CHEER: Conception and Beyond

A Recollection by Aditya Johri

> I like to remember things my own way ... How I remembered them. Not necessarily the way they happened. (Fred Madison (Bill Pullman) / Lost Highway (1997))

Conception

In August of 2009, I received an email from Barbara Olds inviting me to co-author a journal article on "Engineering Student Learning". The article was published in the centennial issue of the *Journal of Engineering Education* in 2011 with a new title "Situated Engineering Learning". CHEER grew out of this collaboration between the co-editors[1].

While working on the JEE article we thought we'd engage the community some more as there was little work on this topic (engineering learning); specifically, there was a paucity of articles that engaged with research coming out of the Learning Sciences. This motivated us to organize a workshop at the 2010 ICLS Conference in Chicago[2]. Our goal was to get together a group of folks that could talk about their own research but also be interested in pursuing joint publications so that, maybe, we can get them to write pieces together for a special issue of JEE that synthesizes their work. Although the submitted papers at the workshop were of interest and of good quality, and we did later bring out a special issue of JEE that included some of the papers, our goal of having review sort of papers didn't work[3]. I was interested to see this kind of an anthology because my experience teaching the Foundations of Engineering Education course at Virginia Tech had made me realize that a cohesive body of work for a field was missing. Scholars had not yet taken the time to synthesize the knowledge within the field. I also knew that such a volume could be incredibly useful as I regularly used the *Cambridge Handbook of Learning Sciences* (CHLS) in my research.

At a chance meeting with Peter Gordon, an editor at Cambridge University Press (CUP), at ASEE that year I proposed the idea of a handbook and he was open to the idea and said that he would be happy to look at a book proposal. Barbara and I were both attending ICLS and we had additional discussions there, including a conversation with Jack Lohmann, who was the JEE editor, and he supported the idea fully. It was important to have his input because as editor of JEE at that time he was well aware of the terrain, in terms of authors, reviewers, and what was in the pipeline or not. He mentioned that he didn't think that this kind of work, review papers, will make it into JEE anytime soon as the centennial issue was already underway. He further suggested that we can include some of the papers from the special issue, if we so wish, in the edited volume and that ASEE will be happy to give us the copyright. Also present at the ICLS meeting was Keith Sawyer who had edited the *Cambridge Handbook of Learning Sciences* (CHLS) not very long ago. Keith was extremely helpful and not only shared his experience of editing the CHLS but was also kind enough to share the book proposal he had submitted. He also suggested that we form an Advisory Board to help give us advice, and legitimacy. Consequently, as we started work on the book proposal we got on board

[1] Johri, A. & Olds, B. (2011). Situated Engineering Learning: Bridging Engineering Education Research and the Learning Sciences. *Journal of Engineering Education*, 100(1):151-185.

[2] International Conference of Learning Sciences (ICLS) organized biannually by the International Society for Learning Sciences (ISLS), http://www.isls.org

[3] Johri, A., Roth, W-M., and Olds, B. (2013). Representations in Engineering Practice: Taking a Turn Towards Inscriptions (Introduction to the Special Issue). *Journal of Engineering Education*, 102(1): 2-19.

Jack Lohmann, Wendy Newstetter, Karl Smith, and R. Keith Sawyer as advisory board members. They all looked at the book proposal draft and gave comments/feedback.

At CUP, and other university presses, book proposals are reviewed externally by multiple scholars in the field. We submitted the first draft of the proposal in October 2010 and received multiple reviews. The reviews were not all flattering; at least one of them questioned the need for a handbook and the reviewer wondered why anyone would need such a volume or read it. There were also concerns with over representation of proposed authors from Purdue and Virginia Tech. We addressed the reviewers' concerns the best we could but given the strong support of Peter, and other reviewers, and the fact that similar handbooks had done good business in the past, we finally received and signed an agreement for the handbook in December 2010. Such contracts are, of course, non-binding on both parties but the norm is that in good faith the editors will work on putting the volume together and that CUP will publish it.

Process

We sent out the first round of invites in March 2011 and the book was finally published in February 2014; it took around three years from the start of the process to finished product. This is not uncommon for a volume of this magnitude but if everything had worked out smoothly, which almost never happens, our timeline was closer to two years. When we sent out the invites we had suggested this aggressive timeline as we knew things will be slower than what we proposed but we also realized the need for such a volume and wanted it published as soon as possible.

Briefly, the process was as follows. We sent out invitations to authors for chapters but we only sent the invitation to one author per chapter. We suggested names of potential co-authors, based on our understanding of the field, but we gave the primary author the discretion of selecting the co-authors. We also suggested that no chapter should have more than four authors. Our book proposal and email specified that the chapters should be around 8,000 words in length and we believed that a manuscript of this length did not need more than four authors. We gave authors some leeway in how they wanted to address a given topic.

After receiving acceptances from authors, we then started the process of giving additional guidelines to authors as well as providing them information about the overall volume. Throughout this process the "table of content" shifted as some authors were unable to contribute for one reason or another. At one point we had 22 chapters in the TOC and we finally ended up with more than 30. Each draft manuscript was assigned 2 to 3 reviewers that included other co-authors as well as external reviewers we recruited for their expertise. At that time I was also teaching the Foundations course at VT and I used the expertise in the classroom to also get feedback on the chapters. Chapters went through multiple rounds of reviews and a lot of them had to be revised substantially. We also had to add a few chapters or get new authors since we wanted to have as broad a coverage as possible but the submissions we had were not enough (both in quality and quantity).

Once all the chapter drafts were in a good shape we started to engage our editor more closely in the process so that he could start the copy-editing process. We had given authors a general framework for formatting the paper, they had to follow APA guidelines, but there were some differences across the papers. Before papers went into production they had to be in a specific format. In addition to formatting, the other big issue that emerged at this point was creating an index for the book. This process was complex not just from the perspective of the length of the book and the amount of text but also from the perspective of what to include and/or exclude. After numerous negotiations, we asked the authors themselves to highlight words in their chapter they thought should be indexed.

Our editor was good enough to create a rough index based on that and then we went through it to delete redundant words but more important to provide some form of cohesion when multiple similar looking words appeared in the index.

Coverage, Audience, and Authorship

More than the process issues, which appear disproportionately important to the editors because of the work involved, the issue with a lot more significance and consequence for the field is what was included, what was left out, and what are the implications of this? Integral to the '*what*' issue is also the issue of *'who'* was included or excluded and how these decisions were made. I now present my view point on this.

For both pragmatic and political[4] reasons, we decided early on to select themes based on the research agenda developed for engineering education through a series of interdisciplinary colloquia funded by the U.S. National Science Foundation and published in the *Journal of Engineering Education* in October 2006. The Colloquies represented significant effort on part of the community, starting in early 2000 and represented a cohesive and agreed upon agenda for the field. They already had some buy in from the community and were also inherently a good way to categorize the topics and provide some form of taxonomy for the handbook. As we sent out invites and got authors on board, things morphed a bit and some chapters changed. There were also some topics that we thought were not covered well and therefore we added a sixth section on Cross-Cutting Issues. Appendix A, B, & C, provide an overview of the list of topics from inception till final proposal.

There is a bias in the coverage given the leanings we have as editors, especially my bias towards focusing more on issues of learning. Engineering education research has focused a lot on what are traditionally administrative issues often discussed in higher education administration and not on learning per se and like any new field a lot of emphasis is on looking at the field itself (navel gazing as a colleague in another field puts it). I also wanted some coverage of the history of the field and we both wanted international authors. There is a U.S. bias in the field, as in most research across the planet, and we wanted to balance this as much as possible. We tried to balance all these issues while using the colloquies framework.

As we sent out the invitations to authors, a big question came up – who is the intended audience for the book? As part of our proposal we had of course included details on the audience but that was from the perspective of who all might buy this book. The authors wanted to know who they should write for – other scholars, graduate students, or disciplinary engineering faculty members. I think this is an issue with which even the journals in the field grapple. Defining boundaries is never easy. We made the decision that we will not limit ourselves to one specific audience but have chapters that addressed multiple audiences or at least as a volume have enough chapters that multiple audiences will be interested in reading them. From my own personal experience I really wanted the volume to help newcomers to the field, which included both graduate students and engineering faculty who were new to engineering education research. I also wanted the volume to be a conversation within the engineering education researchers so that the volume could help move the field forward.

The selection of authors for the most part was not too problematic once we had selected the topics. We both knew who were the major players with expertise, Barbara more than I, and we sent an invite to them. Choice of authors is always a political move as there are many more scholars

[4] I don't mean politics which is on fine display by our so-called leaders but as the art of influence/influencing.

working in an area and often due to epistemological and ontological differences they do not work together. We had also decided early on that we will not favor or discourage any particular worldview as long as the author did work in that area. Also, although we suggested co-authors to the primary author, they made their own decision about who they wanted to work with. We were acutely aware that we cannot possible know all the dynamics within the community, nor did we particularly care, and therefore it was best not to interfere too much with author choices. In some instances even though we knew the authors were not easy to work with we persevered with them given their expertise in the area. Initially, we wanted to avoid multiple chapters by an author but we realized that authors prefer certain co-authors so we dropped that restriction. We also realized that some authors are in demand because they actually get the writing done.

Reflections

Reflecting back on the handbook coverage, I have mixed feelings. I think overall the handbook does a great job but there are certain areas of omission that stand out. Topics such as motivation, teamwork and collaboration, which are integral to engineering learning and education, are not covered. There is no chapter on K12 engineering education. I wish there were more hands on guidance for doing research (I added a chapter written in haste but it is not sufficient) and many emerging topics such as data mining and learning analytics are completely missing. One can argue that there is not sufficient work in those areas yet worthy of a chapter. Policy is another area that needs coverage and I'm sure others can think of other areas.

Working on the handbook also proved to be a lesson on building research capacity. Often, when we think of research capacity we think of infrastructure and other resources but this effort made me think in terms of expertise and quality of work. It also made me think of stagnation in the field, in terms of topics, and how important and difficult it is to keep a social science field vibrant. ENGE is not alone in grappling with these issues; I participate in multiple communities and they are all perennially in flux and constantly in conversation about the future. Essentially, what matters in the long run is impact and measure not just but high quality and highly cited research but also by creation of something new. That new thing can be an artifact, a new way of thinking, new institutions, newly trained workforce, and so on. I think this is where the community has been lacking. Most studies latch on to or appropriate a theoretical idea from psychology or sociology but contribution back is missing. Maybe this is normative nature of the field – utilization of ideas to improve practice.

The uptake of the volume has been interesting. The chapters are getting cited, and I assume they are being read, with over a 100 citations in the last year itself. More interestingly though is what is being read. One of the chapters that have found a lot of favor was in fact the hardest to make it through the reviewers. Even till the end the reviewers felt it was a bad chapter that needed to be not included.

Personally, it has been a rewarding experience as I learned a lot about the field. I also got to work with fabulous people some of whom I still have not met. I was also amazed by the responsiveness of some of the top scholars in the field – they were always on time with everything and their work was of top quality.

APPENDIX A

List of topics

Foundations

1. Historical overview
2. Engineering learning: How People Learn Engineering
3. Design (Thinking and Doing)
4. Conceptual difficulties
5. STS issues
6. Representations
7. Technology?
8. Engineering Education in the Disciplines (Mech, Chem, etc.)
9. Philosophical perspectives

Settings of Learning

10. Professional practice/workplace
11. K-12
12. Kits/Museums
13. Informal/Formal
14. First year programs
15. Graduate education
16. Research laboratories
17. REU kinds of experiences (EWB) (DESIGNED EXPERIENCES)

Applied Issues

18. Global and international issues
19. PBL
20. MEA
21. Concept Inventories, Concept maps
22. Ethics
23. Capstone design (Design experiences)
24. Motivation, Persistence and Retention
25. Identity
26. Gender
27. Learning Styles and Other taxonomies (Felder stuff)
28. Adaptive expertise
29. Service learning
30. Advising
31. Remote laboratories
32. Active learning; Projects, Use of case studies
33. Professional skills: Communication/team work
34. Interdisciplinarity

Methodological Issues

35. Quantitative Methods
36. Qualitative and Ethnographic Methods
37. Large scale data mining (MIDFIELD etc.)

Assessment and Evaluation

38. Assessment
39. Portfolios

Emerging Areas

40. Creativity/Innovation/Entrepreneurship
41. Cyberinfrastructure

Sections

1. Foundations
2. Applied Ideas/Analytical Framework
3. Active Learning Environments
4. Design
5. Across the Lifespan
6. Methodology
7. Technology
8. Assessment, Evaluation and other such issues

Accessible language; Practice toolkit; Research overview

APPENDIX B

Chapter 1. Introduction: Research on Engineering Education.

Part 1. Engineering Epistemologies

Chapter 2. Engineering identity
Chapter 3. Engineering education vs engineering workplace
Chapter 4. Beliefs about engineering careers
Chapter 5. Self-efficacy

Part 2. Engineering Learning Mechanisms

Chapter 6. Misconceptions
Chapter 7. Domain-specific learning
Chapter 8. Expert-Novice (Adaptive Expertise)
Chapter 9. Engineering Identity

Part 3. Engineering Learning Systems

Chapter 10 Research to practice
Chapter 11 Learning theories applied to engineering education (several papers?)
Chapter 12 Learning environments (including technology)
Chapter 13 Faculty beliefs and assumptions

Part 4. Engineering Diversity and Inclusiveness

Chapter 14. Women in engineering
Chapter 15. Minorities in engineering
Chapter 16. The engineering education culture and how to change it
Chapter 17. Learning from other disciplines

Part 5. Engineering Assessment (Promising Methodologies?)

Chapter 18. Beyond ABET
Chapter 19. Design research
Chapter 20. Assessing design
Chapter 21. Assessing teamwork

Chapter 22. Conclusion and Challenges.

APPENDIX C

Chapter 1. Introduction: Research on Engineering Education.

Part 1. Engineering Thinking and Knowing

This section will focus on basic theoretical work that examines the epistemology of engineering from different perspectives. Central to this section are issues such as what does it mean to be an engineer, what does it mean to learn and practice engineering, and what kinds of activities constitute engineering? This section will introduce readers to influential and foundational topics in engineering education research. These approaches have significant literature to draw on.

Chapter 2. Engineering identity

Chapter 3. Engineering education across school and the workplace

Chapter 4. Beliefs about engineering careers

Chapter 5. Self-efficacy

Chapter 6. Engineering design

Chapter 7. The nature of engineering knowledge: Representational and cognitive practices

Part 2. Engineering Learning Mechanisms

This section will focus on topics related to engineering learning that have been documented to be of particular importance and have attracted significant research.

Chapter 8. Misconceptions

Chapter 9. Conceptual change

Chapter 10. Expert-Novice differences and adaptive expertise

Chapter 11. Social shaping of engineering learning

Chapter 12. Individual differences, learning taxonomies, and beyond

Part 3. Engineering Education in Practice

Engineering education research is oriented towards practice but even this approach is evidence based and guided by theoretical foundations. Chapters in this section will review the translation from research into practice and its multi-faceted dimensions.

Chapter 13. Translating research to practice

Chapter 14. Learning theories applied to engineering education

Chapter 15. Engineering learning environments (formal and informal)

Chapter 16. Faculty beliefs and assumptions about engineering education

Chapter 17. Engineering learning trajectory (k-12, undergraduate, graduate, and lifelong)

Chapter 18. Use of technology in engineering education

Part 4. Pathways into Diversity and Inclusiveness

Significant scholarship in STEM and engineering education in particular has focused on issues of diversity and inclusiveness. These have become not just opportunities to increase participation but occasions for scholarship that examine these ideas from multiple perspectives.

Chapter 19. Motivation, persistence and retention

Chapter 20. Social justice and inclusion: women and minorities in engineering

Chapter 21. Engineering disciplinary cultures and how to change them

Chapter 22. Lessons from efforts in science, mathematics and technology education

Part 5. Research Methods & Assessment

This section will review research methods and assessment issues relevant to engineering education research.

Chapter 23. Beyond ABET

Chapter 24. Design-based research

Chapter 25. Assessing learning

Chapter 26. Assessing teamwork

Chapter 27. Emerging Methods

Part 6. Cross-Cutting Issues

This section will review assorted topics that are of significance from a practical standpoint but also from a theoretical perspective as they review important work and also suggest future directions.

Chapter 28. Creativity, innovation, and entrepreneurship

Chapter 29. Engineering communication

Chapter 30. Project and Problem Based Learning (PBL)

Chapter 31. Global and International issues

Chapter 32. Engineering ethics

Chapter 33. Engineering studies

Chapter 34: Cyberinfrastructure for engineering education

Chapter 35: Interdisciplinarity

Chapter 36: Computing Education

Chapter 37.* Final Chapter. Conclusion and Challenges.