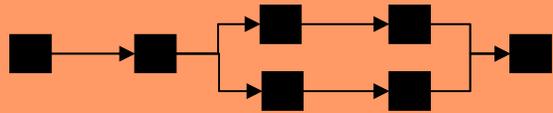
▶ Game-based e-Learning

- 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...

Levels of Engagement

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



Level 3: Contingent scenarios (content seen in response)



Level 2: Linked scenarios (content seen in response)



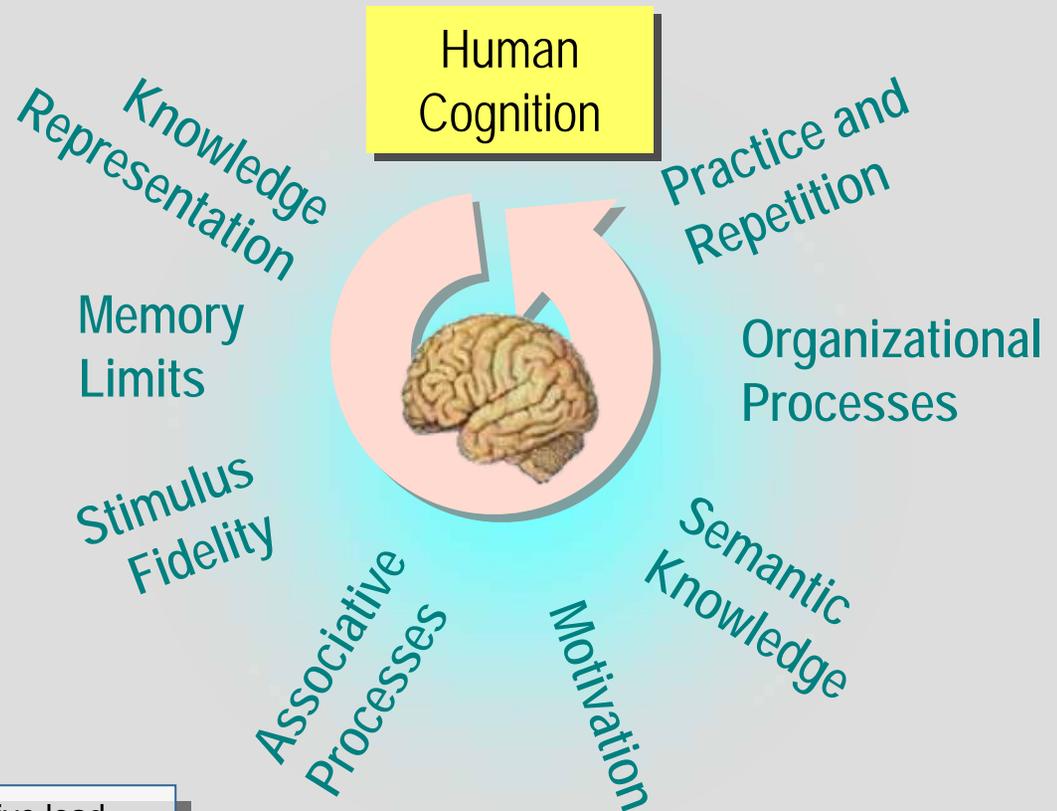
Level 1: Basic scenarios (narrow, focused, independent)

Level 0. Traditional Computer-Based Training

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

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

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...

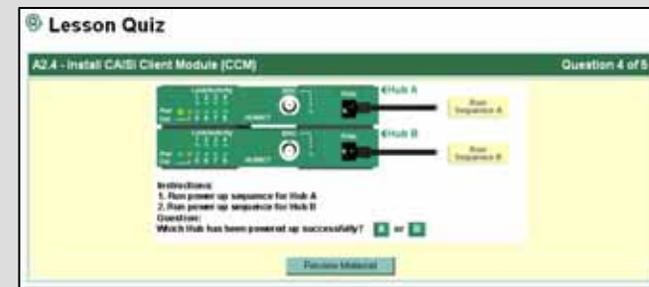


CAISI—Combat System
Support Automated
Information System
Interface e-Learning

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



Building Blocks for Active Learning

Interaction Elements



Did You Know?



Heads-Up



Check Point



Interactive Quizzes



Module Tests

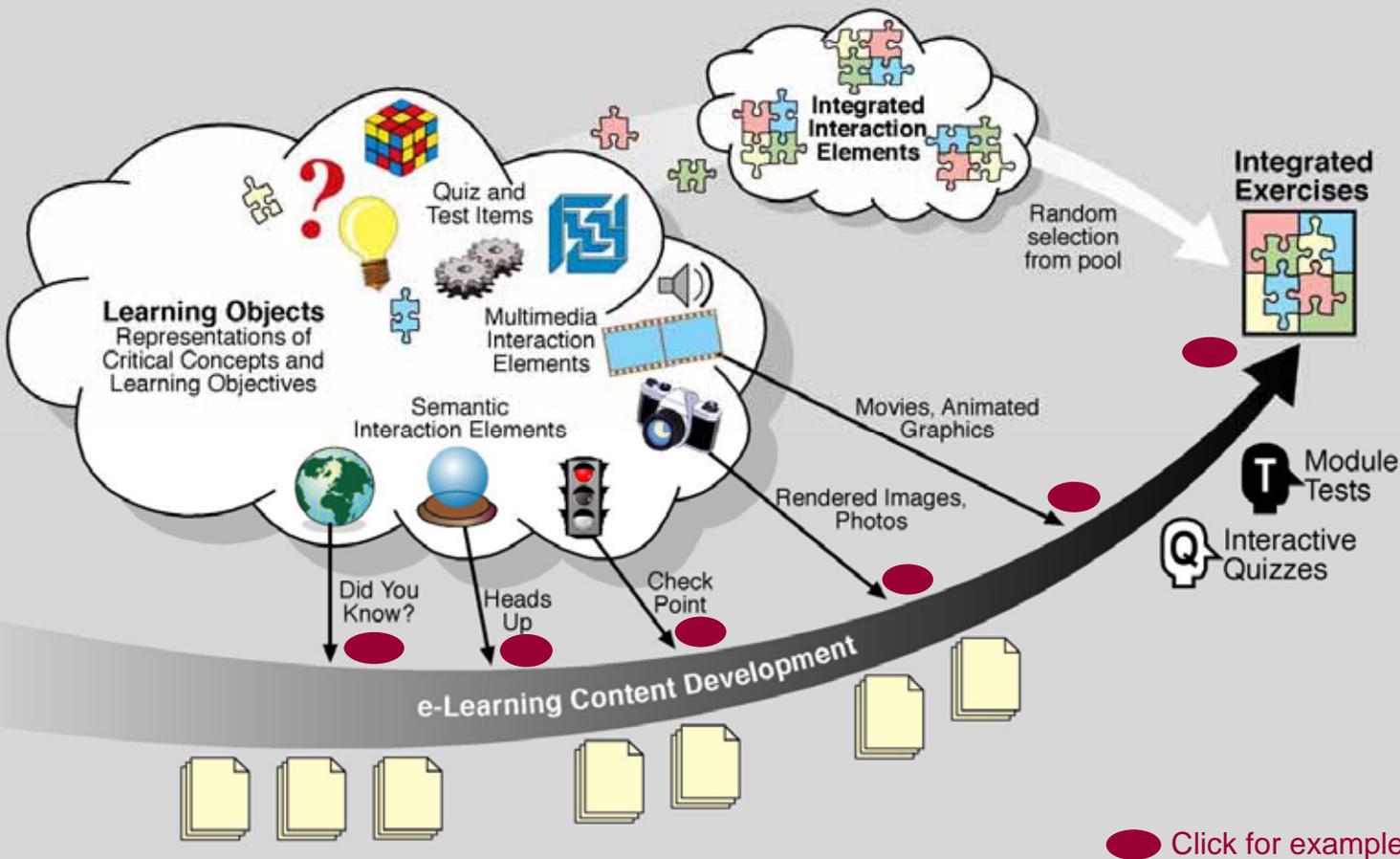


Integrated Exercises

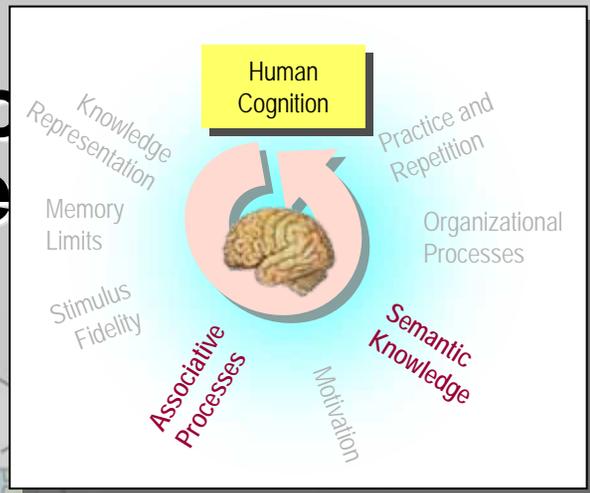
- ▶ Allow learners to check their understanding
- ▶ Guide student practice with “worked” examples
- ▶ Re-use interaction elements to exploit familiarity/build on knowledge acquired (also used in assessments)
- ▶ Building blocks for integrated, practical scenarios

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

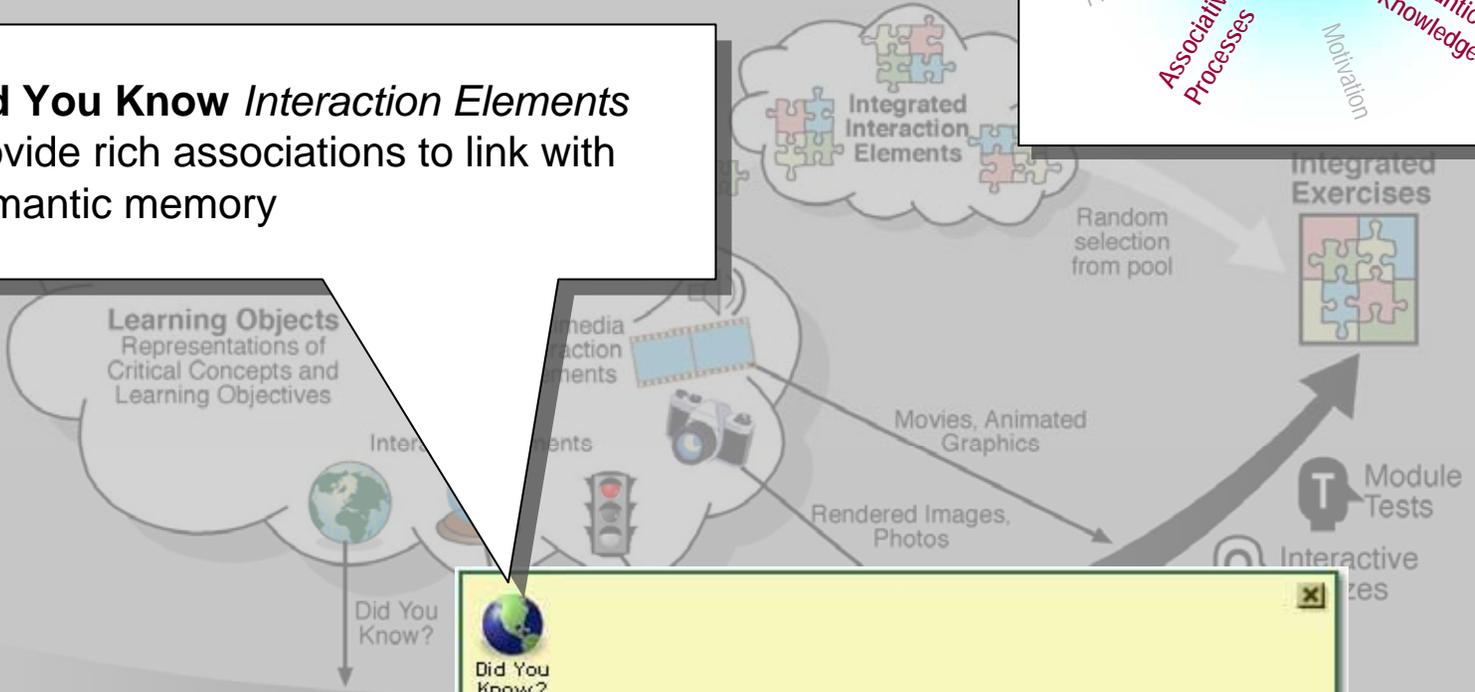
Conceptual Framework for Cognitive-based, Active e-Learning



Conceptual Framework Cognitive-based e-Le



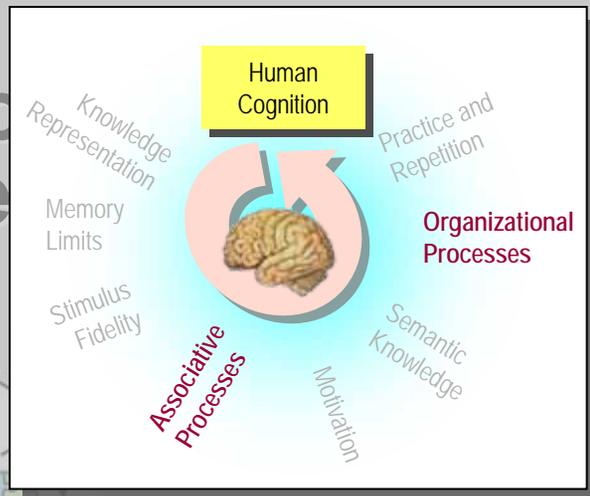
 **Did You Know** *Interaction Elements* provide rich associations to link with semantic memory



 **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.

Conceptual Framework Cognitive-based e-Learning



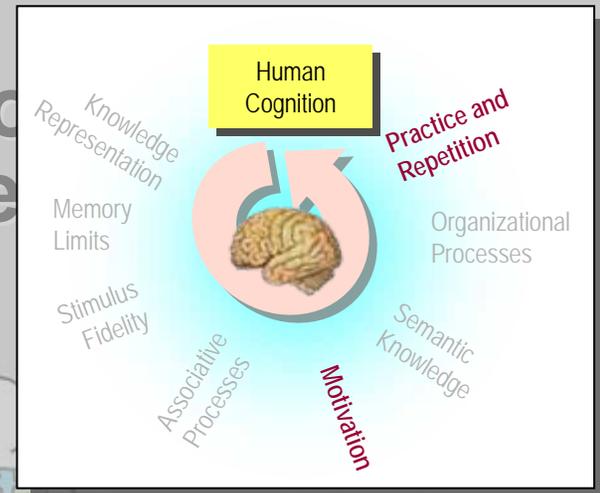
 **Heads Up** *Interaction Elements* reinforce material through associations



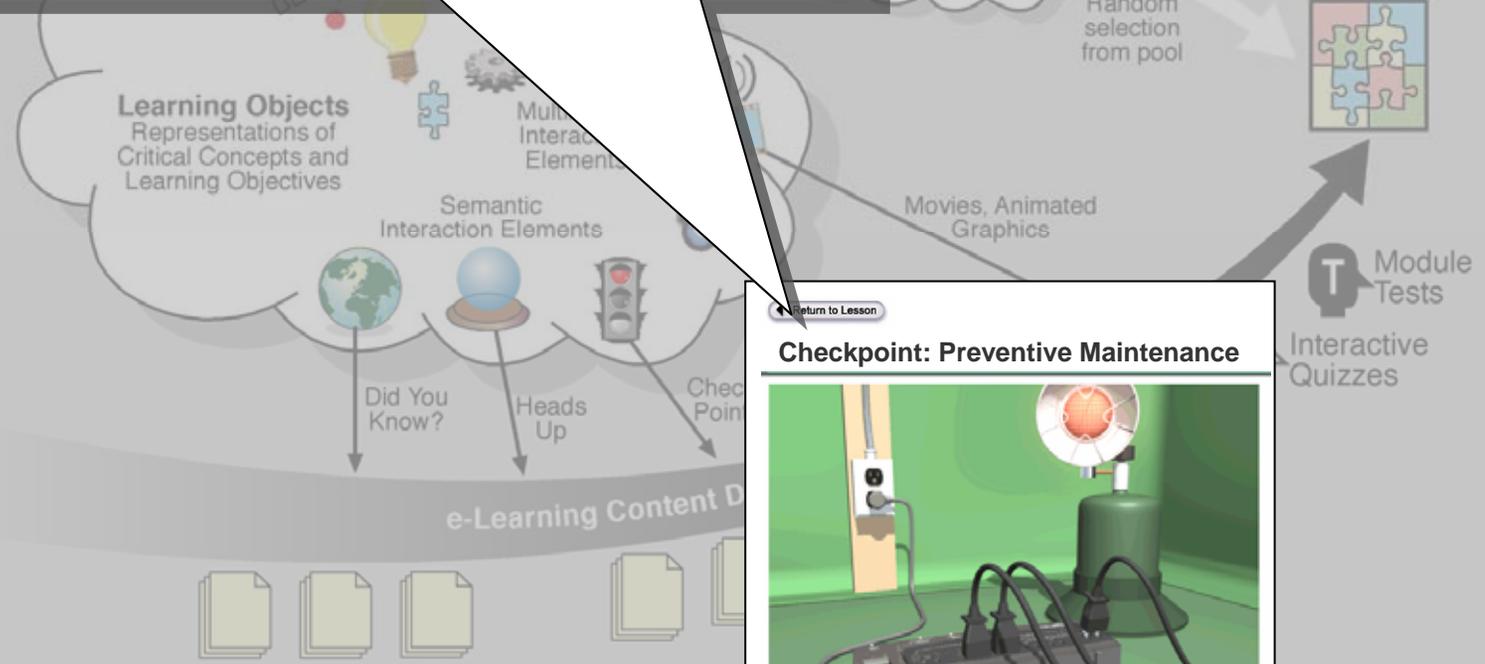

Heads Up

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.

Conceptual Framework Cognitive-based e-Learning



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



[Return to Lesson](#)

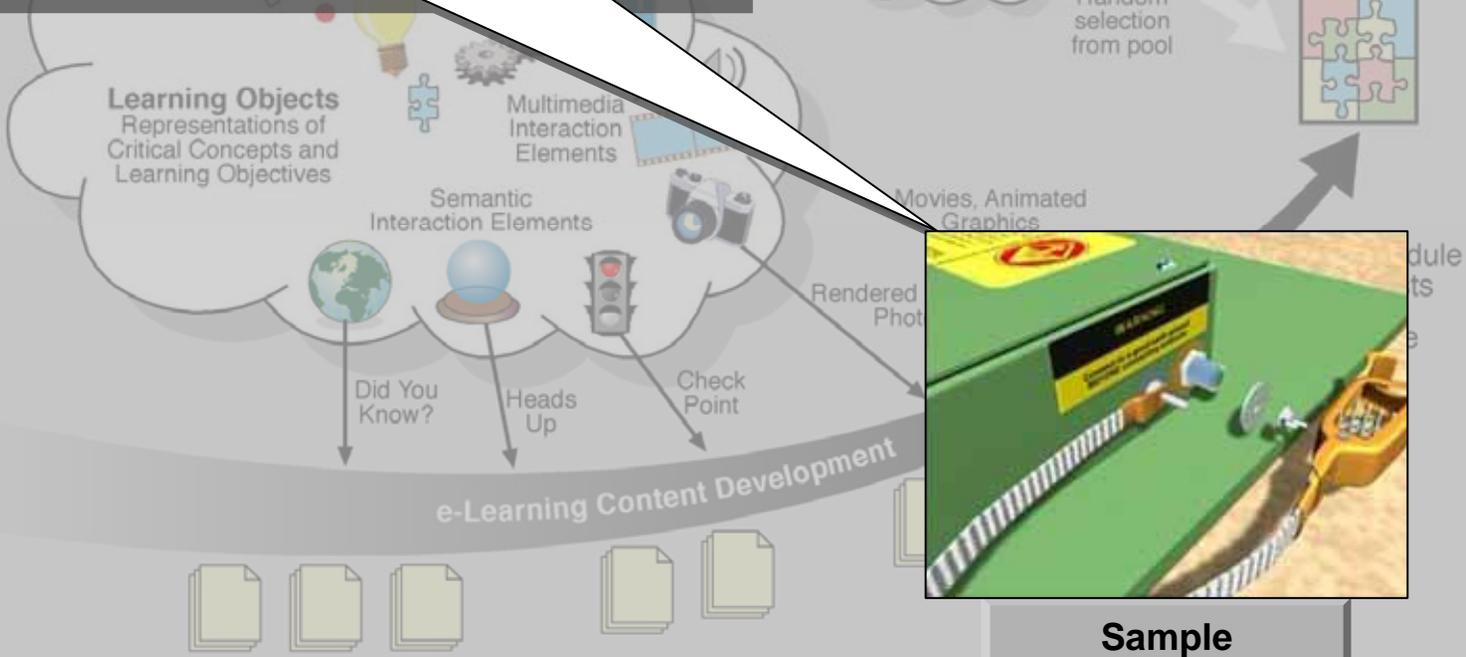
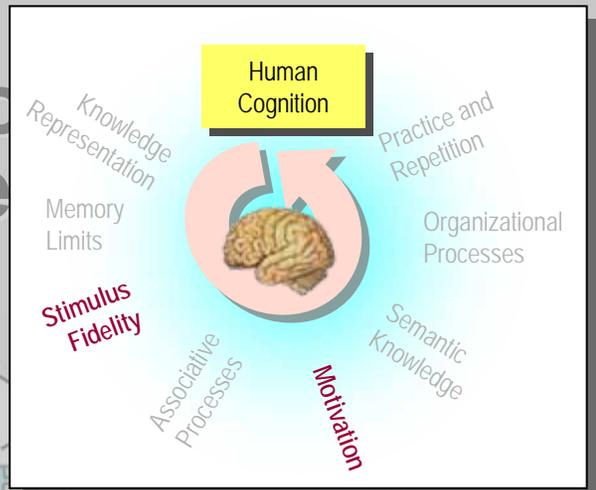
Checkpoint: Preventive Maintenance



Perform a preventive maintenance check on this scene by clicking on the various objects within it. There are at least 4 instances that need to be corrected. Can you find them?

Conceptual Framework Cognitive-based e-Learning

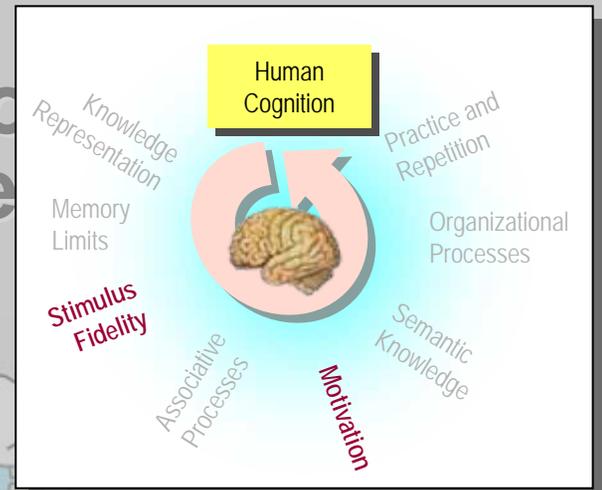
Rendered objects to provide simulations and 3-D representations that maintain stimulus fidelity



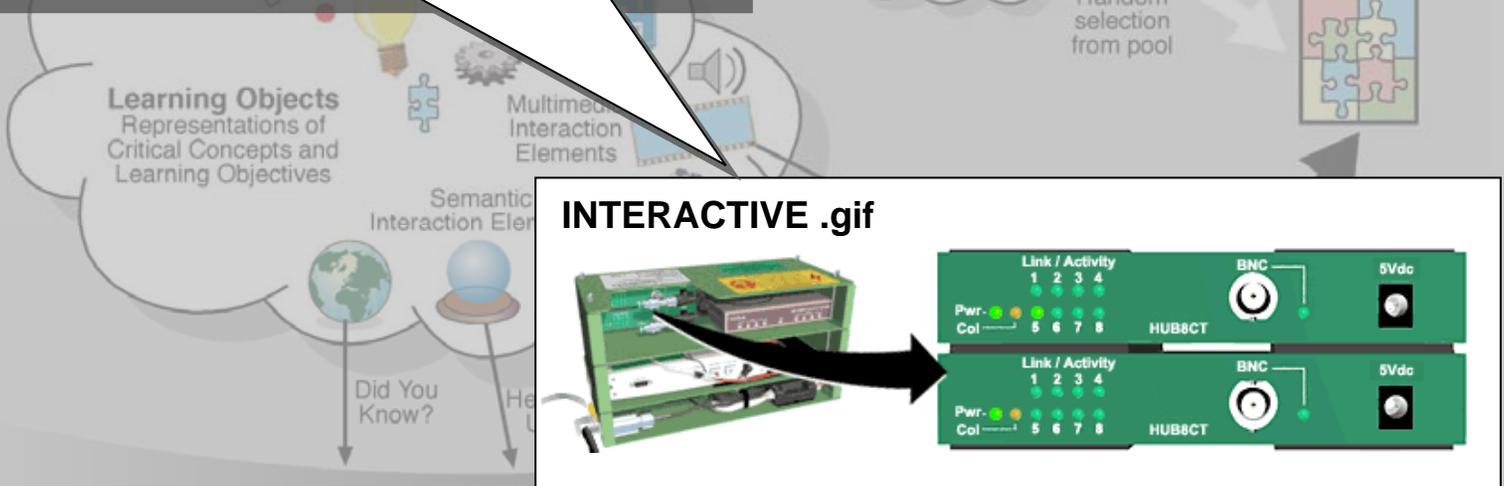
Sample Animation

Conceptual Framework Cognitive-based e-Learning

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



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



INTERACTIVE .gif

The interactive .gif displays a detailed simulation of a circuit board. On the left, a 3D perspective view shows a green PCB populated with various components. A black arrow points from this view to a 2D schematic representation of the same board. The schematic includes:

- Link / Activity** indicators (1, 2, 3, 4) with green status lights.
- Pwr-** and **Col** indicators with green status lights.
- HUB8CT** label.
- BNC** connector.
- 5Vdc** power source.

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▶ Game-based e-Learning

- Potential for reaching out to millennial youth/population
- Challenge: to provide educational benefit

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.)

ESTHER Causal Analysis e-Learning Application

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



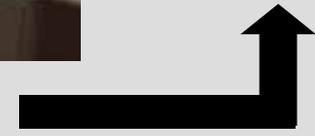
“Junior” Office



“Associate” Office



“Master” Office



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.



Discover Contributors Module – Incident Description

Learner “explores” evidence to discover observations that apply to the scenario...

Incident tab provides description

ESTHER Self-Directed Study

Home Discover Contributors Use Contributors Master Contributors Resources

Improperly Transmitted Mail 1-5/28/04

Incident Overview

Reported Category: Improperly transmitted material: US Mail

Reported Incident: Envelope came open before reaching its target destination, revealing Secret Restricted Data (SRD)

Report Date: May 28, 2004

Instructions

Examine the materials available to you and select all observations, within the categories under the Observations tab, that you believe may have contributed to the reported incident.

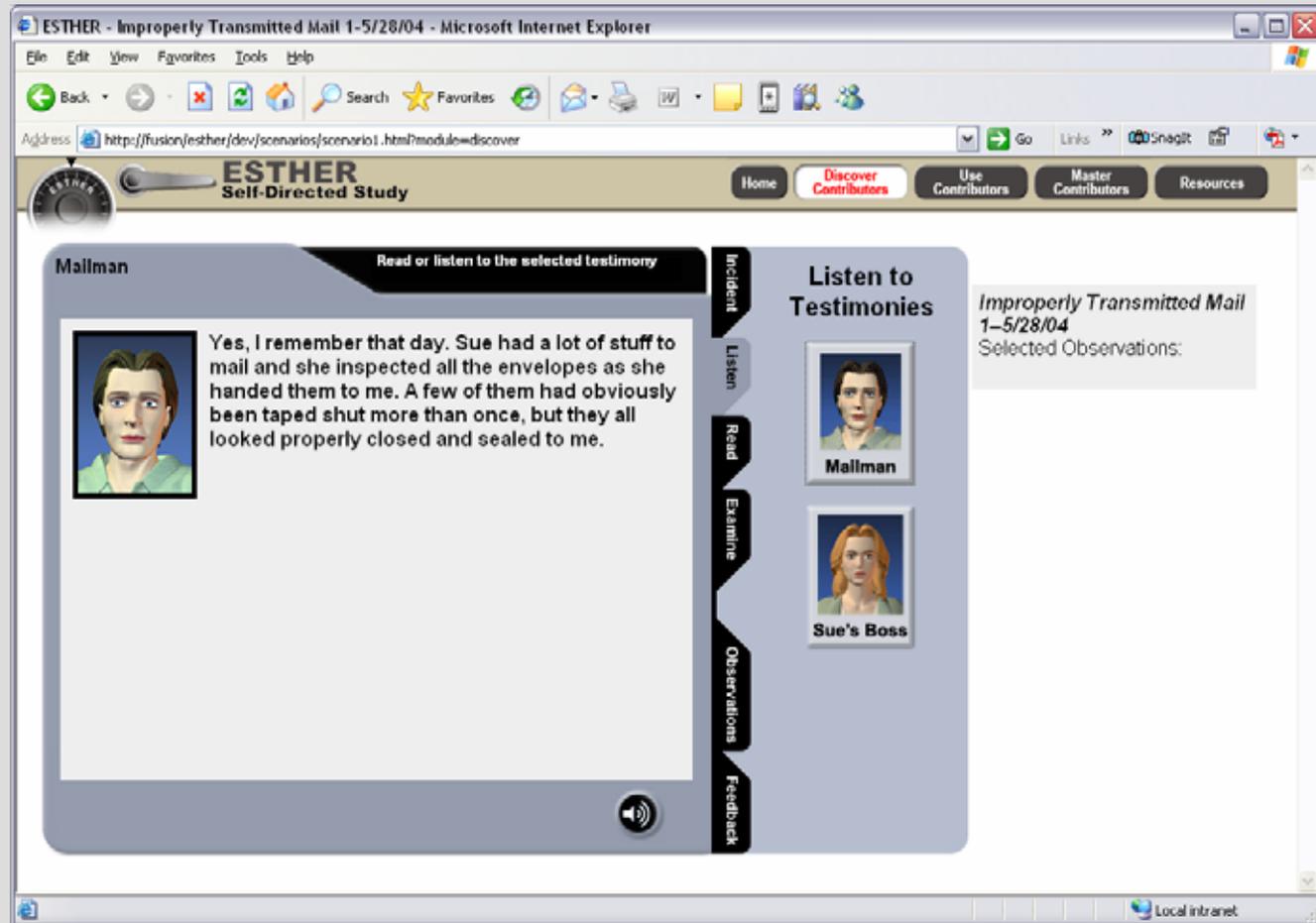
When you have finished selecting your observations, check your answers by clicking the "Submit Observations" button. You will have three tries to find all relevant observations.

Select a tab on the left to begin.

Improperly Transmitted Mail 1-5/28/04
Selected Observations:

Discover Contributors Module – Testimonies

Learner “explores” evidence to discover observations that apply to the scenario...



Listen tab shows testimonies

Read tab shows documents

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

The screenshot shows a Microsoft Internet Explorer browser window displaying the ESTHER Self-Directed Study interface. The address bar shows the URL: `http://fusion/esther/dev/scenarios/scenario1.html?module=discover`. The page title is "ESTHER - Improperly Transmitted Mail 1-5/28/04".

The interface includes a navigation menu with buttons for "Home", "Discover Contributors", "Use Contributors", "Master Contributors", and "Resources". The main content area is titled "ESTHER Self-Directed Study" and features a central simulation window.

The simulation window is titled "You are in the Mail Room" and contains the instruction: "Search for clues in the scene and select them for examination". The simulation depicts a woman in a white shirt and yellow shorts handing a yellow envelope to a man in a green uniform in a mail room. A sign above the woman reads "Mail Pickup 3:00 pm".

To the right of the simulation is an "Examine Scene" panel. It includes a small thumbnail of the scene labeled "Mail Room" and a text box titled "Improperly Transmitted Mail 1-5/28/04" with the sub-heading "Selected Observations:". Below the simulation is a vertical navigation bar with buttons for "Incident", "Listen", "Read", "Examine", "Observations", and "Feedback".

Discover Contributors Module – Feedback

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

Levels of Feedback:

General

Correct/Incorrect

Hints



The screenshot shows a web browser window titled "ESTHER - Improperly Transmitted Mail 1-5/28/04 - Microsoft Internet Explorer". The address bar shows "http://fusion/esther/dev/scenarios/scenario1.html?module=discover". The page header includes "ESTHER Self-Directed Study" and navigation buttons for "Home", "Discover Contributors", "Use Contributors", "Master Contributors", and "Resources".

The main content area is titled "Improperly Transmitted Mail 1-5/28/04" and features a vertical navigation bar on the right with tabs for "Incident", "Listen", "Read", "Examine", "Observations", and "Feedback". The "Feedback" tab is active.

The feedback section contains the following text:

Response Feedback:
Some selected observations are not relevant to this scenario. One or more relevant observations are missing. Make your corrections and continue to review the material to complete the list.

Failure in visual inspection - Correct. Although Sue apparently checked the envelopes, she failed to notice that the envelope was not properly sealed.

Performance concerns - There doesn't seem to be enough evidence for this.

Hints:

- Re-examine the mailroom scene.
- Re-read the documents.

On the right side of the feedback panel, there is a "Feedback" section with the text: "Feedback will appear in this tab each time you click the 'Submit Observations' button." Below this, there is a "Selected Observations:" section with two checkboxes: "Failure in visual inspection" (checked) and "Performance concerns" (unchecked). There is also a "Delete checked items" link and a "Submit Observations" button.

Feedback

Mailman Read or listen to the selected testimony



Yes, I remember that day. Sue had a lot of stuff to mail and **she inspected all the envelopes as she handed them to me. A few of them had obviously been taped shut more than once, but they all looked properly closed and sealed to me.**

• Misperception: Visual inspection failed to reveal an improperly sealed envelope.



Incident
Listen
Read
Examine

Listen to Testimonies



Mailman

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

Mail Pickup

3:00 pm

Time Factors: Mail pickup is 3:00 p.m. daily

You are in the Mail Room Search for clues in the scene and select them for examination

Mail Pickup 3:00 pm







Incident
Listen
Read
Examine
Observations
Feedback

Examine Scene



Mail Room

Discover Contributors Module – Higher Level Concepts

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

ESTHER - Scenario 1 Solution - Microsoft Internet Explorer

Address: http://fusion/esther/dev/scenarios/discover_report/scenario1_report.html

ESTHER Self-Directed Study

Home Discover Contributors Use Contributors Master Contributors Resources

Solution for Scenario 1

Congratulations! You have completed this scenario. Click on "Discover Contributors" to try another.

Click observations to highlight ESTHER contributors. Click contributors to highlight corresponding observations. Note the descriptions entered by the Inquiry Official on the incident reporting form.

Relevant Observations:

Deadline

Inappropriate staffing
Under-staffing
Failure in visual inspection

Incident Reporting Form			
Incident ID: Scenario 1			
Determination of Inquiry: Contributing Factors			
Data Flow	Work Setting	Work Planning/Control	Employee Readiness
<input type="checkbox"/> Information	<input type="checkbox"/> Distractions	<input checked="" type="checkbox"/> Job Pressure	<input type="checkbox"/> Preoccupation/Inattention
<input type="checkbox"/> Procedures/Directions	<input type="checkbox"/> Material/Resources	<input checked="" type="checkbox"/> Time Factors	<input type="checkbox"/> Stress/Anxiety
<input type="checkbox"/> Communication	<input type="checkbox"/> Environment	<input type="checkbox"/> Task Difficulty	<input type="checkbox"/> Fatigue/Boredom
<input type="checkbox"/> System Status/Feedback	<input type="checkbox"/> Management Systems	<input type="checkbox"/> Task Aversion	<input type="checkbox"/> Illness/Injury
	<input type="checkbox"/> Security Practices	<input type="checkbox"/> Change in Routine	<input type="checkbox"/> Drug Side Effects
		<input type="checkbox"/> Task Planning	<input checked="" type="checkbox"/> Misperception
		<input checked="" type="checkbox"/> Management	<input type="checkbox"/> Memory
		<input type="checkbox"/> Ability	<input type="checkbox"/> Reasoning/Judgment
		<input type="checkbox"/> Experience/Skill	<input type="checkbox"/> Values/Attitudes
		<input type="checkbox"/> Knowledge	

Description:

Project/work-related deadline was not met.

You may have felt that some observations apply even though they were not considered "correct." This is open to interpretation and certainly depends upon individual circumstances. Some contributing factors may be expected to occur together. See the [ESTHER Crosswalk](#) job aid for further insight about potentially related contributors. Try the following scenarios, which may help explain why some observations or contributors were deemed significant in one scenario but not in another: **Scenario 2, Scenario 3**

Local intranet

Use Contributors Module

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

ESTHER - Improperly Transmitted Mail 1-5/28/04 - Microsoft Internet Explorer

Address: <http://fusion/esther/dev/scenarios/scenario6.html?module=use>

ESTHER Self-Directed Study

Home Discover Contributors **Use Contributors** Master Contributors Resources

Unsecured/Unattended Material 1-8/12/04

Select appropriate contributing factors in the incident reporting form.

Data Flow	Work Setting	Work Planning/Control	Employee Readiness
<input type="checkbox"/> Information	<input type="checkbox"/> Distractions	<input type="checkbox"/> Job Pressure	<input type="checkbox"/> Preoccupation/Inattention
<input checked="" type="checkbox"/> Procedures/Directions	<input type="checkbox"/> Material/Resources	<input type="checkbox"/> Time Factors	<input type="checkbox"/> Stress/Anxiety
<input type="checkbox"/> Communication	<input type="checkbox"/> Environment	<input type="checkbox"/> Task Difficulty	<input type="checkbox"/> Fatigue/Boredom
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		<input type="checkbox"/> Ability	<input checked="" type="checkbox"/> Reasoning/Judgment
		<input type="checkbox"/> Experience/Skill	<input type="checkbox"/> Values/Attitudes
		<input checked="" type="checkbox"/> Knowledge	

Feedback: Some selected factors are not relevant to this scenario. One or more relevant factors are missing. Make your corrections and continue to review the material to complete the list. *Hint:* Listen to the testimonies again.

Incident Reporting Form

This is a draft electronic representation of the ESTHER portion of the incident reporting form. Note that when you place your mouse pointer over a contributor, a brief definition/explanation of the contributor is displayed.

Mark your answers directly on the form. In actual practice, you will need to type an explanation/description for your answers, but this is not required here.

Click the **Check Answer** button for feedback.

Check Answer

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...

ESTHER - Unsecured/Unattended Material 1-8/12/04 - Microsoft Internet Explorer

Address: http://fusion/esther/dev/scenarios/scenario6.html?module=master2

ESTHER Self-Directed Study Home Discover Contributors

Unsecured/Unattended Material 1-8/12/04 Select appropriate contributing factors in the incident reporting form.

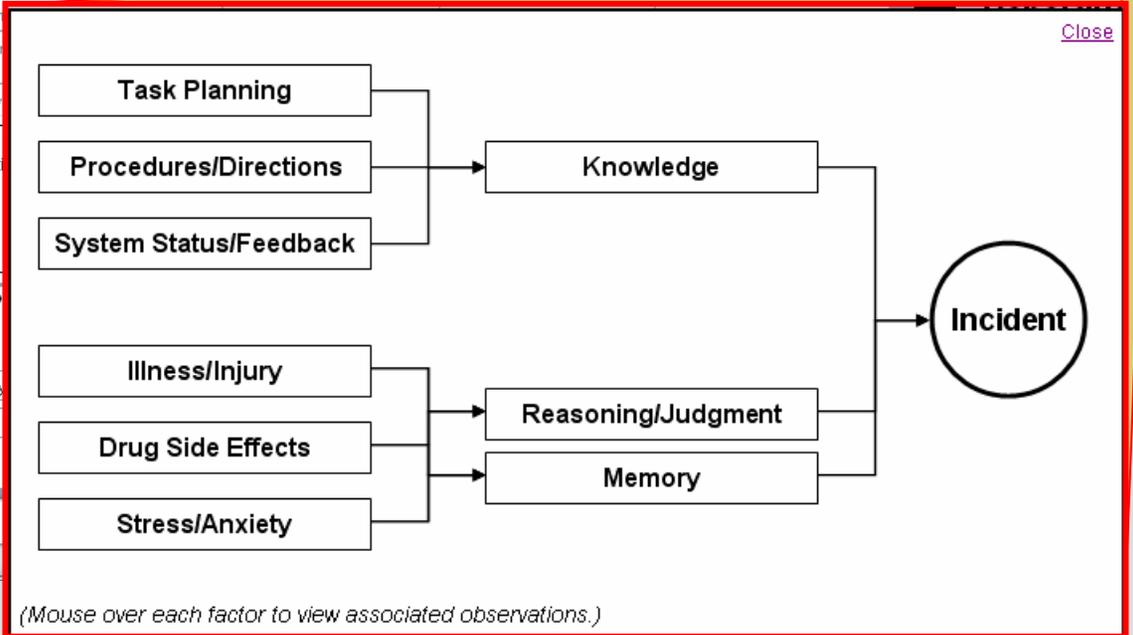
Data Flow	Work Setting	Work Planning/Control	Employee Readiness
<input type="checkbox"/> Information	<input type="checkbox"/> Distractions	<input type="checkbox"/> Job Pressure	<input type="checkbox"/> Preoccupation/Inattention
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<input type="checkbox"/> Communication	<input type="checkbox"/> Environment		
<input checked="" type="checkbox"/> System Status/Feedback	<input type="checkbox"/> Management		
	<input type="checkbox"/> Security		

Description:
Instructions were missing. Medication have adversely affected employee.

Build the appropriate description for the lists below:

- ✓ Subject: Medication
- ✓ Verb: may have adversely
- ✓ Object: employee

Add



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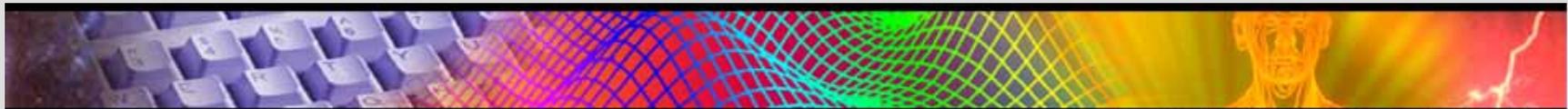
Game-Based Learning

- ▶ 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.

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.

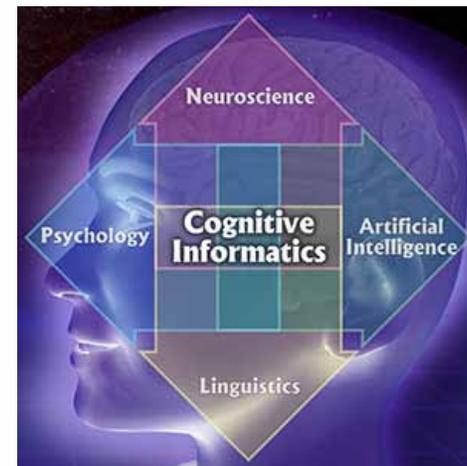
Contact Information



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<http://www.pnl.gov/cogInformatics>

Thank You. Click here to end show.