Cambridge Handbook of Engineering Education Research

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Abstract

Review
The Cambridge Handbook of Engineering Education Research (CHEER) is written by a number of the most respected researchers in the field of engineering education research. It is edited by Aditya Johri from Virginia Tech and Barbara Olds of the Colorado School of Mines and NSF. Contributing authors run the gamut of big names in all aspects of engineering education research. The book begins with an overview of engineering education development by Jeffrey Froyd and Jack Lohmann. This beginning puts the material in the rest of the book into context, explaining the history of the fields’ development along with the major factors that have contributed to the growth of engineering education as a scientific field of inquiry. This chapter mentions, briefly, the world-wide history of the field, but concentrates primarily on its development within the United States.

The remainder of the book is divided into six sections covering important aspects of the field. At a total of over 700 pages, the book provides a great deal of information in the basics of each different aspect, the current state of the art in each area, and open research questions that still need to be answered. Each section has authors that are the current authorities in these fields and a rich bibliography that provides the background information and theories in more detail than can be covered in the text itself. I personally

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bought the Kindle edition of this book to allow me to easily carry the book around and read different chapters as my interest and needs arose. The Kindle edition is well set up for following different cross-references and still being able to get back to where you were after you have explored a tangent.

The remainder of this review discusses the six major sections of the book. These sections are based loosely on the results of interdisciplinary colloquia as reported in an October 2006 issue of the Journal of Engineering Education (“The Research Agenda for the New Discipline of Engineering Education,” 2006). Some of these sections I have read and explored in detail and others I have not. There is a wealth of information in this book and it will likely take years to fully explore it all.

The first section of the book explores issues around “Engineering Thinking and Knowing.” This section focuses on defining what it means to “think like an engineer” in current and future social contexts. This section provides an introduction to learning theories that help researchers define what it means to know and learn engineering principles. It contains the basics of behavioral theories that help to frame the design of engineering curricula and courses to effectively convey these engineering principles to students. Chapters on Learning Theories, Situative Frameworks, and the Social Nature of Representational Engineering Knowledge provide the theoretical background that leads into a chapter that provides an overview of current misconceptions about engineering education and provides a background for theory-based approaches to change. This is followed by a chapter that discusses the problem-solving nature of engineering and presents arguments about the structured nature of most classroom problems versus the unstructured nature of real engineering problems. The section concludes with a chapter that argues that more research is needed to understand professional engineering work in order to better design engineering curricula that can prepare students for the workplace.

The second section of the book focusses on approaches to engineering education that have been advocated over the years as the field has emerged. The chapters in this section cover topics that are likely familiar to engineering education practitioners who have attended the ASEE annual conferences, Frontiers in Education, or other engineering education conferences. Chapters include Problem- and Project-Based Learning, the use of case studies to motivate learning, and issues related to teaching and using engineering design.

The third section, entitled “Pathways Into Diversity and Inclusiveness,” begins with a chapter that discusses the concept of “Engineering Identity” and the theories that explain the development of this identity as well as its impact on student persistence in the field. Additional chapters discuss the myriad pathways that lead individuals into (and out of) engineering careers. There are also chapters that focus on the specific issues faced by women and minorities in these career pathways. This section concludes with a chapter focusing on community engagement and service learning as opportunities to increase both retention and diversity within the engineering student body.

Part four examines practices in engineering education and engineering education institutions that influence student learning and engineering education research. The first chapter in this section discusses the issues related to the acceptance of engineering education research as a
legitimate scientific field. It discusses the continuing problem with institutional cultures that still do not recognize this field as a legitimate research field for faculty with a research expectation for promotion and tenure. Other chapters in this section present a background on teaching practices and faculty development that have existed in engineering education. It makes the case that the increasing focus of higher education on outcomes-based accreditation, the increasing need for more graduates and the maturation of the engineering education research field makes the need for faculty development (or Instructional Development as it is referred to in this section) all the more important for engineering institutions.

The fifth section presents information on the methodologies and assessments that are part of the engineering education research practice. The chapters present information on the conceptual frameworks that are commonly used to guide education research. Qualitative and mixed methods are commonly used in engineering education research but may not be well understood by engineering faculty who are more commonly exposed to quantitative methods in their engineering practice. Several chapters discuss the importance of these methods to the field. This section ends with a chapter that presents the theory behind the design of effective assessment methodologies for the different types of assessment that are typically used within engineering education and gives an example of analyzing a concept inventory using these underlying validity theories.

The final section presents a set of diverse issues that are cross-cutting. Many of these equate to some of the softer skills that are defined in both The Engineer of 2020 as well as the ABET criteria for accreditation of engineering programs. These include issues such as communication, global and societal issues, and interdisciplinary engineering.

The concluding chapter of the book brings together the issues discussed throughout and makes recommendations for educational policy makers for the future.

All-in-all, this book provides a current snapshot of the state of engineering education research, its history as well as the unanswered questions that need to be addressed. It provides, in one resource, a wealth of information for the field and is a valuable resource for individuals and organizations who wish to make a contribution in this field.

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Reference