A Review of Adaptive Training Research at ARL

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Adaptive Training & Education Research Vectors

U.S. ARMY RDECOM® ARL

Real Time Dynamic Processes

Individual Learner & Unit Modeling

- Learner & Unit Data Acquisition
- Learner & Unit State Classification
  - Cognitive
  - Affective
  - Physical
  - Shared States
    - Social, Trust

Instructional Management Principles

- Real-time Adaptation
- Applied Learning Theory
- Modeling Behaviors of Expert Human Tutors

Domain Modeling

- Training domains matched to operational dimensions
  - Definition
  - Complexity
  - Physical Dynamics
  - Portability
- Training in the wild

Offline Processes

Authoring Tools & Methods

- Standards and Content Reuse
  - Serious Games
  - Powerpoint
- Automated Authoring Methods
  - Expert Modeling
  - Game-Tutor Middleware
- Authoring Job Aids

Evaluation Tools & Methods

- Training Effectiveness
  - Performance
  - Learning
  - Retention
  - Time to Competency
  - Transfer
- Data Analytics

Architectural/Ontological Support

Generalized Intelligent Framework for Tutoring

- Existing training systems & games
- Existing training content
- New adaptive tools & methods

Adaptive Instructional Systems

- Improved Performance
- Improved Knowledge & Skill Acquisition
- Longer Retention & Less Refresher Training
- Shorter Time to Competency
- Improved Transfer to Operations

Individual Learner and Team Modeling for Adaptive Training and Education in Support of the US Army Learning Model—Research Outline

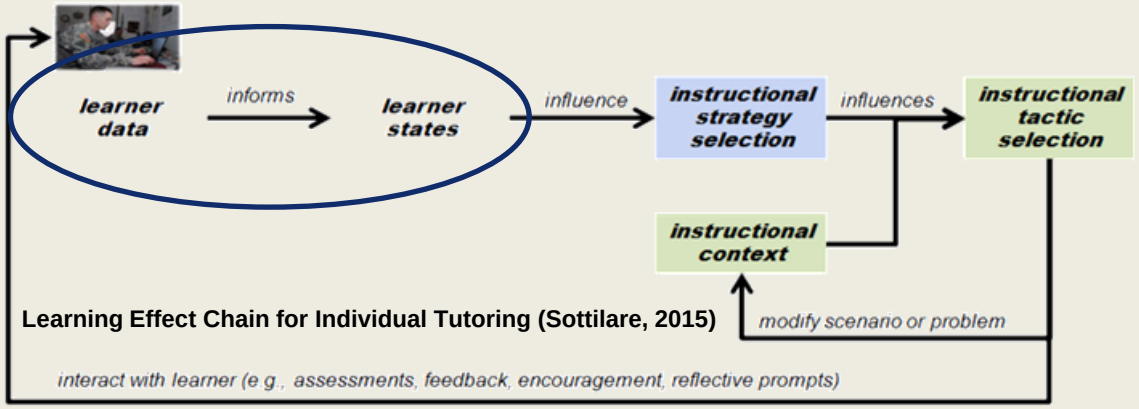
by Greg Goodwin, Joan Johnston, Robert Sottilare, Keith Brawner, Anne Sinatra, and Arthur Graesser

Guiding Learner Modeling Research Question

What does an AIS need to know about the learner to provide an effective learning experience?

- **prior knowledge or domain competence**
- **performance**
- **cognitive state (engagement, cognitive load)**
- **affective state (anger, confusion, boredom)**
- **physical state**
- **other traits or states?**

Learner Modeling Advisory Board



Learning Effect Chain for Individual Tutoring (Sottilare, 2015)

Purpose: Capture current learner modeling best practices through an advisory board composed of academic, government, and industry experts to understand the influence of learner attributes on critical instructional outcomes: learning, performance, competence, retention, and transfer

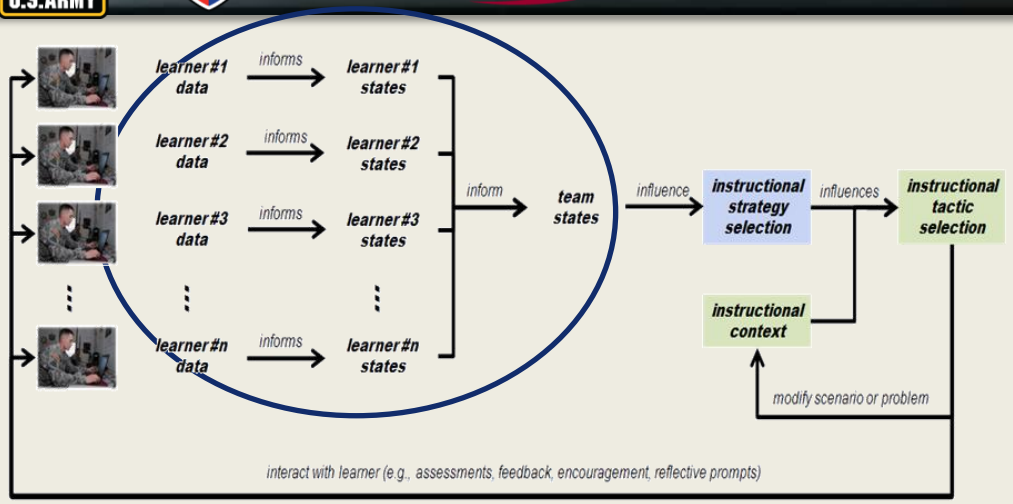
Products:

- Book - Learner Modeling best practices captured in Design Recommendations for ITSs – Volume 1
- Knowledge Representation - learner attributes (traits and states) as antecedents to critical instructional outcomes
- Research Gaps for Learner Modeling

Payoff:

- More focused learner modeling and resulting tools/methods
- Efficient and effective learner models to drive adaptive instruction

Team Modeling Advisory Board



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Purpose: Capture current team modeling best practices through an advisory board composed of academic, government, and industry experts to understand the influence of team attributes on critical instructional outcomes: learning, performance, competence, retention, and transfer

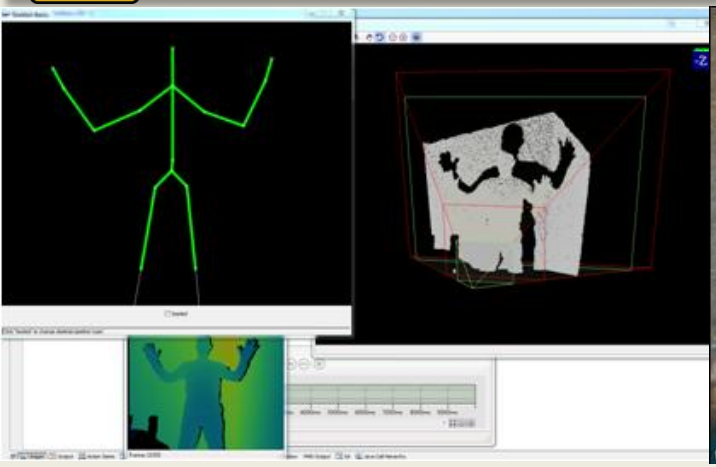
Products:

- Book - Team Modeling best practices captured in Design Recommendations for ITSs – Volume 6
- Knowledge representation - team attributes (traits and states) as antecedents to critical instructional outcomes
- Research Gaps for Team Modeling

Payoff:

- More focused team modeling and resulting tools/methods
- Efficient and effective team models to drive adaptive instruction

Affect Detectors, Implementation & Validation for a Medical Serious Game



Purpose: research methods to unobtrusively acquire military learner data and develop models of affect during training (e.g., game play)

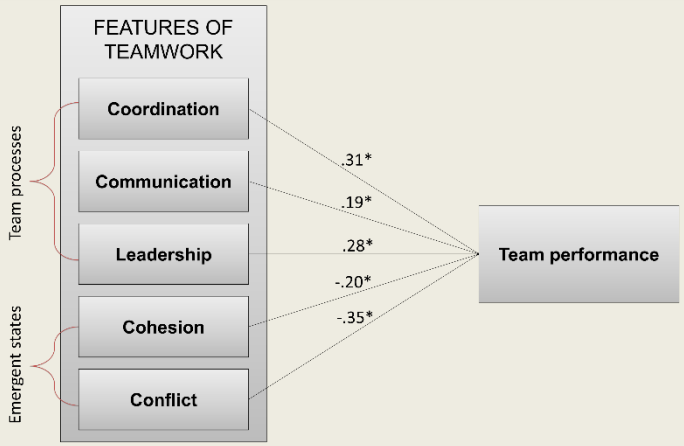
Products:

- Affect detectors correlated with behavioral observations and sensors (Kinect and Q Sensor)
- GIFT Interface to support rapid import of AI/ML models
- Validation study
- Conference papers and Final Report

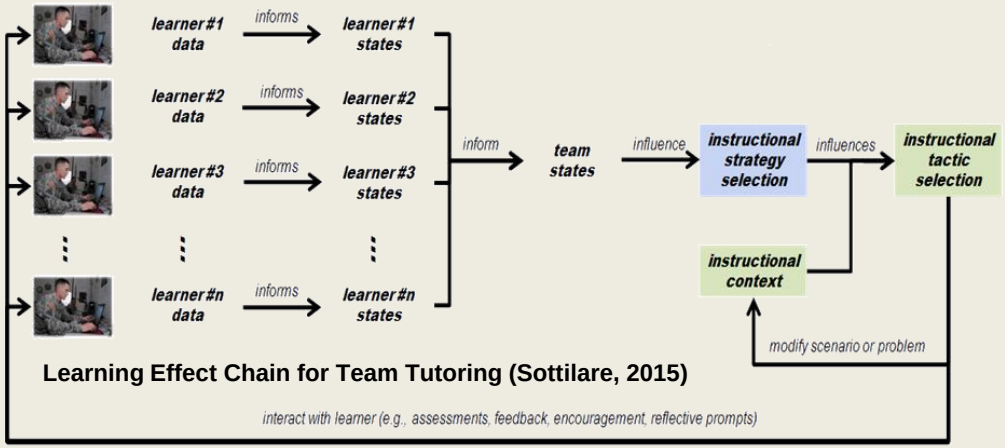
Payoff:

- Enhanced learning through tailored instruction based on support/mitigation responses to positive/negative states

Meta-Analysis of Antecedents of Team Learning, Performance, Satisfaction & Viability



Relative importance of features of teamwork



Learning Effect Chain for Team Tutoring (Sottilare, 2015)

Purpose:

A scientifically-rooted design architecture of team process and performance modeling in adaptive, team-based intelligent tutoring systems

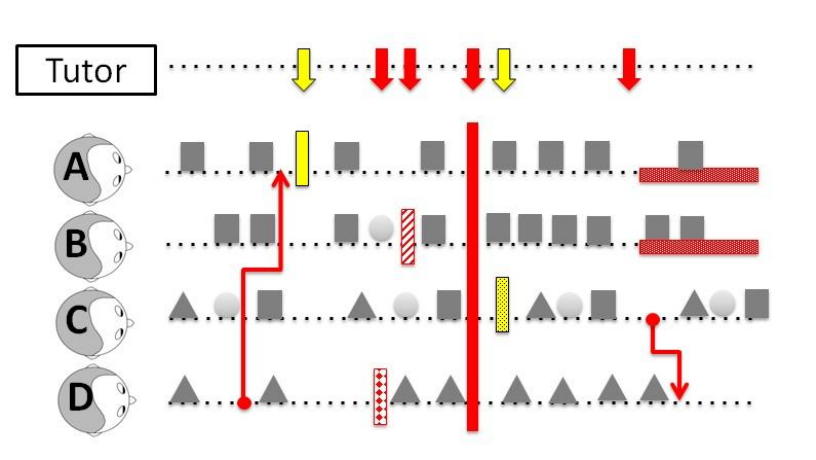
Products:

- Knowledge Representation – team attributes (traits and states) as antecedents to critical instructional outcomes
- Research Gaps for Team Modeling
- I/ITSEC 2015 Conference Paper & Tutorial
- Peer-Reviewed Journal Articles (JAIED, CHB)
- Book - Team modeling best practices captured in Design Recommendations for ITSs

Payoff:

- More focused adaptive team training research
- Efficient and effective team models to drive adaptive instruction

Team Modeling in Virtual, Mixed, and AR Training Environments



Purpose: Discover models of team learning and performance and adapt GIFT to support team tutoring (content, assessment, and feedback) in virtual, mixed, and augmented reality environments

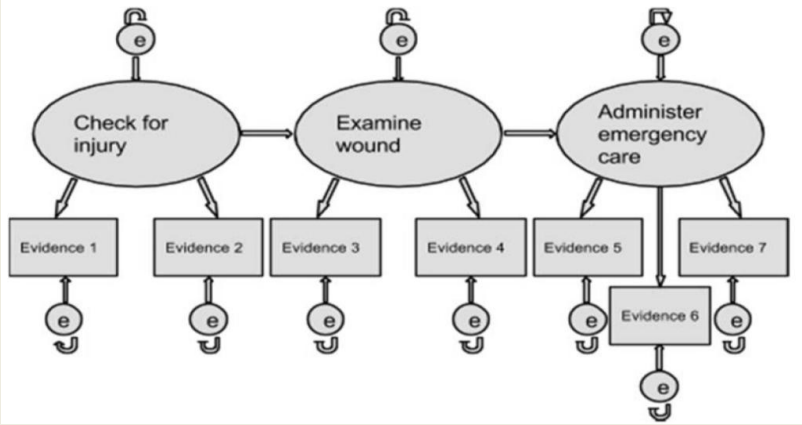
Products:

- Prototype GIFT architectural components to support team tutoring
- GIFT-compatible team tutoring tasks and testbeds for future research
- Research reports, conference papers, and journal articles

Payoff:

- Capabilities to support unit-level adaptive instruction and reduced time to competency
- Methods for team tutoring in existing PEO STRI training systems

Structural Equation Modeling Methods for Performance and Competency



Purpose: Apply Structural Equation Modeling (SEM) techniques within GIFT to model learner performance and competency, and to examine learner data within/across courses to identify effective instructional methods for continuous improvement

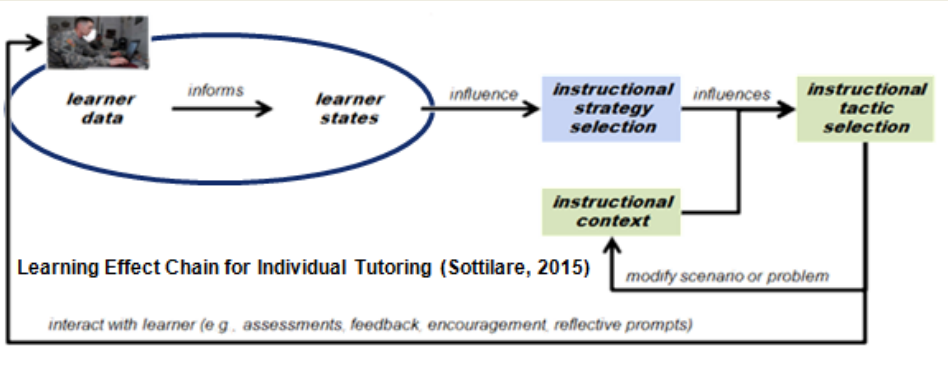
Products:

- A GIFT-compatible Structural Equation Modeling Tool
- Ability to compare learner performance with expert models

Payoff:

- New training effectiveness tool to evaluate impact of adaptive instruction
- Application of SEM to PEO STRI training systems to identify strengths and limitations for continuous improvement

Evaluating a Standard Sensor Suite to Classify Individual Learner States



Purpose: Discover and validate a low cost, passive sensing suite to detect individual behaviors and assess learner states (e.g. engagement, workload, affect) to support adaptive instructional decisions in desktop simulations (e.g., serious games) and simulator modules

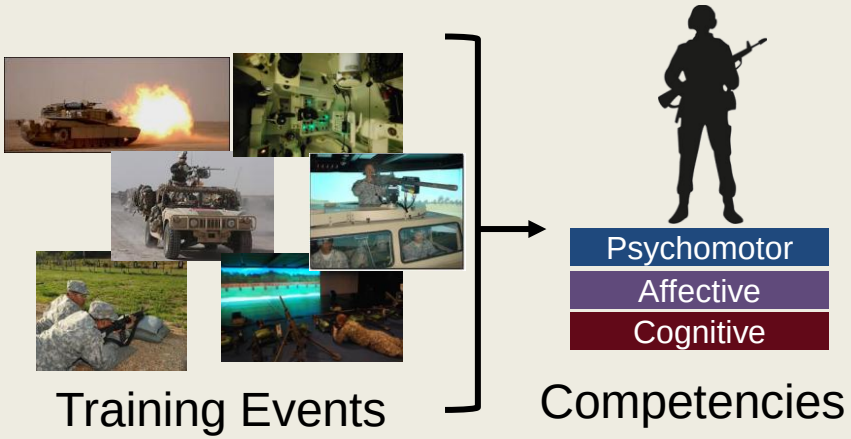
Products:

- Candidate sensor suite (hardware and algorithms) for PEO STRI GFT and manned-modules to support adaptive instruction
- Conference papers and/or journal articles

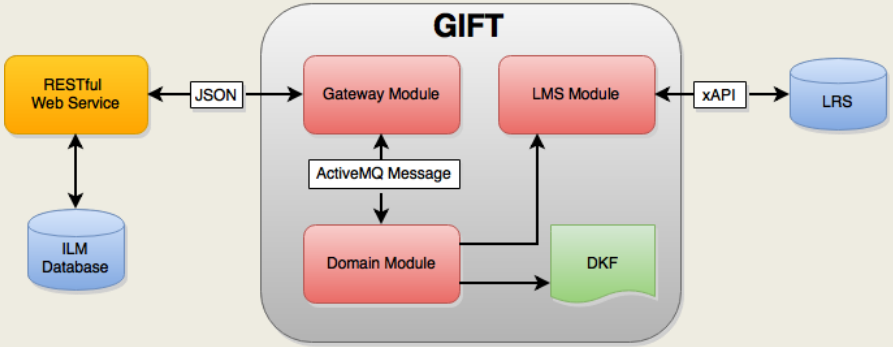
Payoff:

- Ability to classify individual states of team members and understand team states
- Ability to support adaptive instruction of small teams (e.g. squads) and focus instruction/feedback

Long-Term Learner Modeling



Interoperable Competency Model



Purpose: Improve the fit between learner needs and training by automatically tracking and modeling learner competencies over time.

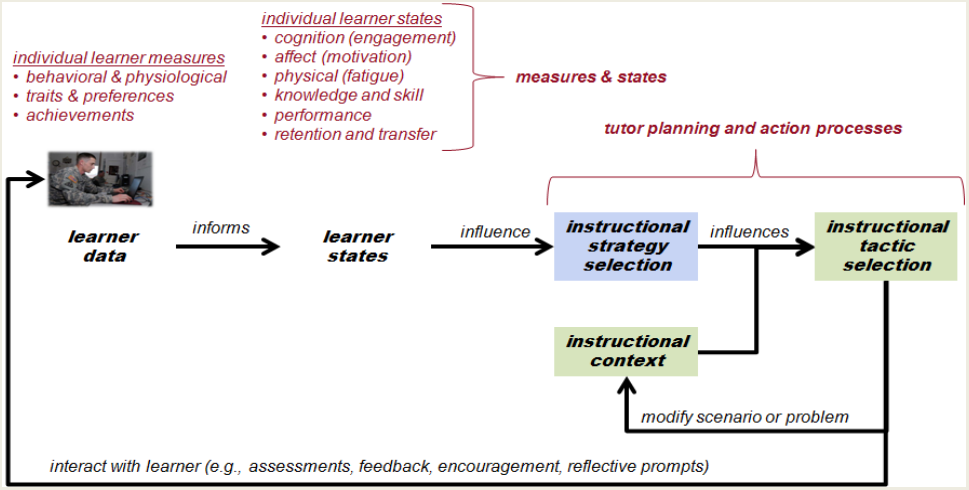
Products:

- Interoperable competency model and supporting architecture for at least one training domain.
- Demonstration and evaluation of the costs and benefits of an interoperable competency model

Payoff:

- More efficient method for developing and maintaining a long-term learner model
- Potential to adapt training to individuals across the full range training venues.

Individual Differences and Long Term Learner Modeling



Openness
Conscientiousness
Extraversion
Agreeableness
Neuroticism

Purpose: Research and develop methods to adapt instruction to individual learners based on individual differences including prior experiences and personality

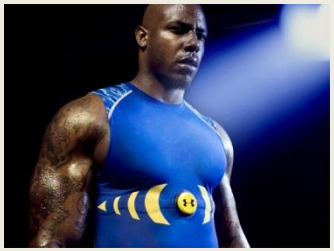
Products:

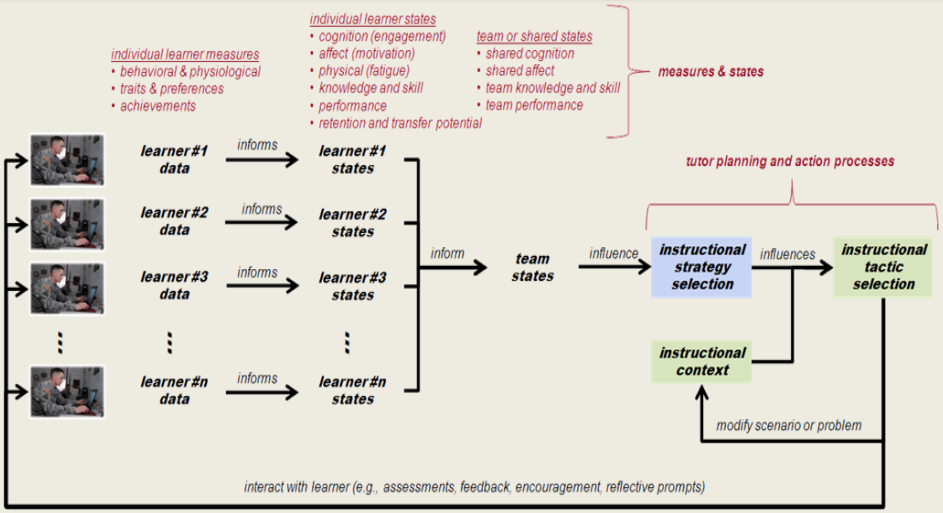
- Algorithms to adjust for the characteristics of specific individuals
- Long-Term Learner Model prototype which accounts for enduring characteristics and traits of an individual (personality)
- Learner model which accounts for the prior experiences and background of the individual learner

Payoff:

- Long term learner model in GIFT that adapts instruction based on individual differences

Low cost, Unobtrusive Sensor Suites for Team State Classification





Purpose: Develop low cost, passive sensing technologies of team member behaviors and internal states as they relate to team states (e.g., learning, performance, viability, and satisfaction)

Products:

- Sensor suites (hardware and algorithms)
- Conference papers and/or journal articles

Payoff:

- Ability to classify individual states of team members and understand team states
- Ability to support adaptive instruction of small teams (e.g. squads) and focus instruction/feedback

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Instructional Management for Adaptive Training and Education in Support of the US Army Learning Model—Research Outline

by Benjamin Goldberg, Anne Sinatra, Robert Sottilare, Jason Moss, and Arthur Graesser

Instructional Management Research Question

What instructional theories or policies provide the most optimal learning experience?

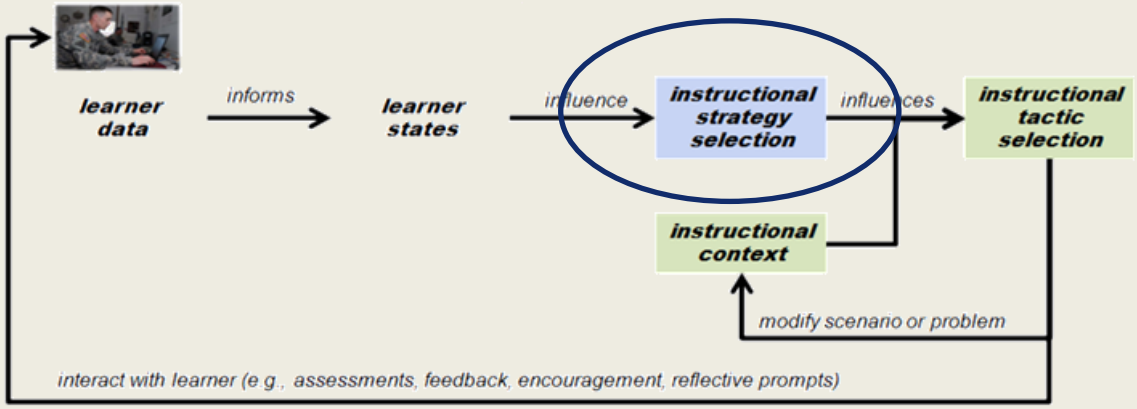
- **domain independent strategies**
- **deep learning**
- **long term trends**
- **recognition of teachable moments**

SOTTILARE AND GOLDBERG

Designing Adaptive Computer-Based Tutoring Systems to Accelerate Learning and Facilitate Retention

Robert Sottilare
Benjamin Goldberg
United States Army Research Laboratory-Human Research and Engineering Directorate

Instructional Management Advisory Board



Purpose: Capture current instructional best practices through an advisory board composed of academic, government, and industry experts to understand the influence of instructional techniques on critical instructional outcomes: learning, performance, competence, retention, and transfer

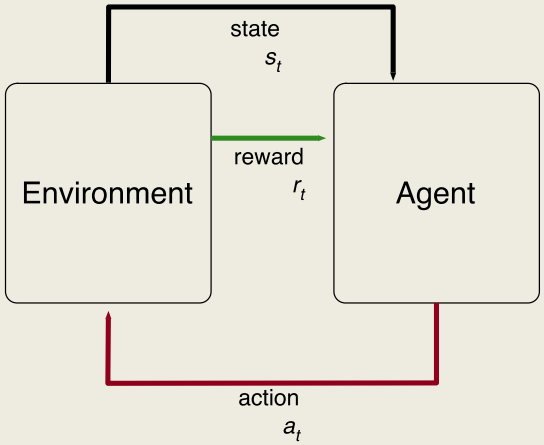
Products:

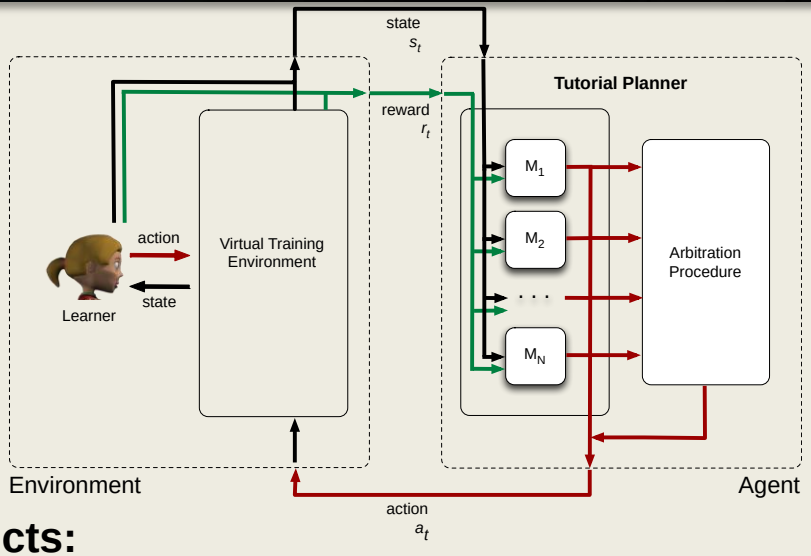
- Book – Instructional Management best practices captured in Design Recommendations for ITSs – Volume 2
- Knowledge Representation – instructional techniques as antecedents to critical instructional outcomes
- Research Gaps for adaptive instructional management

Payoff:

- More focused instructional management research and resulting tools/methods
- Efficient and effective instructional techniques

Tutorial Planning in GIFT using a Modular Reinforcement Learning Framework





Purpose: Develop, integrate, and iteratively refine data-driven tutorial planning models in GIFT using Markov Decision Processes and reinforcement learning methods

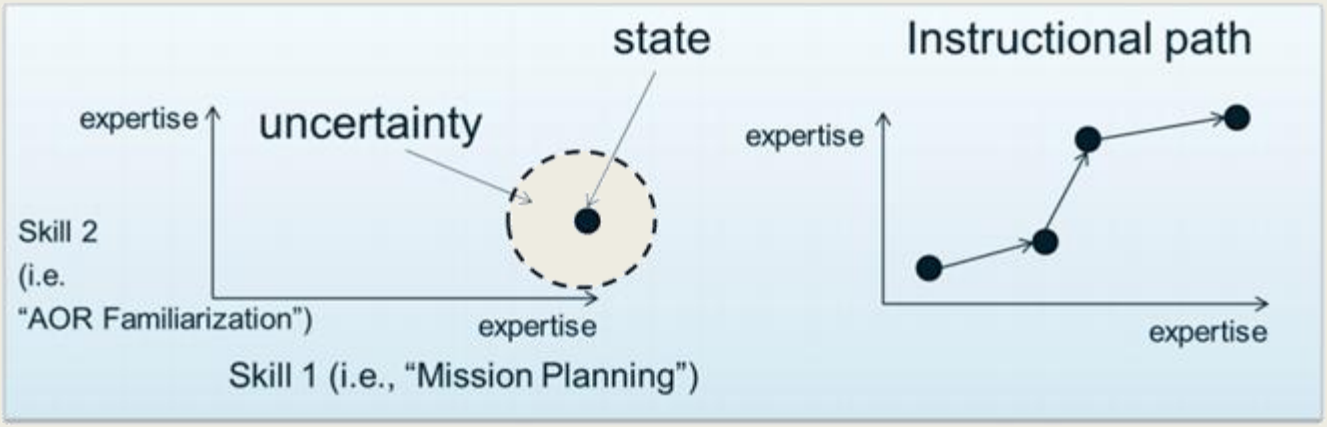
Products:

- Tutorial planning testbed with established scaffolds for UrbanSim
- Experiments to assess scaffolding impacts and collect data for building simulated students
- Established tutorial policies based on simulated students
- Applied reinforcement learning methods in GIFT
- Conference papers and journal articles

Payoff:

- Data-driven probabilistic approach to tutorial planning that optimizes over time as data is produced
- Generalized implementation approach

Developing an Adaptive After-Action Review (AAR) Framework



Purpose: Research and develop technologies to automatically identify critical errors and misconceptions by the learner(s) and automatically select an optimal instructional path and associated instructional content to construct an AAR

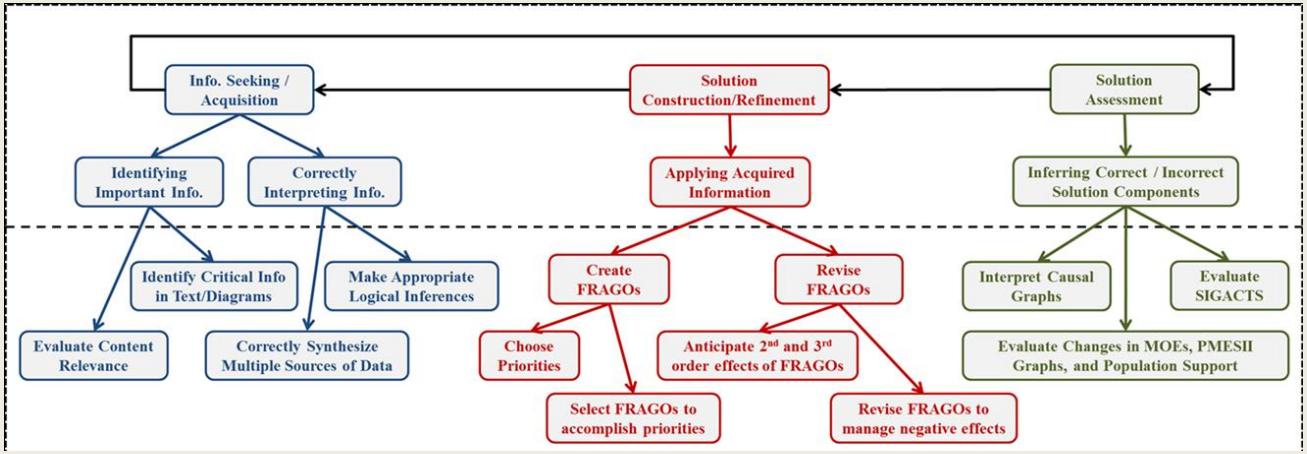
Products:

- Instructional Path Selection
- Adaptive AAR Capability

Payoff:

- Enhanced learning, accelerated time to competency and lower time/skill required to construct AARs

Metacognition and Self-Regulated Learning in GIFT



Purpose: Develop metacognitive tutoring capability in GIFT to enhance 'self-development' of skills applicable across domains and KSAs by enhancing learner modeling techniques and instructional support methods

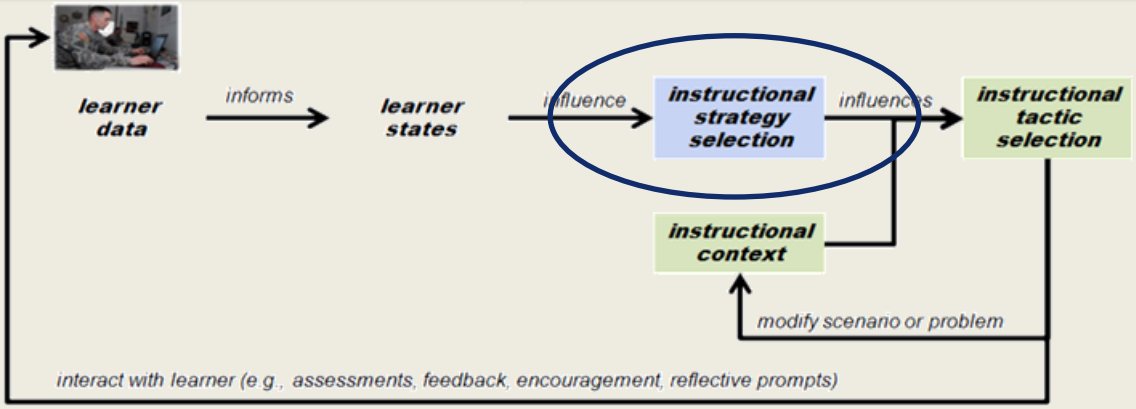
Products:

- Framework and developmental workflow to establish metacognitive modeling methods
- Conversational assessment capabilities
- Prototype testbed applied within UrbanSim
- Persistent learner modeling implementation
- Reinforcement learning methods in GIFT
- Conference papers (AIED, HCII, GIFTSym) & journal articles (TBD)

Payoff:

- Capability to assess metacognitive strategies and train self-regulated behaviors
- Generalized implementation approach

Engine for Management of Adaptive Pedagogy (EMAP) Validation



Component Display Theory Model

Content Mode	The Primary Presentation Forms	
	Expository	Inquisitory
Generality	*Rule*	*Recall*
Instances	*Example*	*Practice*

Presentation Mode

Purpose: To validate EMAP; and to investigate what strategy to implement.

EMAP guides learner through set of interactions associated with Component Display Theory (CDT).

Products:

- First empirical validation study of EMAP.
- Empirical-based principles on what strategy to implement when to present content/feedback, and what modality to present content/feedback in
- Conference proceedings papers and/or journal articles
- Research Gaps for adaptive learning strategy.

Payoff:

- Understand effect on accelerated learning (reduced time to competency)
- Validated framework to support continuing experimentation within learning sciences community.

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Context Personalization Methods

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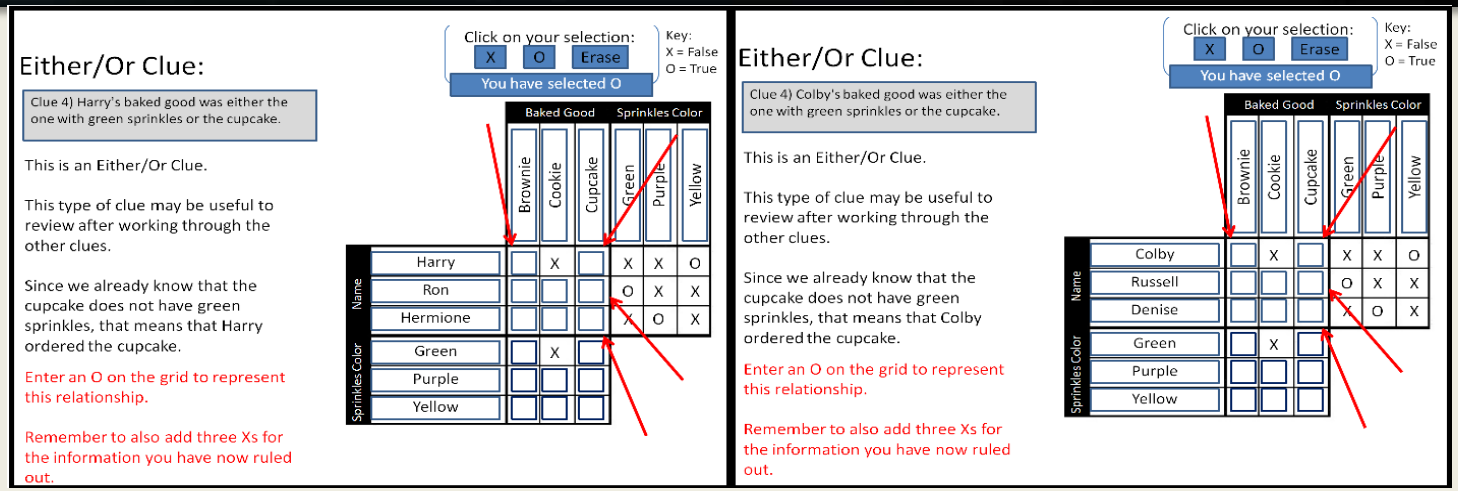


Purpose: Examine the impact of context personalization and self-reference on critical instructional outcomes: learning, performance, competence, retention, and transfer. Conduct experiments regarding cognitive psychology principles and their benefit as pedagogical strategies.

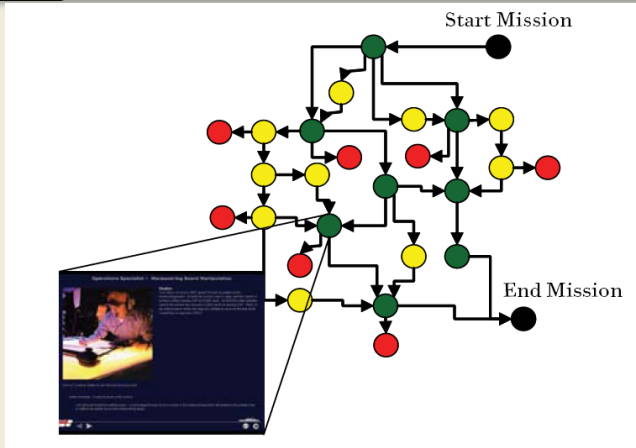
Products:

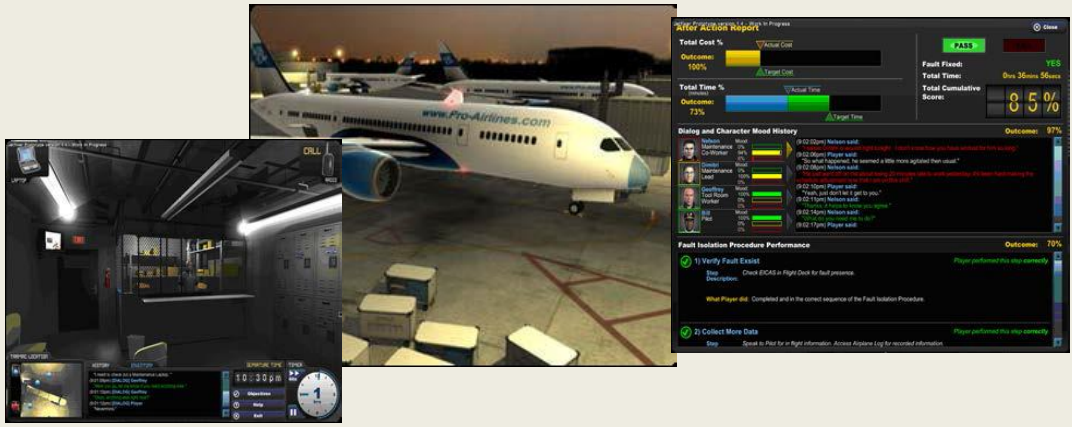
- Experiments to provide empirical evidence of learning effect
- Technical reports, journal articles)
- GIFT modifications to support personalization including eMAP strategies for personalization

Payoff:

- Ability for GIFT to adapt to individual's interests or to include information in materials to enhance their performance and learning

CRADA with Boeing





Purpose: Evaluate the integrated capabilities of Boeing's Intelligent Tutoring System (ITS) product with GIFT in support of ARL's Open Campus Initiative to enhance adaptive instructional capabilities for both participating organizations

Products:

- Enhanced adaptive instructional sequencing capabilities
- Testbed to support joint experimentation
- Conference and Journal Papers

Payoff:

- Establishing collaborative partnership with an industry leader of ITS S&T developmental efforts
- Integration of GIFT in Boeing training products to better support sustainment and future development

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Authoring Tools and Methods for Adaptive Training and Education in Support of the US Army Learning Model—Research Outline

by Scott Ososky, Robert Sottilare, Keith Brawner, Rodney Long, and Arthur Graesser

Authoring Research Question

What are the most effective methods for authoring adaptive instruction in a variety of military domains?

- **candidates for standardization**
- **automated authoring tools & methods**
- **job aids for authoring (ala TurboTax)**
- **usable interfaces for authoring tools**
- **lower cost, time, skills need to author adaptive training systems**

Authoring Tools Advisory Board

Purpose: Capture current authoring best practices through an advisory board composed of academic, government, and industry experts to identify opportunities to reduce the time and skill required to develop adaptive instruction

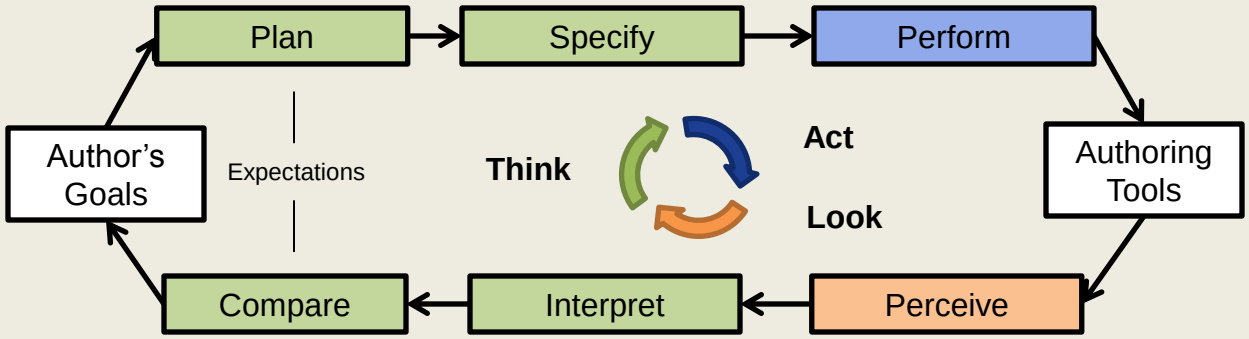
Products:

- Book – Authoring Tools best practices captured in Design Recommendations for ITSs – Volume 3
- Knowledge Representation – techniques to reduce time and skill to author AIS
- Research Gaps for authoring AIS

Payoff:

- More focused authoring research and resulting tools/methods
- Efficient and effective authoring and expert modeling techniques

Evaluating UX in GIFT Authoring Tools



Purpose: Refine the user experience of GIFT's current authoring workflow and interfaces by leveraging user-centered design processes. Understanding authors' goals and intentions will support authoring in GIFT through improved UI usability, new features / tools, and more naturalistic interactions between authors and GIFT.

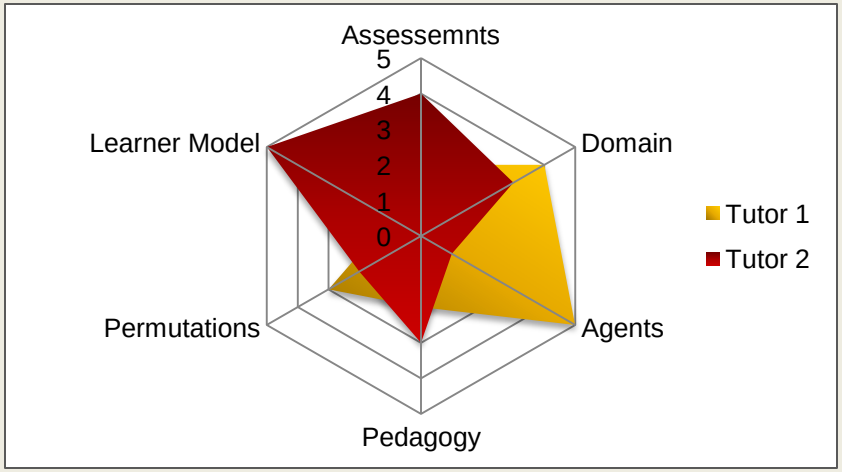
Products:

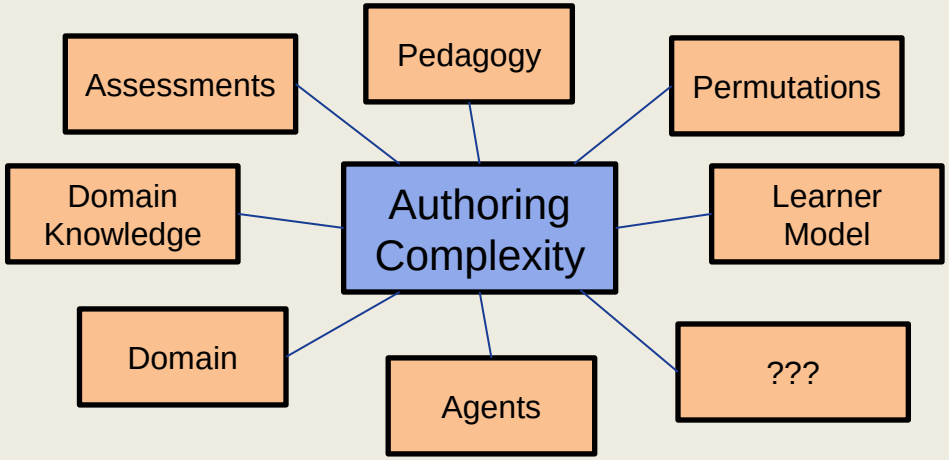
- Knowledge representations and goals of different types of *authors* (researchers, instructors, subject matter experts, etc.)
- Improved interfaces and development tools for GIFT authoring
- Standardized authoring processes

Payoff:

- Reduce the learning curve required to author adaptive tutors
- Reduce the resources (time, effort) required to author adaptive tutors

Modeling Authoring Complexity in GIFT





Purpose: Identify the features and system components that contribute to the complexity of adaptive tutors, and then quantify the impact of those factors (in-part and in-combination) on the overall complexity associated with creating (i.e., authoring) different types of adaptive tutors.

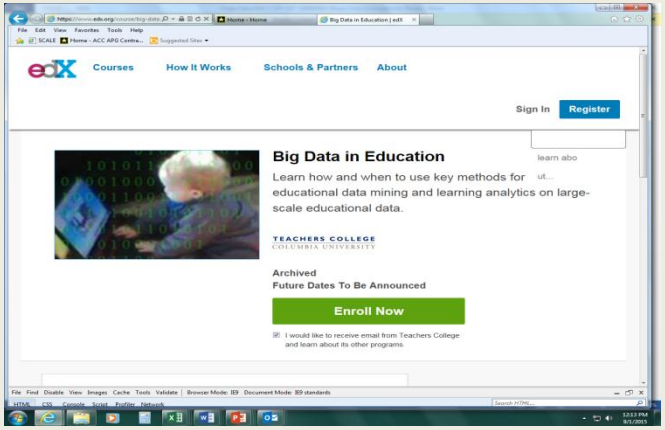
Products:

- Operationalized model of adaptive tutor authoring complexity
- Formalized logic to predict time required to author specific types of adaptive tutors
- Empirically validated method for categorizing tutors based on complexity

Payoff:

- Ability to compare authoring requirements across functionally distinct types of tutors
- Enhanced tracking of GIFT Authoring Tools development with data-driven metrics

MOOCs as Adaptive Training Experiences



Purpose: Investigate the use of integrated adaptive instructional techniques in GIFT to deliver adaptive Massive Open On-Line Courses (MOOCs).

Products:

- Software for CTAT-GIFT integration
- Big Data in Education via adaptive MOOCs
- Final Report describing the case study and providing guidelines for adaptive MOOCs

Payoff:

- Efficient and effective learning through the use of adaptive MOOCs
- Methods to support application of GIFT adaptive instruction

Social Media Support for Adaptive Training Development

Purpose: Explore the use of social media to support the development of adaptive learning environments.

- Support ISD/SME collaboration in course creation
- Capture granular learner feedback
- Facilitate the discussion, decision and updates to the course

Products:

- GIFT-compatible Social Media Framework software
- Conference papers: ITSEC 2014, AIED 2015
- Final Report

Payoff:

- Improved learning environment, through collaboration between ISD, SME, and learners

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Playbook

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Purpose: Capitalize on combat experience by providing a mobile application that can effectively support small unit members in *capturing and sharing Observations, Insights and Lessons (OILs) from tactical events (plays).*

Products:

- User Needs Analysis Report
- Templates for various user communities
- Software for mobile app
- Final Report and conference papers

Payoff:

- Plays are more relevant than current staff-level reports.
- Decreased time from event experienced to event shared
- More “generationally appropriate” than Army Center for Army Lessons Learned (CALL) products, i.e. PowerPoint format

Rapid Authoring of Reusable Learning Objects

Purpose: Provide a rapid authoring platform (mobile app) that will guide SMEs in the development of quality learning content in the form of Reusable Learning Objects (RLOs). Leverages crowd-sourcing as a cost-efficient method to populate the GIFT LCMS/content repository.

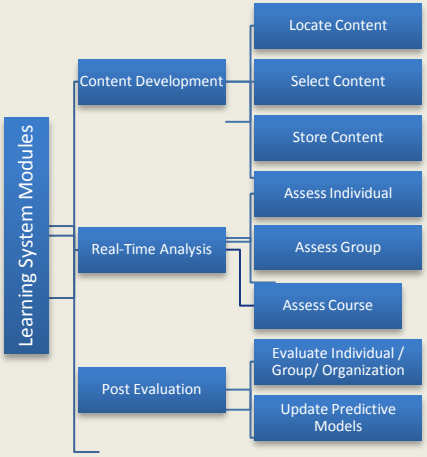
Products:

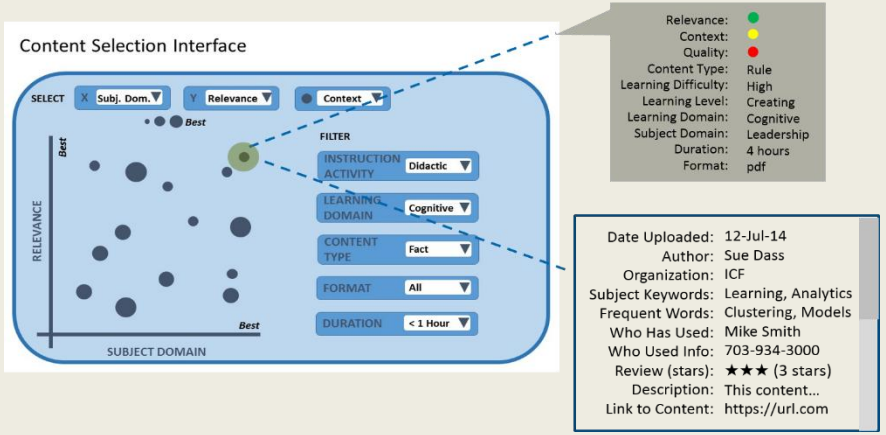
- User Needs Analysis Report
- Prototype mobile app
- Final Report

Payoff:

- Leverages experience and expertise of our Soldiers to generate quality learning content
- Leverages crowd-sourcing to reduce cost of adaptive learning environments

Data Analytics For Adaptive Learning Environments





Purpose: Investigate the application of data analytics models to impact the way adaptive learning environments are designed, executed, and evaluated. Conduct assessments for three use case areas: content location, real time assessment, and post evaluation tailored to GIFT.

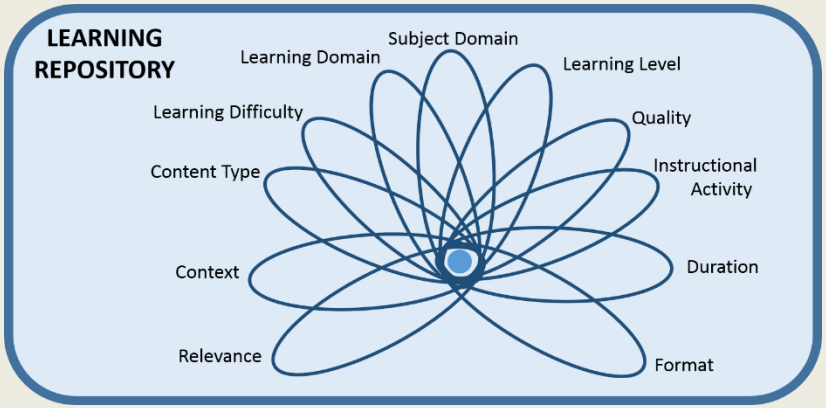
Products:

- Literature Review on the use of data analytic methods to support learning
- Data analytics models to support adaptive learning environments.
- Prototype implementation of GIFT Instructor and Student Dashboards using data analytics models.

Payoff:

- More efficient training
- Improved learning

Data Analytics to Support Reinforcement Learning



Purpose: Investigate the application of data analytics models to support reinforcement learning in GIFT. Use agents to collect user data over time. Apply data analytics to provide optimum path for learning based on user profile.

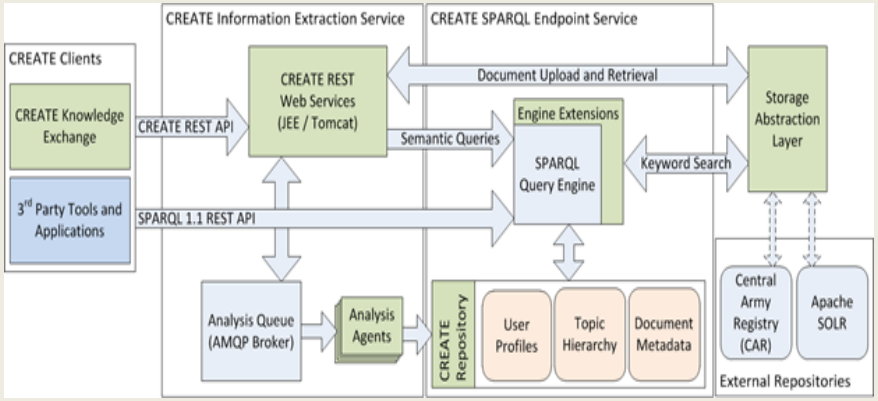
Products:

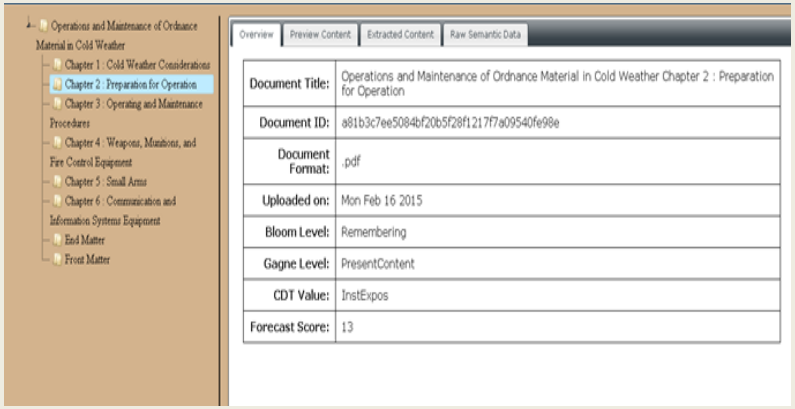
- Final Report
- Prototype software

Payoff:

- More effective and efficient learning

Content Retrieval and Extraction for Advanced Tutoring Environments (CREATE)





Purpose: Provide capability to analyze documents, e.g. field manuals, and segment them into reusable learning objects. Automatically generate metadata based on Bloom's taxonomy, Merrill's Component Display Theory, FORCAST readability model, etc.

Products:

- Final Report
- CREATE software
- Conference papers: GiftSym3, International Semantic Web Conference

Payoff:

- Improved/automated metadata provides more accurate searches
- Costs savings through the use of reusable learning content

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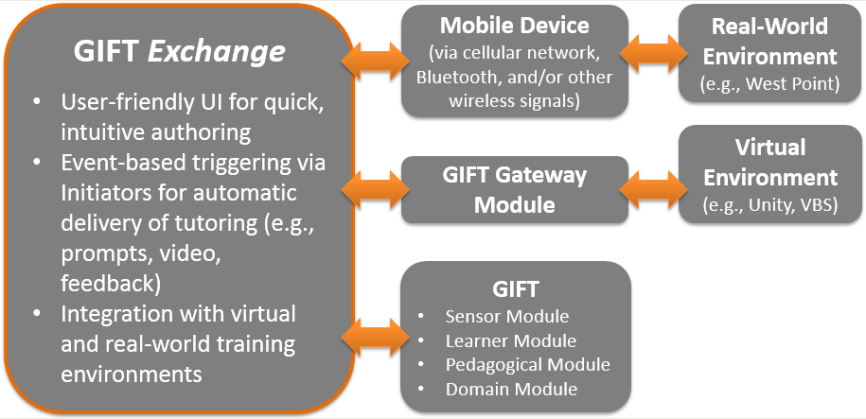
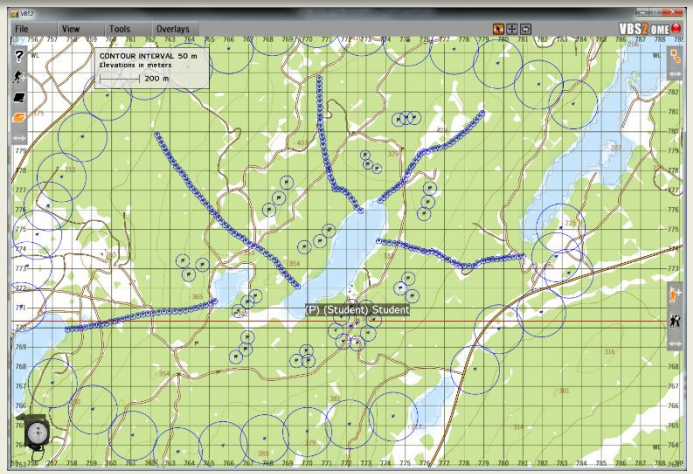
GIFT Exchange

ARL





Purpose: Develop an intuitive, user-friendly module in GIFT that facilitates rapid authoring of assessment conditions and instructional interventions across simulation-based (LVC) training environments

Products:

- Prototype testbed utilizing GIFT standards for establishing real-time assessment conditions as feedback intervention triggers in VBS3
- Preliminary usability testing on authoring workflows
- Conference papers

Payoff:

- Reduction in time/skill required to build assessment conditions in simulation environments
- User-centered approach to linking GIFT modeling standards with mission/scenario editors in simulators
- Interoperability with PEO STRI LVC applications

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GIFT-Learnsphere Interoperability

ARL

LearnSphere

	A	B	C	D	E	F	G	H	I	J	K
1	Data Point	Data Point	Data Point	Data Point	Data Point	Data Point	Data Point	Data Point	Data Point	Data Point	Data Point
2	5	23	35	646	34	324	56	65	12	34	53
3	2	56	5	45	54	23	57	23	46	86	23
4	3	34	35	45	34	23	65	11	33	54	34
5	3	54	35	646	34	324	56	65	12	34	53
6	6	34	5	45	54	23					
7	3	23	35	45	34	23					

PSLC DataShop
a data analysis service for the learning science community

Purpose: Provide the ability to format GIFT's data output in the Learnsphere/Datashop format. DataShop and Learnsphere are data repositories and web applications for learning science researchers. This will allow for data generated by GIFT to be shared with the research community and increase GIFT's interoperability.

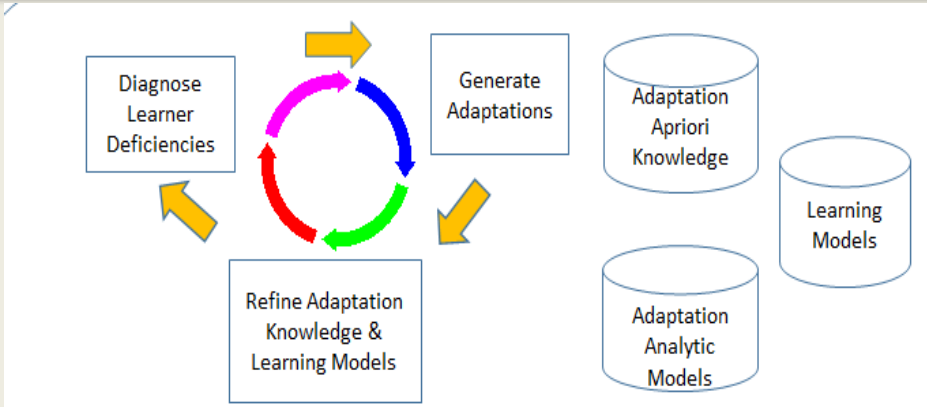
Products:

- Ability to output GIFT data in Learnsphere/Datashop format
- Ability for GIFT users to share data with the Learnsphere and Datashop communities

Payoff:

- More widespread acceptance of GIFT in the intelligent tutoring systems community
- GIFT interoperability with existing tools that enhance it's output and features
- Ability to analyze GIFT generated data using tools from Learnsphere and Datashop

Research in Adaptive Scenario Generation



Purpose: Scenarios developed in current training simulation systems are hand-crafted, static representations of training and mission contexts. This effort will research and develop the ability to dynamically generate scenarios based on rapidly changing learner needs.

Products:

- Final Report
- Prototype software

Payoff:

- Efficient and effective simulation training, tailored to the learner

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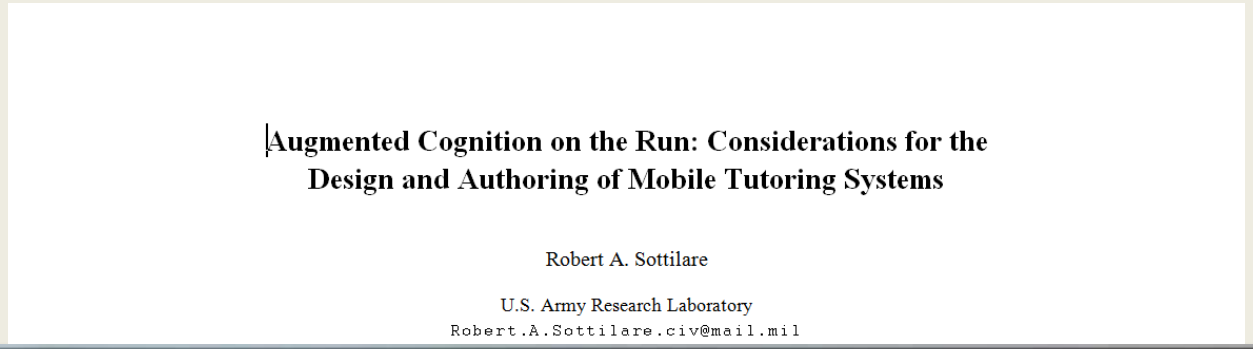
Domain Modeling for Adaptive Training and Education in Support of the US Army Learning Model—Research Outline

by Robert Sottilare, Anne Sinatra, Michael Boyce, and Arthur Graesser

Domain Modeling Research Question

What adaptive training methods provide the best value (effectiveness and affordability) for the comprehensive modeling of Army Training and Education Domains?

- **tutoring beyond the classroom and desktop**
- **militarily-relevant domains**
- **promote optimal learning, retention and transfer of skills to operational environments**



Augmented Cognition on the Run: Considerations for the Design and Authoring of Mobile Tutoring Systems

Robert A. Sottilare

U.S. Army Research Laboratory
Robert.A.Sottilare.civ@mail.mil

Domain Modeling Advisory Board

Purpose: Capture current domain modeling best practices through an advisory board composed of academic, government, and industry experts to identify methods to represent relevant military instructional domains in GIFT ranging from simple to complex, well-defined to ill-defined, and from physically static to dynamic

Products:

- Book – Domain Modeling best practices captured in Design Recommendations for ITSs – Volume 4
- Knowledge Representation – techniques to represent various dimensions of domains
- Research Gaps for modeling cognitive, affective, psychomotor, and social domains

Payoff:

- More focused domain modeling research and capabilities in GIFT
- Efficient and effective domain modeling techniques for adaptive instruction

Assessment Advisory Board

Insert Picture Here

Purpose: Capture current assessment techniques and best practices through an advisory board composed of academic, government, and industry experts to identify methods to assess learning, performance, and retention during instruction in various domains.

Products:

- Book – Assessment best practices captured in Design Recommendations for ITSs – Volume 5
- Knowledge Representation – techniques to author and represent assessment of learning, performance, and retention in various domains
- Research Gaps for determining learning and performance effect of adaptive instruction

Payoff:

- Reduced cost to author adaptive instruction
- More focused assessment research and capabilities in GIFT
- Efficient and effective assessment techniques

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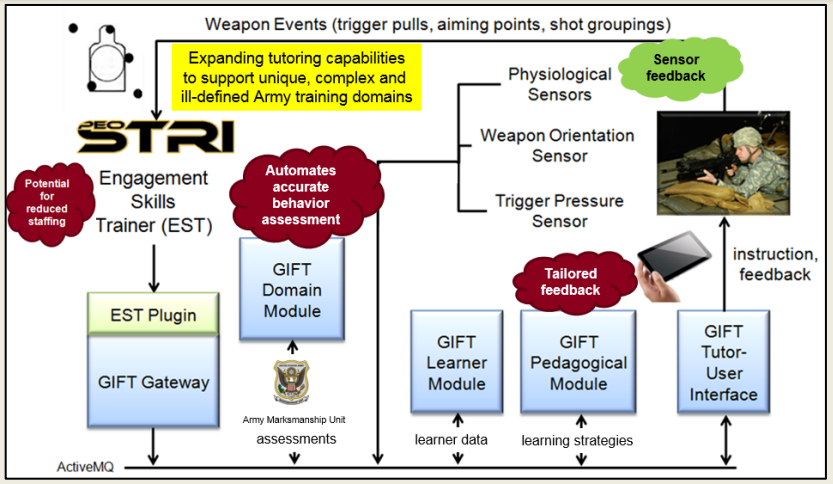
Adaptive Marksmanship

ARL



Purpose: Develop an adaptive training capability in the psychomotor domain of marksmanship using GIFT tools and methods to enhance the Program of Record to support individualized coaching based on AI modeling techniques and sound instructional strategy practices

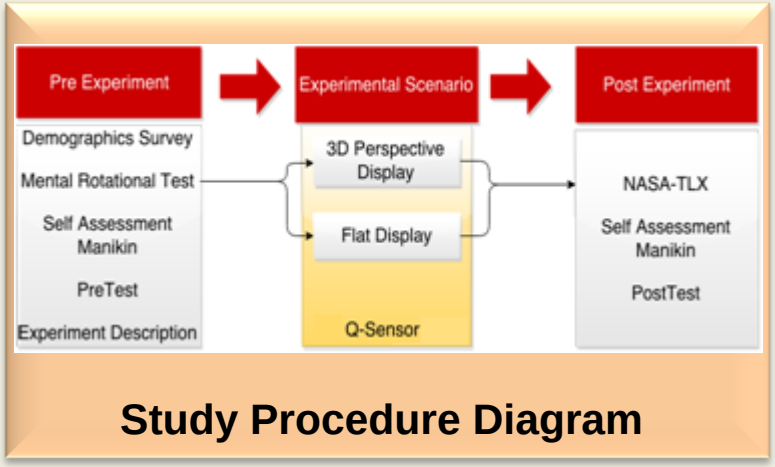
Products:

- Adaptive marksmanship testbed
- Expert model representations of ideal behavior and performance
- Model validation and training effectiveness evaluation assessing the efficacy of these approaches for training psychomotor tasks
- Conference papers and journal articles

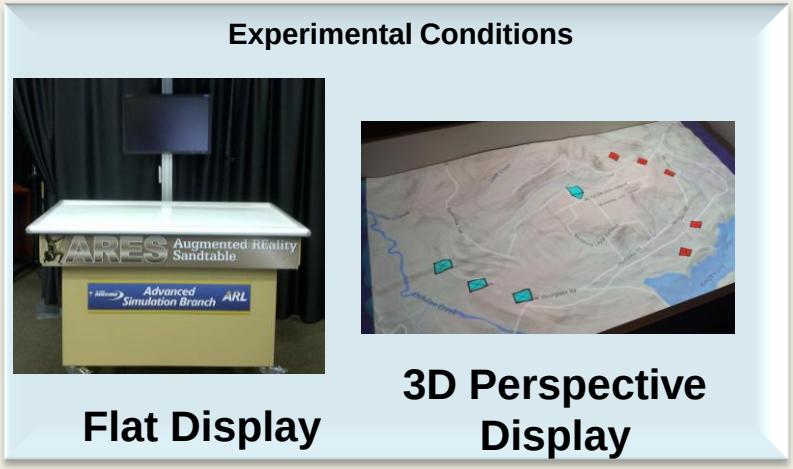
Payoff:

- Potential accelerated skill acquisition of BRM fundamentals in grouping exercises
- ROI metrics highlighting training benefit

The Effect of Topography on Learning Military Tactics



Study Procedure Diagram



Flat Display

3D Perspective Display

Purpose: Examine the learning effect of GIFT as an instructional platform for teaching military tactics in ARES.

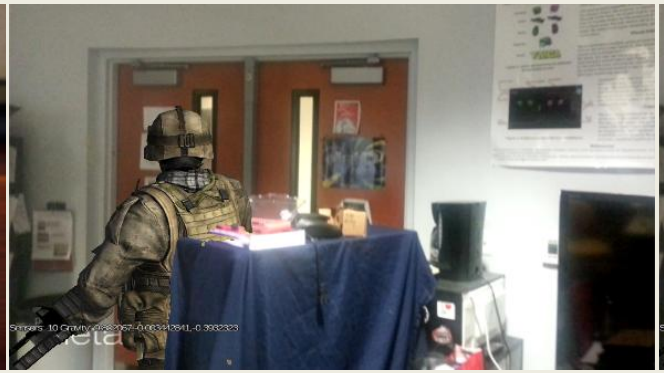
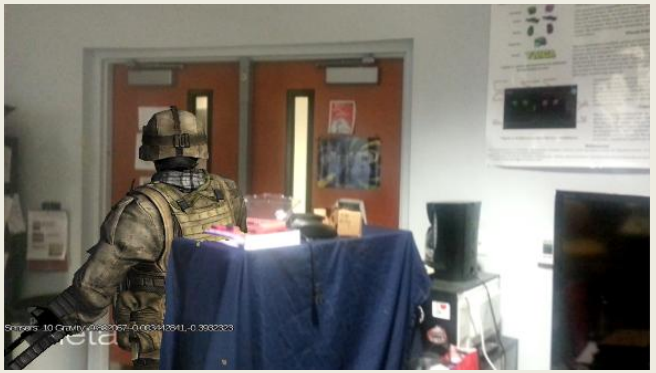
Products:

- I/ITSEC 2015 Paper – Work Domain Analysis for Tangible User Interfaces
- Pilot Study (October 2015) – 20 participants at UCF ROTC
- Development of interoperability between ARES and GIFT

Payoff:

- Impact of ARES and GIFT on learning
- Methods to integrate GIFT with other psychomotor domains
- Integration of tech into a military curriculum

Augmented Reality (AR) Wild

Purpose: Examine usability and human interaction aspects of tutoring psychomotor tasks with augmented models and effects in a live environment

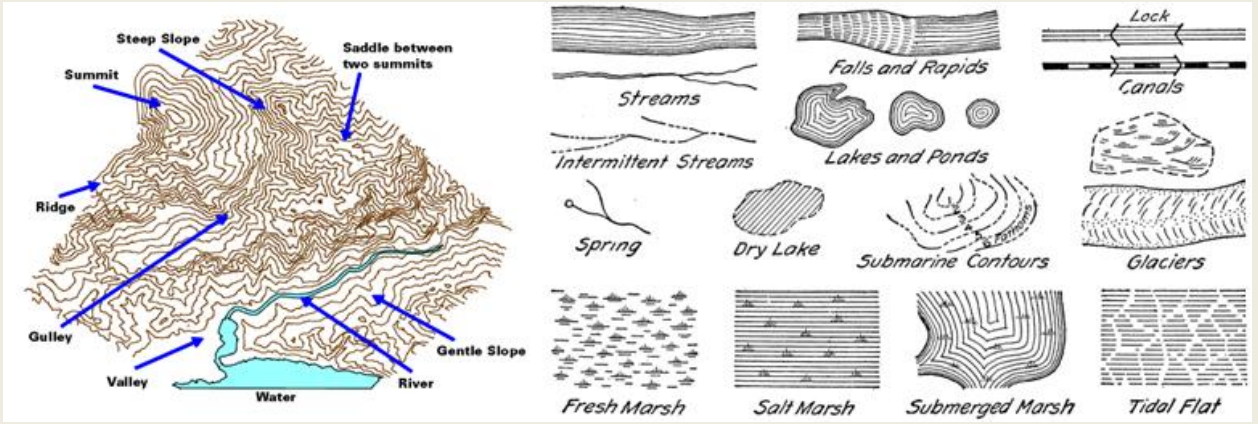
Products:

- Heuristic Evaluation Methods for Tutoring in the Augmented Reality environments
- GIFT interface specification for augmented reality tutoring in the wild
- IITSEC paper – “Using Augmented Reality to Tutor Military Tasks in the Wild”
- Additional conference papers and Final Report

Payoff:

- Opportunity to enhance GIFT to support training tasks in the psychomotor domain
- Enhanced transfer due to the similarity of training and operational execution of psychomotor tasks – train as you fight

Examining Adaptive Instruction for a Land Navigation Task in the Wild



Purpose: Examine usability and human interaction aspects of tutoring a specific psychomotor task, land navigation, in the wild, areas where there are no dedicated infrastructure/instrumentation dedicated to support adaptive training

Products:

- Initial heuristic evaluation methods for tutoring in the wild
- Initial assessment techniques for psychomotor tasks
- IITSEC paper – “Extending Intelligent Tutoring Beyond the Desktop to the Psychomotor Domain”

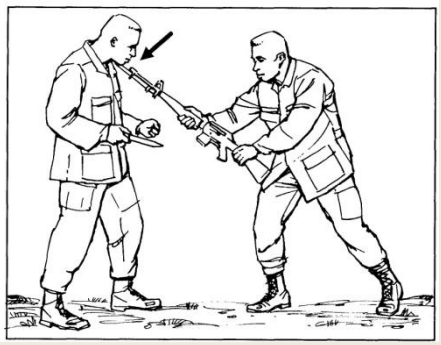
Payoff:

- Opportunity to enhance GIFT to support training tasks in the psychomotor domain
- Enhanced transfer due to the similarity of training and operational execution of psychomotor tasks – train as you fight

Adaptive Instruction for a Variety of Psychomotor Tasks in the Wild

Medic Tasks

Hand-to-Hand Combat



- Land navigation - working
- Planning on sand table - working
- Marksmanship – working
- Hemorrhage control – new

Purpose: Examine usability and human interaction aspects of tutoring a variety of psychomotor tasks in the wild, areas where there are no dedicated infrastructure or instrumentation dedicated to support adaptive training

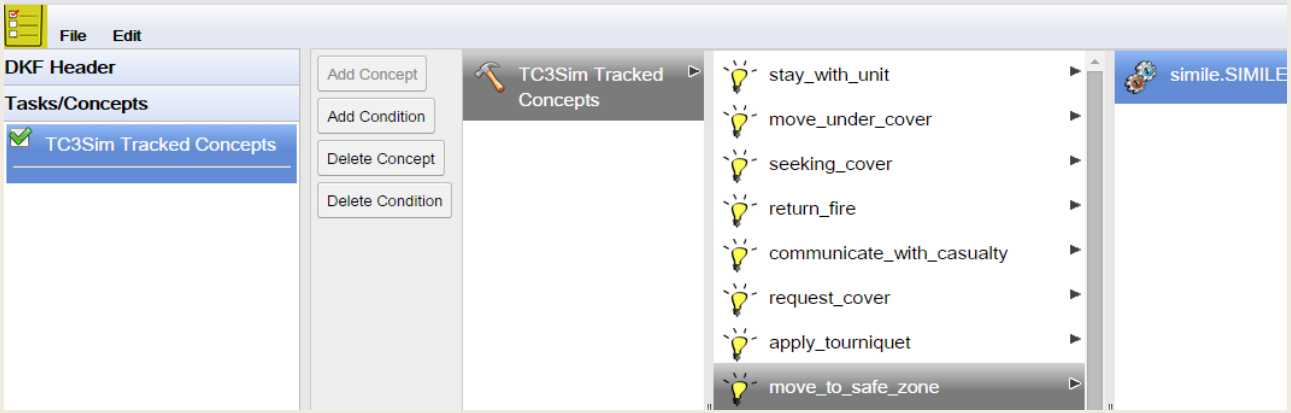
Products:

- Heuristic Evaluation Methods for Tutoring in the Wild
- Modeling of assessments for psychomotor tasks
- Journal paper (JDMS – hemorrhage control) and conference papers

Payoff:

- Opportunity to enhance GIFT to support training tasks in the psychomotor domain
- Enhanced transfer due to the similarity of training and operational execution of psychomotor tasks – train as you fight

Domain-General Context Determinants for Informing Assessment Outcomes



Purpose: Augment assessment practices in GIFT to extend the schematic ontological representation to account for error types, providing more granular information to inform strategy selection and to support constraint-based modeling techniques

Products:

- A prototype domain model schema with varying detectable assessment patterns (e.g., context errors, errors of omission, timing violation, etc.)
- Design of mid-lesson summary reports informed through constraint-based modeling techniques
- Conference Papers

Payoff:

- Enhances GIFT's domain-agnostic schemas to provide meaningful assessment information to guide instructional strategy selection

Effectiveness Evaluation Tools and Methods for Adaptive Training and Education in Support of the US Army Learning Model—Research Outline

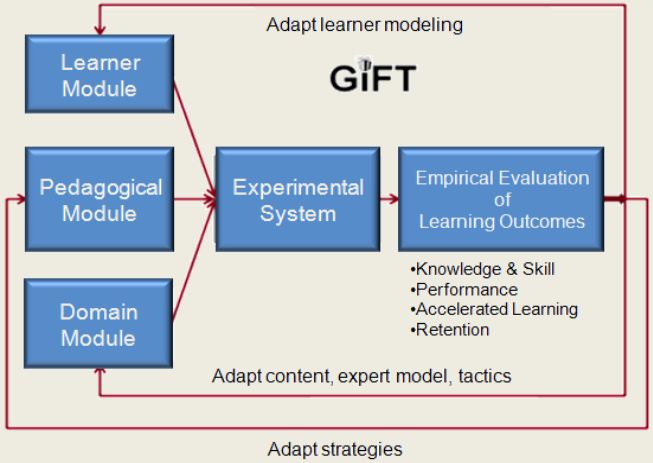
by Joan Johnston, Greg Goodwin, Jason Moss, Robert Sottilare, Scott Ososky, Deeja Cruz, and Arthur Graesser

Effect Evaluation Research Question

What are the most efficient methods for evaluating the impact of adaptive training methods?

- **automated evaluation**
- **evaluation of training/learning effect**
- **evaluation of retention and transfer**
- **valuation of meta and para-data**
- **data analytics and reinforcement learning techniques for continuous improvement of adaptive training processes**

Effectiveness Evaluation Advisory Board



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Purpose: Capture current evaluation techniques and best practices for AIS through an advisory board composed of academic, government, and industry experts to identify methods to evaluate learning, performance, retention and transfer within Army training systems and across populations

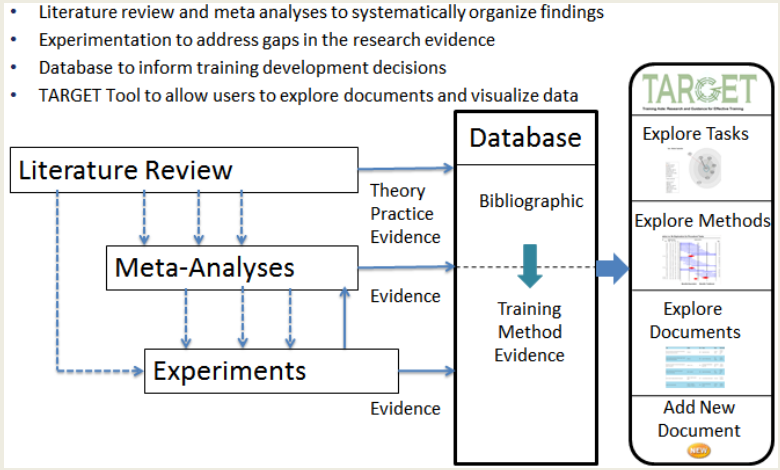
Products:

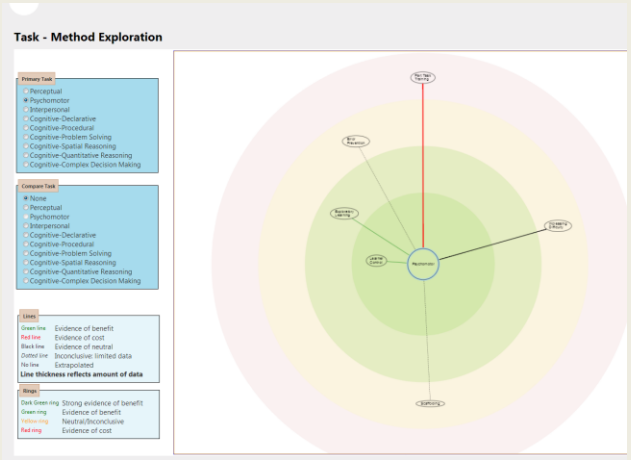
- Book – Effectiveness Evaluation best practices captured in Design Recommendations for ITSs – Volume 7
- Knowledge Representation – techniques (manual and automated) to conduct training effectiveness evaluations for adaptive systems
- Research Gaps for determining learning and performance effect of adaptive instruction

Payoff:

- Reduced time/cost to conduct TEEs
- Efficient and effective evaluation techniques

Predicting and Understanding Gaps in Training Effectiveness





Purpose: Use meta-analytic effect size data to select the best training method given training objective and learner characteristics. Develop better interfaces for training developers and adaptive training systems using the Training Aide Research Guidance for Effective Training (TARGET) tool.

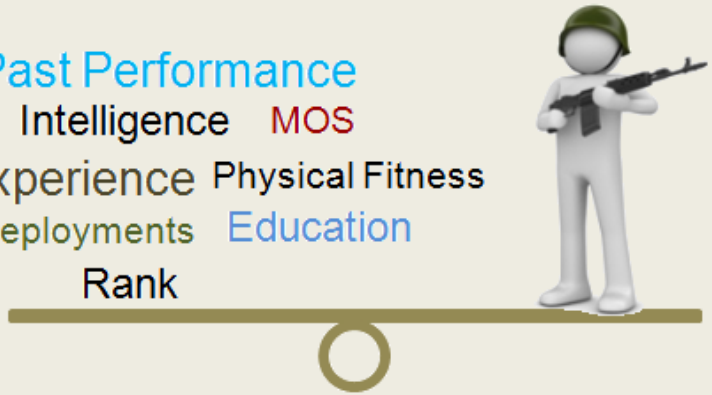
Products:

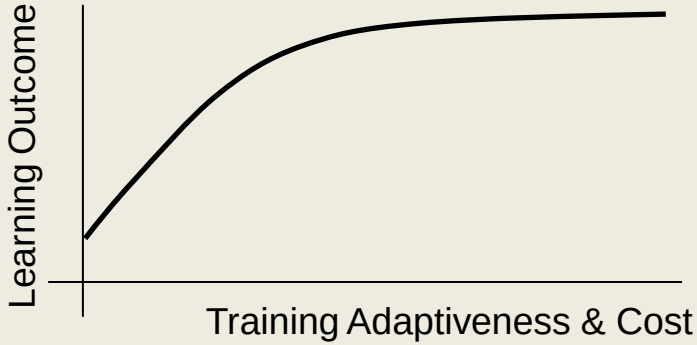
- Tools for instructors to easily select training methods given objectives and learner characteristics.
- Interface with GIFT to optimize course authoring and update of TARGET database.
- Interface with IMPRINT to improve modeling of training needs.

Payoff:

- Improve ease of access to research findings to improve training outcomes.

Models of Successful Students: Data Analytics





Purpose: Use data generated by learners in GIFT to develop predictive models of training outcomes based on student characteristics in the Army population.

Apply those models to determine the expected benefits of adaptive training for typical Army students.

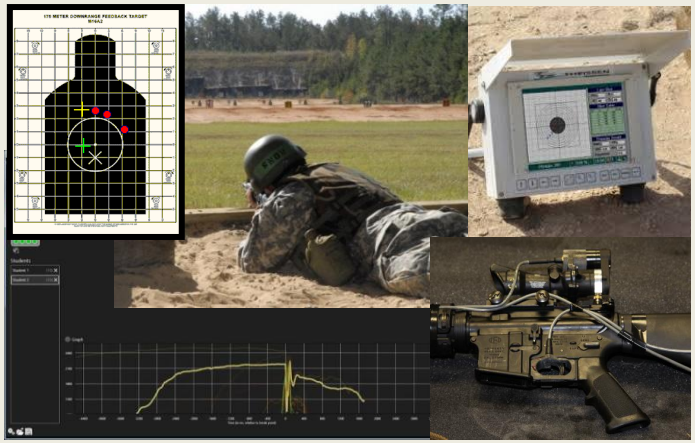
Products:

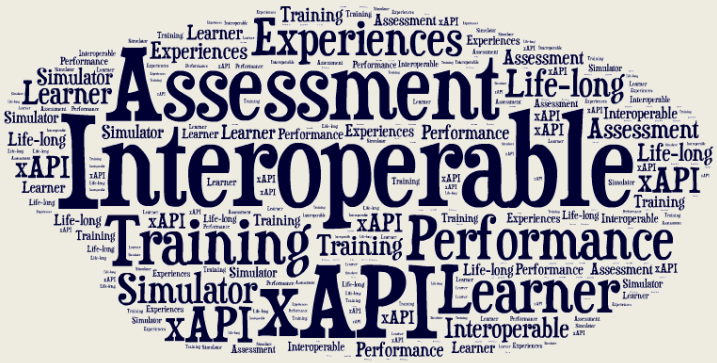
- GIFT function that automates generation of predictive models of training outcomes
- Tools that enable course authors to predict adaptive training methods that maximize training benefits

Payoff:

- Ability to determine potential benefits of training before committing resources to build the training
- Adaptive instruction that is optimally tailored to elicit successful learner characteristics

Support for Training Effectiveness with Data Interoperability (STEADI)





Purpose: Evaluate the benefits/operational impact of automated performance assessment on training effectiveness, training resource use, training management, and adaptive training systems.

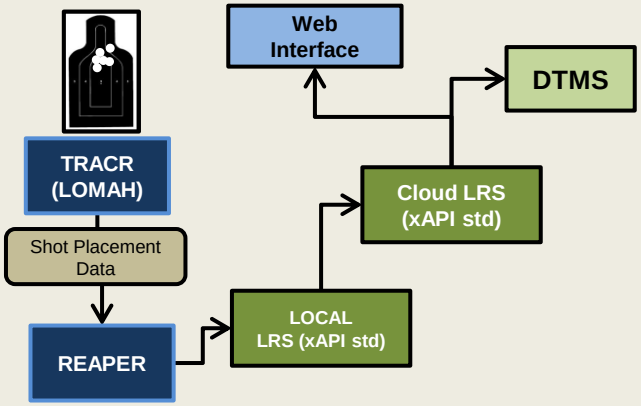
Products:

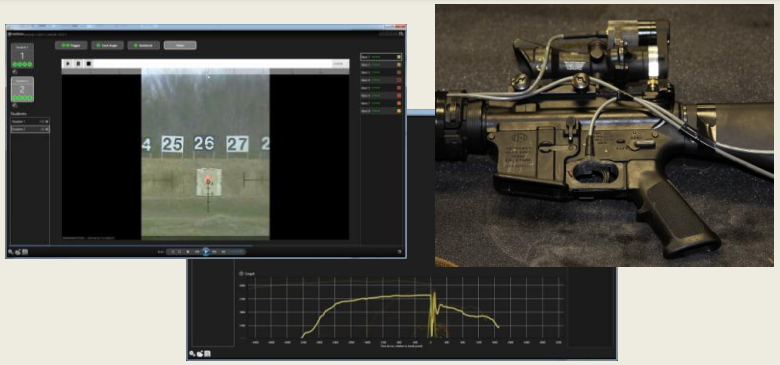
- Standards for interoperable performance assessment that across multiple training platforms.
- Tools for measuring training effectiveness, diagnosing shooter errors, predicting resource use, and tracking skill acquisition.

Payoff:

- Lower cost for conducting training effectiveness analysis.
- Provide better decision support for trainers, managers, and leaders

Range Experience Acquisition Portal for Evaluation and Reporting: REAPER II





Marine Corps MAT-MP System

Purpose: Expand the REAPER architecture to capture performance data from additional LOMAH targets, Field Fire ranges, and MAT-MP system. Provides support for the STEADI research effort.

Products:

- Architecture that provides ability to track individual learner performance across periods of instruction.
- Automated scorecard update to the Army Digital Training Management System

Payoff:

- Rich database of performance measures to support future marksmanship training research and analysis.
- As database grows over time, potential to support use of “big data” for improving marksmanship training efficiency and effectiveness.

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Architectural and Ontological Services for Adaptive Training and Education in Support of the US Army Learning Model—Research Outline

by Keith Brawner, Robert Sottilare, Benjamin Goldberg, Anne Sinatra, Michael Boyce, Greg Goodwin, and Arthur Graesser

DRAFT – Not yet released

Generalized Intelligent Framework for Tutoring (GIFT)

A free, modular, open-source tutoring architecture to:

- capture best tutoring practices and support rapid authoring, reuse and interoperability of AIS (e.g., ITSs)
- lower costs and entry skills needed to author AIS
- enhance the adaptiveness of AIS in support of the Army Learning Model

- ontology
- tools
- methods
- standards
- exemplars

Powered By GIFT
Generalized Intelligent Framework for Tutoring
www.GIFTtutoring.org

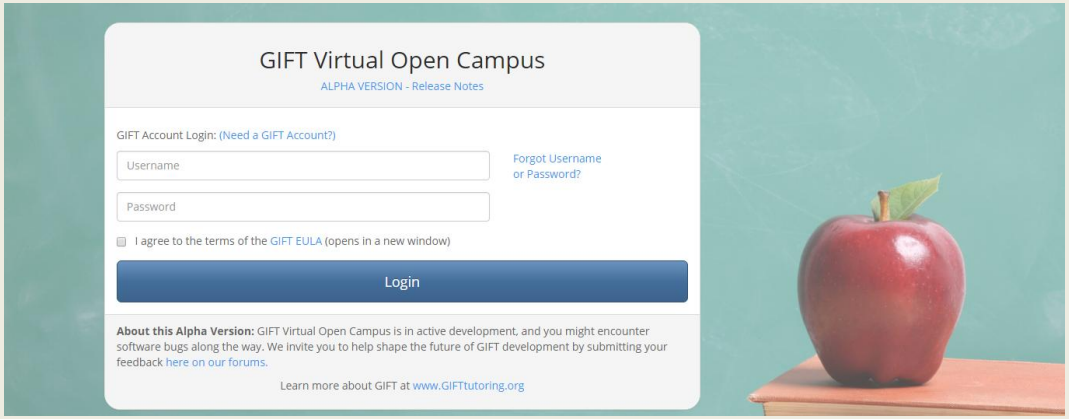
- Automated Authoring
- Automated Instruction
- Accurate Learner Modeling
- Comprehensive Domain Modeling
- Evaluation Tools

Adaptive Instructional Systems

- Focused
- Affordable
- Effective

- Gritty
- Flexible
- Collaborative
- Critical Thinkers

Cloud GIFT – A Virtual Open Campus



Purpose: Provide ready access to GIFT and its associated authoring, evaluation, and experimentation tools and service without the need to download and install software.

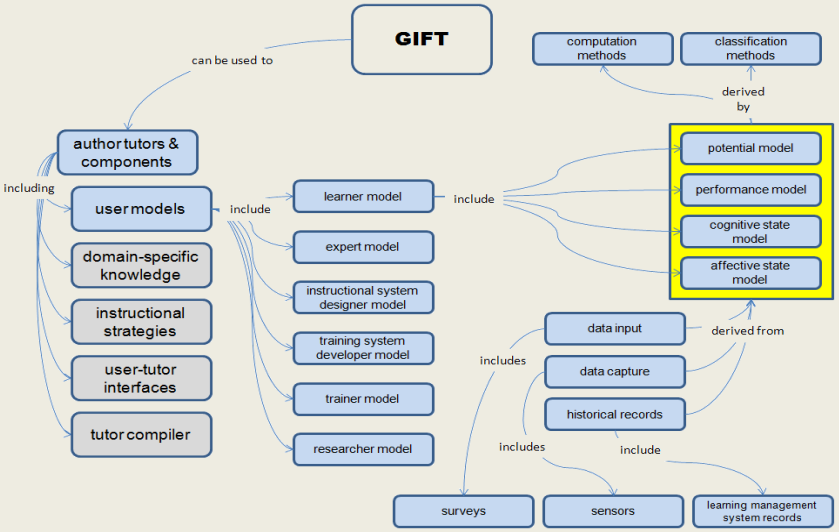
Products:

- GIFT VOC in support ARL Open Campus
- Cloud-based authoring, evaluation and experimentation tools and services

Payoff:

- Easy access for growing GIFT community
- Access to learner, author, and power-user data to identify new research gaps and capability requirements
- Access to user-generated content (e.g. social media) to support continuous improvement

GIFT Ontology



Purpose: Define an ontology for GIFT to support development of future authoring, instructional, and evaluation capabilities

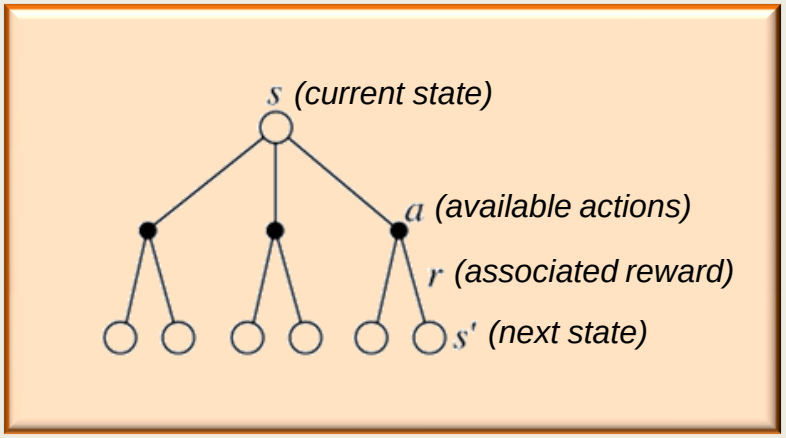
Products:

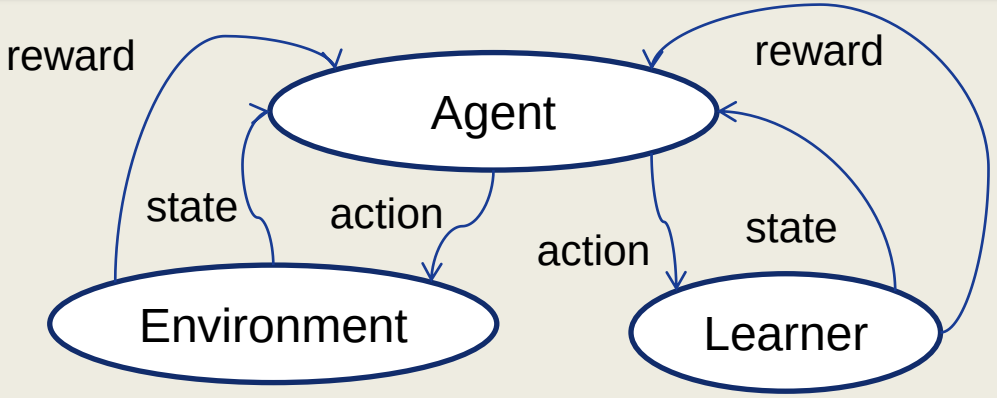
- Ontology - formal naming and definition of the types, properties, and interrelationships of the entities within the adaptive instructional domain represented by GIFT

Payoff:

- Opportunity to automate and reduce time/skill needed to author adaptive instruction

Multi-Agent Architecture for Individual and Team Training





Purpose: Research and develop a multi-agent architecture within GIFT to track learner states and optimize instructional decisions

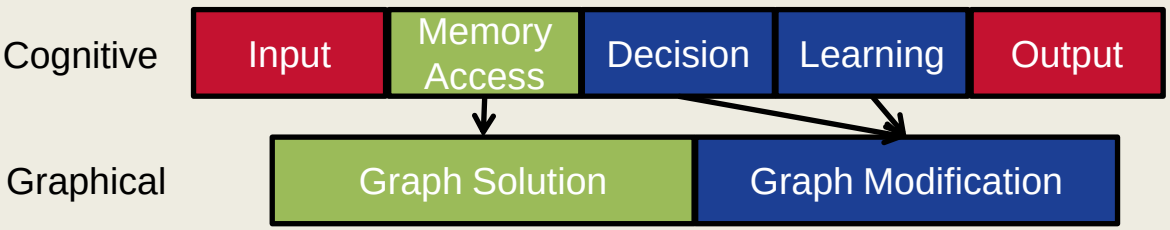
Products:

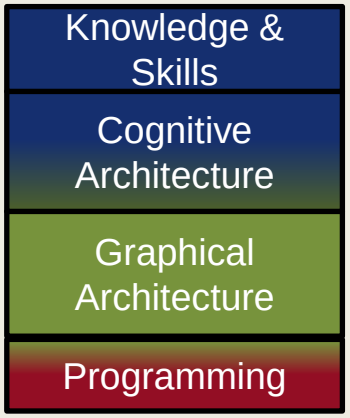
- Agent Architecture to support policies
  - Error Sensitive Feedback
  - Mastery Learning
  - Metacognitive Prompting
  - Adaptive Spacing & Repetition
  - Fading Worked Examples

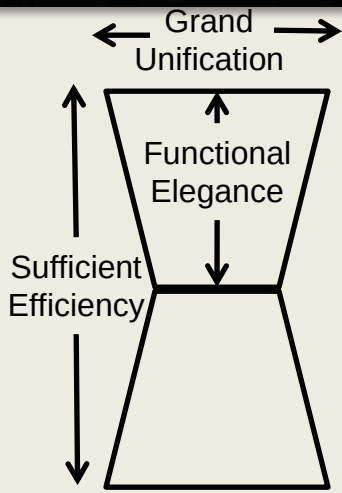
Payoff:

- Ability to adaptively instruct more complex and ill-defined military tasks

SIGMA and Cognitive Architectures







Purpose: Collaboration with ICT, use/familiarity with ICT research products, application of AGI technology to specific problems (transition).

Products:

- Research; papers, collaborations
- Improved modeling techniques applicable to a wider variety of products/projects ?

Payoff:

- "Complete" knowledge/training, involving fixed architecture (traditional), agent/service-based architecture (emerging), and flexible learning systems (research), resulting in better informed decisions.

Note: my hope is that a good Sigma (or other cognitive architecture) can serve as the starting place for each agent in a system composed of agents.