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Enhancing Performance through Pedagogy and Feedback: Domain Considerations for Intelligent Tutoring Systems (ITSs)

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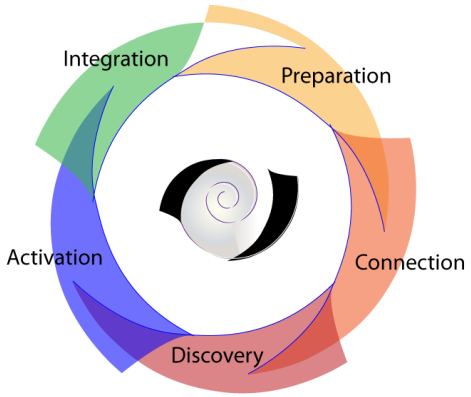
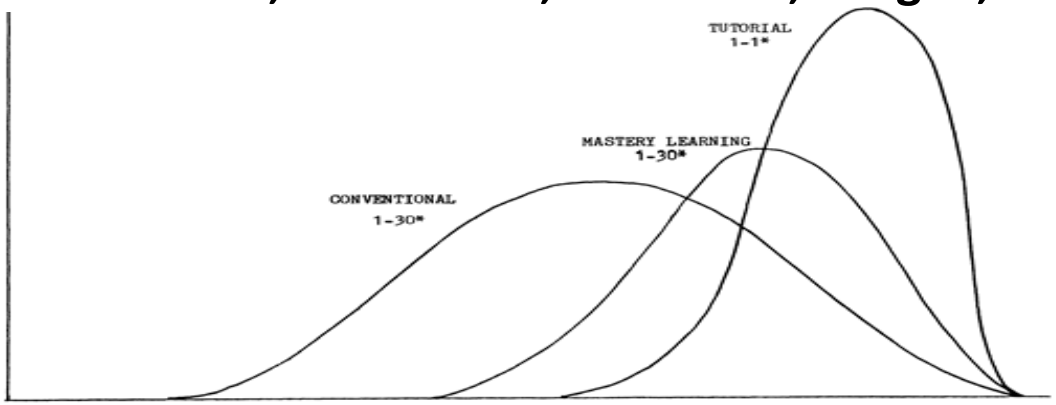
Push for Accelerated/ Self-Directed Learning

- What needs to be in place?
  - Technology Focused (computers/laptops/smartphones/tablets)
  - Sound Instructional Design
  - Mechanisms for Feedback
  - Capability to Compensate for Individual Differences



Intelligent Tutoring Systems

- Goal
  - Maintain a “readiness to learn” state by adapting training experiences to meet needs of the trainee
  - Emulate human tutors for achieving performance comparable to Bloom (1984).
- What are ‘needs’ defined as:
  - Performance/Competency Deficiencies
  - Negative Cognitive/Affective States
    - Boredom, Frustration, Confusion, Fatigue, etc…



Current State of Practice

- ITS Research has reported significant learning gains over long-established one-to-many instructional methods
  - Best platforms reporting 1.0 Sigma increase in performance when compared to conventional techniques
    - Virtual Sand Table ITS (Wisher et al, 2001)
    - ANDES Physics Tutor (VanLehn et al, 2005)
    - PUMP Algebra Tutor (Koedinger et al, 1997)

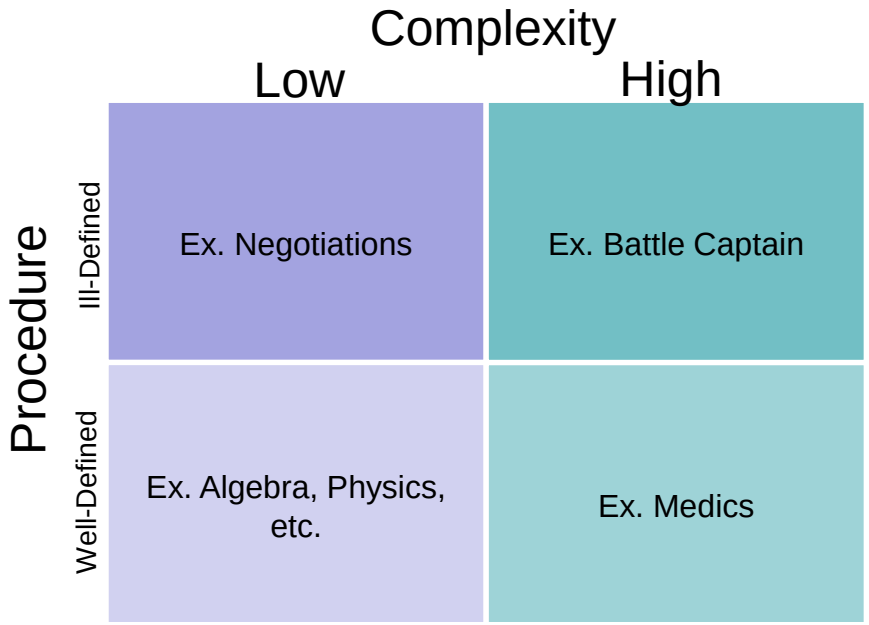
  Limited to well-defined domains where performance is easily measured
- New efforts are measuring and adapting training experiences based on diagnosed cognitive and affective states
  - Calvo & D'Mello, 2010 ; McQuiggan, Lee & Lester, 2007; D'Mello, Taylor & Graesser, 2007

Need for Standards

- Define Training Experiences around objectives within the domain definition framework
  - Will drive scenario selection and adaptations as trainee progresses from novice to expert
  - Pedagogy and Feedback are dependent to the scenario context
- What must be addressed:
  - Curriculum
  - Instructional Strategy
  - Measures of Performance
  - Pedagogical Adaptations/Interventions
  - Student Modeling

Considerations for Enhancing Adaptive Capabilities

- **Establish Framework for Domain Definition**
  1. **Well vs. Ill- Defined**
  2. **Level of Task Complexity**
     - **Task Dependent**
       - **Difficulty**
         - » **Easy vs. Hard**
       - **Opposition**
     - **Task Independent**
       - **Environmental factors**
         - » **Weather**
         - » **Terrain**
         - » **Visibility**
       - **Neutral Forces**
         - » **Civilians**
         - » **Refugees**
         - » **Victims**



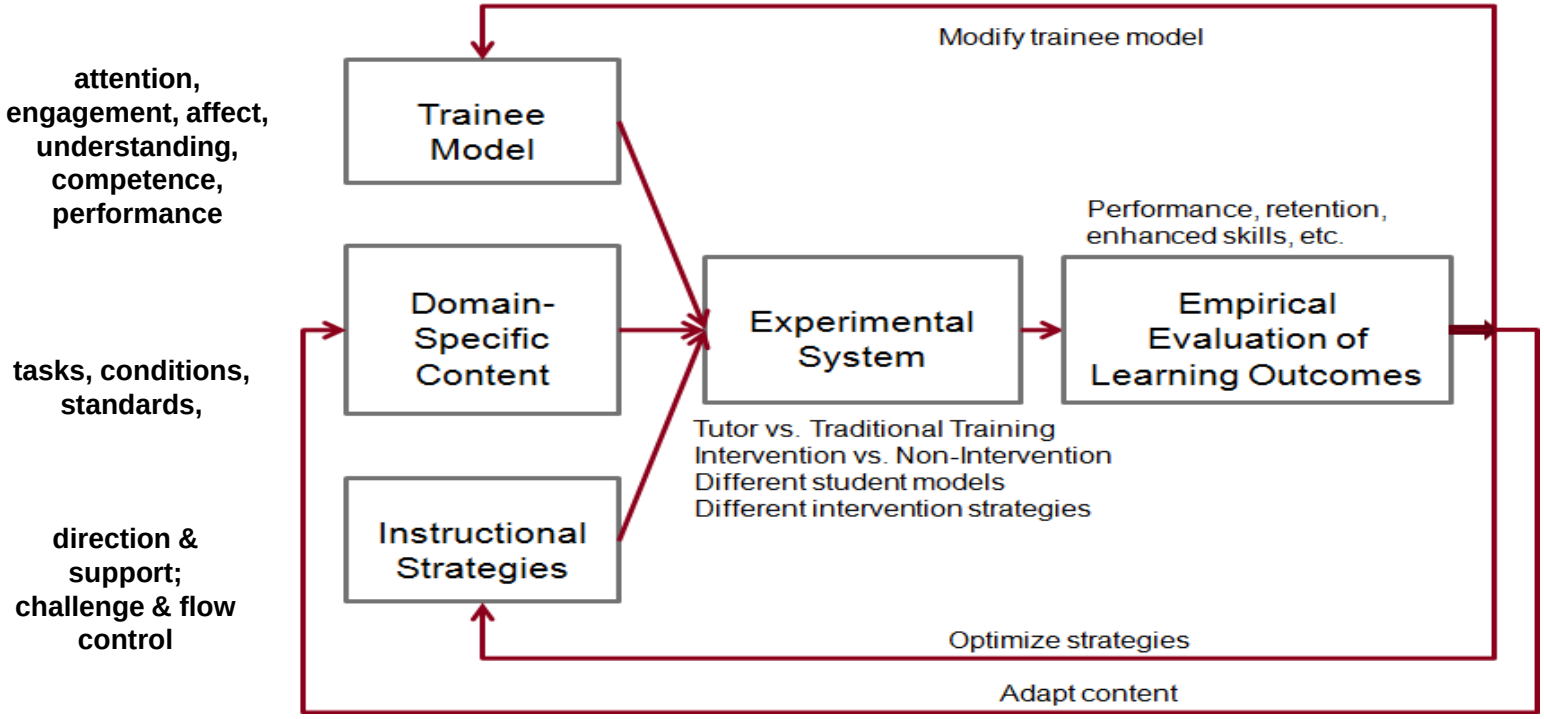
Road Ahead

Identify instructional and feedback implementation strategies that have an impact on learning outcomes

Requires Empirical Evaluations

Achieved through Modularity

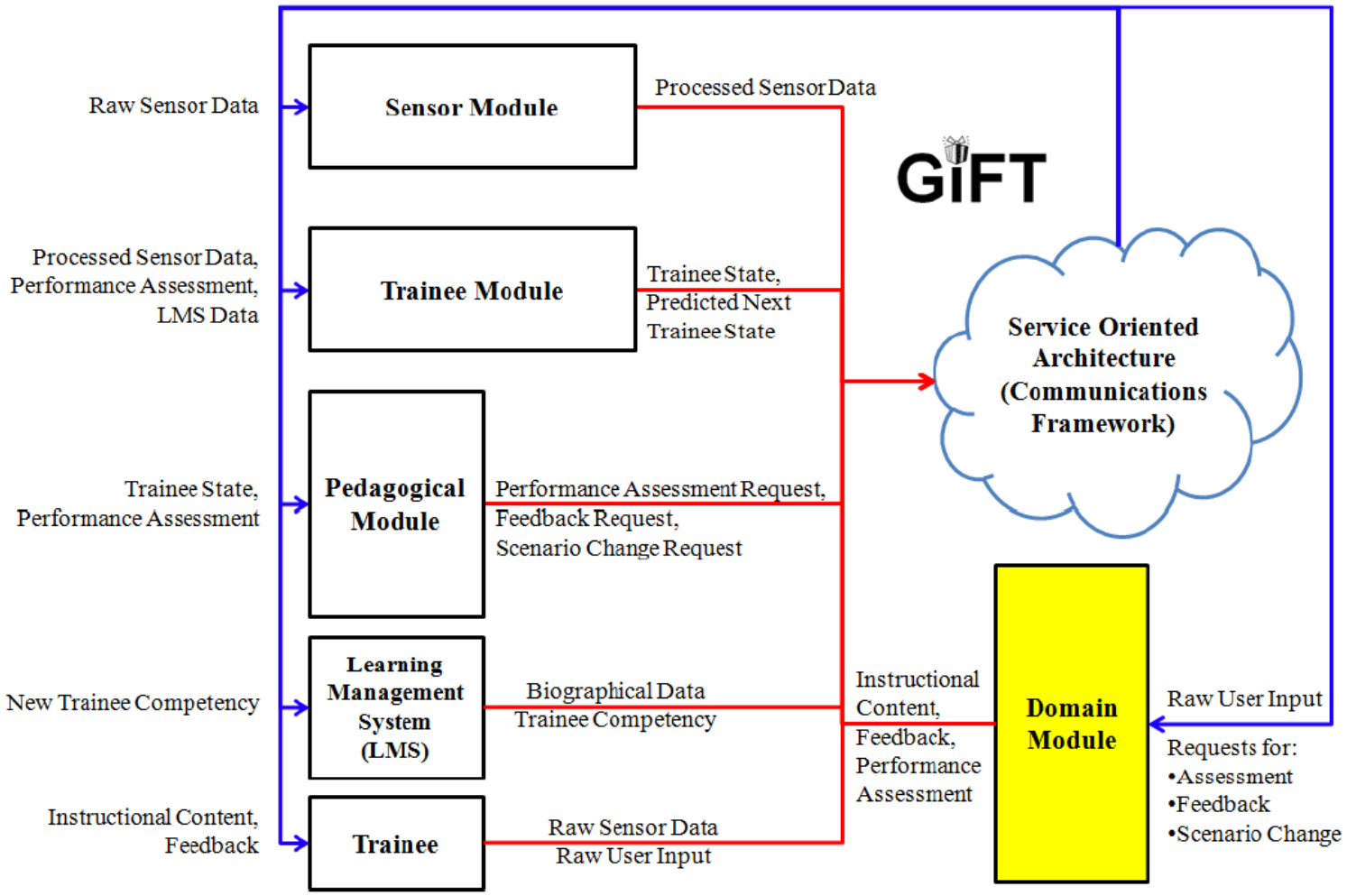
- **Modular Architecture applied as testbed for evaluating adaptive tutoring approaches across multiple domains**



Methodology derived from:

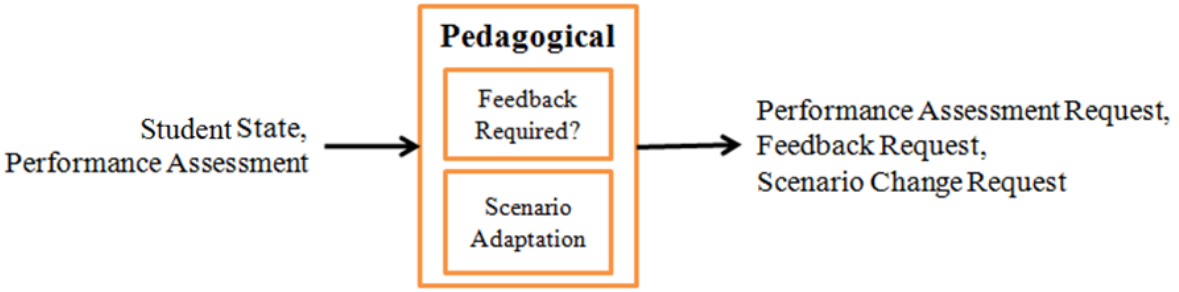
Hanks, S., Pollack, M.E. and Cohen, P.R. (1993). Benchmarks, Test Beds, Controlled Experimentation, and the Design of Agent Architectures. AI Magazine Volume 14 Number 4.

Generalized Intelligent Framework for Tutoring (GIFT)



The Pedagogical Module

- Comprised of generalized pedagogy and feedback interventions
  - Necessary to maintain
  - Based on Performance, Traits, and States
- Inextricably linked to the Domain Module
  - Must be able to support all intervention requests made by the pedagogical model



Pedagogical Outputs

- Four Primary Messages
  - Performance Assessment Request
  - Whether to make an Intervention
  - The Recommended Type of Intervention
    - Domain-Specific
      - Hint, Prompt, Remediation, Environmental Cues, etc.
    - Domain-Independent
      - Motivational Encouragement, Metacognitive Prompt
  - Next Scenario/Content to be Presented
    - Modify Pace/Complexity/Difficulty
    - Introduce new elements to current scenario

Future Work

- Integrate GIFT with Training Platforms
  - VBS2
  - VMedic
- Evaluate and Compare modeling/adaptation approaches within individual training support packages (TSPs) through GIFT's Modular Architecture
  - Investigate across multiple domains
- Expand GIFT to support Small Team and Mobile Platform Training

Conclusion

- Decisions on how to adapt training experiences in computer-based platforms follow few standards
- Establishing framework for domain definition is a starting point to determine appropriate strategies
  - Based on Task Definition (well vs. ill defined) and Task Complexity
- Requires empirical evaluations
  - GIFT's Modularity supports this approach

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Questions