US ARMY RDECOM

U.S. Army Research, Development and Engineering Command

A Modular Framework to Support the Authoring and Assessment of Adaptive Computer-Based Tutoring Systems (CBTS)

ARL

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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LITELab

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Outline

- **Motivation for a Generalized Framework for Authoring & Assessment**
- **GIFT authoring construct**
- **GIFT assessment construct**
- **Future Work**

- **Notes:**
  - ***Computer-Based Tutoring Systems (CBTS)***
  - ***CBTS = Intelligent Tutoring Systems***
  - ***CBTS = Adaptive Tutoring Systems***
  - ***CBTS is a subset of Computer-Based Training (CBT)***
  - ***GIFT is a capability for authoring and assessing tutoring systems***

CBTS are effective learning tools

Tutoring Methods and Effect Sizes…

.42 Unskilled human tutors (Cohen, Kulik, & Kulik, 1982)
(↑ median score from 50th percentile to 66th percentile)

.79 Skilled human tutors (VanLehn, 2011)
(↑ median score from 50th percentile to 79th percentile)

.80 AutoTutor (20 experiments) (Graesser and colleagues)

1.05 Other tutoring systems (↑ median score from 50th to 85th)

PACT Geometry Tutor (Anderson, Corbett, Koedinger & Pelletier, 1995)

Atlas-Andes (VanLehn, et al, 2005; Rose, et al, 2001)

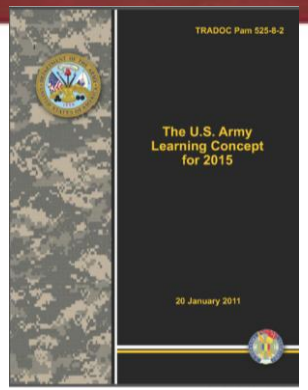
Diagnoser - physics (Hunt & Minstrell, 1994)

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.

CBTS are needed for military training



- ***Army Learning Model (ALM) for 2015 (U.S. Army Training & Doctrine Command, 2011)***
  - ***Adaptive learning, intelligent tutoring… will provide Soldiers with opportunities for engaging, relevant learning at any time and place***
- ***On Learning… the Future of Air Force Education & Training (U.S. Air Force Air Education & Training Command, 2008)***
  - ***provide electronic-based delivery of training that is customized to the learners abilities***
- ***U.S. Navy STEM Grand Challenge (ONR, 2012)***
  - **develop adaptive, generalizable intelligent tutors for Science, Technology, Education and Mathematics (STEM) initiatives or development, and naval training and education**
- ***OSD Readiness &Training Vision for a Personalize Learning Associate***
  - ***application of learning technologies in DoDEA schools is envisioned to provide a 24/7 personalized learning associate/tutor for students across the entire learning continuum.***

CBTS are not ubiquitous in military training

Why?

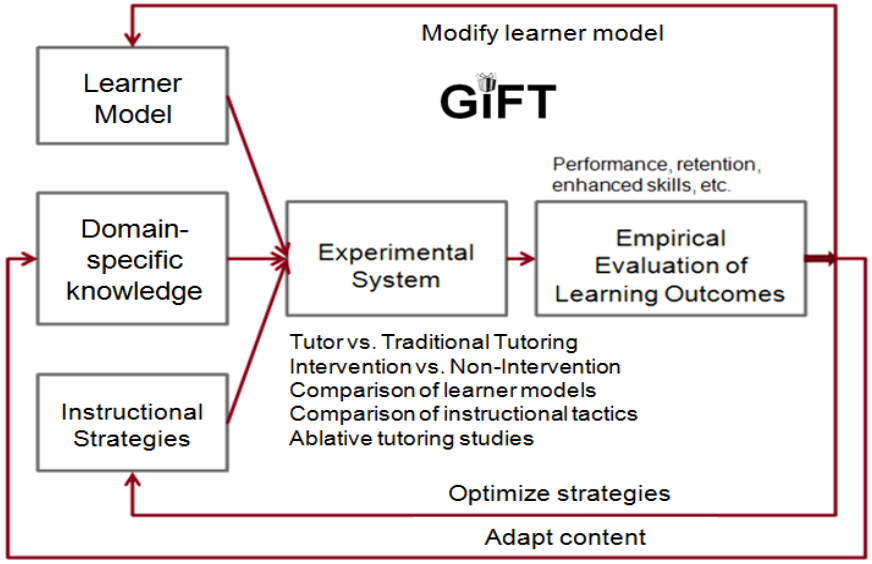
CBTS are:

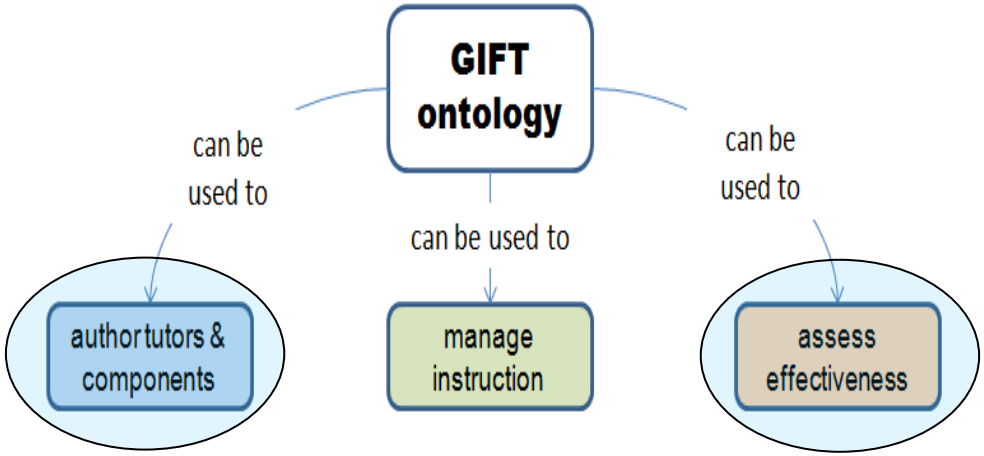
- ***expensive and labor intensive to author, test, validate***
- ***minimally adaptable to the real-time needs of the learner***
- ***generally not tailored to the competency of the learner***
- ***poorly adapted to support ill-defined (fuzzy) training domains***
- ***generally not capable of conducting unit training***

We need a capability to help us author and assess adaptive tutoring systems to support self-regulated training experiences, develop standards and promote reuse…

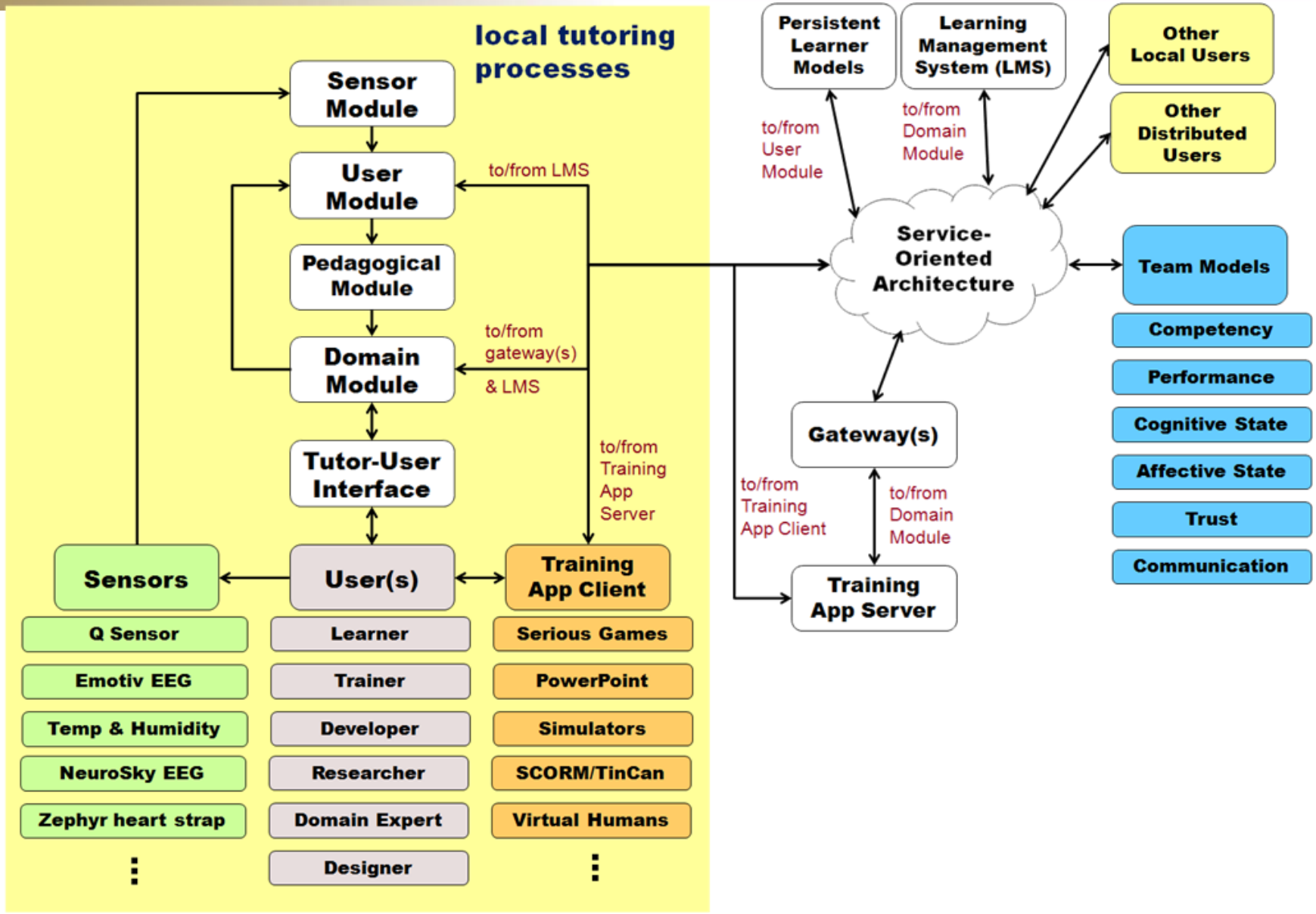
Generalized Intelligent Framework for Tutoring (GIFT)

- ***Objective: research and prototype a computer-based tutoring system (CBTS) 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 and tools***

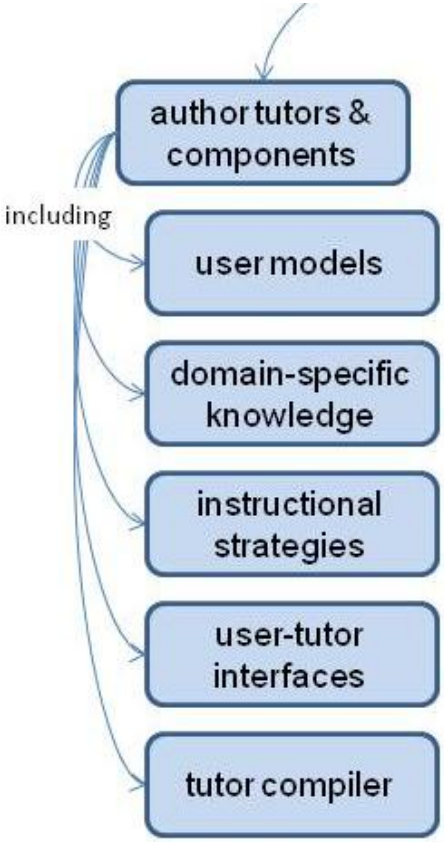




GIFT Functional Diagram (online processes)



GIFT's Authoring Construct

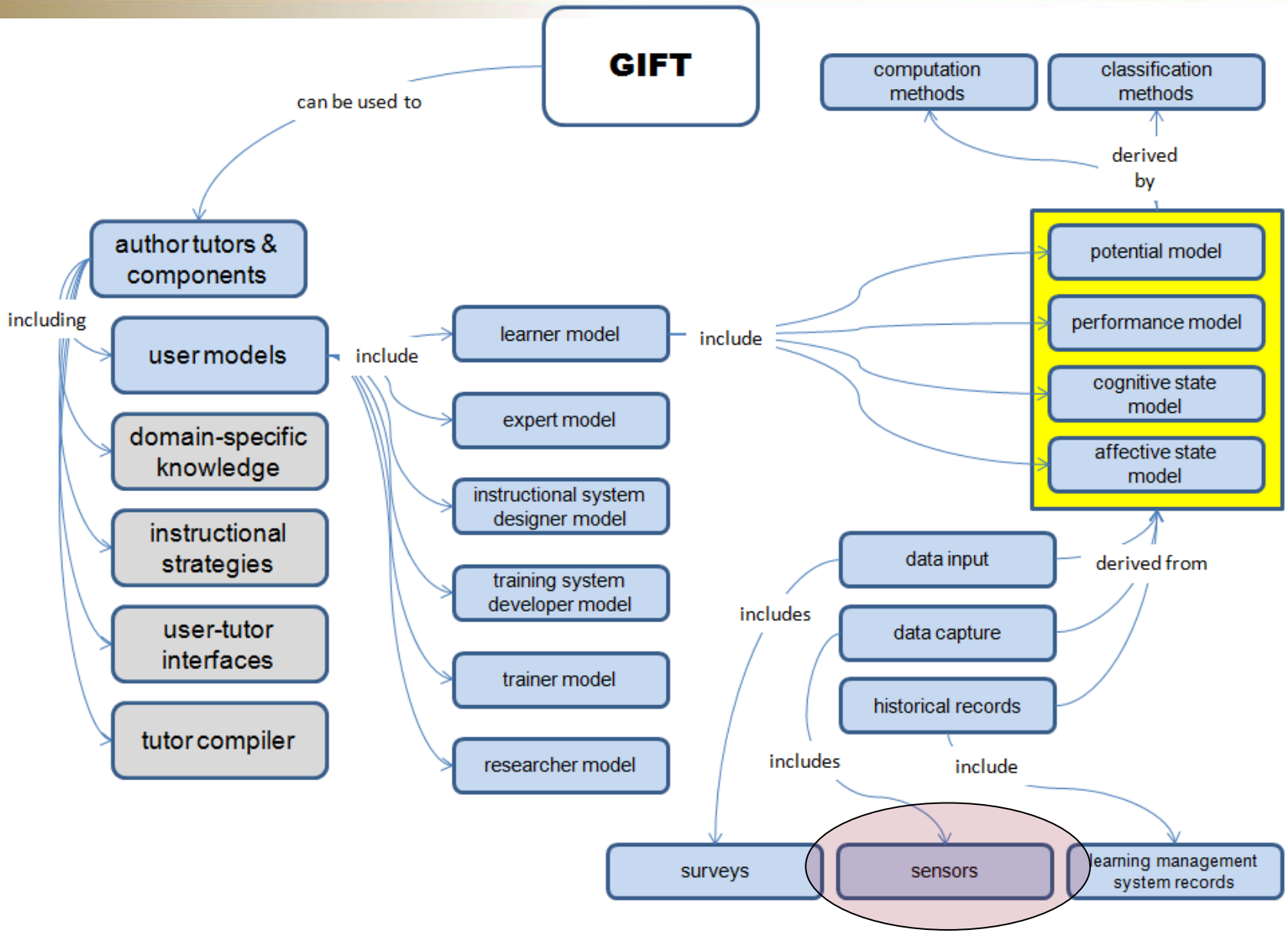


Authoring Goals for GIFT

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

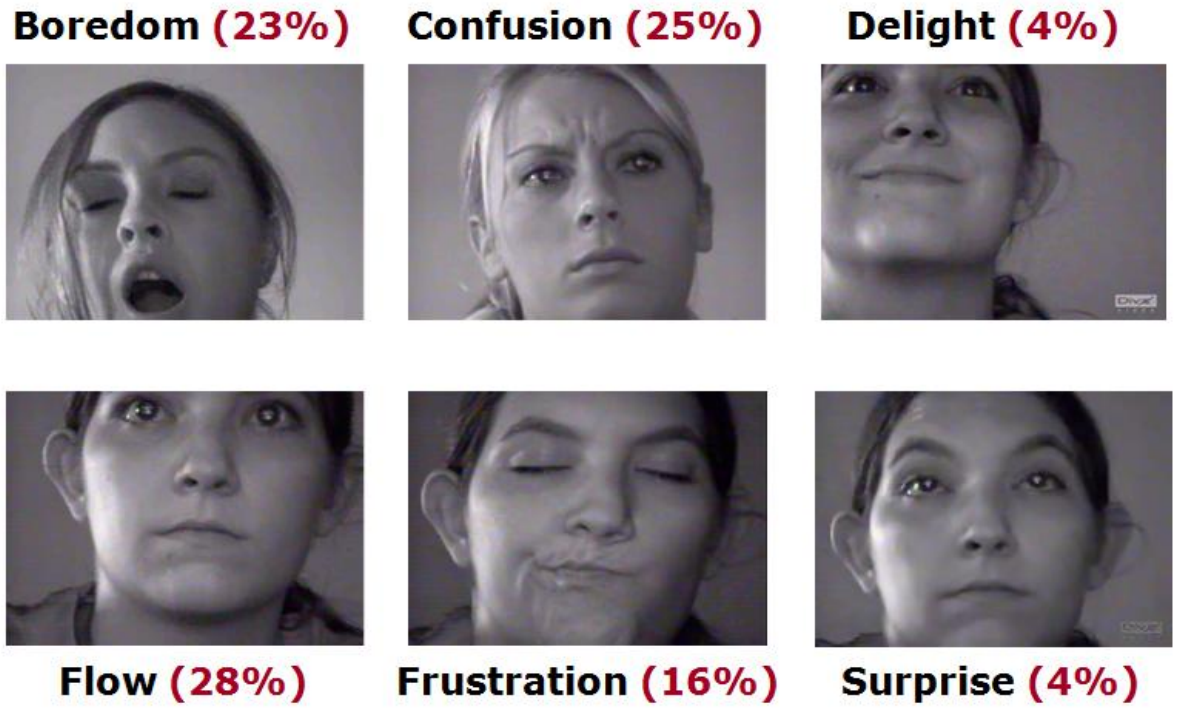
- **Decrease the effort (time, cost, and/or other resources) for authoring and assessing CBTS;**
- **Decrease the skill threshold by tailoring tools for specific disciplines to author, assess and employ CBTS;**
- **Provide tools to aid the designer/author/trainer /researcher organize their knowledge;**
- **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) (Sottilare & Gilbert, 2011)**

Authoring User Models



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?***



Graesser and D'Mello (2012, in press)

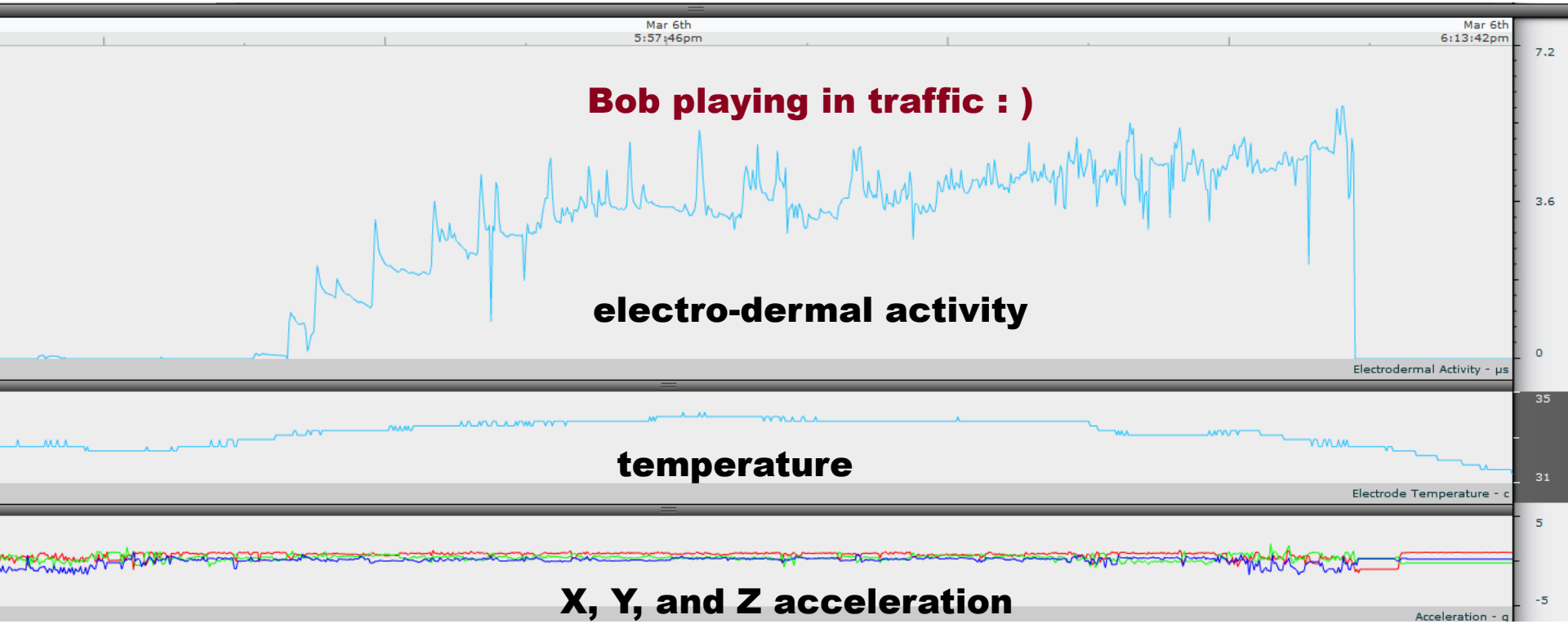
Sensor Configuration Authoring Tool

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

Sensors implement in GIFT 2.0

- ***Affectiva QSensor***
  - ***electro-dermal activity (EDA)***
  - ***skin temperature and acceleration***
- ***Emotiv EEG***
- ***temperature and humidity mouse (custom)***
- ***Surrogate sensors for temp, humidity and assessment***
- ***NeuroSky and ABM EEGs***
- ***Webcam (1Hz)***
- ***Zephyr heart rate monitor***
- ***Sonar distance sensor***
- ***Pressure chair (custom)***

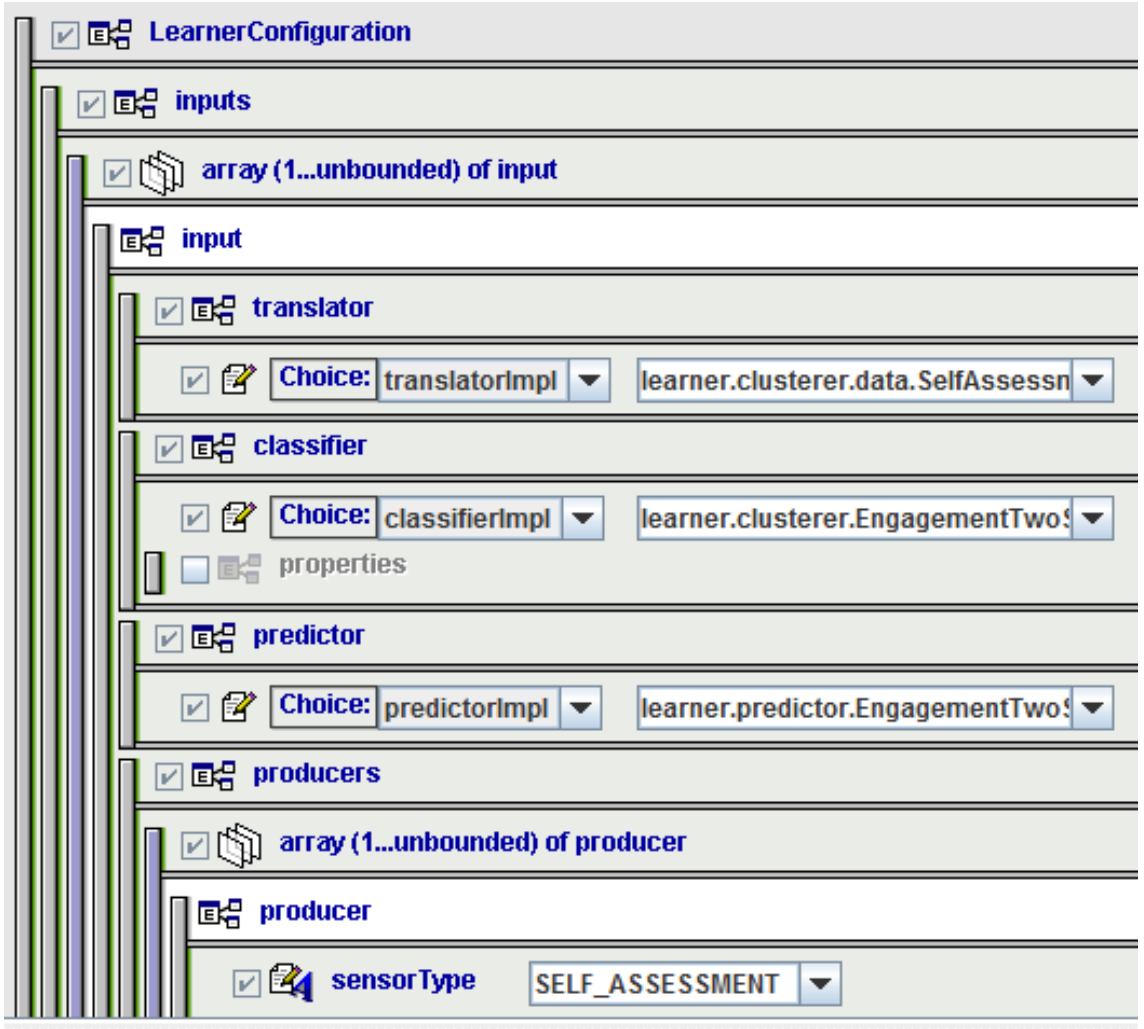
Passive Sensing – Q Sensor



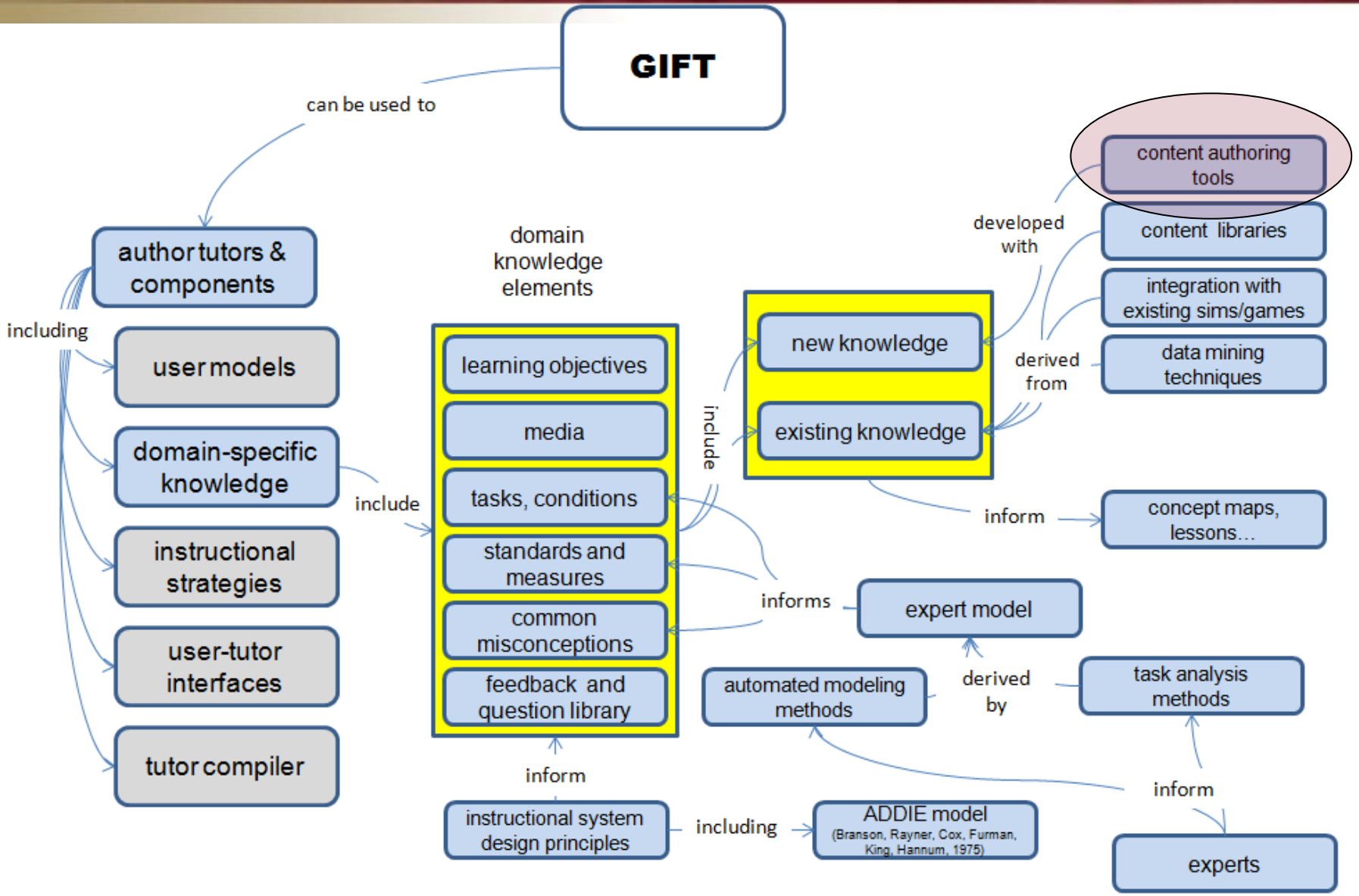
Research question: **what is the minimum set of sensors needed to assess engagement, workload, motivational level and emotional state?**

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

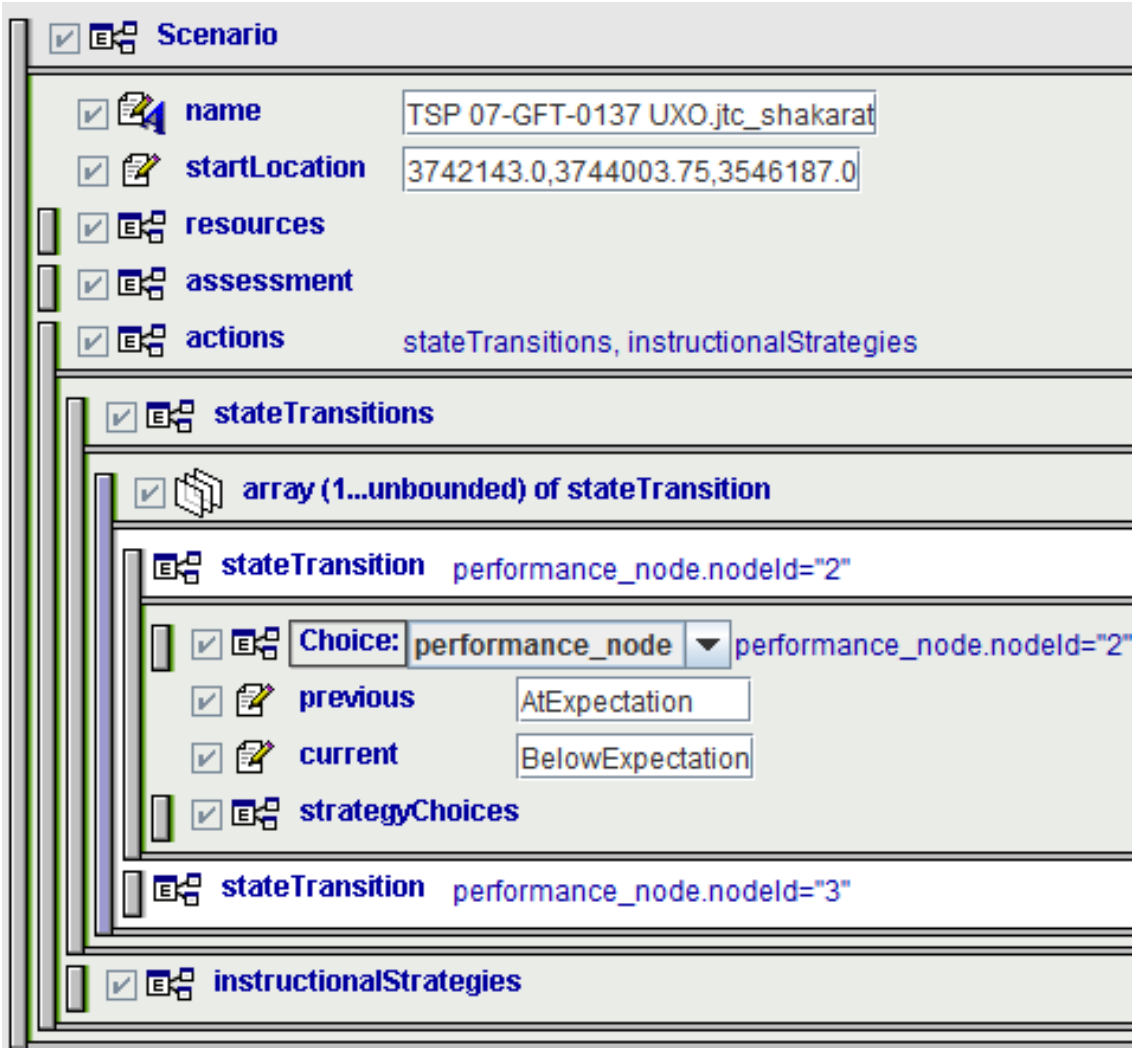


Authoring Domain Knowledge

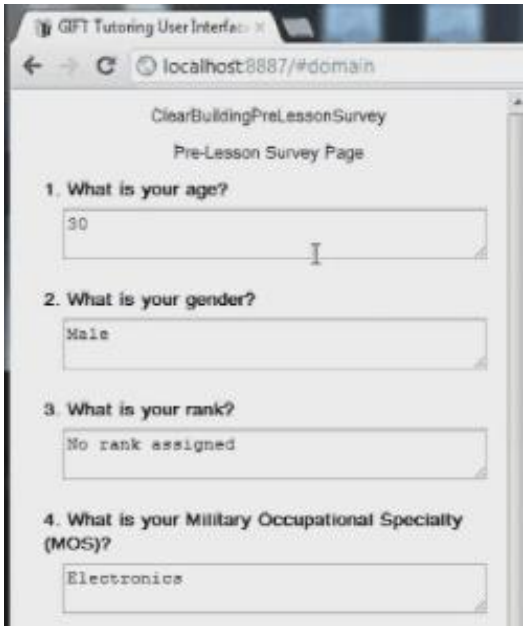


Domain Knowledge File Authoring Tool

- simple interface for authoring Domain Knowledge Files (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



Survey Authoring Tool



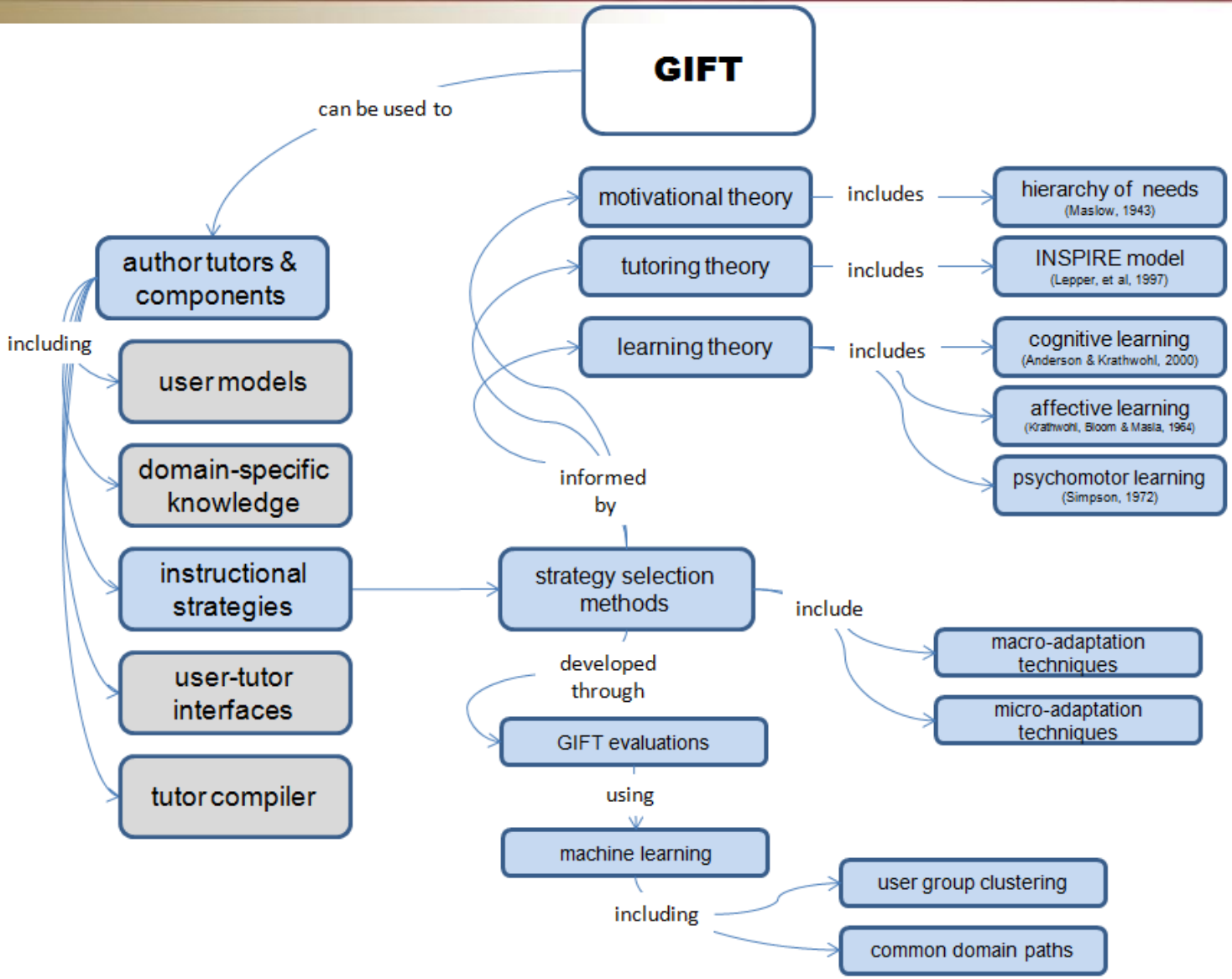
- ***author questions***
- ***author surveys***
- ***assign surveys***
- ***present surveys***

Question Bank | Surveys | Survey Contexts

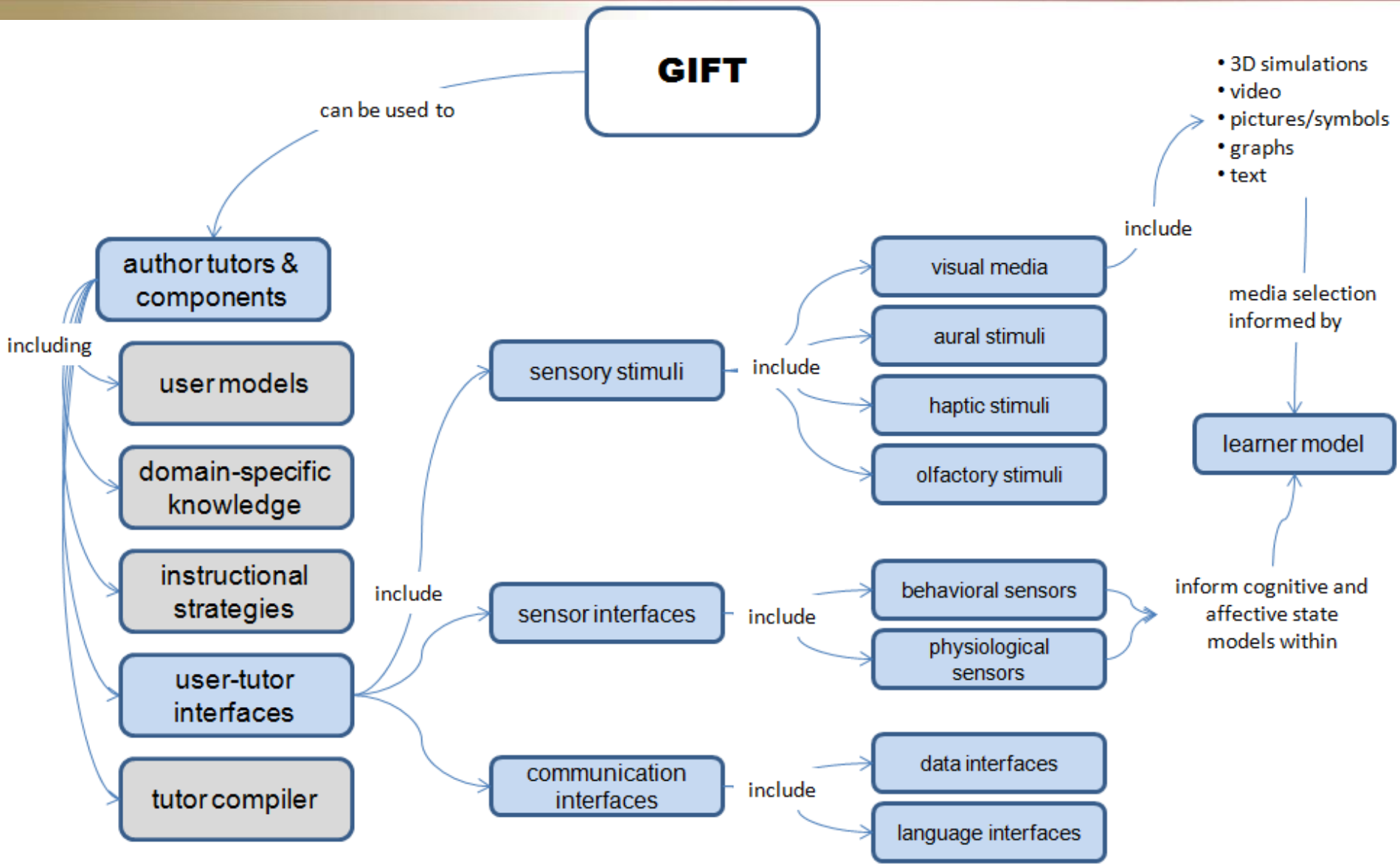
Create Question | Reply Set Editor

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

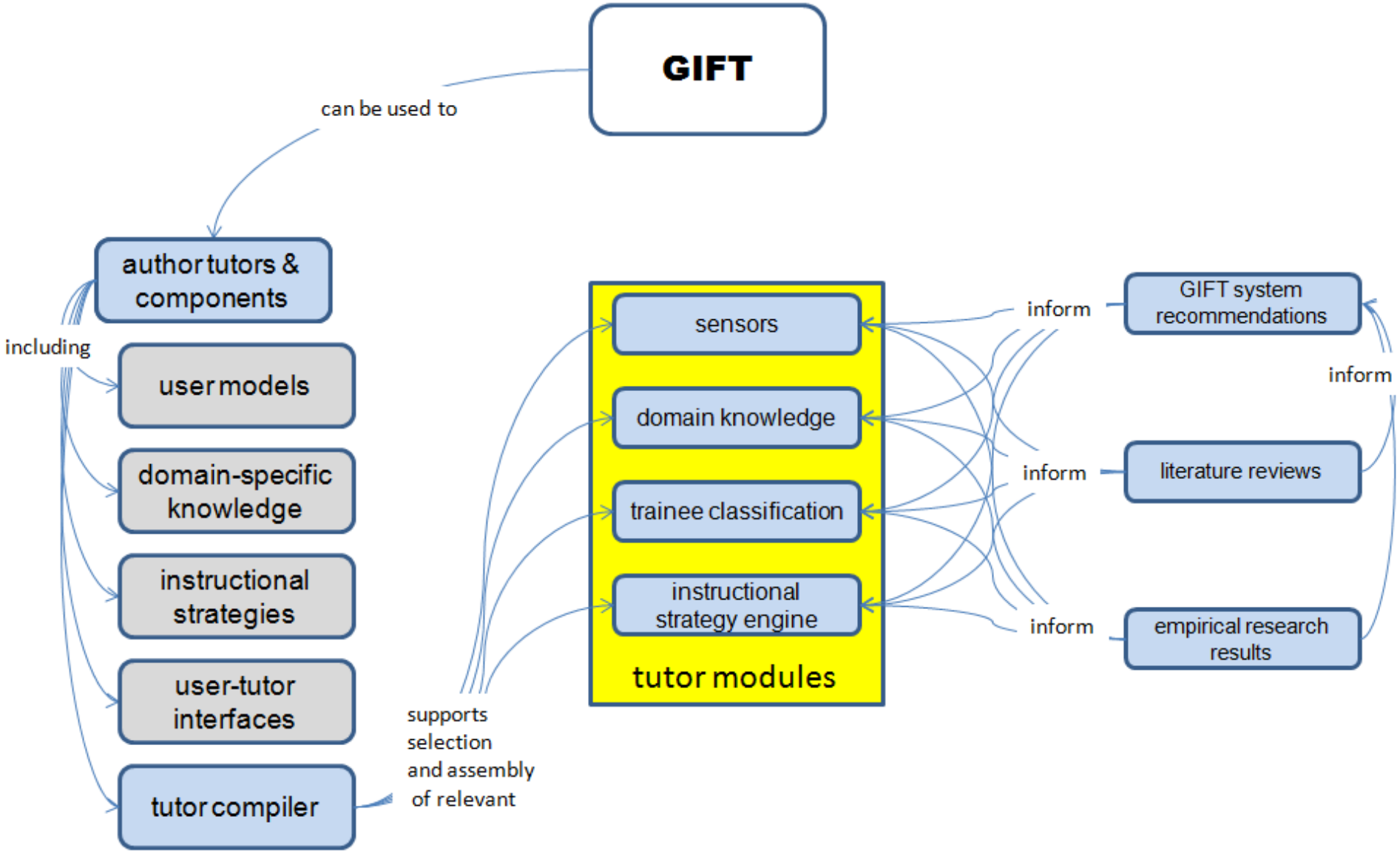
Authoring Instructional Strategies



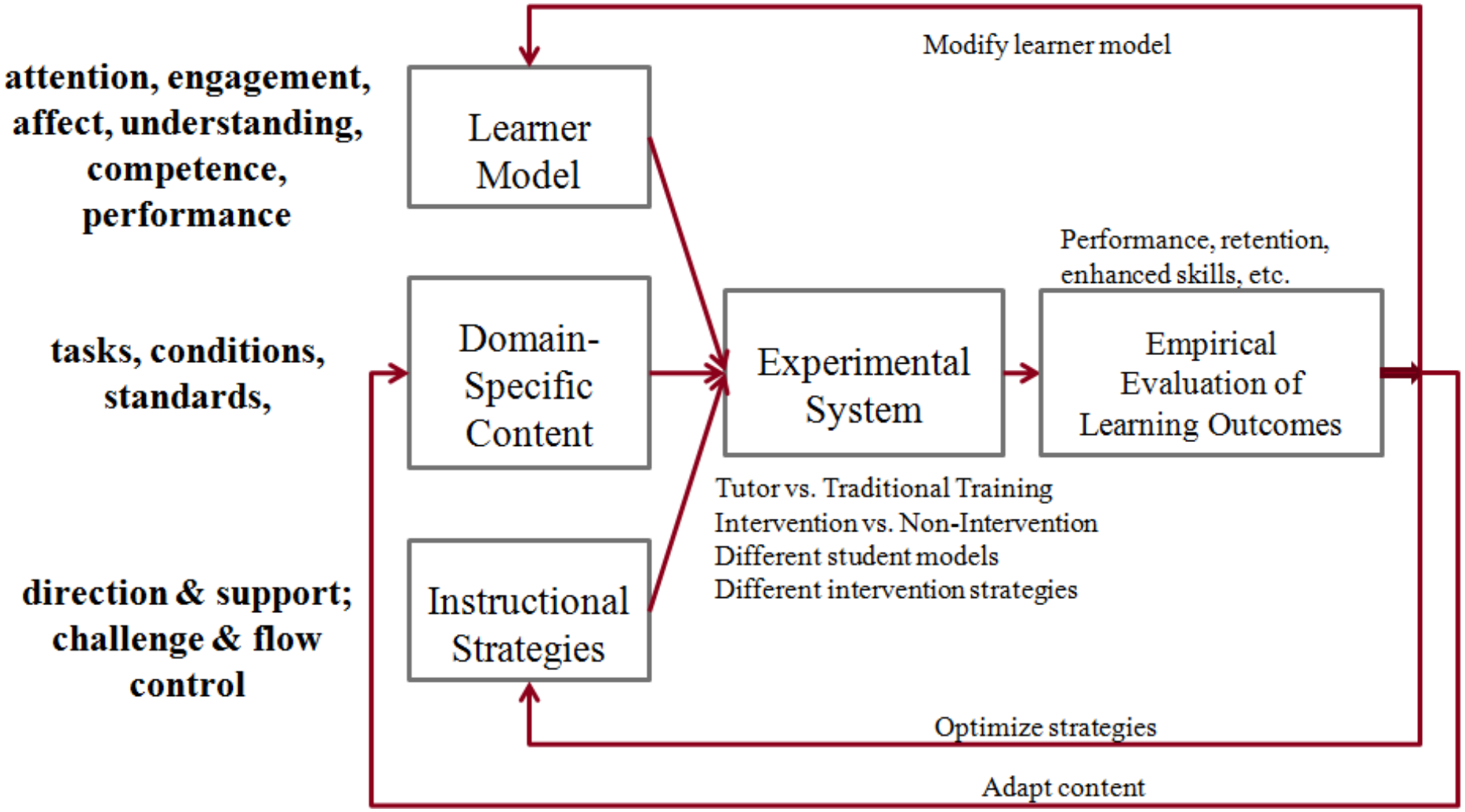
Authoring User-Tutor Interfaces



Authoring: Compiling Tutors



GIFT's Assessment Construct



Future Work

- **GIFT was initially released in May 2012 and is scheduled to release builds every six months (May and November) over the next five years**

- **Research integration and functional capability additions planned for the next few versions:**
  - ***commercial sensor integrations***
  - ***user interfaces (learner, researcher, trainer…)***
  - ***training domain application clients***
  - ***assessment studies for learner affect, motivation and engagement***
  - ***team tutoring models***

Outline

- **Motivation for a Generalized Framework for Authoring & Assessment**
- **GIFT authoring**
- **GIFT assessment**
- **Conclusions and Future Work**

Thank you for your attention

Questions?

Interested in knowing more about GIFT?

Go to GIFTtutoring.org