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# Generalized Intelligent Framework for Tutoring (GIFT)

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# Generalized Intelligent Framework for Tutoring (GIFT)

# ARL

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

**Robert Sottolare, Ph.D.**

**Associate Director for Science & Technology**

**Director, Learning in Intelligent Tutoring Environment (LITE) Laboratory**

**Army Research Laboratory - Human Research & Engineering Directorate (HRED)**



**31 July 2012**

- **People**
- **Motivation for Computer-Based Tutoring**
- **Problem Statement**
- **GIFT Research Objectives and Purpose**
- **GIFT Authoring Construct**
- **GIFT Demo**
- **GIFT Instructional Management Construct**
- **GIFT Assessment Construct**
- **How to request GIFT... [GIFTtutoring.org](http://GIFTtutoring.org)**
- **References**
- **Questions**

- **Adaptive Tutoring Research @ the Learning in Intelligent Tutoring Environments (LITE) Laboratory**
  - **Dr. Robert Sottolare, ARL-HRED AD for S&T, LITE Lab Director**
  - **Dr. Heather Holden, Trainee Modeling & HCI Lead for LITE Lab**
  - **Mr. Keith Brawner, Authoring and Expert Modeling Lead for LITE Lab**
  - **Mr. Benjamin Goldberg, Instructional Strategy Lead for LITE Lab**
  - **Mrs. Janice Connor, Research Assistant**
  - **Dr. Anne Sinatra, Post-Doc**



**Co-creators of GIFT**

The word "GIFT" in a large, bold, sans-serif font. A small icon of a gift box with a ribbon is positioned above the letter "I".





charles river analytics

**GIFT**

Georgia  
Tech

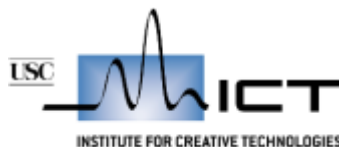
College of  
Computing  
School of Interactive Computing



**ARL**



INSTITUTE for  
SIMULATION  
& TRAINING



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

## Tutoring Methods and Effect Sizes...

- .42 Unskilled human tutors (Cohen, Kulik, & Kulik, 1982)**  
( ↑ median score from 50<sup>th</sup> percentile to 66<sup>th</sup> percentile)
- .79 Skilled human tutors (VanLehn, 2011)**  
( ↑ median score from 50<sup>th</sup> percentile to 79<sup>th</sup> percentile)
- .80 AutoTutor (20 experiments) (Graesser and colleagues)**
- 1.05 Other tutoring systems ( ↑ median score from 50<sup>th</sup> to 85<sup>th</sup>)**
  - PACT Geometry Tutor (Anderson, Corbett, Koedinger & Pelletier, 1995)**
  - Atlas-Andes (VanLehn, et al, 2005; Rose, et al, 2001)**
  - Diagnoser - physics (Hunt & Minstrell, 1994)**
  - Sherlock (Lesgold, et al, 1988)**
- 2.00 Skilled human tutors (Bloom, 1984)**

❖ Adapted from information provided by Dr. Art Graesser, University of Memphis, and Dr. Beverly Woolf, University of Massachusetts - Amherst.

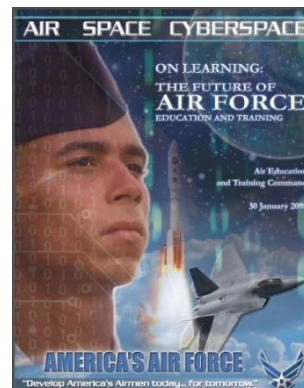
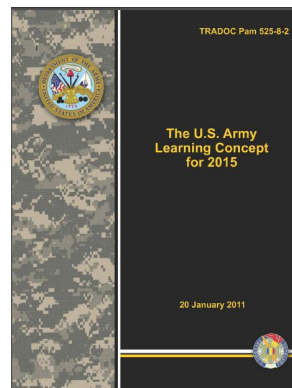


**Computer-based tutoring systems (*CBTS*) have demonstrated significant promise in *tutoring individuals in well-defined domains*, but...**

**Fifty years of research have been unsuccessful in making *CBTS* ubiquitous in military training... Why?**

***CBTS* are *expensive to author* and are *insufficiently adaptable* to support the *tailored, self-regulated, individual & small unit* tutoring experiences required to support:**

- ***U.S. Army Learning Model (ALM) for 2015 (TRADOC, 2011)***
- ***U.S. Air Force (AETC, 2008)***
- ***U.S. Navy STEM Grand Challenge (ONR, 2012)***
- ***OSD R&T Vision for PAL***
- ***NATO HFM RTG 237 (Advanced ITS)***
- ***TTCP HUM TP-2 (Training Panel)***



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

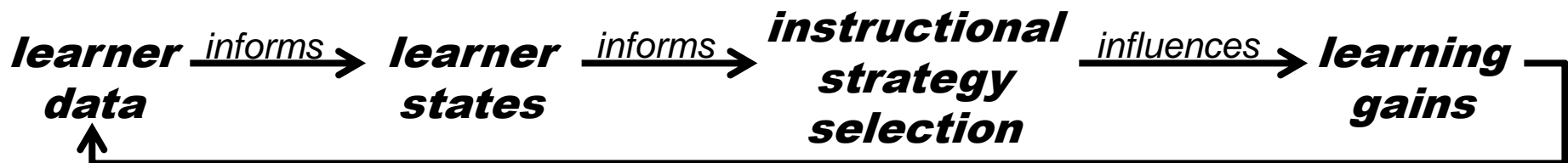
- **Tutor Authoring**

- **promote reuse through *common tools and standards***
- **promote reuse through *domain-independent modules***
- **leverage *open source solutions***
- **leverage existing training environments (e.g., *games*)**

- **Tutor Adaptability**

- **develop methods to *accurately classify learner states* (e.g., cognitive, affective, psychomotor, social)**
- **develop methods to *select optimal instructional strategies* given the learner's existing states**

## ***Adaptive Tutoring Learning Effect Chain***

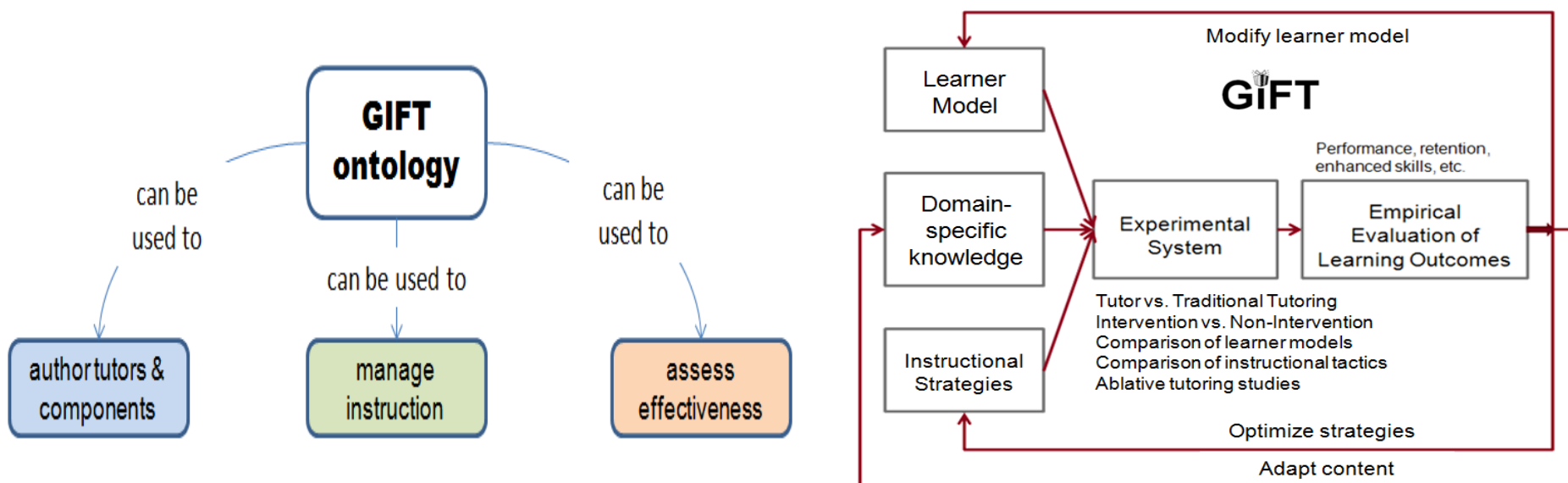


**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

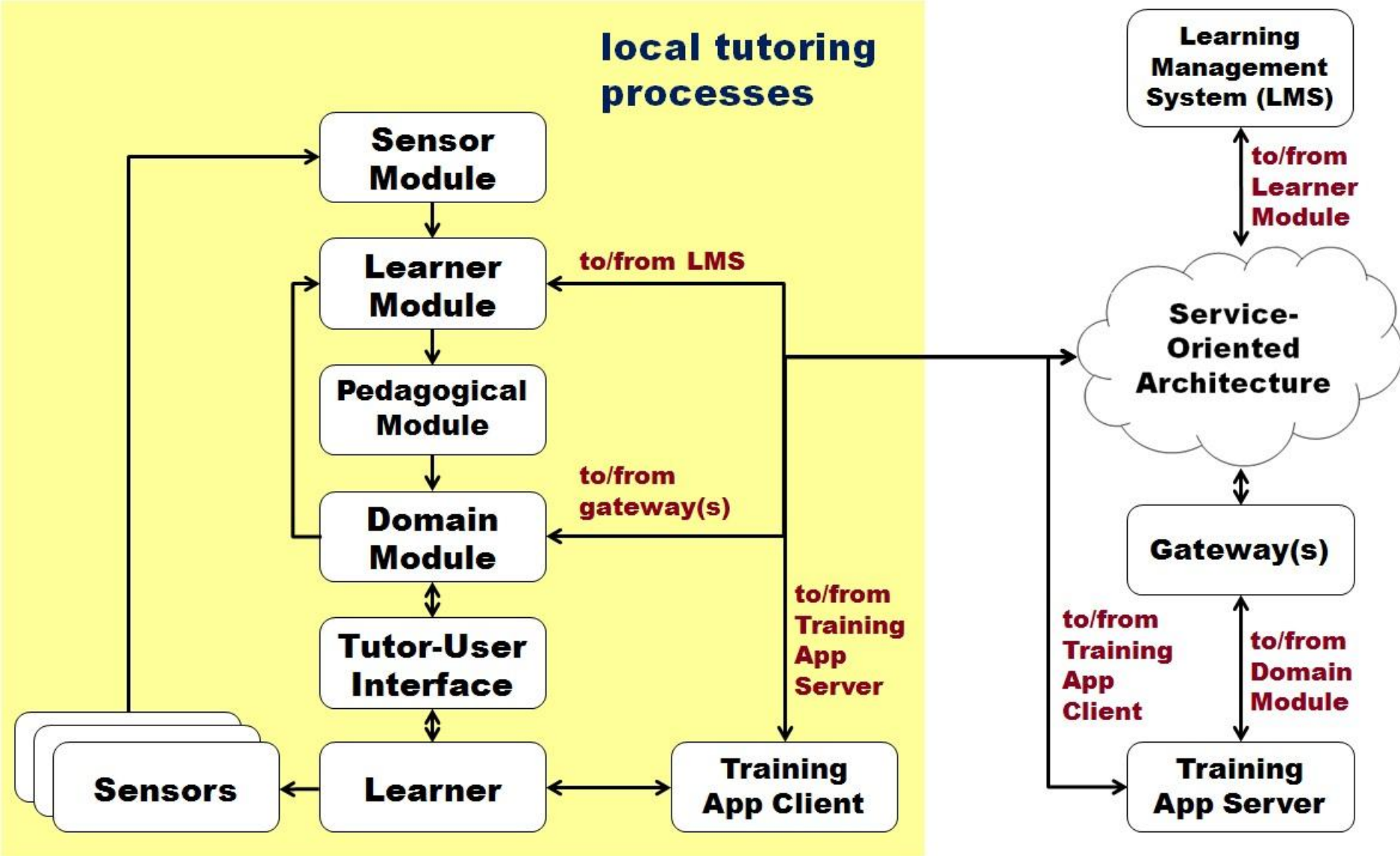




- ***Research and prototype a computer-based tutoring framework to evaluate adaptive tutoring concepts, models, authoring capabilities, and instructional strategies across various populations, training tasks and conditions, thus enabling summative and formative evaluations including between system evaluations***
  - ***empirically assess CBTS , CBTS models, methods, and components using GIFT***
  - ***use results to build CBTS standards***



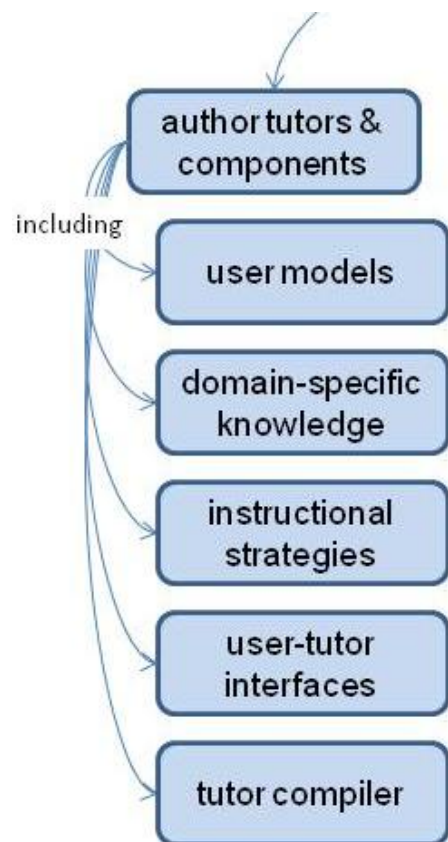
## local tutoring processes



## Authoring Goals for GIFT

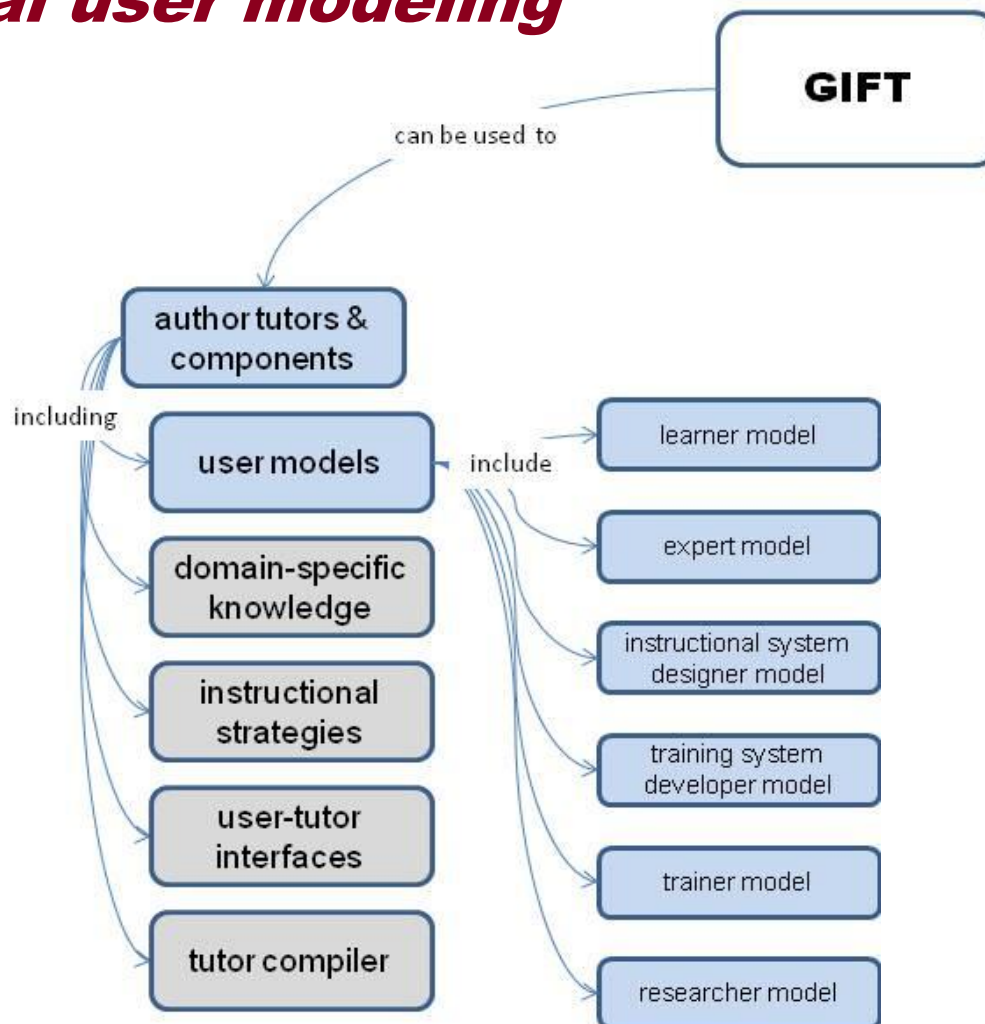
(adapted from Murray, 1999; Murray, 2003; Sottolare & Gilbert, 2011)

- **Decrease the effort (time, cost, and/or other resources) for authoring and assessing CBTS;**
- **Decrease the skill threshold by tailoring tools for specific disciplines to author, assess and employ CBTS;**
- **Provide tools to aid the designer/author/trainer /researcher organize their knowledge;**
- **Support (i.e. structure, recommend, or enforce) good design principles (in pedagogy, user interface, etc.);**
- **Enable rapid prototyping of CBTS to allow for rapid design/evaluation cycles of prototype capabilities.**
- **Employ standards to support rapid integration of external training/tutoring environments (e.g., games) (Sottolare & Gilbert, 2011)**



- Approach: functional user modeling***

- standard structures and graphical user interfaces***
- GUIs based on function (e.g., researcher) and functional competency***
  - learners***
  - subject matter experts***
  - instructional system designers***
  - system developers***
  - trainers***
  - researchers***

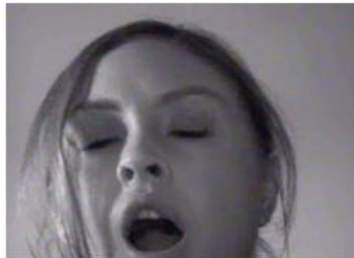




- Approach: learner affect modeling***

- what does the tutor need to know about the learner to classify their affect?***
- how does the tutor get that information?***
- which affective states are important to recognize?***
- how does classification of state influence instructional decisions?***

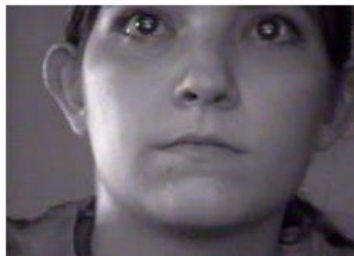
**Boredom (23%)**



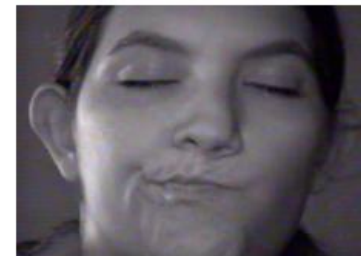
**Confusion (25%)**



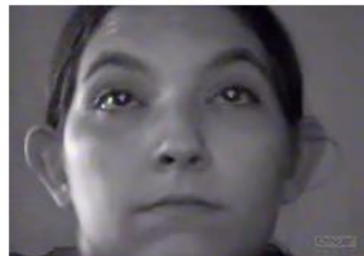
**Delight (4%)**



**Flow (28%)**



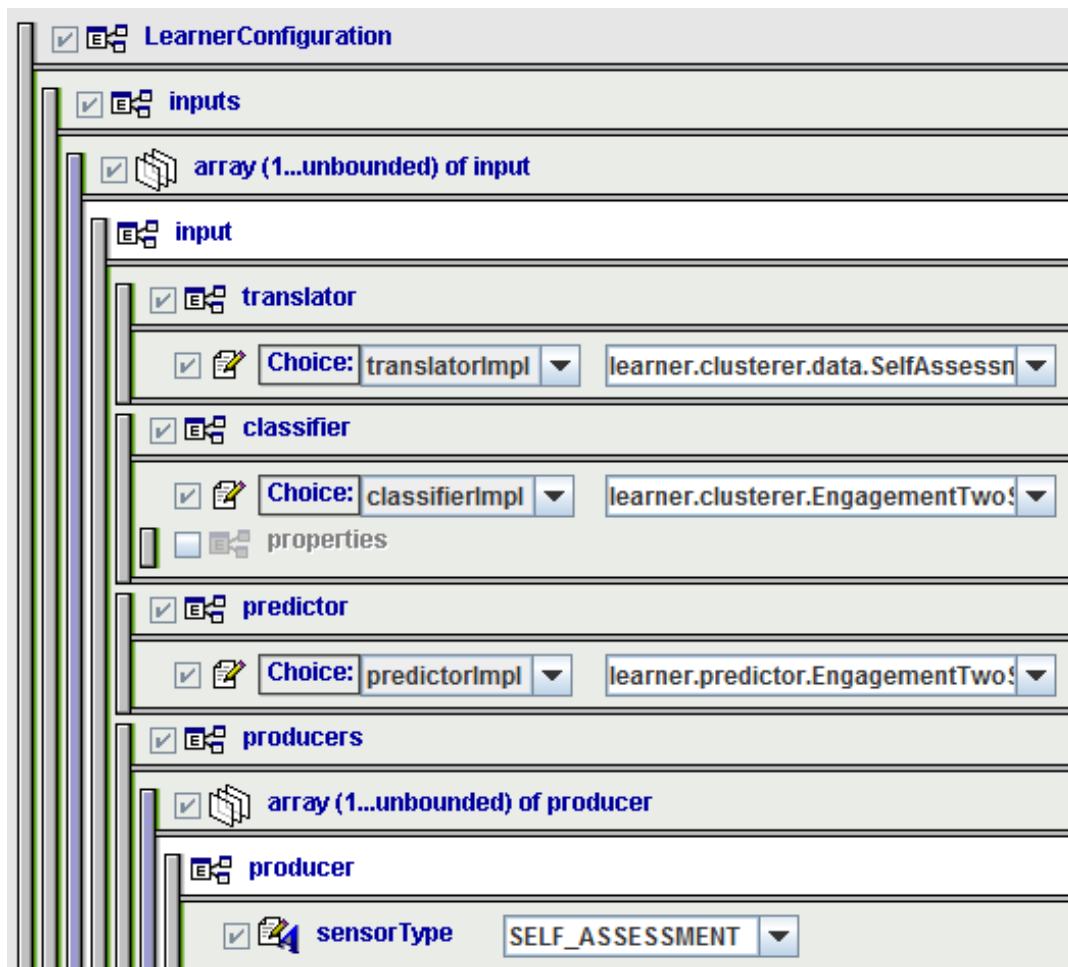
**Frustration (16%)**



**Surprise (4%)**

**Graesser and D'Mello (2012, in press)**

- ***Approach: learner configuration authoring tool***
- **simple interface for authoring learner models**
- **tree structure driven by XML schema**
- **prevents learner model authoring errors by validating against the learner model XML schema**
- **provides ability to validate learner model using GIFT source w/o having to launch the entire GIFT architecture**







- ***Approach: sensor configuration authoring tool***



- ***Implemented sensors***

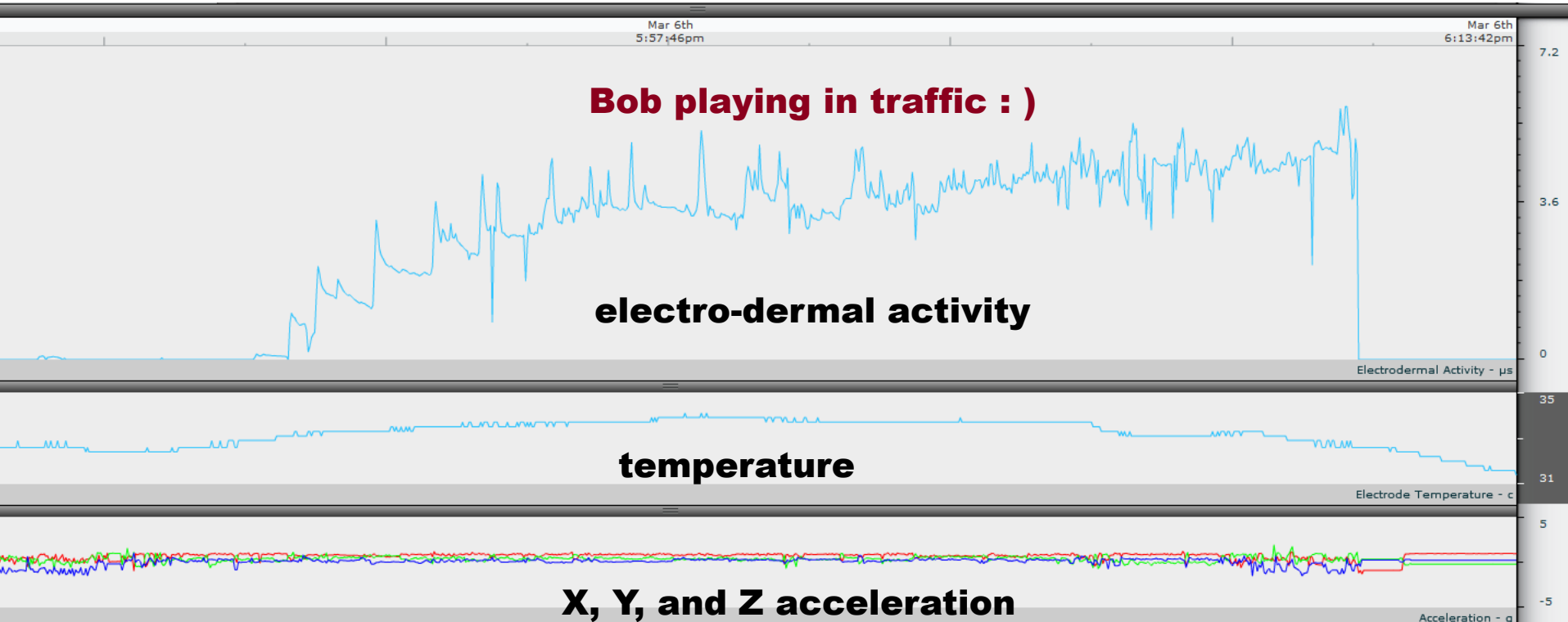
- ***Affectiva QSensor***
  - *electro-dermal activity (EDA)*
  - *skin temperature and acceleration*
- ***Emotiv EEG***
- ***temperature and humidity mouse (custom)***
- ***Surrogate sensors for temp, humidity and assessment***

- ***behavioral sensors***
- ***physiological sensors***
- ***state classification models***



- ***Sensors under consideration***

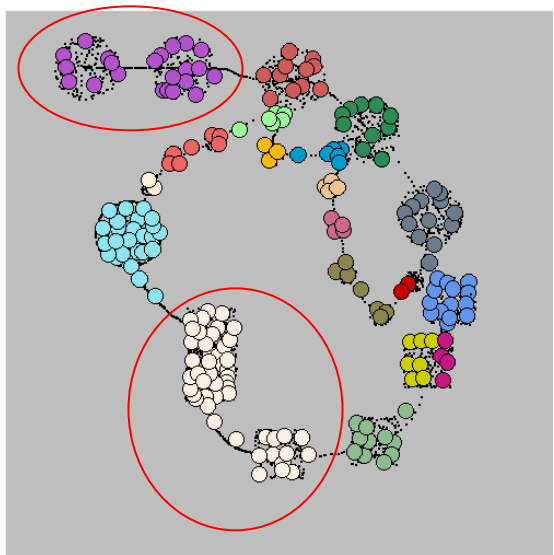
- ***NeuroSky and ABM EEGs***
- ***Webcam (1Hz)***
- ***Zephyr heart rate monitor***
- ***Sonar distance sensor***
- ***Pressure chair (custom)***
- ***Pupil diameter (custom)***
- ***Design Interactive EmoPro***



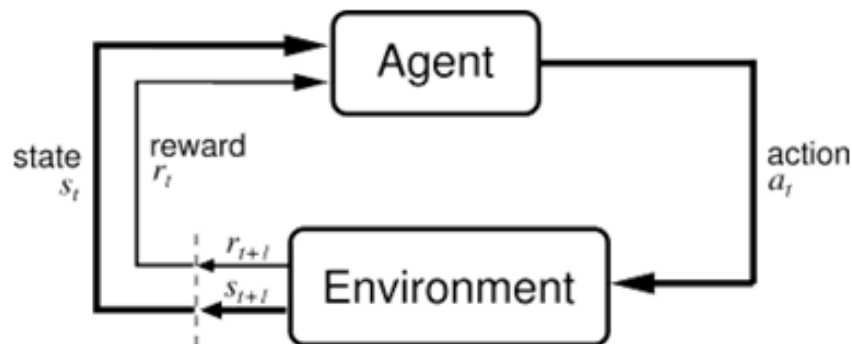
**Research question:** what is the minimum set of sensors needed to assess engagement, workload, motivational level and emotional state?



- Approach: clustering, classification & optimization***

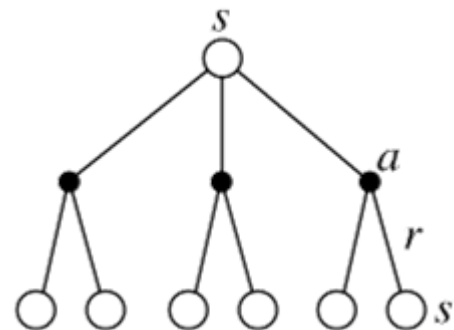


**Growing Neural Gas Clustering Technique**



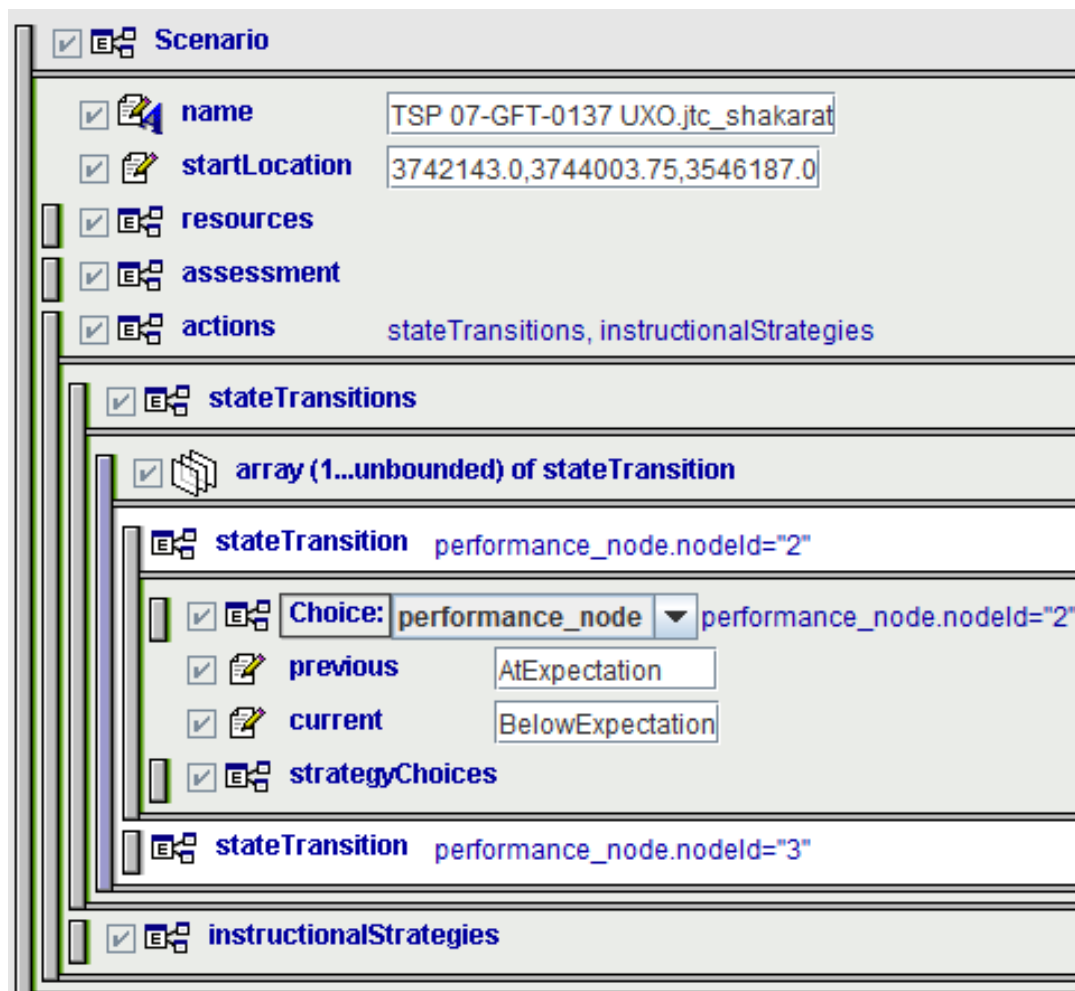
$$V^{\pi}(s) = E_{\pi}\{R_t | s_t = s\} = E_{\pi}\left\{ \sum_{k=0}^{\infty} \gamma^k r_{t+k+1} \mid s_t = s \right\}$$

## Reinforcement learning in Markov Decision Processes



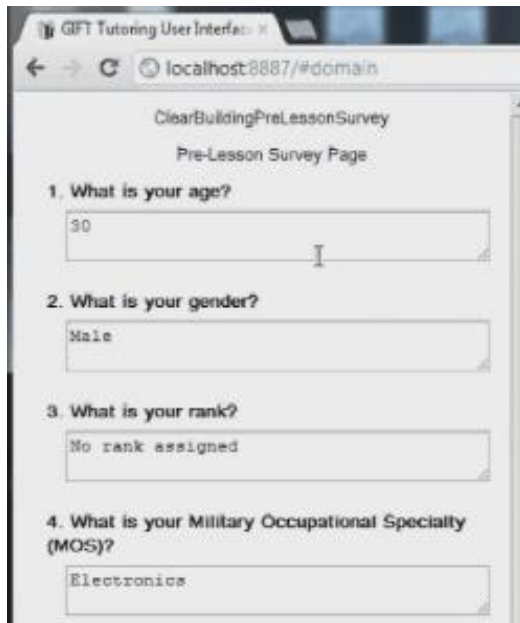
## • *Approach: Domain Knowledge File (DKF) authoring tool (DAT)*

- **simple interface for authoring DKFs**
- **tree structure driven by XML schema**
- **prevents DKF authoring errors by validating against DKF XML schema**
- **provides ability to validate DKF content using GIFT source w/o having to launch the entire GIFT architecture**



The screenshot displays the GIFT Authoring Construct (DAT) interface, which is a tree-structured form for authoring Domain Knowledge Files (DKFs). The interface is organized into a hierarchical tree structure, with each node representing a different component of the DKF. The root node is "Scenario", which is expanded to show its sub-nodes: "name", "startLocation", "resources", "assessment", and "actions". The "actions" node is further expanded to show "stateTransitions" and "instructionalStrategies". The "stateTransitions" node is expanded to show an "array (1...unbounded) of stateTransition". This array contains two "stateTransition" nodes. The first "stateTransition" node is expanded to show its sub-nodes: "Choice:", "previous", "current", and "strategyChoices". The "Choice:" node is set to "performance\_node", and the "previous" and "current" nodes are set to "AtExpectation" and "BelowExpectation" respectively. The "strategyChoices" node is also expanded to show its sub-nodes. The second "stateTransition" node is set to "performance\_node.nodid='3'". The "instructionalStrategies" node is also expanded to show its sub-nodes.

## • *Approach: survey authoring tool*



GIFT Tutoring User Interface

localhost:8887/#domain

ClearBuildingPreLessonSurvey

Pre-Lesson Survey Page

1. What is your age?

30

2. What is your gender?

Male

3. What is your rank?

No rank assigned

4. What is your Military Occupational Specialty (MOS)?

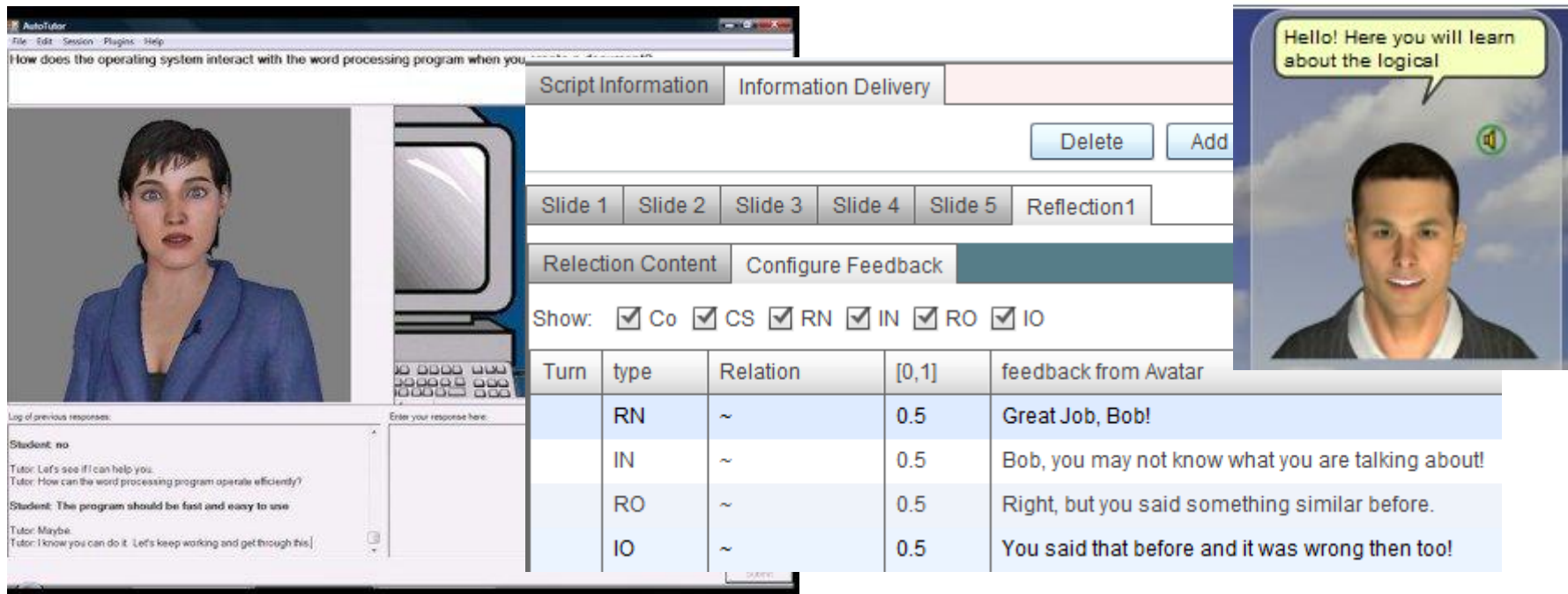
Electronics

- *author questions*
- *author surveys*
- *assign surveys*
- *present surveys*

Question Bank Surveys Survey Contexts		
Create Question		Reply Set Editor
ID	Question	Answer Type
1	What is your age?	Fill in the blank
2	What is your gender?	Fill in the blank
3	What is your rank?	Fill in the blank
4	What is your Military Occupational Specialty (MOS)?	Fill in the blank
5	How many hours of sleep did you get last night?	Fill in the blank
6	Have you had any caffeine in the last two hours?	Fill in the blank
7	Rate your level of experience with computers	Multiple Choice Single Select
8	How often do you play computer/video games?	Multiple Choice Single Select
9	What color was the pickup truck?	Fill in the blank
10	How many people did you see in the compound?	Fill in the blank
11	Were any people identified carrying weapons? If so, how many?	Fill in the blank
12	How many people/vehicles are around the target?	Fill in the blank
13	Describe a vehicle: # doors / color / make (sedan   truck   SUV   van)?	Fill in the blank
14	Were there any Military Age Males (MAMs)?	Fill in the blank
15	Were they carrying weapons? How many?	Fill in the blank



- Approach: leverage elements of AutoTutor & AutoTutor Lite***



The screenshot displays the AutoTutor software interface. On the left, a female avatar is shown. The central panel contains several tabs: 'Script Information', 'Information Delivery', 'Delete', 'Add', 'Slide 1', 'Slide 2', 'Slide 3', 'Slide 4', 'Slide 5', 'Reflection1', 'Relection Content', and 'Configure Feedback'. Below these tabs, there are checkboxes for 'Show: Co', 'CS', 'RN', 'IN', 'RO', and 'IO'. A table is visible with columns: 'Turn', 'type', 'Relation', '[0,1]', and 'feedback from Avatar'. The table contains four rows of data:

Turn	type	Relation	[0,1]	feedback from Avatar
	RN	~	0.5	Great Job, Bob!
	IN	~	0.5	Bob, you may not know what you are talking about!
	RO	~	0.5	Right, but you said something similar before.
	IO	~	0.5	You said that before and it was wrong then too!

On the right, a male avatar is shown with a speech bubble that says: 'Hello! Here you will learn about the logical'.



- ***Approach: game-based tutoring***

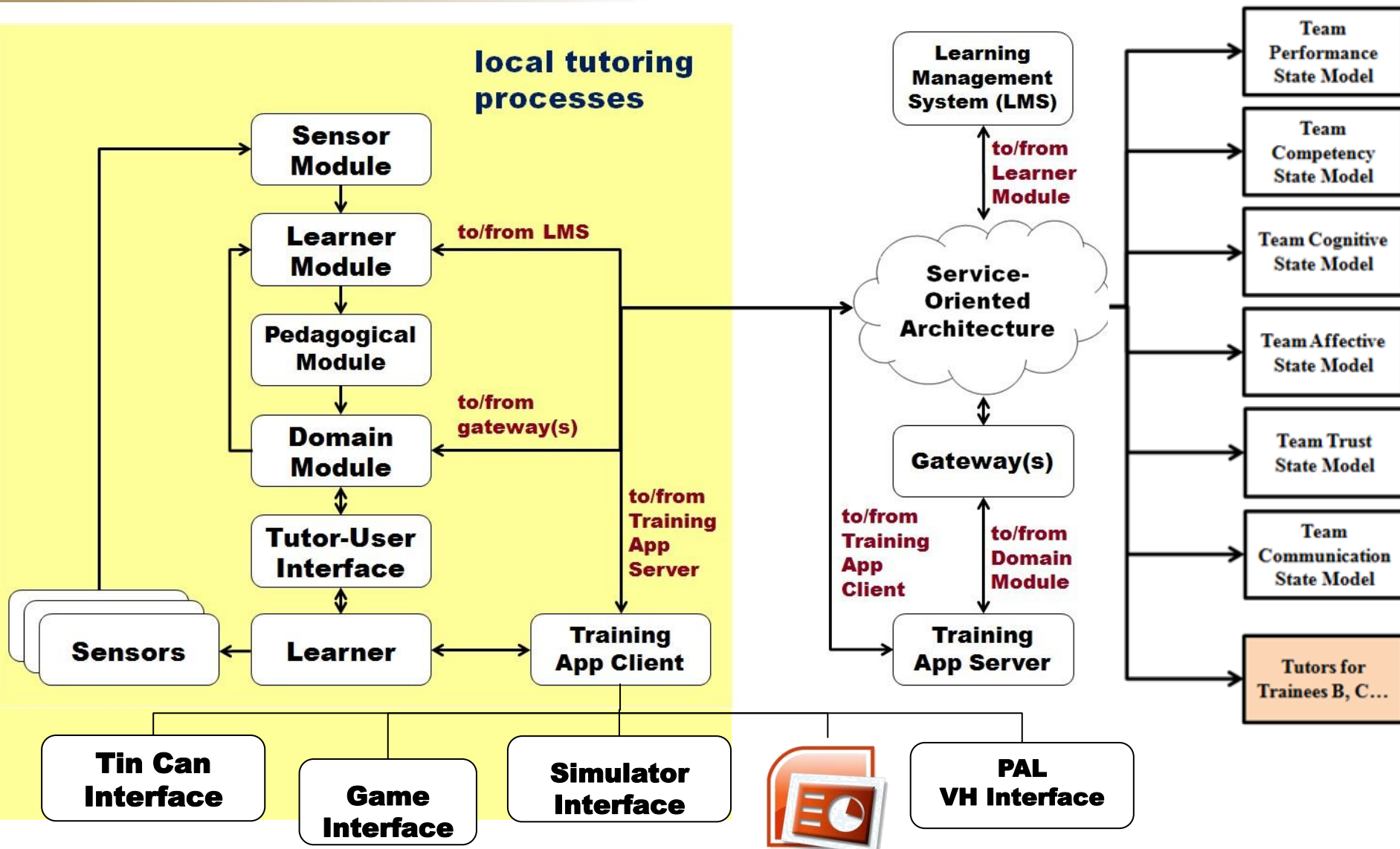


- ***prototype integration with VBS2***
- ***real-time feedback***
- ***learner model influences challenge level within game***



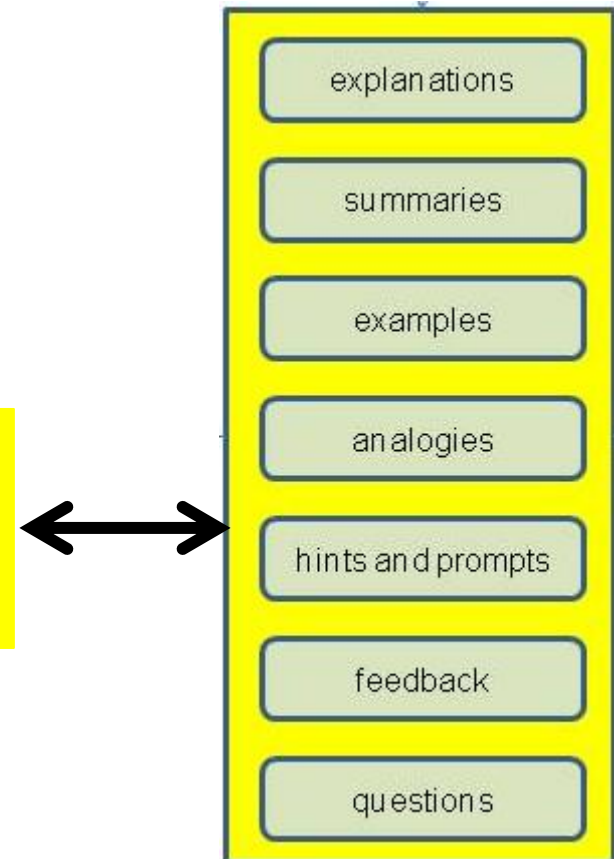
- **Hard to demo an architecture** – but here it is
- Completely **separable processes** using **standardized communications**
  - Developers need not be sensor experts AND Instructional Strategy experts
  - Each box an active area of research
- **Functional architecture** and **experimental platform**
- Ability to **author** questions
- Ability to pull in any content which is **web-enabled**
- Content developed here is directly pulled from **another trainer** (PEO-STRI)
  - The idea that you can latch ITS tech onto any trainer
  - Two things need to be written – assessments and feedback
    - “You bring the content, we bring the tutoring”
- Mission briefing developed with SME aid, things on the mission briefing are **assessments**
- Surveying the building
- In the event that you can't assess something, you can directly ask (**authored questions**)

- Nighttime
  - **Survey->sensorAssessment->TraineeModule->Ped->Domain->selected intervention**
  - **Sensor can turn it back to day (same information channel)**
- **Sensors can trigger instructional events**
  - Cue the fog!
- **[remediation Feedback]** Selecting a door
  - These could all be within-game interactions with 1 line of code changed
- [remediation feedback] shooting the guy
- **[Reflective feedback]** clearing the room
- **[2<sup>nd</sup> level remediation Feedback]** shooting guy 2
  - Supports **n levels** of feedback
- [Feedback]
  - Note that these feedbacks are authored, have an authoring tool, and are stored in the 'Domain Knowledge File (DKF)'. They are somewhat customizable
    - Mention SIMILE?
- Filling out a report (additional functionality supported by TUI)
- Experimenter questions
  - Authorable
- AAR
  - Can be fed via this information
- LMS
  - Data is stored about the student



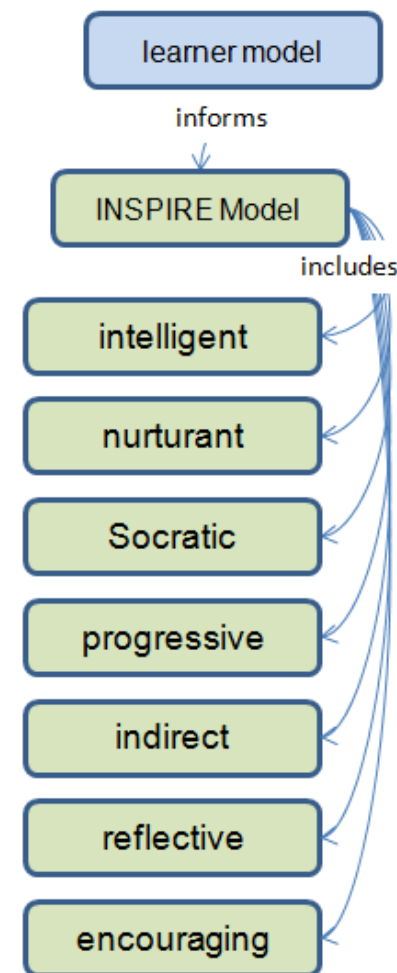
## Tutoring Process (Person, et al, 1995, p. 167)

1. Tutor asks a question.
2. Student answers the question.
3. Tutor gives feedback on the answer.
4. Tutor and student collaboratively improve the quality of (or embellish) the answer.
5. Tutor assesses student's understanding of the answer"



- ***Approach: model successes of expert human tutors to support pedagogy***

- ***INSPIRE model (Lepper, Drake & O'Donnell-Johnson, 1997)***
- ***facts about human tutoring (Person & Graesser, 2003)***
- ***importance of questioning (Dillon, 1988)***
- ***relation between deep reasoning questions and exam scores (Graesser & Person, 1994)***
- ***nine events of instruction (Gagne, 1985)***
- ***politeness strategies (Person, et al, 1995)***

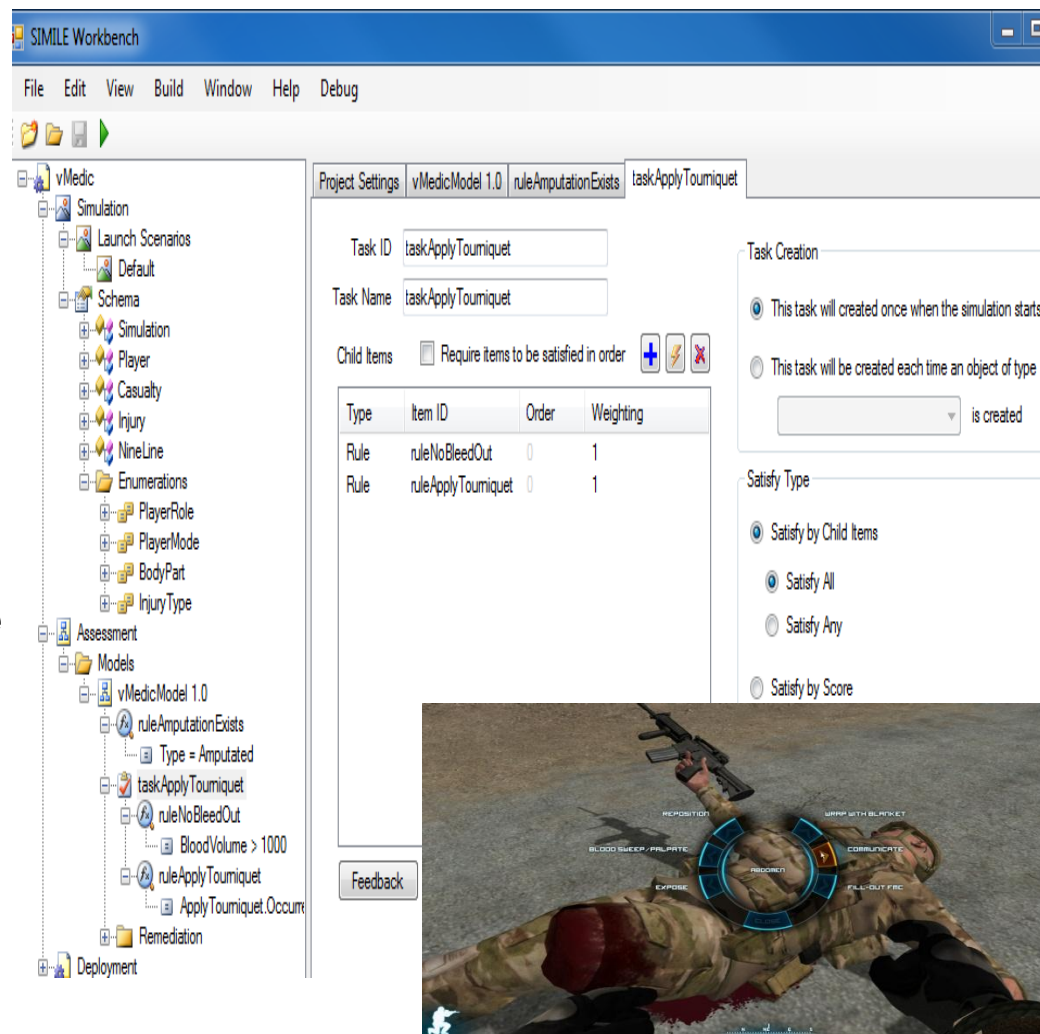


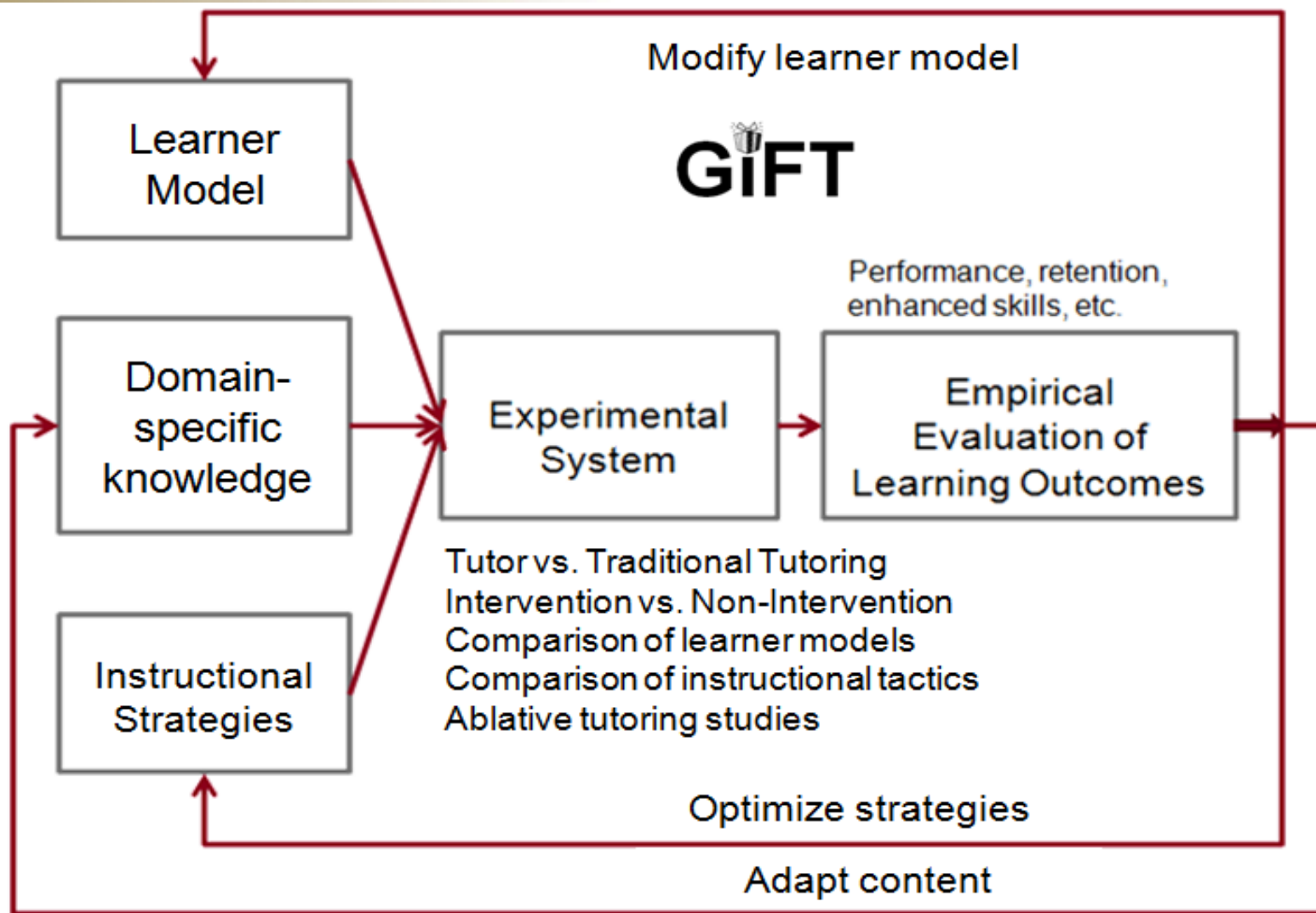


- ***Approach: investigate the influence of learning class in selecting effective instructional strategies for computer-based tutoring***
- ***Learning Classes***
  - ***cognitive learning (Anderson and Krathwohl, 2000)***
  - ***affective learning (Krathwohl, et al, 1964; Goleman, 1995)***
  - ***psychomotor learning (Simpson, 1972)***
  - ***social learning (Sottolare, et al, 2011; Soller, 2001)***
  - ***hybrid learning***

## • *Approach: leverage objective-task framework in SIMILE*

- **Student Information Models for Intelligent Learning Environments (SIMILE)**
- **standardized, adaptable, and generic mechanism for learner assessment in simulated training environments**
- **middleware with tools for the creation of assessment models that are distinct and separate from the simulation itself**
  - **Example Shown: Model rules for applying a tourniquet in the TC3 vMedic Trainer**





Methodology derived from: Hanks, Pollack, and Cohen (1993).



- ***Approach: event report tool***

- **post-hoc analysis tool**
- **provides a user interface to select important pieces of data from gift output file(s) such as the message logs, sensor data and IOS/EOS bookmarks**
- **creates a single output file (currently csv) with the selected events of interest**
- **output file can be consumed by third party applications for sorting by time, filtering by values, statistical analysis, etc.**

## Generate Report For

domainSession137\_2012-07-06\_10-43-48.log

Select the Events of Interest

<input type="checkbox"/> ACK	<a href="#">Customize</a>
<input type="checkbox"/> CloseDomainSessionRequest	<a href="#">Customize</a>
<input type="checkbox"/> DisplayTextTutorRequest	<a href="#">Customize</a>
<input type="checkbox"/> InitializeDomainSessionRequest	<a href="#">Customize</a>
<input type="checkbox"/> ProcessedACK	<a href="#">Customize</a>
<input type="checkbox"/> SensorFileCreated	<a href="#">Customize</a>
<input checked="" type="checkbox"/> SensorFilterData	<a href="#">Customize</a>
<input type="checkbox"/> Siman	<a href="#">Customize</a>
<input type="checkbox"/> StartDomainSession	<a href="#">Customize</a>

Customize the Default Columns

Column Name	Column Header	
<input checked="" type="checkbox"/> Time	Time	▲ ▼
<input checked="" type="checkbox"/> Domain Session Time	DS_Time	▲ ▼
<input checked="" type="checkbox"/> Domain Session Write Time	DS_Write_Time	▲ ▼
<input checked="" type="checkbox"/> Event Type	Event_Type	▲ ▼
<input checked="" type="checkbox"/> Content	Content	▲ ▼







Empty Cell Value

Report File Name

EventReportTool.out.csv

Create File

Cancel


[gifttutoring.org https://gifttutoring.org/projects/gift/wiki/Overview](https://gifttutoring.org/projects/gift/wiki/Overview)



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## Overview

### Generalized Intelligent Framework for Tutoring (GIFT)

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### Description

GIFT is an empirically-based, service-oriented framework of tools, methods and standards to make it easier to author computer-based tutoring systems (CBTS), manage instruction and assess the effect of CBTS, components and methodologies. GIFT is being developed under the Adaptive Tutoring Research Science & Technology project at the Learning in Intelligent Tutoring Environments (LITE) Laboratory, part of the U.S. Army Research Laboratory - Human Research and Engineering Directorate (ARL-HRED).

<top>

### Background

The technology gap for a reusable CBTS framework to support individual and small team tutoring was identified through a review of the intelligent tutoring systems (ITS) literature in 2009-2010 and the Training and Doctrine Command (TRADOC) formalized the Army requirement for GIFT in their Army Learning Concept (2011). GIFT was brought to practice in 2011 by the LITE Lab team. The first public demonstration of GIFT was conducted at the Interservice/Industry Training Systems and Education Conference (I/ITSEC) in December 2011. The first release of GIFT was completed in May 2012.

While GIFT is being developed to facilitate the use of CBTS by the U.S. Army, the intent is to collaboratively develop GIFT and have it function as a "nexus" for CBTS research being conducted within government, industry and academia.

<top>

### Research Goals

Adaptive Tutoring research goals that are driving future GIFT development include:

## Wiki

- [Start page](#)
- [Index by title](#)
- [Index by date](#)

- Anderson, J. R., Corbett, A. T., Koedinger, K. R., and Pelletier, R. (1995). Cognitive tutors: Lessons learned. *The Journal of Learning Sciences*, 4, 167-207.
- Anderson, L. W., and Krathwohl, D. R. (Eds.). (2001). A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of Educational Objectives: Complete edition, New York : Longman.
- Bloom, B. S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher*, 13(6), p. 6.
- Cohen, P.A., Kulik, J.A., & Kulik, C.L.C. (1982). Educational outcomes of tutoring: A meta-analysis of findings. *American Educational Research Journal*, 19, 237-248.
- Committee on Science Learning: Computer Games, Simulations, and Education; National Research Council. (2011). In M.A. Honey and M. Hilton (Eds.) *Learning Science Through Computer Games and Simulations*. National Academies Press.
- Dillon, T.J. (1988). *Questioning and Teaching: A Manual of Practice*. New York: Teachers College Press.
- Gagne, R. (1985). *The Conditions of Learning* (4th.). New York: Holt, Rinehart & Winston.
- Goleman, D., (1995). Emotional Intelligence. Bantam Books: New York.
- Graesser, A. C., & Person, N. K. (1994). Question asking during tutoring. *American Educational Research Journal*, 31, 104-137.
- Graesser, A.C., & McNamara, D.S. (2010). Self-regulated learning in learning environments with pedagogical agents that interact in natural language. *Educational Psychologist*.
- Graesser, A.C. and D'Mello, S. (2012). Emotions During the Learning of Difficult Material. In: Brian H. Ross, Editor(s), *Psychology of Learning and Motivation*, Academic Press, Volume 57, Chapter 5, Pages 183-225, ISSN 0079-7421, ISBN 978012-3942937, 10.1016/B978-0-12-394293-7.00005-4.



- Graesser, A.C., & D'Mello, S. (2012, in press). Emotions during the learning of difficult material. In. B. Ross (Eds.), *The Psychology of Learning and Motivation*, vol. 57. Elsevier.
- Hanks, S., Pollack, M.E. and Cohen, P.R. (1993). Benchmarks, Test Beds, Controlled Experimentation, and the Design of Agent Architectures. *AI Magazine* Volume 14 Number 4.
- Hunt, E., and Minstrell, J. 1994. A cognitive approach to the teaching of physics. In McGilly, K. (ed.), *Classroom Lessons*. Cambridge, MA: MIT Press, pp.51-74.
- Kim, Y., Xu, B. 1, & Sharif, A. (2008). Pedagogical agents rendering social context to an online learning environment MathGirls. *International Transactions on Systems Science and Applications*, 4(2), 99-106.
- Kim, Y. (2007). Desirable characteristics of learning companions. *International Journal of Artificial Intelligence in Education*, 17(04), 371-388.
- Kim, Y., Baylor, A. L., Shen, E., & PALS Group (2007). Pedagogical agents as learning companions: The impact of agent affect and gender. *Journal of Computer-Assisted Learning*, 23(03), 220-234.
- Krathwohl, D.R., Bloom, B.S., and Masia, B.B. (1964). Taxonomy of Educational Objectives: Handbook II: Affective Domain. New York: David McKay Co.
- Lepper, M. and Woolverton, M. (2002). The Wisdom of Practice: Lessons Learned from the Study of Highly Effective Tutors. In J. Aronson (Ed.), *Improving academic achievement: impact of psychological factors on education* (pp. 135-158). New York: Academic Press.
- Lepper, M. R., Drake, M., & O'Donnell-Johnson, T. M. (1997). Scaffolding techniques of expert human tutors. In K. Hogan & M. Pressley (Eds), *Scaffolding student learning: Instructional approaches and issues* (pp. 108-144). New York: Brookline Books.
- Lesgold, A.M., Lajoie, S., Bunzo, M., & Eggan, G. (1988). Sherlock: A coached practice environment for an electronics trouble shooting job. LRDC Report. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center.

Mehrabian A.: Pleasure-arousal-dominance: A general framework for describing and measuring individual differences in temperament. *Current Psychology*, 14, 261-292 (1996).

Murray, T. (1999). Authoring intelligent tutoring systems: An analysis of the state of the art. *International Journal of Artificial Intelligence in Education*, 10(1):98–129.

Murray, T. (2003). An Overview of Intelligent Tutoring System Authoring Tools: Updated analysis of the state of the art. *Authoring tools for advanced technology learning environments*. 2003, 491-545.

Person, N. K., & Graesser, A. C., & The Tutoring Research Group (2003). Fourteen facts about human tutoring: Food for thought for ITS developers. *AI-ED 2003 Workshop Proceedings on Tutorial Dialogue Systems: With a View Toward the Classroom* (pp. 335-344). Sydney, Australia.

Person, N. K., Kreuz, R. J., Zwaan, R. A., & Graesser, A. C. (1995). Pragmatics and pedagogy: Conversational rules and politeness strategies may inhibit effective tutoring. *Cognition and Instruction*, 13(2), 161–188.

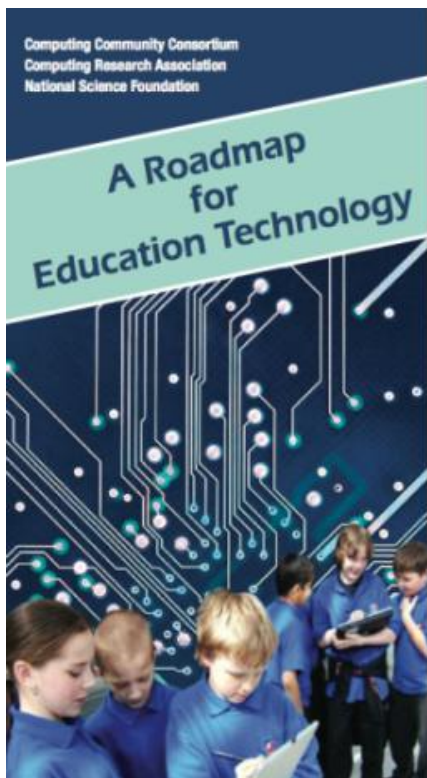
Rose, C. P., Jordan, P. W., Ringenberg, M., Siler, S., Vanlehn, K., & Weinstein, A. (2001). Interactive conceptual tutoring in Atlas-Andes. In J. D. Moore, C. Redfield, & W. L. Johnson (Eds.), *Artificial intelligence in education: AI-Ed in the wired and wireless future* (pp. 256–266). Washington, DC: IOS.

Simpson, E. (1972). *The classification of educational objectives in the psychomotor domain: The psychomotor domain*. Vol. 3. Washington, DC: Gryphon House.

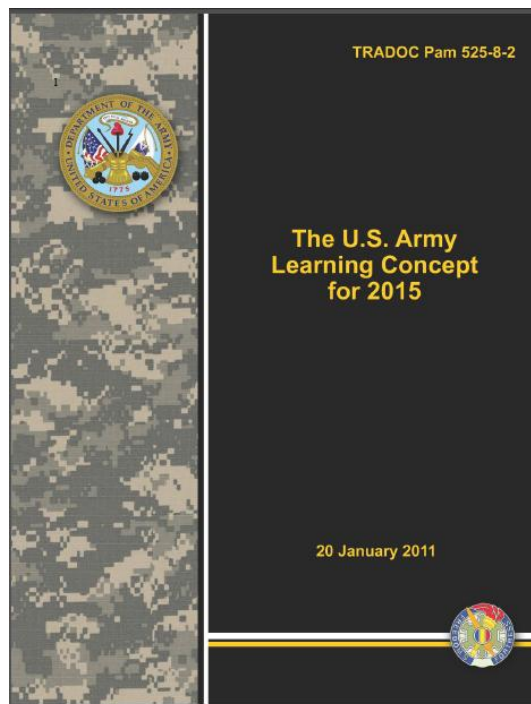
Soller, A. (2001). Supporting social interaction in an intelligent collaborative learning system. *International Journal of Artificial Intelligence in Education*, 12(1), 40-62.

Sottolare, R. and Gilbert, S. (2011). Considerations for tutoring, cognitive modeling, authoring and interaction design in serious games. Authoring Simulation and Game-based Intelligent Tutoring workshop at the Artificial Intelligence in Education Conference (AIED) 2011, Auckland, New Zealand, June 2011.

- Sottolare, R., Holden, H., Brawner, K. and Goldberg, B. (2011). Challenges and Emerging Concepts in the Development of Adaptive, Computer-based Tutoring Systems for Team Training. *Interservice/Industry Training Systems & Education Conference*, Orlando, Florida, December 2011.
- Sutton, R. S. and Barto A. G. (1998). Reinforcement Learning: An Introduction. *The MIT Press*, Cambridge, MA,
- U.S. Air Education and Training Command (2008). On Learning: The Future of Air Force Education and Training. Randolph AFB, TX. <http://www.aetc.af.mil/shared/media/document/AFD-080130-066.pdf>
- U.S. Army Training & Doctrine Command (2011). *The United States Army Learning Concept for 2015*. Fort Monroe, VA.
- U.S. Office of Naval Research (2012). STEM Grand Challenge Winners to Build Better Digital Tutors for Students. Arlington, VA. <http://www.onr.navy.mil/Media-Center/Press-Releases/2012/STEM-Grand-Challenge-ONR-Grants.aspx>
- VanLehn, K., Lynch, C., Schulze, K., Shapiro, J. A., Shelby, R., Taylor, L., et al. (2005). The Andes physics tutoring system: Lessons learned. *International Journal of Artificial Intelligence and Education*, 15(3), 147–204.
- VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems and other tutoring systems. *Educational Psychologist*, 46, 4, 197-221.
- Woolf, B. P. (2010). A Roadmap for Education Technology. *National Science Foundation* # 0637190
- Zeng D., Sycara K., 1995, Using Case-Based Reasoning as a Reinforcement Learning Framework for Optimization with Changing Criteria, *Proceedings of ICTAI'95*, Washington, USA, pp. 56–62.



**Woolf (2010)**



**TRADOC (2011)**



**Committee on  
Science  
Learning (2011)**

- **People**
- **Motivation for Computer-Based Tutoring**
- **Problem Statement**
- **GIFT Research Objectives and Purpose**
- **GIFT Authoring Construct**
- **GIFT Demo**
- **GIFT Instructional Management Construct**
- **GIFT Assessment Construct**
- **How to get GIFT**
- **References**



# **Thank you for your attention**

## **Questions?**