Beyond knowledge

The legacy of competence in meaningful computer-based learning environments

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Learning and instruction with computers is intrinsically tied to current educational practice in schools, universities, the corporate world and informal settings of learning. However, integration of technology in the practice of education is a sensitive task that has to be well planned in order to meet the needs of learners and teachers . Current changes in European education stress the role of competencies and educational standards; thus, fostering both within the practice of education is eminently important. Meaningful computer-based learning environments contribute to the achievement of learner's acquisition of competence and directly address the superordinate standards of education. They stimulate active learning by providing students with control over learning environments and offer realistic problems with which to practice—environments that can simulate conditions impossible to mimic in the real world, and environments that can embed learning scenarios within the structure of interactive and highly motivating games (Merrill, 2002; Reigeluth, 1999; Van Merriënboer & Kirschner, 2001). Furthermore, the environments also provide the capability of leveraging vast information resources within a myriad of modality-specific deployments—for example, texts, auditory fragments, and animations.

This book presents a highly select compilation of research dedicated to these environments—empirical research (both basic and applied) aimed at the analysis, understanding, and promotion of learning by computer-based and other instructional state-of-the-art approaches.

Section one of this book is dedicated to approaches of competence-based instruction in mathematics and sciences. By definition, competence is characterized by integrativity, specificity, and durability. Integretivity refers to the combination of knowledge, skills and attitudes as well as aptitudes of students; specificity, refers to the idea that competence is always bound to a context that is either highly specific (e.g., a profession) or more general (e.g., a career); durability relates to the notion that competence does not rely exclusively on tools, working methods or technologies per se(Van Merriënboer, Van der Klink & Hendriks, 2002). Thus, competence-based instruction requires a holistic approach, consisting of whole tasks that address the coordination and integration of knowledge, skills and atti-

tudes (Van Merrienboer & Kester, 2007). From this perspective, the chapters in this section address the question of how scientific thinking, and epistemological beliefs, in the context of a science classroom, can be extended and enriched by digital learning environments as well as innovative approaches of instructional design.

Part two of this book explores current approaches aimed at analyzing and fostering collaborative learning. As such, these approaches consider collaborative learning under the auspices of information and communication technologies (ICT) in addition to issues of knowledge sharing. The social and communicative aspects of learning are addressed in addition to suggestions for enhancing collaborative transactions of learners in group-based instruction.

The third section is dedicated to issues of e-Learning and mobile learning in general. There is little doubt that when using mobile devices, the opportunity to learn alone or in groups comes with unique and special requirements. These requirements refer to the issue that technical devices, like mobile phones, iPods and other mobile appliances need to be handled as learning tools – tools that must be able to negotiate the ubiquity of open learning environments that are, by comparison to traditional environments significantly more amorphous. That means the environments in which students learn need to be prepared by the learners themselves so that the learning processes are appropriately initiated and properly controlled by continuous metacognitive processes. The research in this section addresses these issues directly, especially with regard to the innovative applied approaches to support and design meaningful and competence oriented learning environments as they are exploited by the use of mobile tools.

Computers as learning tools and tool support for computer-based learning are the focus of the fourth section of this volume. Rich computer-based learning environments enable a qualitatively different way of learning compared to traditional learning environments. By comparison to typical school classrooms, computer-based learning environments allow for non-linear learning by giving students control over the instructional material they are intending to learn. Thus, students are allowed to select information, tasks, instructional formats (e.g., video, audio, graphics, or text), interface properties, and content (e.g., examples, analogies) in their preferred order and at their own pace (Merrill, 1994). Although learner control can be highly motivating (Gray, 1987; Lawless & Brown, 1997; Lou, Abrami, & d'Apollonia, 2001), its effect on learning outcomes is not unequivocally supported (Fry, 1992). Thus, the use of support tools in computer-based learning might be an important means to enhance the learning outcomes of students in control over their own learning; however, at present the complexity of these environments renders them currently vulnerable to outcome efficacy debate. Answers to questions about the nature and surplus value of learning support devices, as well as outcome oriented instructional design approaches are major themes that guide the contributions in this section.

The topic of the final section of this book is multimedia learning. There are three perspectives on multimedia learning presented by the research in this sec-

tion. First, the psychological perspective describes memory systems and cognitive processes that explain how people process different types of information and how they learn with different senses. For example, Paivio's dual coding theory (1986; Clark & Paivio, 1991) and Baddeley's working memory model (1992; 1997) form the bases for this perspective. Second, the design of instructional messages identifies multimedia principles and provides guidelines for devising multimedia messages consisting of, for instance, written text and pictures, spoken text and animations, or explanatory video with a mix of moving images with spoken and written text (e.g., Mayer's generative theory of multimedia learning (2001) and Sweller's cognitive load theory (2004; Sweller, van Merriënboer, & Paas, 1998)). Finally, models for course and curriculum design prescribe how to develop educational programs, which contain a mix of educational media including texts, images, speech, manipulative materials, and networked systems. In short, the research in this section explores the three perspectives underlying multimedia in varied and important experimental work/

The chapters in this book provide excellent research having undergone double-blind peer review comprising newly completed investigations in the field. As such, they reflect new data, fresh thinking and new findings in the field. On the other hand, we also decided to include research notes that represent work-in-progress—innovative approaches that might affect future research. These selected research notes also underwent a double-blind process of peer review in order to emphasize the role of current and future processes of instructional design and learning and instruction with computers. We hope to present a valuable resource for this field and thank all contributors for their excellent and outstanding work.

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