Research to Practice: Adaptive Technologies and Approaches to Performance Improvement

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Abstract. This paper introduces adaptive training as a concept and affirms the importance of current adaptive training research, emerging technologies, and future concepts to more efficient and effective guided learning experiences within the training community.

Keywords: adaptive training, Intelligent Tutoring Systems

1 Introduction

Systems that tailor and personalize training needs of individual trainees can reduce costs and deliver more effective training results. Researchers and developers of online learning, computer-based intelligent tutoring systems (ITSs), virtual worlds and laboratories, distributed simulations, and learning management systems (LMSs) are exploring ways to better understand and use learning analytics to improve instruction and learning.

The emphasis on self-development (also known as self-regulated learning) in the military community has largely driven the need for adaptive ITSs (often referred to as computer-based tutoring system or CBTS) which tailor planning based on individual learner needs and manage real-time instructional decisions to optimize learning. These systems are often employed to support point-of-need training in environments where human tutors are either unavailable (e.g., in the field) or impractical. For example, it is impractical to provide a human tutor for each trainee in large organizations like the U.S. military. Effective human tutors ask questions, tailor feedback, provide opportunities for reflection, and change the content, direction, pace, and challenge level of instruction to optimize learning (e.g., acquisition of knowledge or skills). Adaptive ITSs also attempt to select optimal instructional strategies to meet the specific learning needs of individuals or teams [1].

While research in this area is making great strides, there is still work to be done. This parallel session highlights adaptive training research from the government, academia, and the commercial sector. The session authors present current research, re-

search in practice (e.g., emerging technologies) as well as provide future concepts which may lead to state of the art in the near-term.

2 What is Adaptive Training?

Over a number of years, research and practice have shown that people learn differently, at different rates, and using different styles [2]. Yet often, instruction is presented linearly and uniformly to all trainees, regardless of each trainee's actual proficiency in the knowledge and skills he/she is trying to learn. That is, training content, as well as when and how it is presented, remains the same for all trainees. This can result in training inefficiencies, such as when individuals spend time in training areas in which they are already proficient, rather than receiving enhancement training that would remediate shortfalls in other areas. This can also result in bored or demotivated learners. Practically speaking, these inefficiencies can translate into time misspent by both instructors and trainees in misaligned training; resources expended to develop and maintain misaligned training; and, ultimately, decreased performance and task readiness in areas critical to success of both for the government agencies and the industrial base.

This parallel session highlights current and emerging research as well as areas of interest, tools and methods related to adaptive training and intelligent tutoring with the goal being to provide actionable research that can be applied to practice.

3 Current Adaptive Training Research

Within the adaptive training literature, current research has focused on expert modeling techniques for ITSs, semantic analysis for dialogue-based tutors, and cognitive techniques to aid the learner. The first three papers within this session highlight research findings in these areas.

3.1 Paper 1: Just Enough Fidelity in Student and Expert Modeling for ITS

Authors: Brandt Dargue

Current research at Boeing has focused around ITSs and expert, domain and student modeling. Research efforts have centered on enabling the optimum tailored experience as compared to traditional classroom instruction. While complexities have shown ITSs to be successful, they have also prohibited their widespread use. Automated authoring, instructional management and analysis continues to be largely the dominion of computer scientists. Simplifications of expert and system models have shown greater success and gains in effectiveness. Results of these effectiveness studies are shared as well as guidelines in determining the level of fidelity required for effective student, expert, and system models of the ITS.

3.2 Paper 2: Semantic Representation Analysis: A general framework for individualized, domain-specific and context-sensitive semantic processing

Authors: Xiangen Hu, Benjamin D. Nye, Chuang Gao, Xudong Huang, Jun Xie & Keith Shubeck

Computational linguistics researchers are increasingly focusing their efforts around language agnostic methods for semantic extraction, encoding, and applications. The second paper in this session introduces an analytic framework for vector-based semantic representation called semantic representation analysis (SRA). The goal of the paper includes providing rationale for this framework, highlighting successes around a cloud-based implementation of SRA, and challenges to future implementation. Additionally, a domain-specific semantic processing portal is presented along with applications of analysis of online text streams, analysis of the impression formation over time, and a virtual learning environment called V-CAEST that is enhanced by a dialogue-based ITS.

3.3 Paper 3: Combining Cognitive and Metacognitive Support to help students become Independent Learners

Authors: Gautam Biswas, James Segedy & John Kinnebrew

The authors of this paper examine methods to enhance the ability of students to manage their own learning through both cognitive and metacognitive support. Cognitive support guides the process of learning to meet the intended domain objectives while metacognitive methods aid the student in developing, modifying, and reconstructing mental models through reflection.

4 Research in Practice: Emerging Adaptive Training Technologies

Recently efforts at the US Army Research Laboratory (ARL) have shown significant success in developing and prototyping a generalizable architecture for tutoring with an open-source approach to community development. The Generalized Intelligent Framework for Tutoring (GIFT) is currently being utilized across a variety of efforts which are demonstrating practical use cases for military trainers and trainees, academic partners, and commercial sector clients. GIFT currently has over 300 users in 19 different countries. The next two papers touch upon two key issues related to the adaptive tutoring learning effect chain [1, 3, 4], a model of instruction basic to GIFT: learner data and modeling; and the support of self-regulated learning.

4.1 Paper 4: Using Learner Data to Influence Performance during Adaptive Tutoring Experiences

Author: Robert A. Sottilare

This paper highlights the roles and influence of learner data in both short-term (also called run-time or session) learner models and long-term (also called persistent) learner models used to support adaptive tutoring decisions within ITSs. GIFT is a set of authoring, instructional management, and analysis tools used to determine the influence of learner, pedagogical, and domain model elements. Additionally, recommendations for future learner models to enhance the usability and effectiveness of ITSs are also presented.

4.2 Paper 5: Utilizing the Generalized Intelligent Framework for Tutoring to encourage Self-Regulated Learning

Author: Anne M. Sinatra

This paper reviews self-regulated learning as it is implemented within GIFT as part of adaptive, automated instruction. The authoring capabilities of GIFT are also discussed, and recommendations formulated to support the development of ITSs which enhance self-regulated learning outcomes.

5 Future Concepts in Adaptive Training

While research on intelligent tutoring systems and adaptive training environments are making great strides, there are still areas left to be explored. The final paper in this session will focus on research gaps in the area of adaptivity and performance improvement.

5.1 Paper 6: What is Adaptivity? Does it Improve Performance?

Authors: Jacqueline A. Haynes, Jody S. Underwood, Robert Pokorny & Amit Spinrad

The last paper in this session focuses on adaptivity and candidate methods that should be used to tailor the interactions between learner, context, objective, and instructional approach to maximize learning and performance. This paper defines adaptivity, reviews different types of adaptivity used for instruction and examines effects within the learning environment and longitudinally. The authors provide examples of how they have used adaptivity for short- and long-term improvement in performance and learning. The authors conclude that adaptivity in learning environments should be used to focus on deep conceptual learning to promote long-term results.

6 Conclusions

While research gaps still exist on retention and deep learning, there is a community of practice that is shaping the future of personalized and tailored learning. Technology development continues to grow around those systems that are connecting methods and approaches for tracking the learners experience from both macro and micro levels. With increasing pressure to achieve greater efficiency and effectiveness in training investments, there has been greater interest in adaptive training solutions and systems among researchers and practitioners. Adaptive training represents a method to achieve better results at lower cost, and thus there exists significant interest in exploring its potential by some of the largest customers for training in the United States and abroad [5].

7 References

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