New Directions for Educational Technology

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Abstract: I see three important areas of research for the future development of educational technology: instructional strategy prescriptions, tools to help designers, and applications (contexts). The purpose of this chapter is to identify specific new directions, within each of these three areas, that I think are most important for future research. However, before discussing these new directions for educational technology, I would like to briefly comment on some concerns I have regarding many of the chapters in this volume.

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1. Concerns

My primary concern is that many chapters represent a very narrow view of the field. Most of them are about intelligent tutoring systems (ITS). Although this is indeed an important new direction for educational technology, it is only one of many important new directions. As Merrill [9] has pointed out, tutoring (whether done by an experienced human or an artificially intelligent machine) is not always the best mode of instruction. Computer-based simulations provide a powerful environment with which the learner can interact to discover principles and develop methods for solving problems in a much more powerful way than a tutor could ever provide through dialogue alone. And for automatizing lower-order skills (procedural knowledge) and facts (declarative knowledge), drill-and-practice games are far more cost-effective and motivational than an ITS. We must not ignore such other aspects of educational technology when we discuss important new directions deserving of our time and funders' support.

The foundations of educational technology are based in media, and focused on the "hard technologies" to the exclusion of the "soft technology" of how to optimize the process of learning. We have gone through cycles of embracing a hard technology as affording a radically improved method of educating children, then having our expectations shattered, then embracing a new hard technology, and so on. We have seen radio come and go, followed by tape-slide and television, to name the most famous cases. Part of the problem comes from overhyping and overpromising, part is due to failure to recognize that the hard technology is not a universal tool that is equally effective for all types of learning, and part is due to failure to recognize the importance of the soft technology -- instructional theory -- for guidance as to what the instruction should be like regardless of the medium (the hard technology). As McCalla warns in his chapter in this volume, ITS is in danger of falling into this same trap.

Another concern is that many reports and presentations on ITS remind me of "show and tell." There seems to be little interest in developing and reporting generalizable prescriptions or rules which govern an intelligent tutor. What little generalizing is done is usually along the lines of descriptive theory (e.g., cognitive learning theory) rather than prescriptive theory (instructional theory). Although there are indeed few rules or prescriptions which would generalize to all learning situations, surely the vast majority generalize beyond a single topic. In this volume Collins discusses the need for a design science similar to aeronautics. ITS projects should contribute toward the building of such a prescriptive design science or theory.

The other side of this coin is the syndrome of "reinventing the wheel" to which McCalla also referred in his chapter. Most ITS projects seem to have ignored the existing knowledge base of instructional theory when designing their intelligent tutors. Instructional theory offers many validated prescriptions (rules) which should govern any effective instructional system, including an intelligent tutor. In his chapter, Ferguson discusses the distinction between instruction and construction, and suggests that the ITS people may ignore the existing instructional theory knowledge base because they perceive it as irrelevant to their focus on construction. I certainly agree that the construction mind-set is important for the more complex kinds of learning, and I have used it recently in my work to develop prescriptions for teaching "understanding" [11].

However, in adopting such a mind-set, we must be careful to maintain our interest in prescribing what a teacher or other instructional medium should do to facilitate construction. In other words, instruction is also required for construction -- they are not mutually exclusive terms. It is not sufficient to just describe what goes on (or should go on) inside a learner's head; it is important to prescribe what a teacher (or other medium) should do to make it happen. And much of what exists in the current instructional theory knowledge base is indeed relevant to facilitating construction of meaning by a learner. I have seen some features of ITS's touted as a great discovery, when they were in fact a clear implementation of an instructional theory prescription. Reiser, in his chapter, discusses a variety of general prescriptions for an intelligent