



U.S. Army Research, Development and Engineering Command

Considerations in the Development of an Ontology for a Generalized Intelligent Framework for Tutoring (GIFT)



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Robert Sottolare, Ph.D.

**Director, Learning in Intelligent Tutoring Environment (LITE) Laboratory
SFC Paul Ray Smith Simulation & Training Technology Center (STTC)
Army Research Laboratory - Human Research & Engineering Directorate (HRED)**



September 2012

- **Motivation for Computer-Based Tutoring**
- **Problem Statement**
- **Adaptive Tutoring Learning Effect Chain**
- **Ontology and considerations for a GIFT**

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)**

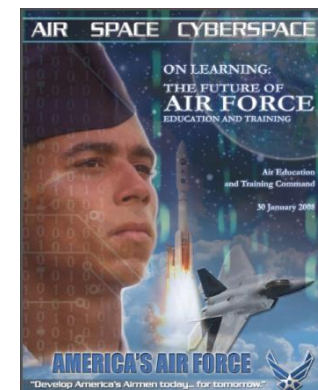
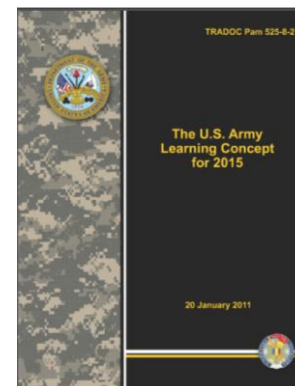
❖ Adapted from information provided by Dr. Art Graesser, University of Memphis, and Dr. Beverly Woolf, University of Massachusetts - Amherst.

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

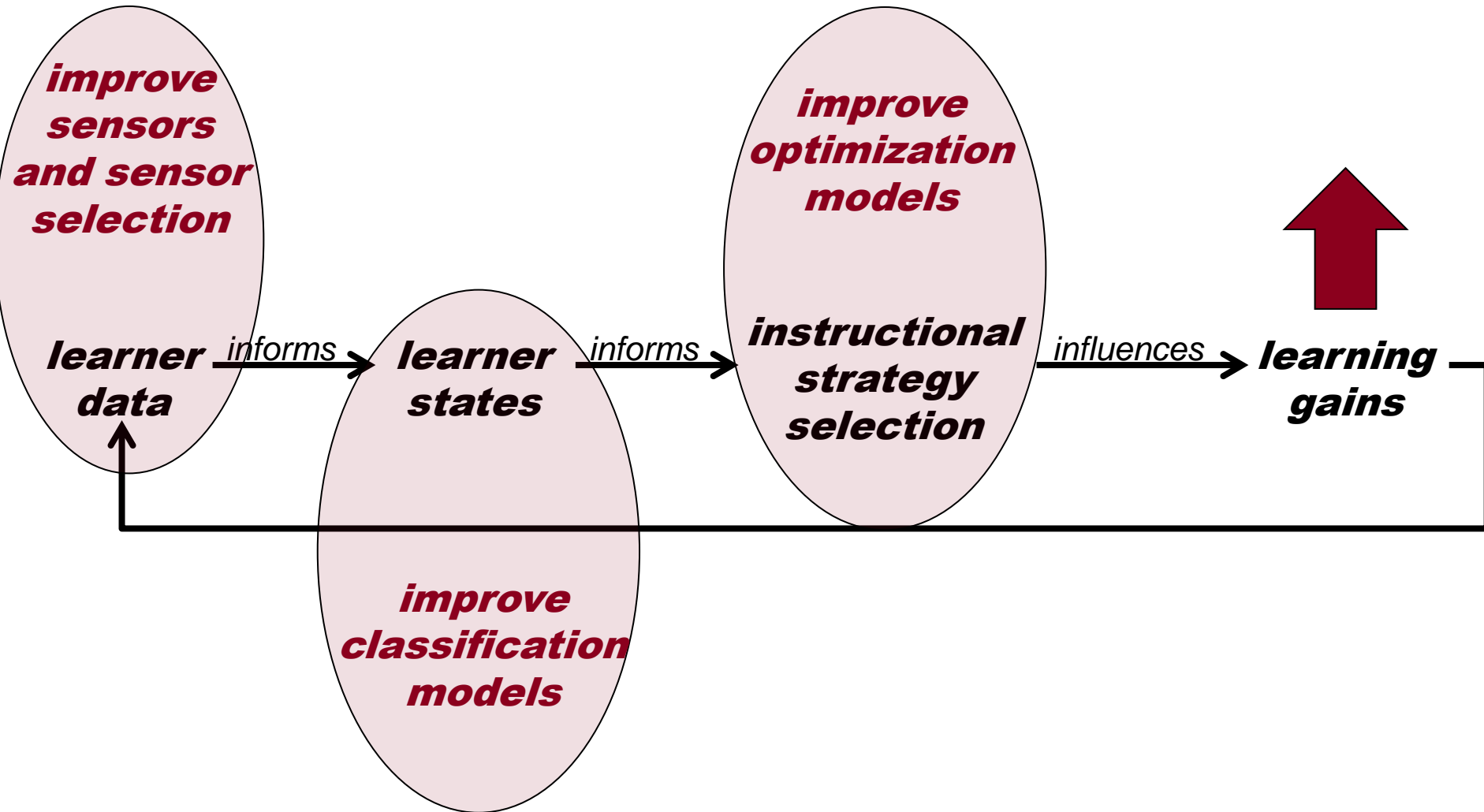
Fifty years of research have been unsuccessful in making *CBTS* ubiquitous in military training... Why?

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

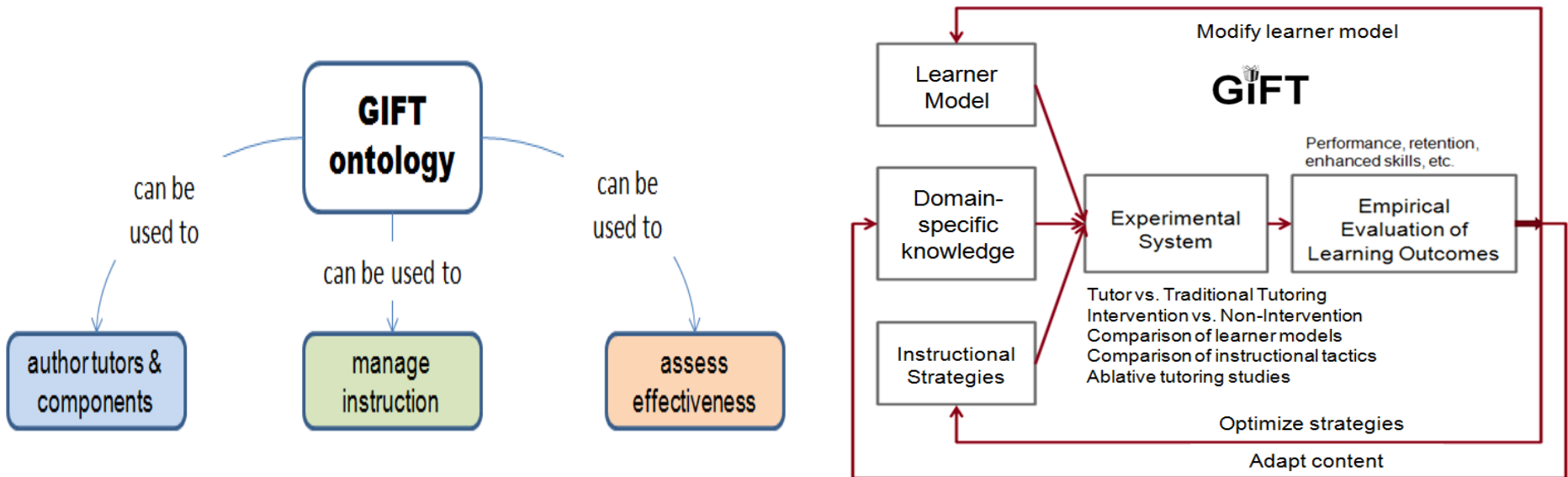
- **U.S. Army Learning Model (ALM) for 2015 (TRADOC, 2011)**
- **U.S. Air Force (AETC, 2008)**
- **U.S. Navy STEM Grand Challenge (ONR, 2012)**
- **OSD R&T Vision for PAL**
- **NATO HFM RTG 237 (Advanced ITS)**
- **TTCP HUM TP-2 (Training Panel)**



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.



- 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 and tools**

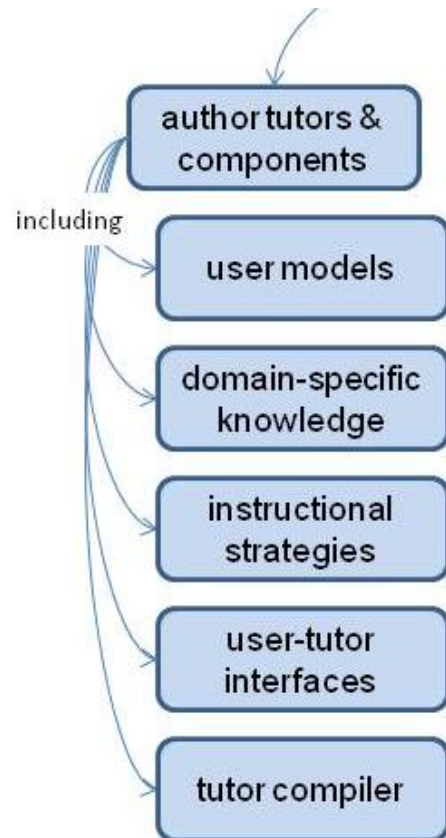


TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

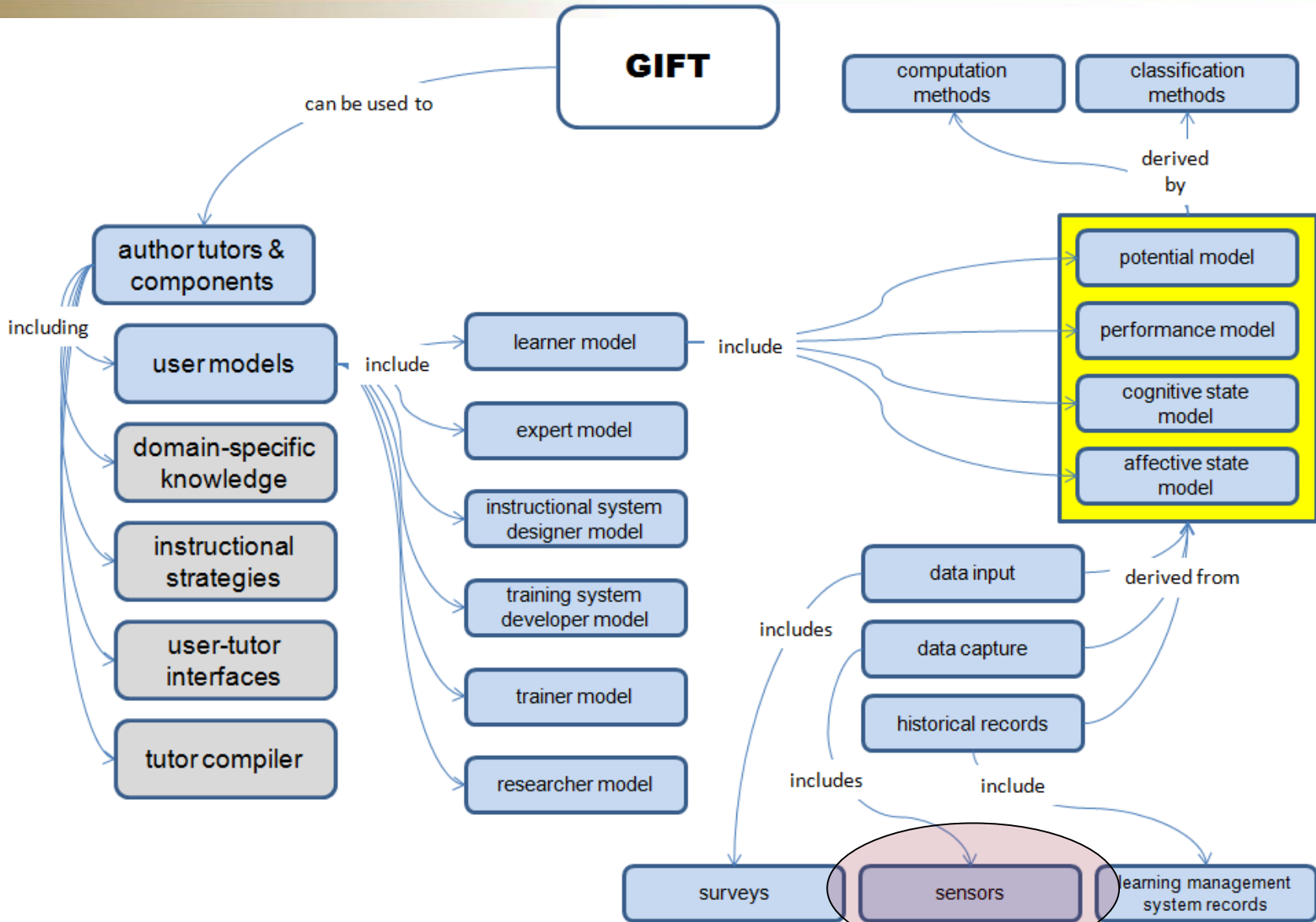
Authoring Goals for GIFT

(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)**



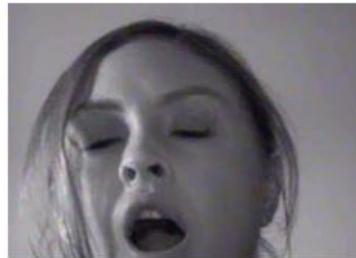
Consideration: Authoring User Models



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

- ***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?***

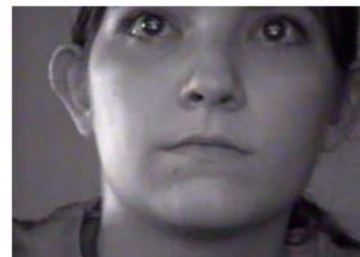
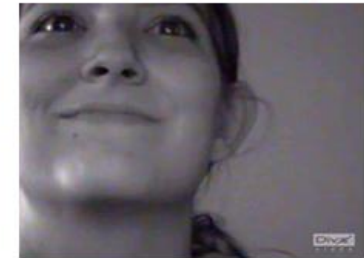
Boredom (23%)



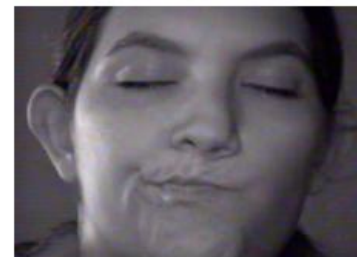
Confusion (25%)



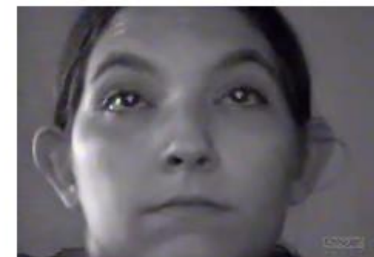
Delight (4%)



Flow (28%)



Frustration (16%)



Surprise (4%)

Graesser and D'Mello (2012, in press)

- **Approach: 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**

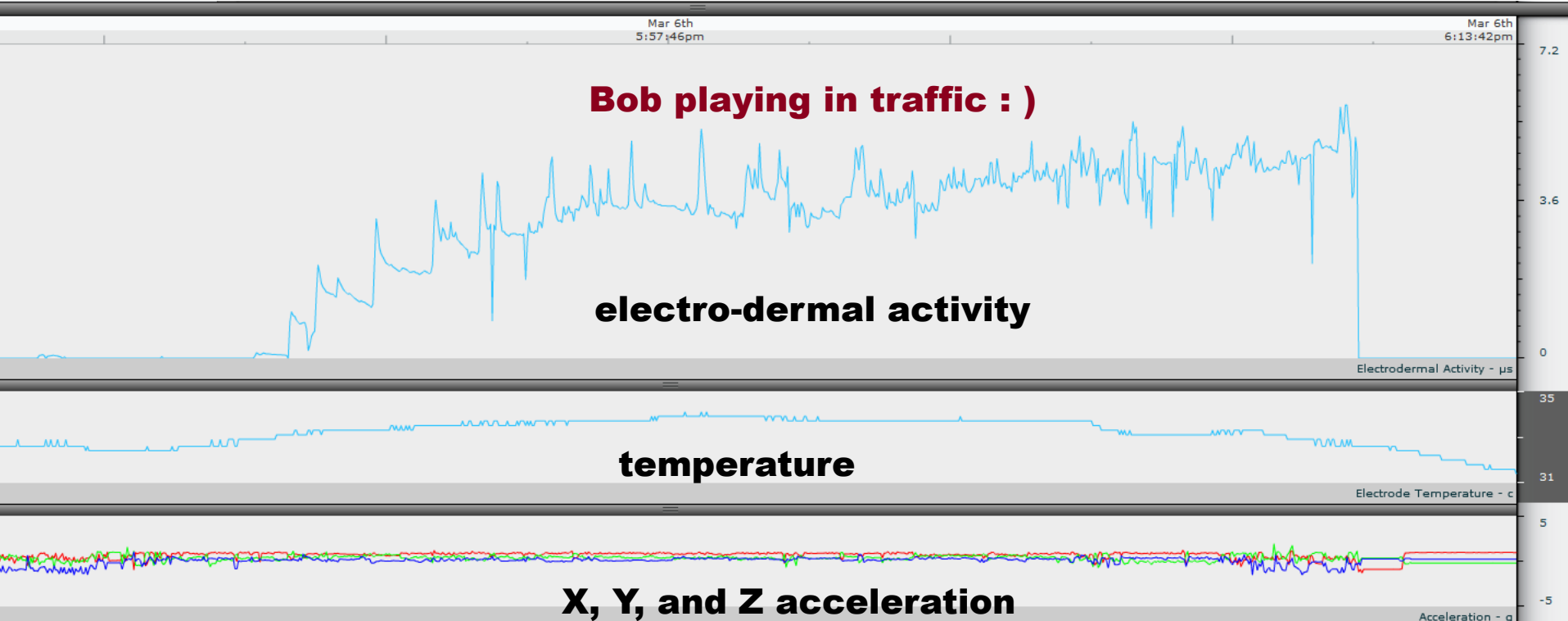
- **behavioral sensors**
- **physiological sensors**
- **state classification models**



- **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**

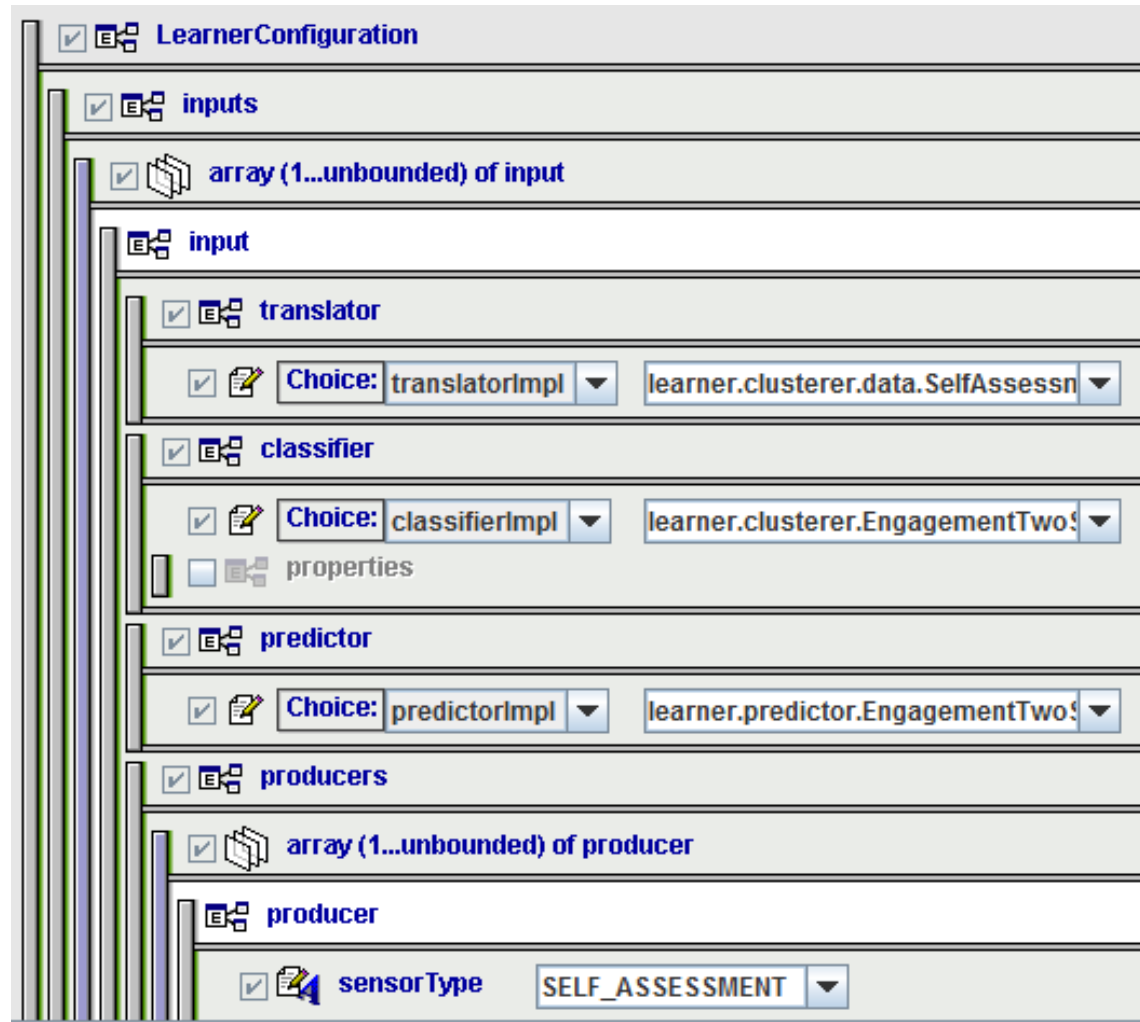
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.



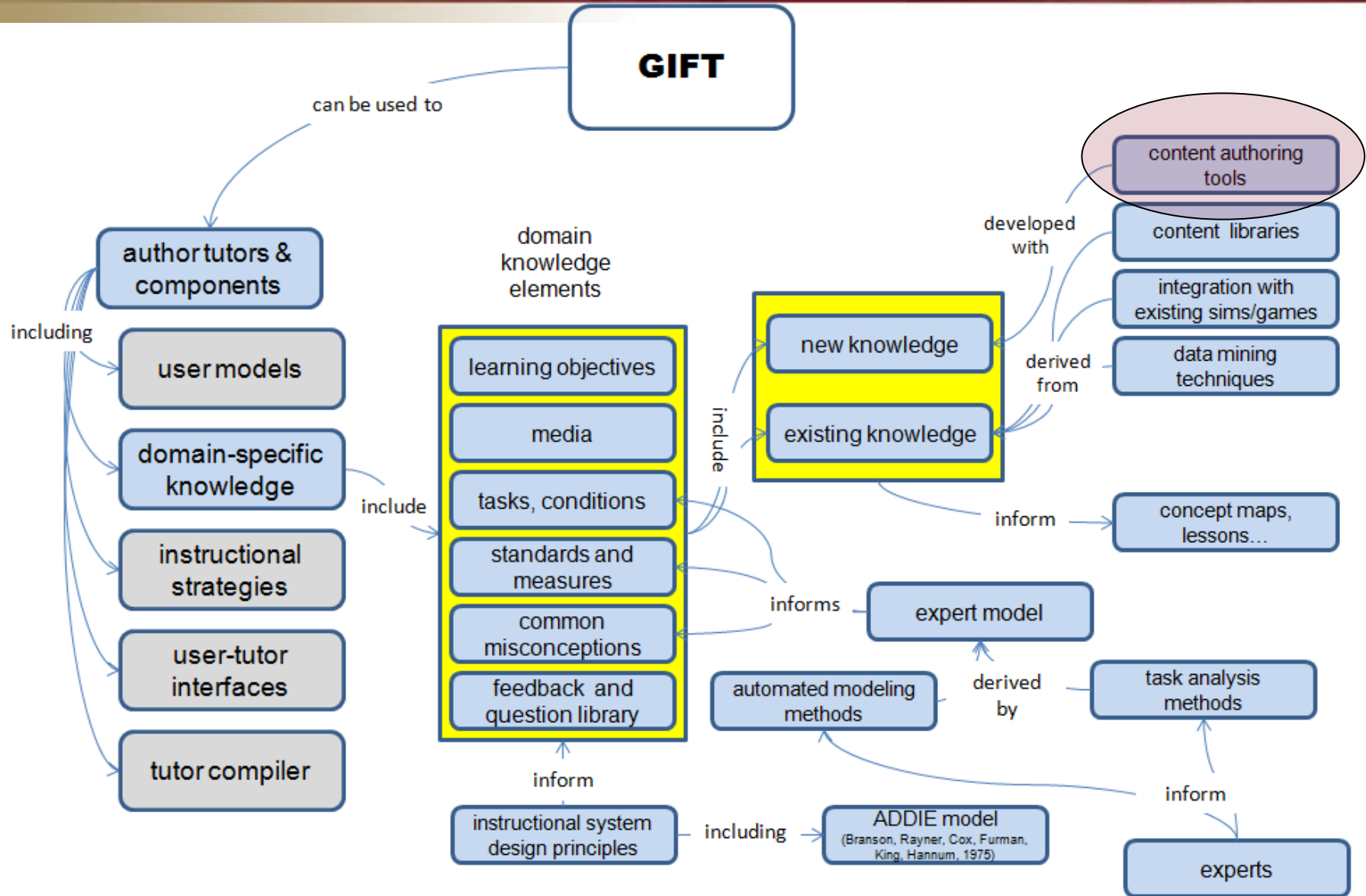
Research question: what is the minimum set of sensors needed to assess engagement, workload, motivational level and emotional state?



- **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**

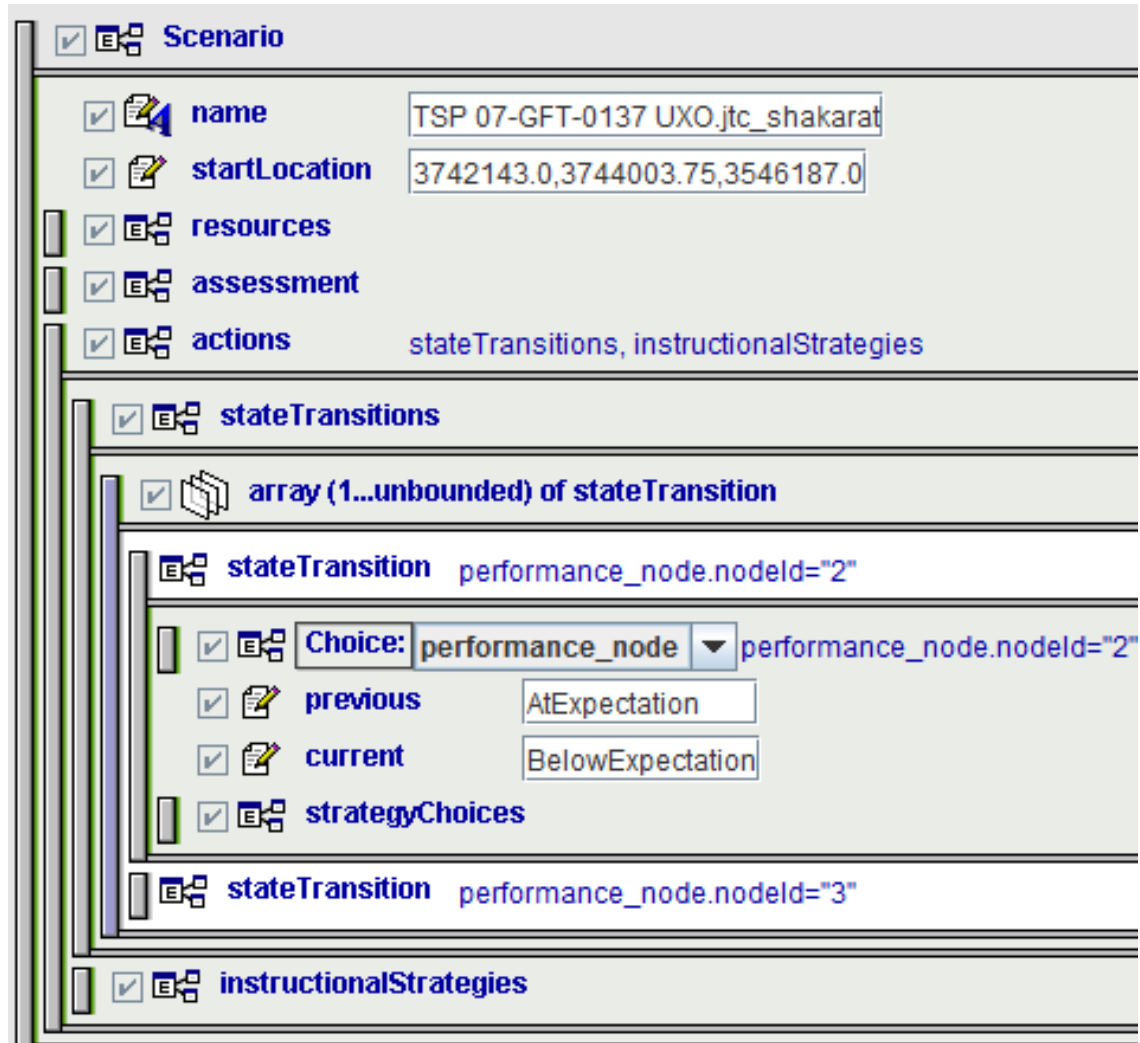


Consideration: Authoring Domain Knowledge



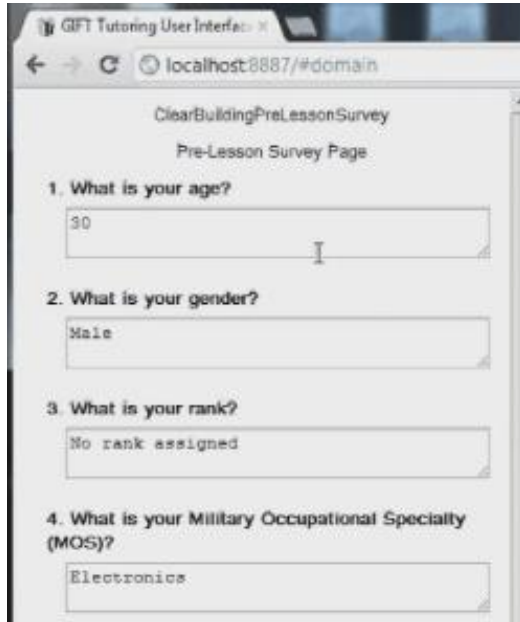
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

- **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**



The screenshot displays the Domain Knowledge Authoring Tool interface. The main window shows a tree structure for a Scenario. The tree is expanded to show the following elements:

- Scenario** (checked)
 - name** (checked) [TSP 07-GFT-0137 UXO.jtc_shakarati]
 - startLocation** (checked) [3742143.0,3744003.75,3546187.0]
 - resources** (checked)
 - assessment** (checked)
 - actions** (checked) [stateTransitions, instructionalStrategies]
 - stateTransitions** (checked)
 - array (1...unbounded) of stateTransition** (checked)
 - stateTransition** performance_node.nodId="2"
 - Choice:** performance_node [▼] performance_node.nodId="2"
 - previous** [AtExpectation]
 - current** [BelowExpectation]
 - strategyChoices**
 - stateTransition** performance_node.nodId="3"
 - instructionalStrategies** (checked)



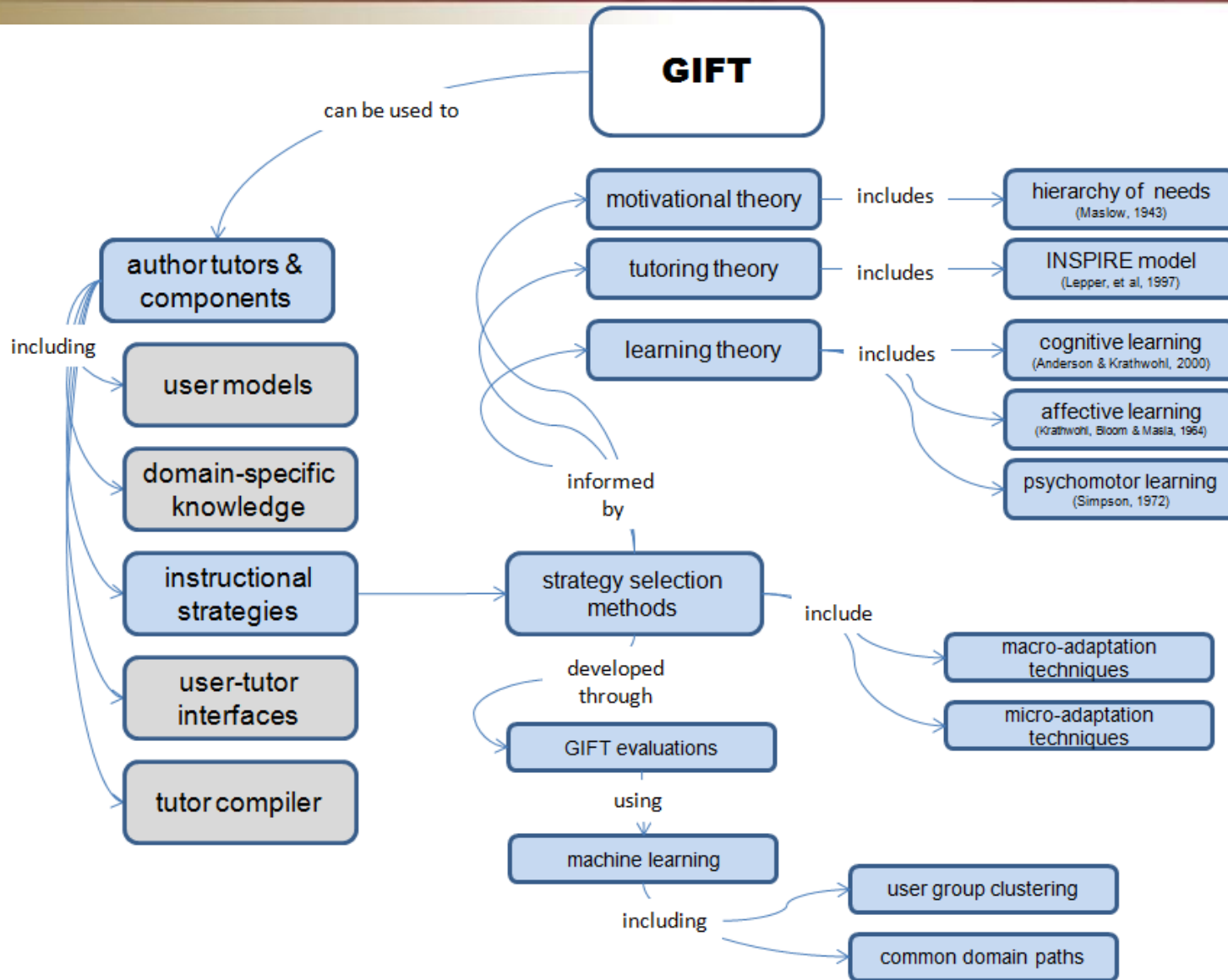
ClearBuildingPreLessonSurvey
Pre-Lesson Survey Page

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

Consideration: Authoring Instructional Strategies



GIFT

can be used to

- 3D simulations
- video
- pictures/symbols
- graphs
- text

author tutors & components

user models

domain-specific knowledge

instructional strategies

user-tutor interfaces

tutor compiler

sensory stimuli

sensor interfaces

communication interfaces

visual media

aural stimuli

haptic stimuli

olfactory stimuli

behavioral sensors

physiological sensors

data interfaces

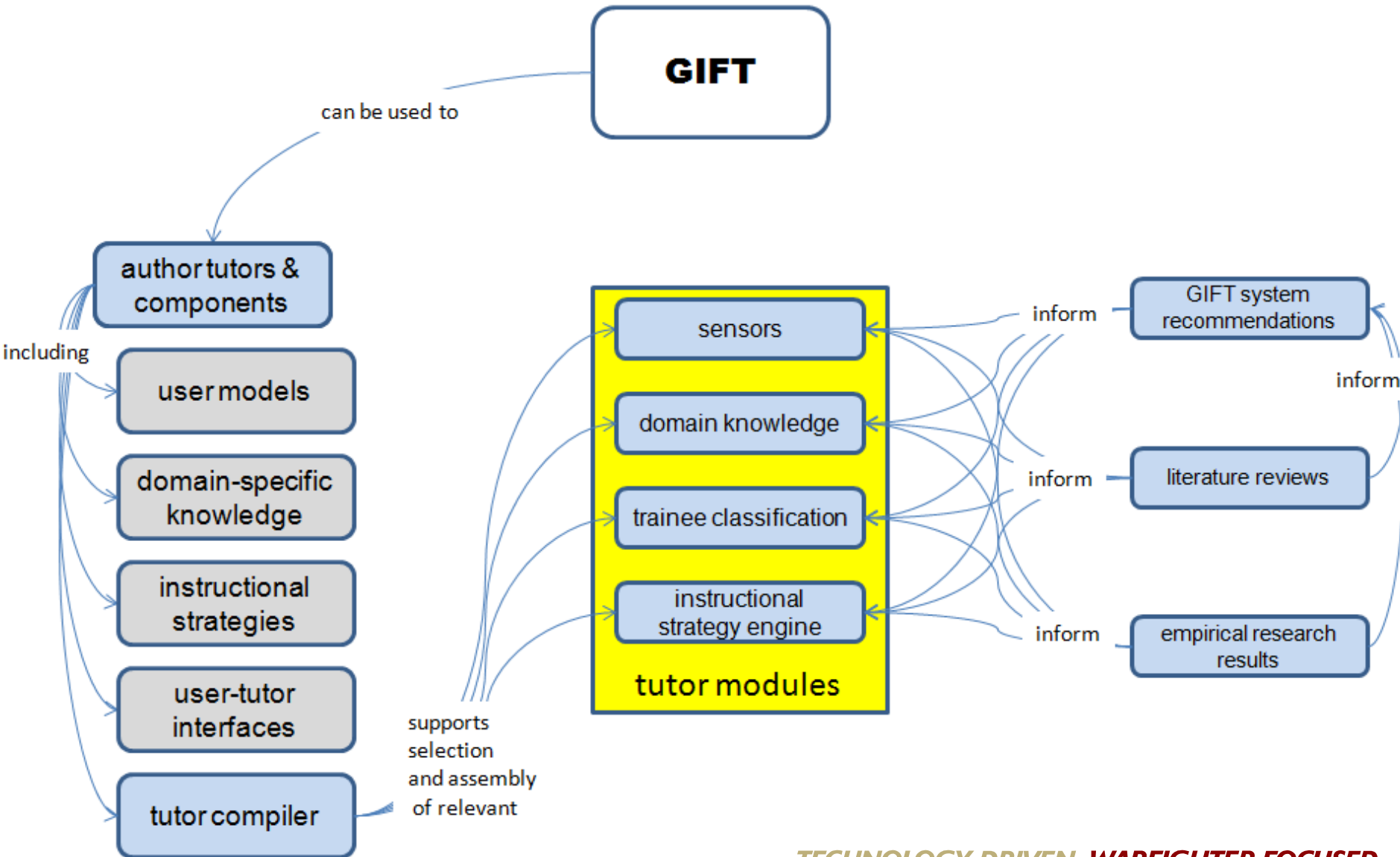
language interfaces

learner model

media selection informed by

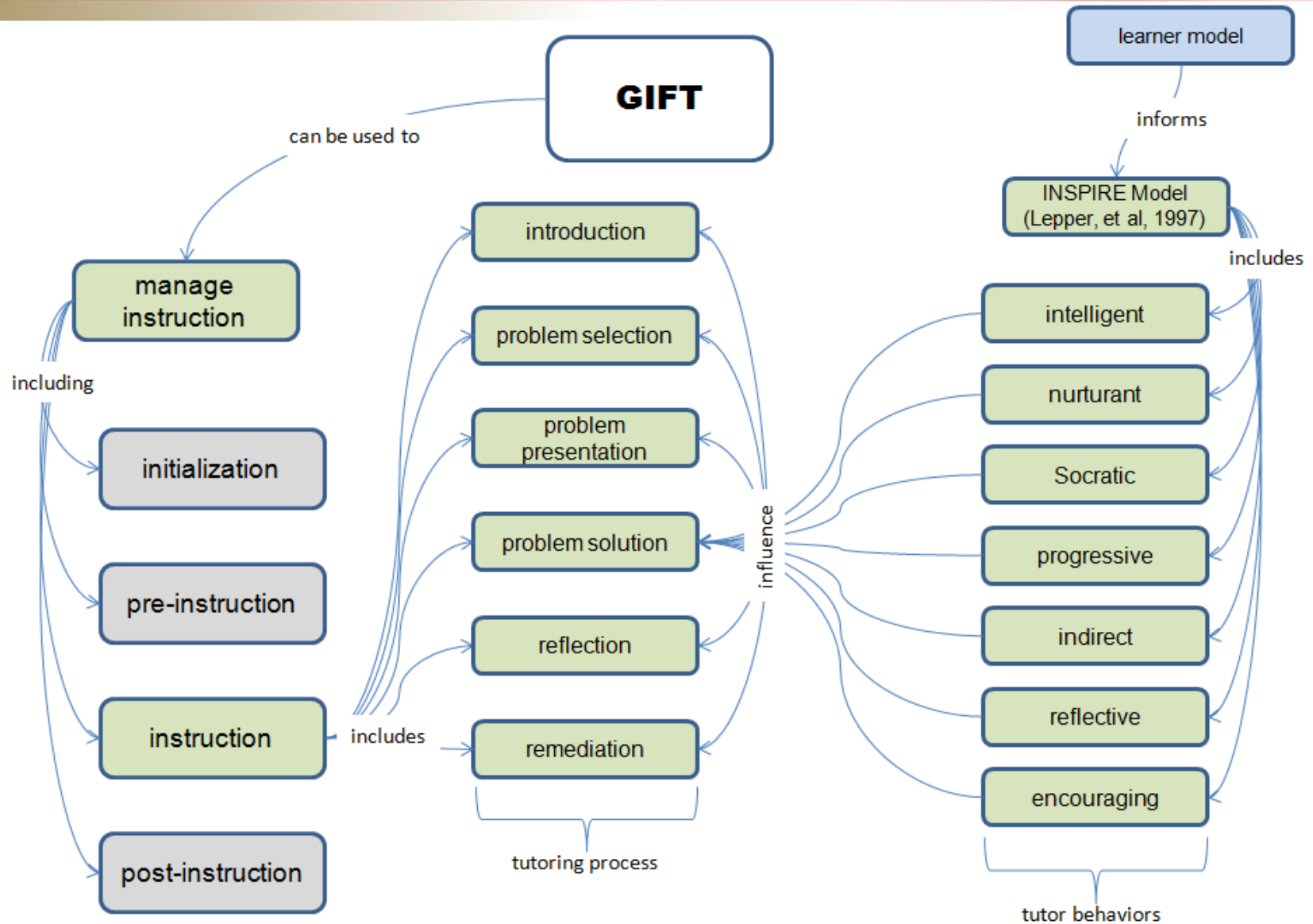
inform cognitive and affective state models within

Consideration: Compiling Tutors

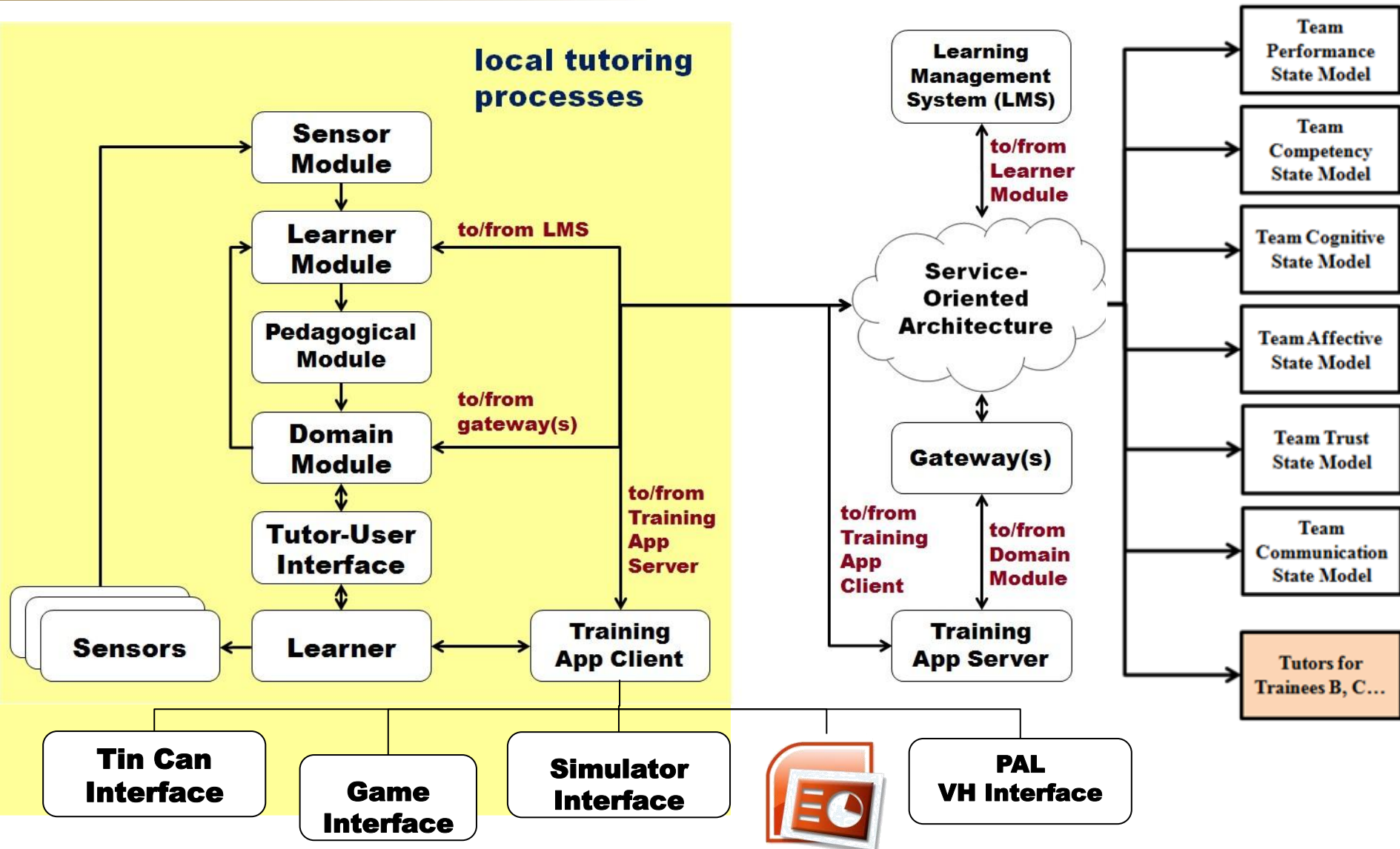


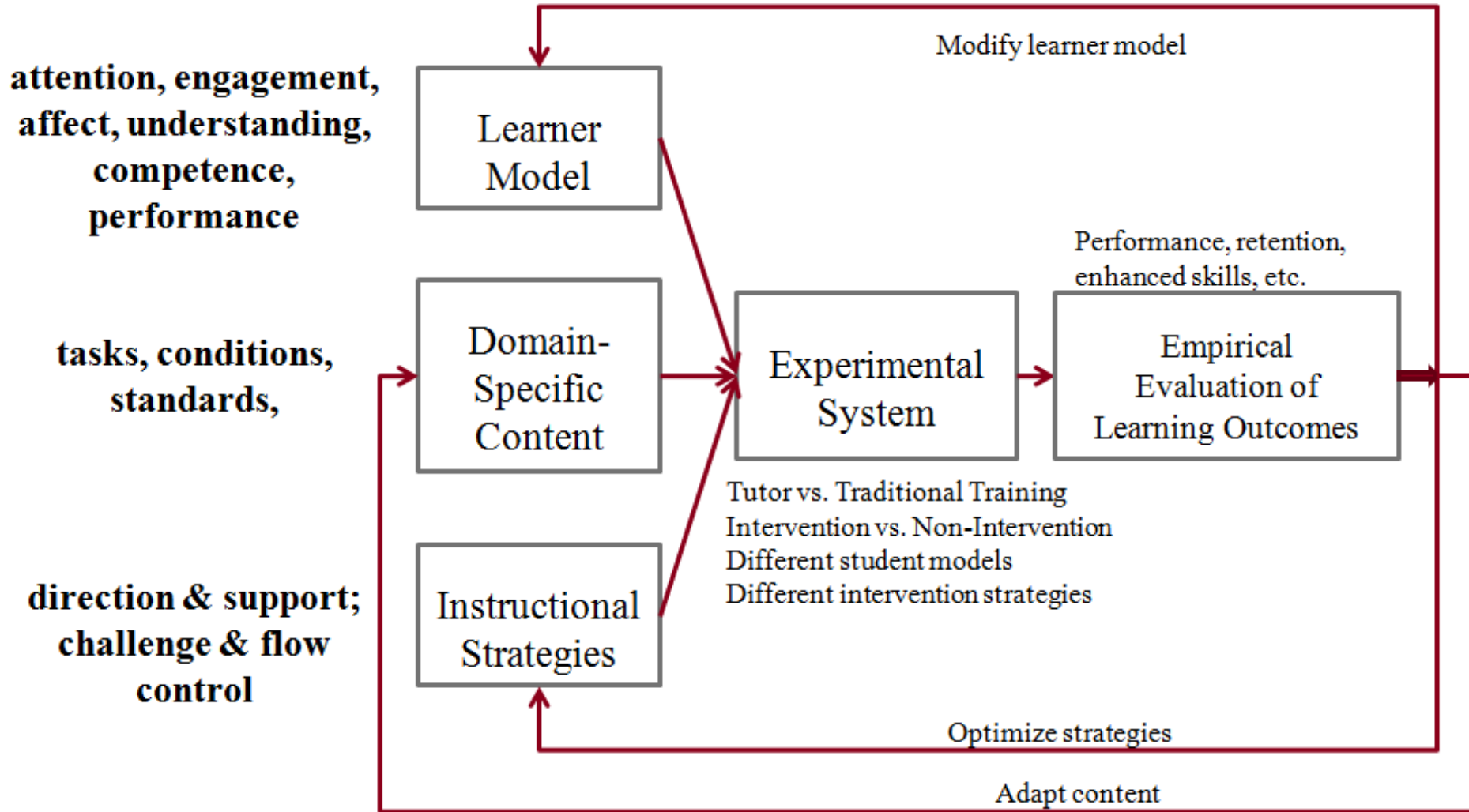
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Consideration: Managing Instruction



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.





- **Motivation for Computer-Based Tutoring**
- **Problem Statement**
- **Adaptive Tutoring Learning Effect Chain**
- **Ontology and considerations for a GIFT**

Thank you for your attention

Questions?

Interested in knowing more about GIFT?

Go to GIFTtutoring.org