Adaptive Learning:
How It is Learned or What Is Learned?

There has been a major disconnect since their inceptions between theory, research and instructional application in structural learning (e.g., Scandura, 1971, 1973, 1977) and in what later became known as cognitive science (e.g., Brown & Burton, 1978, Anderson, 1988). With few exceptions (e.g., Scandura, Koedinger, Mitrovic & Ohlsson & Paquette, 2009), most of this work has been done in isolation.

Consequently, many ITS researchers have a basic misconception of SLT and its now proven benefits in developing and delivering dynamically adaptive tutoring systems (e.g., Scandura, 2013b). Because the general goals are similar, many investigators use the same lens to evaluate what are fundamentally different paradigms.

ITS development has traditionally been based on the assumption that it is essential for teachers to understand what is going on in student minds – to understand how students learn. Many ITS systems are based on often elaborate cognitive theories (e.g., Anderson et al, 1988, 1995, 1998). Development of dynamically adaptive tutoring systems based on SLT is fundamentally different. SLT is equally precise, but is more comprehensive in scope. It is explicitly concerned not only with learning but with teaching as well (e.g., Scandura, 2001, 1977). Differences between how experts and novices solve problems is critical in purely cognitive theories, where the goal is detailed explanations on what goes on in student minds.

This is important in SLT, but it is handled very differently. Teachers know that students with different degrees of expertise need different kinds of help at various times during the course of learning. Among other things experts generally deal with bigger “chunks” of knowledge. They typically get to desired results far more quickly and/or effortlessly. From an SLT perspective, all students learn in the same way. What differs is what students know at each point in time relative to what is to be learned. This is what determines what the teacher (or automated TutorIT tutoring system) should do next – for example, whether to test or teach, and what to test or teach. How something is taught is strictly secondary.
How is this possible? We have found a way (based on SLT) to systematically
represent all knowledge in a uniform way that encompasses ALL levels of
expertise simultaneously. All knowledge, whether expert, novice or anywhere in
between, can now be represented systematically based on recently patented
methods and technologies (Scandura, 2013a, US Patent No. 8,750,782, June 14,
2014). To be acquired knowledge is represented hierarchically, simultaneously
at all levels of abstraction (represented as Abstract Syntax Tree-based SLT
rules). Individual knowledge at any or all levels of expertise is measured relative
such SLT rules. Using overlays is not new. An essential part of what is new is
representing individual knowledge as overlays on hierarchical knowledge
representations and automatically drawing inferences about mastery on other
items (see our patent for details). Another essential is introducing higher order
SLT rules that operate on and either generate or select SLT rules (cf. Scandura,

In short, the focus in SLT, and the AuthorIT and TutorIT technologies based
thereon, is on what subject matter and instructional design experts (SMEs) believe
should be learned for success. This to-be-acquired knowledge provides a uniform
method for representing individual knowledge - whether expert, novice or any-
where in between. Methods reduced to practice in AuthorIT and TutorIT tech-
nologies make it possible to represent all knowledge hierarchically, simultaneously
at ALL levels of abstraction.

Using these patented methods to develop TutorIT tutorials has made it possi-
ble to avoid complications cognitive scientists have long faced in building ITS.
Focusing concern on how experts, naïve etc. students solve problems adds sig-
nificant complications – precisely because there are any number of gradations
and variations. The solution implemented in AuthorIT is to represent all levels of
expertise simultaneously. TutorIT then automatically uses these hierarchical
knowledge representations as a measuring device to identify what any given
student in a given population does and does not know at each point in time deliv-
ering precisely what the student needs to progress. This new paradigm has proven
to simplify the task of building and delivering dynamically adaptive tutoring sys-
tems by an order of magnitude.

Joseph M. Scandura
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scandura@scandura.com
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