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Learning in Intelligent Tutoring Environments (LITE) Lab personnel at USMA, April 2011 (L-R):

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TECHNOLOGY DRIVEN. ***WARFIGHTER FOCUSED.***

Challenges and Emerging Concepts in the Development of Adaptive, Computer-based Tutoring Systems for Team Training

August 2011

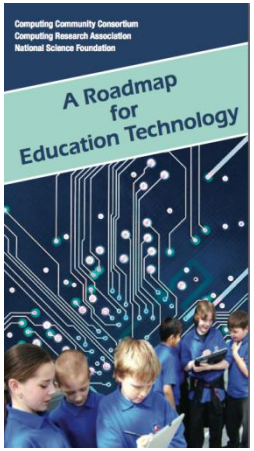
LITE Lab

Agenda

- Computer-based tutors
- Research Motivation for Team Tutoring
- Payoff: Learning Effectiveness
- Team Tutoring Design Goals
- Team Tutoring Challenges
- Cognition and Affect in Team Tutoring
- Tutoring Frameworks
- Tutoring System Evaluation Standards

Research Motivation for Team Tutoring

- **Grand Challenges for Education Technology (Woolf, 2010)**
  - **Personalize Education**
  - **Assess Student Learning**
  - **Support Social Learning**
  - **Diminish Boundaries**
  - **Develop Alternative Teaching Methods**
  - **Enhance the Role of Stakeholders**
  - **Address Policy Changes**



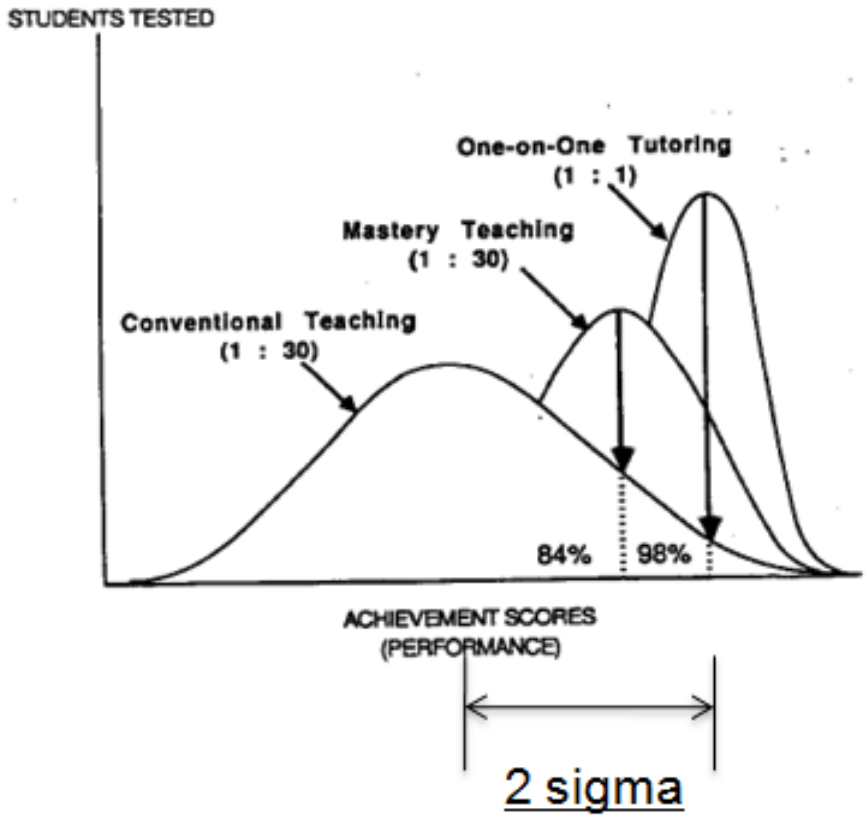
- **Computer-based Intelligent Tutors work: (Woolf, 2011)**
  - **Nearly the same improvement as one-on-one human tutoring.**
  - **Effectively reduce the time required for learning by 1/3 to 1/2.**
  - **Networked versions reduce the need for training support personnel by about 70% and operating costs by about 92%**

Woolf, B. P. (2010). *A Roadmap for Educational Technology. National Science Foundation # 0637190*

Woolf, B.P. (2011). Intelligent Tutors: Past, Present and Future. Keynote address at the Advanced Distributed Learning ImplementationFest, August 2011, Orlando, Florida.

Payoff: Improved Learning

- **2 sigma improvement for human one-on-one tutoring over conventional teaching (Bloom, 1984)**
- **.50 sigma for interactive multimedia (Woolf, 2011)**
  - **raises the median score from 50% to 69%**
- **1.05 sigma for intelligent tutors (Woolf, 2011)**
  - **raises the median score from 50% to 85%**



Bloom, Benjamin S. (1984) The 2-sigma problem: The search for methods of group instruction as effective as one-to-one tutoring, Educational Researcher 13: 4-16.

Woolf, B.P. (2011). Intelligent Tutors: Past, Present and Future. Keynote address at the Advanced Distributed Learning ImplementationFest, August 2011, Orlando, Florida.

Team Tutoring Design Goals

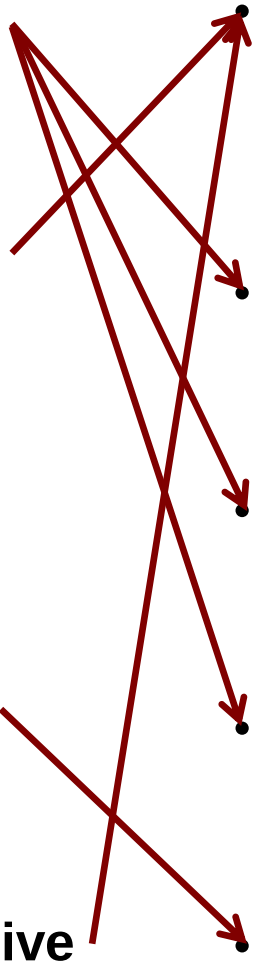
- **Design Goal 1: accurate:**
  - correctly assess team states (e.g., trust)
  - correctly assess individual trainee states
- **Design Goal 2: low-cost**
  - modular, low-cost sensors
- **Design Goal 3: portable**
  - hosted on mobile computing devices
- **Design Goal 4: real-time or near real-time**
  - real-time interaction with intelligent agents in a distributed tutoring environment
- **Design Goal 5: unobtrusive**
  - passive sensing of behaviors and physiological measures

Team Tutoring Challenges

- **Challenge 1: Low cost, passive sensing of behavioral and physiological data**
- **Challenge 2: Classification of Affect and Trust**
- **Challenge 3: Selection of Instructional Strategies**
- **Challenge 4: Tracking Multi-Dimensional States**
- **Challenge 5: Real-time Interaction**

Relating Challenges and Goals

- Design Goal 1: accurate
- Design Goal 2: low-cost
- Design Goal 3: portable
- Design Goal 4: real-time
- Design Goal 5: unobtrusive



Challenge 1: Low cost, passive sensing of behavioral and physiological data

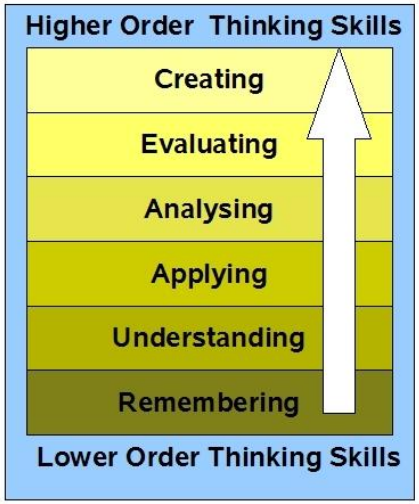
Challenge 2: Classification of Affect and Trust

Challenge 3: Selection of Instructional Strategies

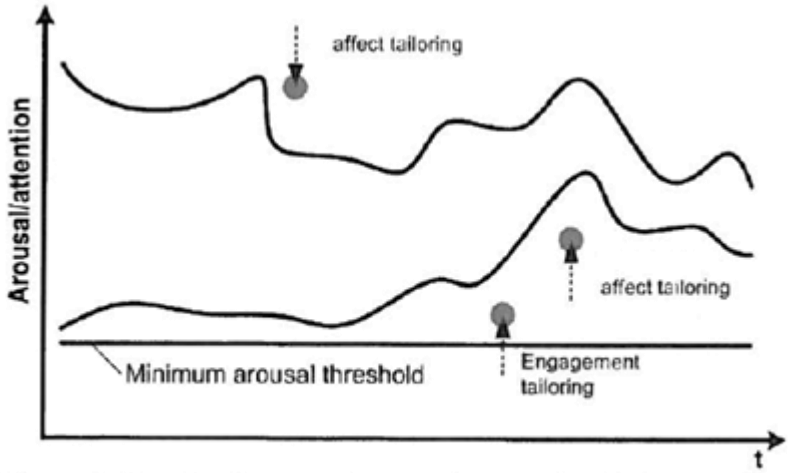
Challenge 4: Tracking Multi-Dimensional States

Challenge 5: Real-time Interaction

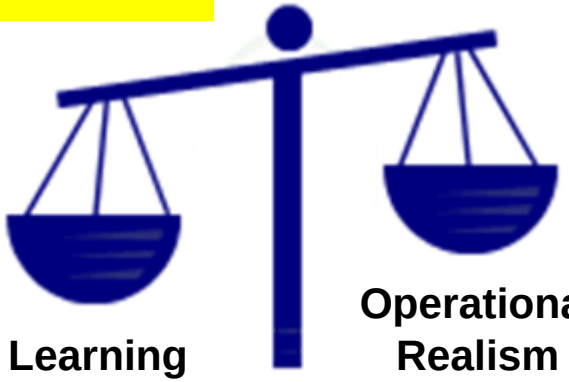
Cognition and Affect in Team Training



Assessing individual cognition and affect during team training is on the critical path of adapting that training to resolve conflict and enhance cooperation among team members



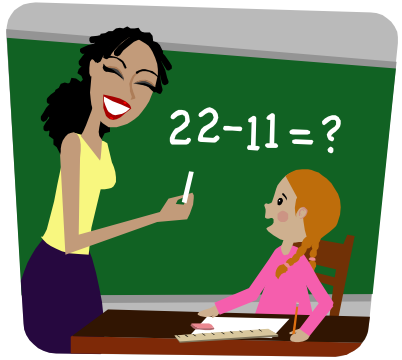
Vygotsky, L.S. (1978). Mind in Society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.



Bjork, R. A. (1994). Memory and metamemory considerations in the training of human beings. In J. Metcalfe and A. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp. 185–205). Cambridge, MA: MIT Press.

Human Tutoring Use Cases

One-to-One (Private Tutoring)



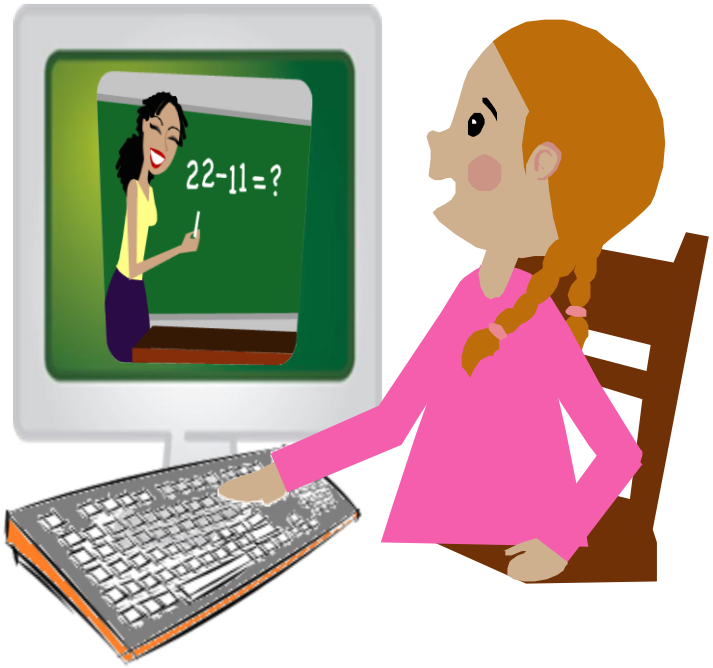
One-to-Many (Traditional Classroom)

Students who work one-to-one with expert human tutors often score 2.0 standard deviations higher than students in a conventional classroom (Bloom, 1984)

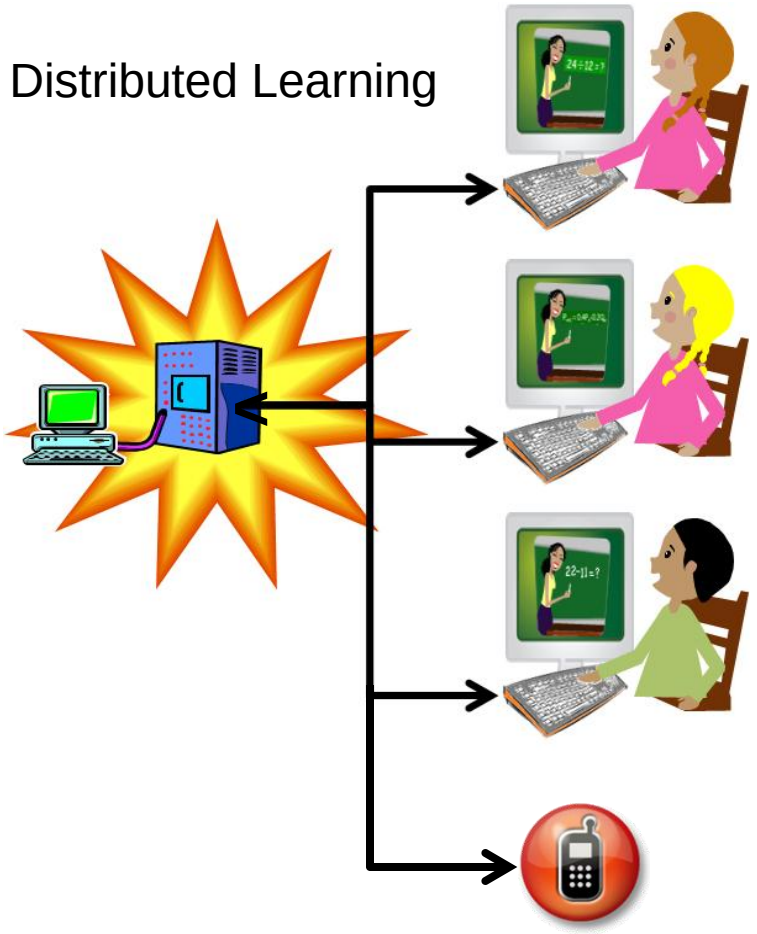
Bloom, Benjamin S. (1984) The 2-sigma problem: The search for methods of group instruction as effective as one-to-one tutoring, Educational Researcher 13: 4-16.

Computer-Based Individual Tutoring Use Cases

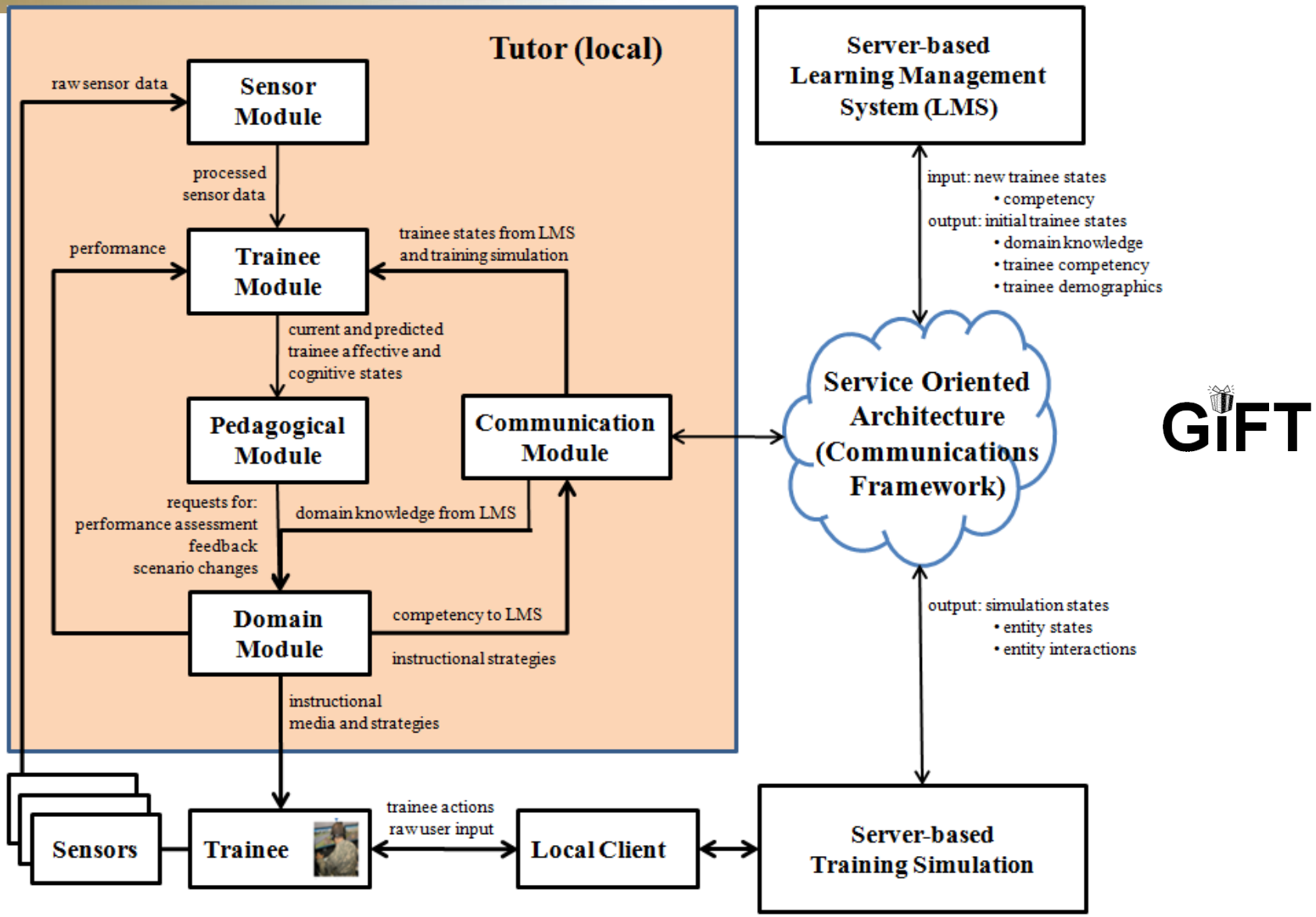
One-to-One (Private Tutoring)



One-to-Many (Concurrent Users Working Separately, Asynchronously)



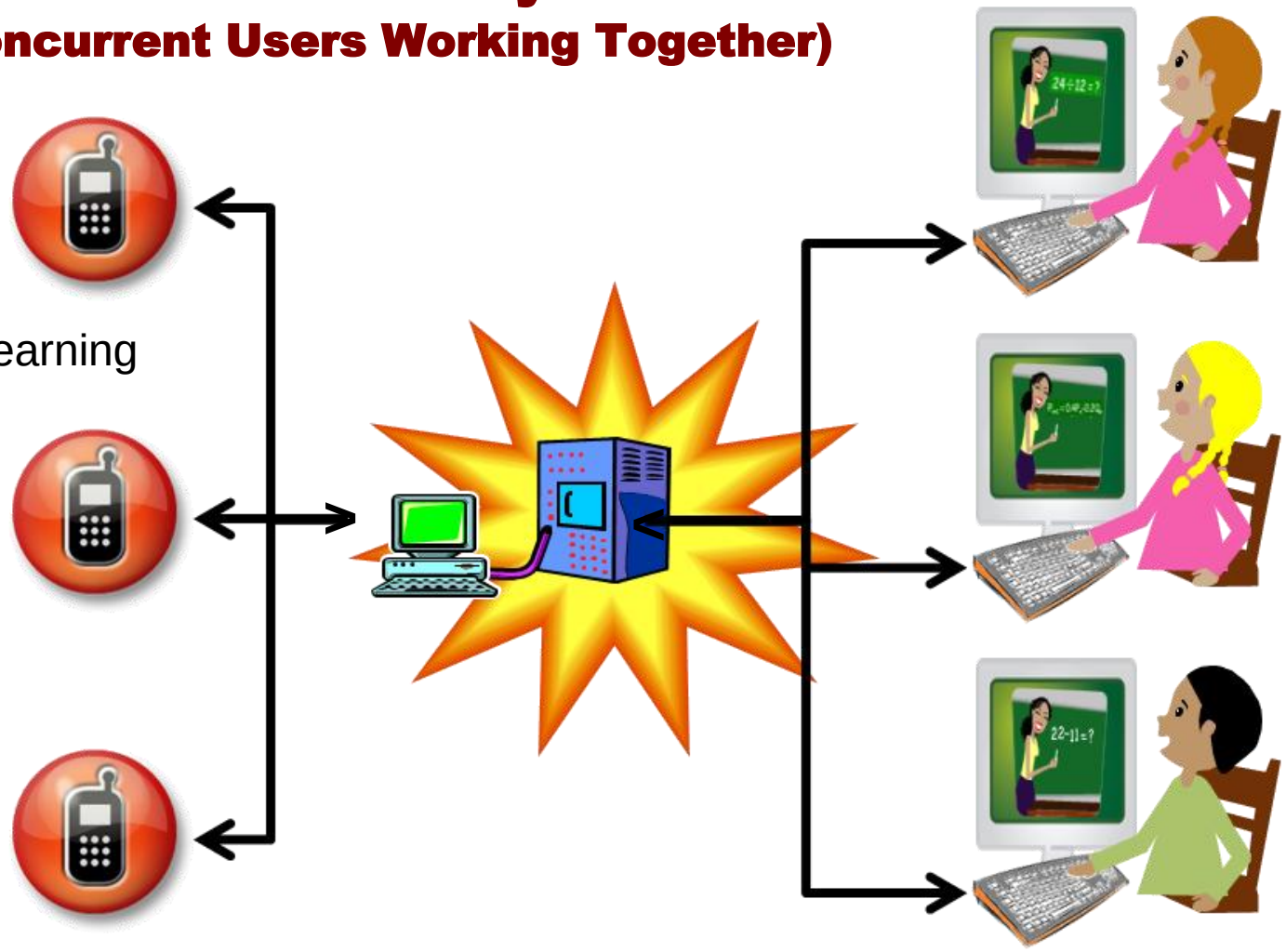
Tutoring Framework for Individual Training



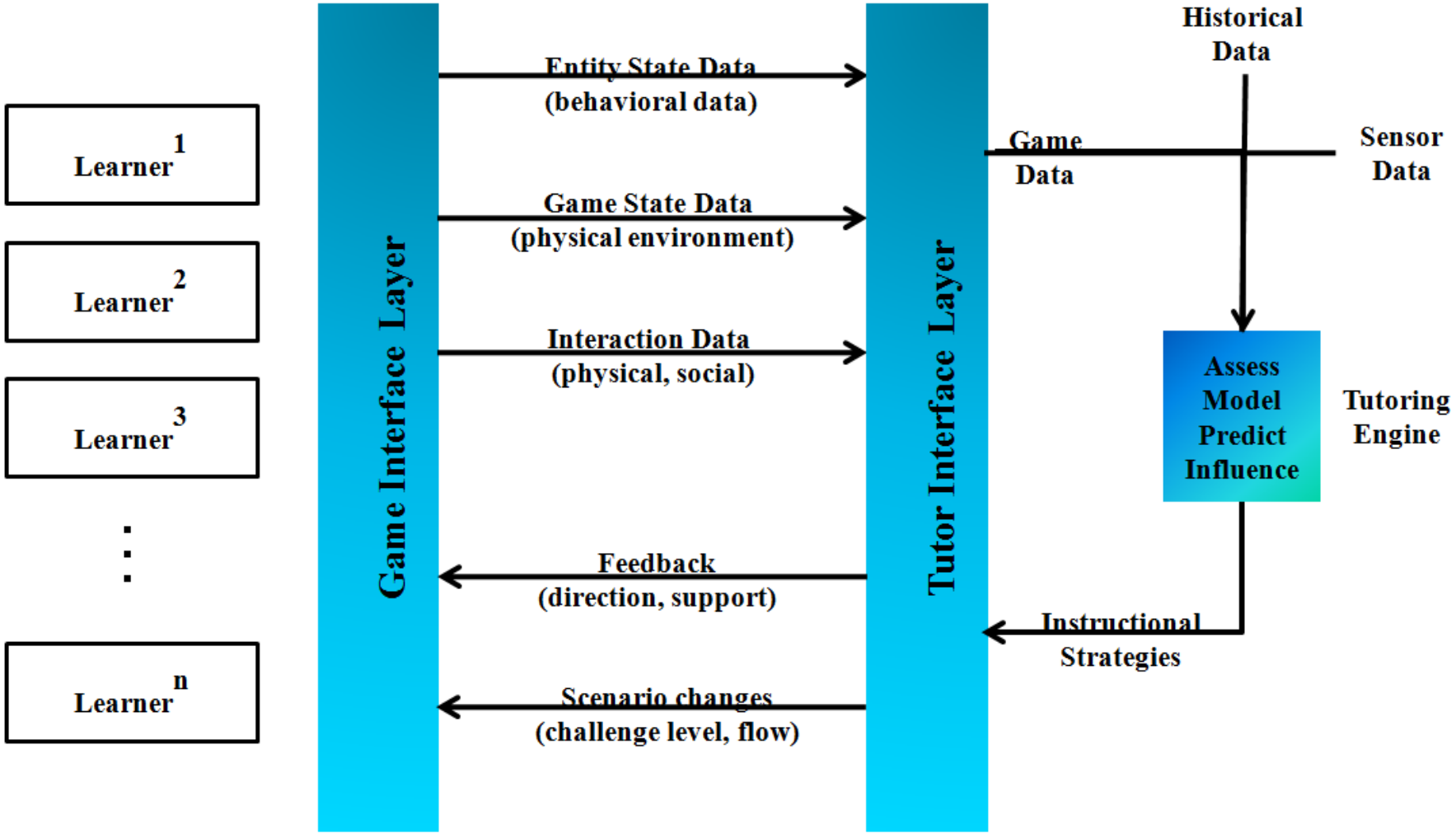
Computer-Based Team Tutoring Use Case

One-to-Many
(Concurrent Users Working Together)

Mobile Learning

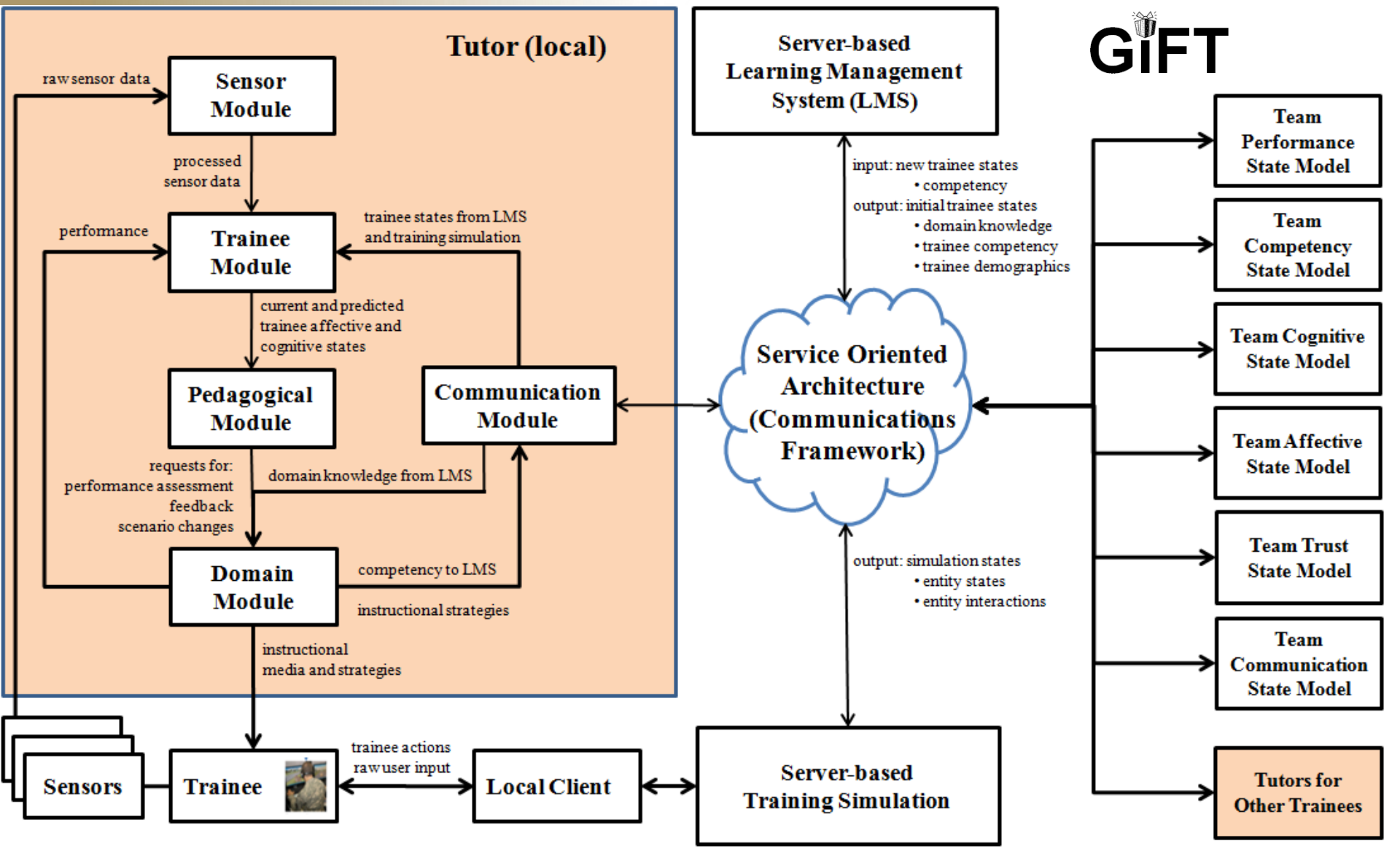


A step toward team tutoring...
tutor interaction with game-based training



Sottilare, 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.

Tutoring Framework for Team Training



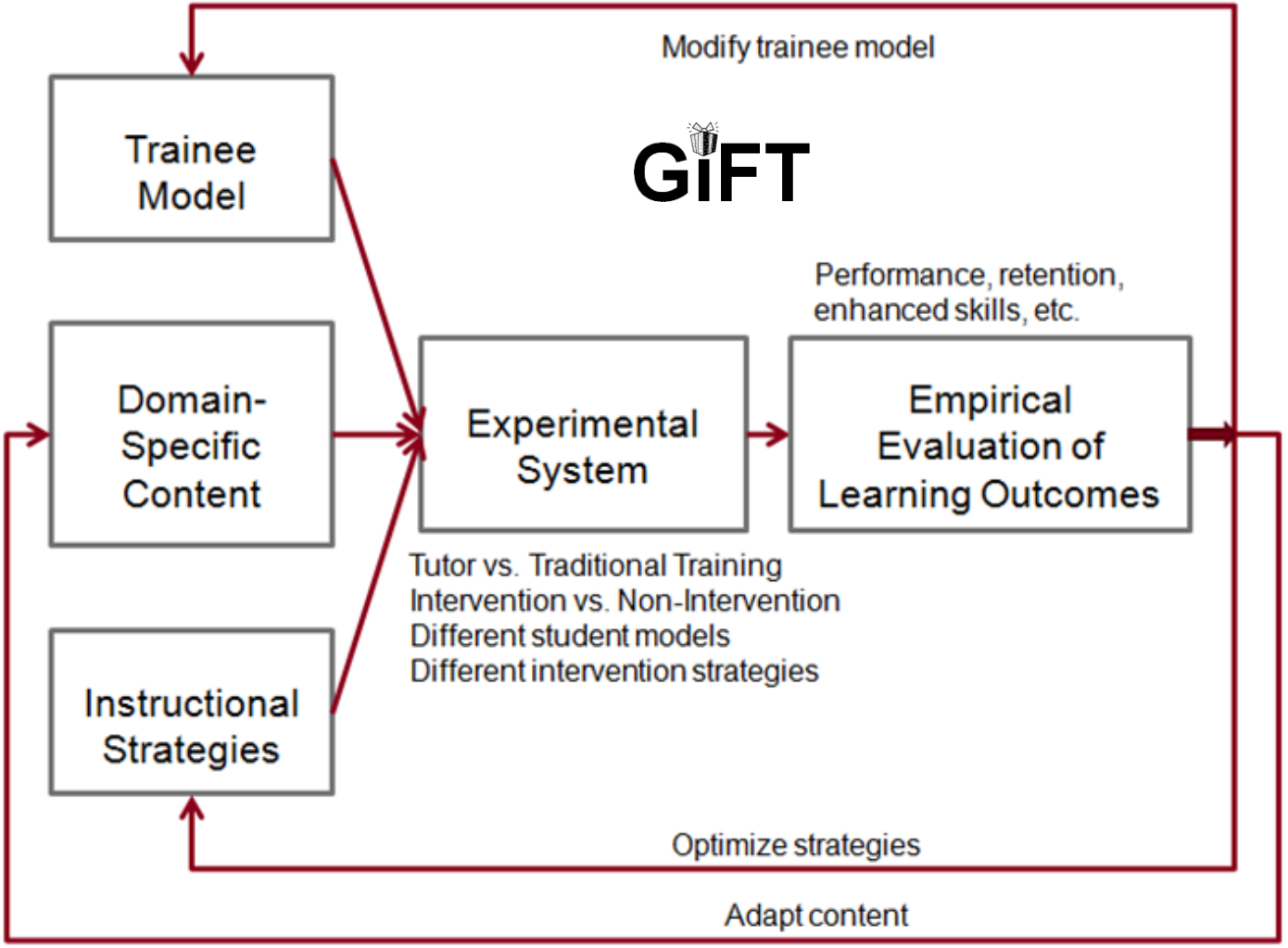
Generalized Intelligent Framework for Tutors (GIFT) Methodology

Assess → Model → Predict → Adapt → Influence Learning

understand individual trainee learning needs

make tutors & models easy to create and use

use trainee state & learning context to select appropriate strategies



Methodology derived from:

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.

Standards for Evaluating Tutors
Platinum Tutors

- **adapt to the learner better than a human tutor**
- **enable learning better than a human tutor**
- **fully perceive learner behaviors and physiology through remote sensing**
- **support fully mobile training**
- **are consistently accurate (near 100%) in classifying the learner's cognitive state in near real-time**
- **have an optimized repertoire of instructional strategies**
- **are automatically integrated with a variety of training platforms (e.g., serious games, commercial/military training simulations).**

Sottilare, 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.

Bronze Tutor **Silver Tutor** **Gold Tutor** **Platinum Tutor**

Questions

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