Problem-Based and Project-Based Learning in Engineering Education

Merging Models
Kolmos, Anette; de Graaff, Erik

Published in:
Cambridge Handbook of Engineering Education Research

DOI (link to publication from Publisher):
10.1017/CBO9781139013451.012

Publication date:
2014

Document Version
Early version, also known as pre-print

Link to publication from Aalborg University

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

? Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
? You may not further distribute the material or use it for any profit-making activity or commercial gain

Take down policy
If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from vbn.aau.dk on: May 30, 2019
Contents

Editors  page xiii
Contributors xv
Foreword xxv
Norman L. Fortenberry
Acknowledgments xxvii

Introduction  1
Aditya Johri and Barbara M. Olds

1. Chronological and Ontological Development of Engineering Education as a Field of Scientific Inquiry  3
Jeffrey E. Froyd and Jack R. Lohmann

PART 1
ENGINEERING THINKING AND KNOWING

2. Learning Theories for Engineering Education Practice  29
Wendy C. Newstetter and Marilla D. Svinicki

3. Situative Frameworks for Engineering Learning Research  47
Aditya Johri, Barbara M. Olds, and Kevin O’Connor

4. The Social Nature of Representational Engineering Knowledge  67
Wolff-Michael Roth
5. Conceptual Change and Misconceptions in Engineering Education: Curriculum, Measurement, and Theory-Focused Approaches ................................. 83
   Ruth A. Streveler, Shane Brown, Geoffrey L. Herman, and Devlin Montfort

6. Engineers as Problem Solvers ................................. 103
   David H. Jonassen

7. Professional Engineering Work .................................................. 119
   Reed Stevens, Aditya Johri, and Kevin O’Connor

PART 2
ENGINEERING LEARNING MECHANISMS AND APPROACHES

8. Problem-Based and Project-Based Learning in Engineering Education: Merging Models ................................. 141
   Anette Kolmos and Erik de Graaff

9. Case Studies in Engineering .................................................. 161
   Claire Davis and Aman Yadav

10. Curriculum Design in the Middle Years ................................. 181
    Susan M. Lord and John C. Chen

11. Engineering Design Education: Research, Practice, and Examples that Link the Two .................................................. 201
    Cynthia J. Atman, Ozgur Eris, Janet McDonnell, Monica E. Cardella, and Jim L. Borgford-Parnell

12. Adaptive Expertise and Knowledge Fluency in Design and Innovation .................................................. 227
    Ann F. McKenna

    Kristen Bethke Wendell and Janet L. Kolodner

PART 3
PATHWAYS INTO DIVERSITY AND INCLUSIVENESS

14. Engineering Identity .................................................. 267
    Karen L. Tonso

15. Studying the Career Pathways of Engineers: An Illustration with Two Data Sets .................................................. 283
    Sheri D. Sheppard, Anthony Lising Antonio, Samantha R. Brunhaver, and Shannon K. Gilmartin

16. Retention and Persistence of Women and Minorities Along the Engineering Pathway in the United States .................................................. 311
    Gary Lichtenstein, Helen L. Chen, Karl A. Smith, and Theresa A. Maldonado

17. Social Justice and Inclusion: Women and Minorities in Engineering .................................................. 335
    Donna Riley, Amy E. Slaton, and Alice L. Pawley
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Community Engagement in Engineering Education as a Way to Increase Inclusiveness</td>
<td>357</td>
</tr>
<tr>
<td></td>
<td><em>Christopher Swan, Kurt Paterson, and Angela R. Bielefldt</em></td>
<td></td>
</tr>
<tr>
<td><strong>PART 4</strong></td>
<td><strong>ENGINEERING EDUCATION AND INSTITUTIONAL PRACTICES</strong></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Translating Research to Widespread Practice in Engineering Education</td>
<td>375</td>
</tr>
<tr>
<td></td>
<td><em>Thomas A. Litzinger and Lisa R. Lattuca</em></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Research-Guided Teaching Practices: Engineering Threshold Concepts as an Approach to Curriculum Renewal</td>
<td>393</td>
</tr>
<tr>
<td></td>
<td><em>Sally A. Male and Caroline A. Baillie</em></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Engineering Instructional Development: Programs, Best Practices, and Recommendations</td>
<td>409</td>
</tr>
<tr>
<td></td>
<td><em>Richard M. Felder, Rebecca Brent, and Michael J. Prince</em></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Understanding Disciplinary Cultures: The First Step to Cultural Change</td>
<td>437</td>
</tr>
<tr>
<td></td>
<td><em>Elizabeth Godfrey</em></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Preparing Engineering Educators for Engineering Education Research</td>
<td>457</td>
</tr>
<tr>
<td></td>
<td><em>Maura Borrego and Ruth A. Streveler</em></td>
<td></td>
</tr>
<tr>
<td><strong>PART 5</strong></td>
<td><strong>RESEARCH METHODS AND ASSESSMENT</strong></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Studying Teaching and Learning in Undergraduate Engineering Programs: Conceptual Frameworks to Guide Research on Practice</td>
<td>477</td>
</tr>
<tr>
<td></td>
<td><em>Lisa R. Lattuca and Thomas A. Litzinger</em></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Design-Based Research in Engineering Education: Current State and Next Steps</td>
<td>497</td>
</tr>
<tr>
<td></td>
<td><em>Anthony E. Kelly</em></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Quantitative and Mixed Methods Research: Approaches and Limitations</td>
<td>519</td>
</tr>
<tr>
<td></td>
<td><em>Barbara M. Moskal, Teri Reed, and Scott A. Strong</em></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Framing Qualitative Methods in Engineering Education Research: Established and Emerging Methodologies</td>
<td>535</td>
</tr>
<tr>
<td></td>
<td><em>Jennifer M. Case and Gregory Light</em></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Conducting Interpretive Research in Engineering Education Using Qualitative and Ethnographic Methods</td>
<td>551</td>
</tr>
<tr>
<td></td>
<td><em>Aditya Johri</em></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>The Science and Design of Assessment in Engineering Education</td>
<td>571</td>
</tr>
<tr>
<td></td>
<td><em>James W. Pellegrino, Louis V. DiBello, and Sean P. Brophy</em></td>
<td></td>
</tr>
</tbody>
</table>
# PART 6
## CROSS-CUTTING ISSUES AND PERSPECTIVES

30. Engineering Communication  
   *Marie C. Paretti, Lisa D. McNair, and Jon A. Leydens*  
   601

31. Use of Information Technology in Engineering Education  
   *Krishna Madhavan and Euan D. Lindsay*  
   633

32. Global and International Issues in Engineering Education  
   *Aditya Johri and Brent K. Jesiek*  
   655

33. Engineering Ethics  
   *Brock E. Barry and Joseph R. Herkert*  
   673

34. The Normative Contents of Engineering Formation: Engineering Studies  
   *Gary Lee Downey*  
   693

35. Interdisciplinarity in Engineering Research and Learning  
   *Nancy J. Nersessian and Wendy C. Newstetter*  
   713

Conclusion: Engineering at the Crossroads: Implications for Educational Policy Makers  
   *John Heywood*  
   731

*Index*  
   749