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Training of Expertise and Expert Performance

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INTRODUCTION

The goal of this special *TICL* issue is to stake out a territory for instructional approaches that leverage the theories, findings, and methods of expertise research in order to systematically train expertise in developing learners. The disciplinary perspective of this issue is instructional design, as reflected by the term *training* in the title of the special issue. Consistent with the ethos of TICL, however, the special issue draws upon the other areas of learning sciences to inform the design of instruction. Indeed, most of the other authors represented in this special issue would not claim instructional design as their disciplinary home. However, the instructional design perspective should provide an interesting viewpoint even for those readers who identify with other aspects of technology, instruction, cognition, and learning.

EXPERTISE AND EXPERT PERFORMANCE

Expertise and expert performance is the term used by researchers and theorists to refer to a distinct body of research that is exemplified by the landmark *Cambridge Handbook of Expertise and Expert Performance* (Ericsson, Charness, Feltovich, & Hoffman, 2006). This special issue includes articles that deal with both the *expertise* component (what experts know) and the *expert performance* com-

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ponent (what experts do). Expert performance is the more emphasized component by expertise researchers while expertise is more closely associated with *knowledge representation* as it is regularly, rigorously, and creatively addressed through symposia sponsored by the TICL special interest group at meetings of the American Educational Research Association and by publication in the *TICL Journal*, including the expansive 2007 special issue on knowledge representation (Vol. 5, nos. 2–4). Of course, the goal of representing expert knowledge is not solely descriptive but rather with the intent of making that expert knowledge available to learners in systematic, often computer-based, instructional environments. The tradition of intelligent tutoring systems (ITS) is obviously foundational to TICL and is represented in this special issue by Dirk Ifenthaler's article on *Model-based Feedback for Improving Expertise and Expert Performance*.

Mental Model Feedback

In the study reported by Ifenthaler, model-based feedback was automatically provided by a computerized system that generated a mental map based on learners' comprehension of a text passage on climate change. An expert's mental map based on the same passage was also generated and learners were presented with both maps (model-based feedback). The experiment compares the effectiveness of a full comparison of expert and learner-generated mental maps with a representation of both maps that depicts only the differences between the expert's and the learners' mental maps. The underlying theory is that learners will implicitly come to think more like experts after being presented with mental-model feedback, especially in formats that highlight differences.

Extracting expertise, packaging it as instructional materials and activities, transmitting it to learners, and measuring results are obviously all significant challenges of any instructional design approach and all the more so when dealing with expert knowledge and skills. Model-matching feedback, whether in a computer-based context or not, offers the potential for a "low overhead" approach to extracting, packaging, transmitting, and measuring the progression of learners in thinking more like experts—at least within the confines of a particular representative task.

Cognitive Task Analysis

Cognitive task analysis (CTA), a higher overhead method of extracting expertise, is the subject of *A Case Study of Instruction from Experts: Why Does Cognitive Task Analysis Make a Difference?* by David Feldon and Kirk Stowe. In their study, a well-established biology professor participated with two other biology education experts in a CTA process to extract expertise and to construct learning materials. The cooperating biology professor then taught his original lesson plans in one section of a college biology course and taught the CTA version of the same lessons in another section of the same course. The study thereby removed the instructor as a confounding variable and revealed that CTA-produced content can deliver better learning compared to a single subject-matter expert. The specificity of content derived by the CTA processes, especially, was associated with greater student achievement. Such findings are valuable to instructional designers in deciding if and when the benefits of CTA justify the investment of effort.

Expert-Novice Paradigm

The other research articles in the special issue report on continuing programs of research rather than individual studies. The article by Stepich and Ertmer on *Teaching Instructional Design Expertise* and the article by Ward, Suss, and Basevitch on *Expert Performance and Evidence-based Training in Complex Domains* both draw upon the body of expertise research that traces its roots to investigations of expert memory in the field of chess (deGroot, 1965; Simon & Chase, 1973). As represented in the *Cambridge Handbook of Expertise and Expert Performance* (Ericsson et al., 2006), this body of research has used the *expert-novice* paradigm to generate studies of expert performance in domains as diverse as sports, music, aviation, and physics problem solving. While these expert-novice studies typically *describe* expert performance, expertise researchers have more recently begun to develop training programs that repurpose the tasks used for research purposes into instructional activities intended to specifically develop the skills that research shows differentiate expert from novice performers.

The repurposing of expertise research methods to instructional methods has been pioneered in the realm of sports expertise research. Ward, Suss, and Basevitch provide a thorough review of sports expertise research, the focus of which is identifying the domain-specific perceptual-cognitive skills that underlie expert performers' remarkable anticipation, recognition, and decision-making in high-stress, time constrained situations. A body of expertise research in sports has developed training protocols based on the representative tasks and video-simulation methods used in sports expertise research—an approach that the authors refer to as *evidence-based training*. The authors then describe the application of this approach to innovative programs that train perceptual-cognitive skills in a range of performance domains including military, law enforcement, and nursing. The implications are far reaching for systematically training aspects of expert performance that are commonly thought to come only with massed domain experience.

Stepich and Ertmer demonstrate that expert-novice research and instruction approaches can apply in strictly cognitive as well as psychomotor domains of performance. In a series of studies, Stepich and Ertmer have investigated the instructional design performance of professional and academic instructional designers (experts) and compared their instructional design process to that of instructional design graduate students (novices). Although the comparison of experts and novices is made across different studies, the findings are clear. Expert instructional designers differ from novice instructional designers primarily in the *problem finding* rather than the problem solving stages of instructional design. Stepich and Ertmer follow up this descriptive research by suggesting ways in which the professional education of instructional designers can be adjusted to emphasize problem-finding skills—thereby facilitating advancing learners' development of instructional design expertise.

Expertise-Based Training

My contribution to the special issue, *Expertise-Based Learning (XBT): Getting More Learners Over the Bar in Less Time*, provides a theoretical argument for using the theories, findings, and methods of expertise research in order to create instruction that is intended to hasten the development of expertise in realms associated with training (such as aviation) and also in professional education. Because an instructional theory should demonstrate utility, the article includes a description of how expertise research in the area of student-centered teaching might be adapted to create instructional activities intended to enhance pre-service teachers' development of the student-centered teaching skills that are associated with expert teaching.

CONCLUSION

While the instructional design perspective of this special issue may be outside of the usual interests of many *TICL* readers, the application of theories, findings, and methods from expertise research to the design of instruction also serves to validate the underlying cognitive theories of expertise and expert performance—and to point to areas for reconsideration or further exploration. I hope that the five articles presented in this special issue will encourage researchers in cognitive psychology, intelligent tutoring systems, instructional design, and simulation training to further develop and report training approaches based on the theories, models, findings, and methods of expertise research.

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