Editors' Notes

This special issue of *New Directions in Teaching and Learning* presents research that has come from a collaboration among learning scientists, assessment experts, learning technologists, and bioengineering domain experts as part of the VaNTH ERC community. VaNTH, founded in 1999, is the Vanderbilt-Northwestern-Texas-Harvard/MIT Engineering Research Center, funded by the National Science Foundation, which has as its vision the transformation of bioengineering education to produce adaptive experts by developing, implementing, and assessing learning processes, materials, and technologies. Our overall strategy from the onset of this collaboration has been to bring learning scientists, assessment experts, learning technologists, and domain experts together in an integrated effort to develop learning environments centered on challenge-based instruction, with major support from technology. This effort has required a significant rethinking of the structure of knowledge (in our case, bioengineering) and a selection of principles from learning science that are likely to have significant impact on education.

This special issue has seven chapters and one final commentary. There are numerous ways of thinking about how to categorize these seven pieces, including by institution, by use of technology, or by specific domain content. We have decided to use framing that we believe provides significant intellectual leverage as well as addresses some significant issues that currently underlie much of the research in the learning sciences. Specifically, this volume addresses issues of communities of practice, taking content seriously, and K–12 implementation of VaNTH research and practice. In closing, we hear from Ann McKenna, a learning scientist from Northwestern University, on the challenges and benefits of implementing learning-science research at the university level.

We open this issue with the topic of communities of practice. In the first chapter, "The Emergence of a Community of Practice in Engineering Education," by Yifat Ben-David Kolikant, Ann McKenna, and Bugrahan Yalvac, the authors investigated how engineering faculty and learning scientists developed a collective wisdom—shared language, capabilities, and worldview—in order to work together to achieve a common goal of developing course materials in the domain of biomedical engineering. The collaboration

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between learning scientists (LS) and engineering domain experts (DE), though mutually dependent, changed during the module-development process: as domain experts gave access to the learning scientists, the latter coached the former through educational research until the domain experts could begin to play more active roles in the educational researcher community of practice. Chapter Two, "Desegregated Learning: An Innovative Framework for Programs of Study," by Arturo A. Fuentes, Robert Freeman, Stephen Crown, Javier Kypuros, and Hashim Mahdi, defines desegregated learning and presents a framework for a mechanical engineering program in which integrative student learning experiences are discussed. Desegregated learning, as the authors explain, is a goal of reforming engineering education programs through the consideration of desired learning outcomes; student and faculty needs; and optimal desegregation of student and faculty involvement, course content, educational programs and settings, and student and faculty demographics to create engineers who are lifelong learners. The theory and design of this reform as well as a template for enacting it are included in their discussion.

The second topic area in this special issue (Part Two) looks at taking content seriously in learning-science research. This part opens with a chapter titled "The Development of Adaptive Expertise in Biotransport" by Taylor Martin, Anthony J. Petrosino, Stephanie Rivale, and Kenneth R. Diller. The authors use a biotransport course to consider a model for the continuous development of adaptive expertise, with growth along the dimensions of innovation and knowledge. Initial beliefs about adaptive expertise were not predictors of success in developing adaptive expertise, and students made progress along both dimensions of the model. In the next chapter, "Establishing Experiences to Develop a Wisdom of Professional Practice," by Joan M. T. Walker, Sean P. Brophy, Lynn Liao Hodge, and John D. Bransford, the authors evaluated first-year and senior students' perceptions of two types of instructional materials focused on engineering professionalism. Although seniors generated more examples in one of the tasks, there was a treatment effect only for first-year students. The role of experience in learning about professionalism is discussed, with particular emphasis on how educational materials may be tailored to meet the needs of first-year and advanced undergraduates. The last chapter in this section is by Bugrahan Yalvac, H. David Smith, Penny L. Hirsch, and Gülnur Birol, titled "Teaching Writing in a Laboratory-Based Engineering Course with a 'How People Learn' Framework." The authors discuss the effectiveness of a How People Learn (HPL) framework used in a laboratory-based tissue-engineering module designed in part to improve students' written communication skills without compromising content-knowledge instruction. HPL modules allowed both content and writing to be taught concurrently and in a meaningful way, such that students saw changes in their writing, saw reason for their writing, and wrote better than did those in the control group.

A significant aspect of the VaNTH ERC effort has been focused on the application, creation, and adaptation of bioengineering modules for use in middle- and secondary-school settings. Part Three focuses on this aspect. It leads off with Chapter Six, "Learning Content Using Complex Data in Project-Based Science: An Example from High School Biology in Urban Classrooms," by David E. Kanter and Melissa Schreck. The authors explore the extent to which project-based science (PBS) curricula designed with scaffolds for students' inquiry into complex scientific data can help urban students make sense of such data and promote their deep understanding of standards-based content. Using a mixed-methods approach to evaluate the implementation of "Disease Detectives," a PBS high school biology curriculum, the authors found that students learn standards through inquiry and even can perform near transfer tasks, indicating deep learning, especially when scaffolds are provided. Because there was a differential effect in which initially higher-scoring students exhibited greater gains, further research is needed to determine how to close this gap. The second chapter in this section, Chapter Seven, is by Stacy S. Klein and Melissa J. Geist. In their chapter, "The Effect of a Bioengineering Unit Across High School Contexts: An Initial Investigation in Urban, Suburban, and Rural Domains," the researchers discuss the implementation and assessment of a high school-level bioengineering curriculum unit in urban, suburban, and rural settings. Rural students have less access to innovative curriculum, and rural students have been less well studied; thus, the authors investigated to what extent such a curriculum would be effective. The rural students reached the same gains as the other groups, except on tests of transfer, in which they underperformed compared to their more urban counterparts.

Finally, we hear from Ann McKenna on "Implementing Learning-Science Research in University Settings: New Research Opportunities." In this chapter, McKenna highlights some specific differences in faculty, students, and subject matter encountered between K–12 and higher-education settings as a way to provide a context for several research studies under way in engineering education.

We believe that this is an especially exciting time for the learning sciences. Within the past decade we have seen the creation of the International Society of the Learning Sciences (ISLS) and the establishment of two international conferences: International Conferences of the Learning Sciences (ICLS) and the International Conference on Computer-Supported Collaborative Learning (CSCL), as well as two internationally known journals, the *Journal of the Learning Sciences* and the *International Journal of Computer-Supported Collaborative Learning*. Moreover, due in part to the National Science Foundation funding of Science of Learning Centers (SLCs), and visionaries in the field that preceded such funding, the learning sciences is now a part of an increasing number of university programs and research groups, including Indiana University, Northwestern University, Vanderbilt

University, Stanford, Georgia Tech University, the University of Washington, and The University of Texas at Austin. Our hope is that this volume will contribute to this growing field of research.

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