Section V
Domain-Specific Strategies and Models

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This fifth section of the *Handbook* is aimed at providing the educational technology research community with reviews of research on domain-specific instructional/learning strategies and models. This section has been added based on the very positive feedback to the chapter on domain-specific strategies in the 3rd edition of the *Handbook* (Spector, Merrill, van Merriënboer, & Driscoll, 2008). Because this section is entirely new, there is no duplication with previous editions, and the research findings and perspectives reported in these chapters are new. The domains covered in this section include science, healthcare, mathematics, engineering, social studies, visual arts, and literacy. There are of course other domains in which educational technology plays a major role (e.g., language learning), and we expect that additional domains will be covered in future editions of this *Handbook*.

The section begins with Ji Shen and colleagues reviewing research on technology-enhanced instruction in science education. Of particular focus is both qualitative and quantitative modeling and associated scaffolding strategies related to the cognitive, social, and curriculum aspects of learning science, particularly in K-12 settings. The need to promote systems thinking, model-based reasoning, and scientific exploration are discussed in the context of a number of research studies involving technology-based systems such as River City, Model-It, and Molecular Workbench. The authors note that in spite of such powerful learning environments there is still little evidence of effective integration in science education curricula—educational practice continues to lag far behind the technology and the research findings associated with these science education learning environments.

The chapter by Richard Clark on cognitive task analysis in healthcare tells a somewhat different story. Perhaps because healthcare involves life and death issues and the medical education community is generally well funded, the impact of educational technology in this domain is more pervasive. In any case, the focus is on how cognitive task analysis (CTA) has been adopted in healthcare education and has resulted in many positive and sustained outcomes. Medical trainees are highly motivated to develop expertise, and the CTA method discussed in detail in this chapter shows how expertise can be analyzed and used to effectively inform the instructional design process. The example elaborated in detail involves surgery. While educational technology has been wholeheartedly embraced by the medical community, the use of CTA has yet to achieve its full potential, according to Clark.

The chapter by Verschaffel and Greer on mathematics education reports considerable maturation of the field and its use of technology to support learning. The chapter opens with a declaration of independence that emphasizes that mathematical knowledge and its acquisition are domain specific and cannot benefit all that much from domain-independent theories of learning, cognition, or technology integration. While this bold statement appears defensible, it may be somewhat misleading. The CTA procedures discussed by Clark can and have been applied to mathematics education. Moreover, experienced instructional designers readily admit that the content and its mastery are paramount. While it is important to recognize the domain specificity of mathematics knowledge, the same claim can be made for knowledge in almost any field. The risk of overemphasizing domain specificity is the further fragmentation of educational technology and instructional design expertise, resulting in the creation of academic and practitioner silos that are self-limiting. Just as instructional design practitioners can benefit from design expertise in other domains such as architecture, mathematics education can certainly benefit from educational technology expertise developed in other domains. The discussion by Verschaffel and Greer on realistic mathematics education, design research, higher order reasoning, and other topics demonstrates an awareness of the value to be gained by looking outside the specific domain

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of mathematics to find appropriate methods and strategies to enhance the development of mathematical reasoning.

The chapter by de Graaf and Kolmos addresses the role of technology in promoting innovation and supporting research in engineering education. Most of the discussion is focused on engineering education research in Europe and North America, which provides a rich set of cases and research studies. The authors provide a research agenda for engineering education towards the end of this chapter that will be useful for the editors of the fifth edition of this *Handbook*. They also lament the fact that within the engineering academic community, the value of engineering education research is not generally as highly valued as research on specific engineering efforts. This is also true in other domains and remains a challenge for serious educational researchers working in any domain.

The chapter by Green, Ponder, and Donovan on educational technology in social studies education addresses the fact that twenty-first century skills include technology skills and are often an important aspect of social studies education. In a sense, then, this chapter is about research on the use of technology in a domain where those technologies are an important and featured aspect of the curriculum. As the authors note, the primary purpose of social studies is to help students develop into responsible citizens able to make informed and reasonable decisions. In an important sense, then, this notion of civic competence involves, among other things, developing twenty-first century skills. Because social studies as a discipline is relatively young, and because the knowledge and skills involved in becoming a responsible citizen change rapidly, research in this area is particularly interesting but often challenging, as the authors note. As in other domains, there is a movement away from teacher-centered approaches to more student-centered approaches.

The chapter by Lockee and Wang on visual arts education addresses the fact that images represent a long-standing aspect of being a person and play a central role in culture and society (dating back to petroglyphs and now evident in such forms as Facebook and YouTube). Given the centrality of images and visual representations, the importance of visual arts education should be obvious. Modern digital learning environments benefit significantly from the images and other media included almost as a necessity to support learning or as direct objects of learning. This chapter provides a short history of visual arts education and then treats in detail the influence of digital technologies in the visual arts. The twenty-first century skills discussed in the previous chapter on social studies education certainly include skills related to interpreting visual representations. This chapter goes further by discussing how to develop skills in creating visual representations for a variety of purposes, and what research on visual arts education, which is still in its infancy, has shown.

The final chapter in this section by Connor, Goldman, and Fishman addresses research on technologies that support students' literacy development from preschool settings through high school. There has been a great deal of research over the years in this area, and technology has come to play a central role in supporting the development of literacy (reading and writing skills). The authors include the role of technology in assessing literacy skills, which is a most welcome addition to the research in this area. Computer-based assessments are common in many domains, and the role of technology in supporting assessments and evaluation is appropriately treated by the authors. The authors also address the important role that technology plays in teacher professional development. Overall, the authors report highly encouraging outcomes, which perhaps should not be a surprise given the long-standing emphasis placed on literacy development in the form of training, research, and technology support.

We believe that this domain-specific research section of the *Handbook* will continue to expand and be an important part of future editions. Educational technology is obviously multidisciplinary (cutting across and being applied in many different domains), inherently interdisciplinary (requiring multiple disciplines for effective design, development, and deployment), and increasingly transdisciplinary (crossing and including multiple disciplines in a holistic manner—a kind of meta-discipline composed of and created within other disciplines) (Spector & Anderson, 2000; Spector, 2012).

References

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* An asterisk next to a reference entry throughout this Handbook indicates a reference that the author(s) considers to be central to the topic.