ITADS: A Real-World Intelligent Tutor to Train Troubleshooting Skills

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Abstract

Real-world intelligent tutoring systems are important ambassadors for promoting wide adoption of the technology. Questions about affordability, quality control, operational readiness, training effectiveness, and user acceptance are significant in this context. This paper describes ITADS, an intelligent tutor developed to provide a problem-based, experiential learning tool to complement schoolhouse training. The goal was to train US Navy Information Systems Technology support staff in troubleshooting skills through the use of realistic simulations and automated assessment and feedback. This paper describes the tutoring system and a preliminary validation study of its training effectiveness. The results demonstrate that the system is effective in improving troubleshooting knowledge and skills. The ITADS system was successfully developed in twenty-six months from requirements to validation, following strict systems engineering procedures. The results of the training effectiveness study indicate that the ITS also leads to significantly improved performance among Navy IT recruits in troubleshooting tasks.

Addressing a Practical Need

The US Navy needed a problem-based trainer to help their **Information Technicians** to bridge the transition from schoolhouse learning to on-the-job performance.

Objectives:
1. Teach troubleshooting knowledge and skills
2. Provide hands-on practice on realistic problems
3. Provide automated assessment and coaching for self-paced learning
4. Adapt sequences of exercises based on performance
5. Include an authoring capability for in-house content creation and maintenance

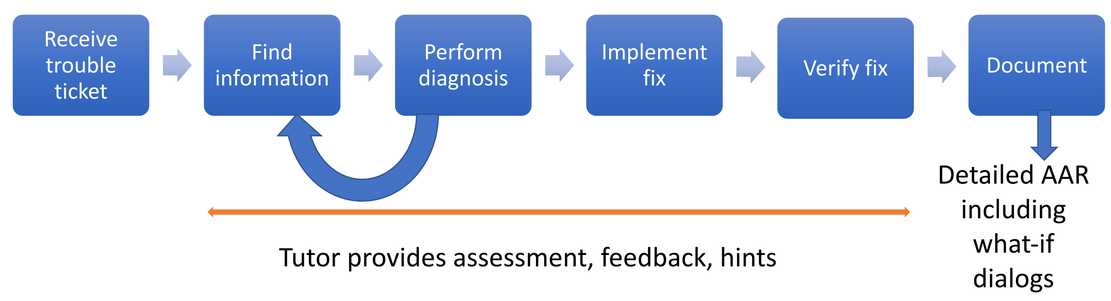
Schedule: 27 months for requirements, development, and validation

ITADS Highlights

- ITADS stands for Intelligent Tutoring and Authoring Delivery System
- It provides *problem-based learning* approach through the use of simulation exercises
- The simulator consists of a dedicated virtual IT network of virtual machines (VMs) that is an exact representation of the Naval Shipboard IT network.
- Each scenario involves a VM fault that the learner has to troubleshoot and fix.
- ITADS automatically *assesses performance* and provides *adaptive coaching and feedback*.
- It supports two modes of operation:
  - Full Tutoring: Full ITS mode that includes assessment, feedback, hints, after-action review, and adaptive exercise selection
  - Assessment Only: This is a purely assessment mode with no feedback or hints, and bare-bones after-action review.
- It performs *model-based assessment* of student performance.

ITADS Problem-Solving Exercise Flow

Based on the Navy's prescribed 6-step troubleshooting process



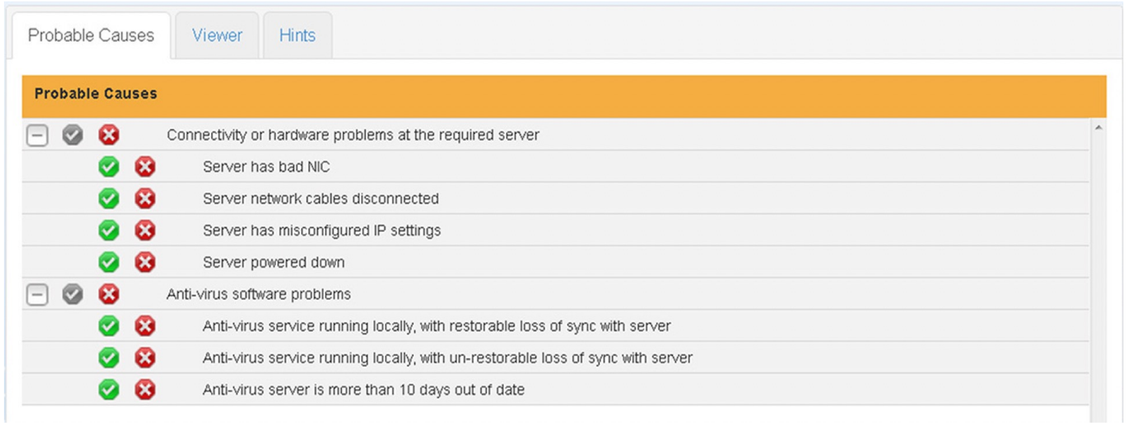


Figure 1. Part of the Tutor UI. The panel shows the list of current active fault hypotheses. Students can assert/refute hypotheses at any point. Assessment and feedback based on hypothesis updates.

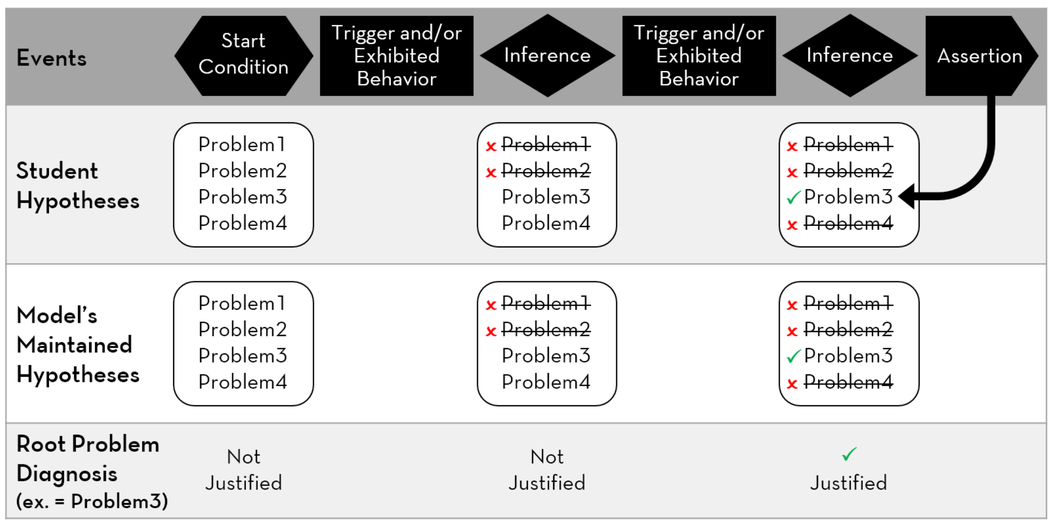


Figure 2. Hypothesis updates and assessment.

Preliminary Evaluation

- Limited, controlled evaluation
- Participants separated into two groups
  - Experimental group: Complete program of training with ITADS
  - Control group: Only didactic lessons
  - Size: Experimental group = 10
    Control group = 5
- The same post-test administered to both groups
  - Post-test = Set of ITADS simulation exercises in the assessment only mode
  - Six troubleshooting scenarios presented in a fixed sequence
- Data collected: Exercise scores, completion times, and transcripts
  Survey responses to measure reactions

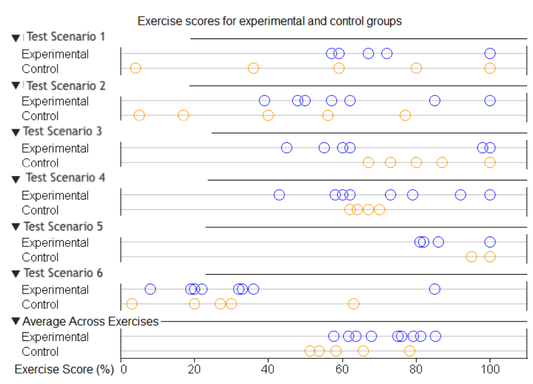
Results

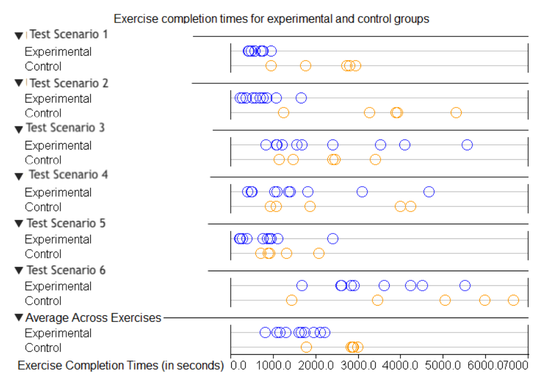
Compared the performance of the experimental and controls groups on:
1. Post-test exercise scores,
2. Post-test exercise completion times, and
3. Successful completion rates on post-test exercises.

Exercise scores: Experimental group scored **19% higher** than the control group (not statistically significant).
Exercise completion times: Experimental group was 70% faster (significant, $p<0.001$)

Table 1. Comparison of exercise completion rates

Average completion rate	Experimental Group	Control Group
Diagnosis phase	85%	63%
Fix phase	82%	53%
Both phases	62%	38%





Conclusion

The ITADS system was successfully developed in twenty-six months from requirements to validation, following strict systems engineering procedures.

Our evaluation demonstrated the potential for ITADS to substantially improve performance on real-world IT troubleshooting problems.

Contact

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