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Book Review: Improving How Universities Teach Science: Lessons from the Science Education Initiative

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Weiman, C. (2017). *Improving how universities teach science: Lessons from the science education initiative*. Harvard University Press. <https://doi.org/10.4159/9780674978911>

Discipline-based education research (DBER) has consistently revealed that traditional lecture methods for teaching undergraduate science, technology, engineering, and mathematics (STEM) are ineffective for facilitating deep learning, long-term retention, and application of information. In *Improving How Universities Teach Science: Lessons from the Science Education Initiative*, Carl Weiman (2017), a professor of physics and education at Stanford University, suggests that improving undergraduate STEM education at research-intensive universities is limited because faculty are either unaware of effective evidence-based pedagogy, have restricted time to learn novel practices, or are not provided with direct incentives for enhancing their teaching. Moreover, when efforts for improving science education are initiated, they often involve individual faculty working in isolation and their instructional materials are difficult to sustain with frequent changes to teaching assignments. How can universities, therefore, establish large-scale implementation of DBER to ultimately improve teaching and learning of undergraduate STEM?

This 265-page text provides a clear and systematic description of how Weiman addressed this question at two large research universities through the implementation of the Science Education Initiative (SEI). Exceptionally well-organized, this six-chapter publication details how the SEI used a competitive one-time grant funding model to facilitate the transformation of over 200 courses across multiple STEM departments at the University of British Columbia and Colorado University. It also strategically outlines the major lessons learned from the program, common roadblocks that were encountered, and practical advice for adopting similar initiatives at other post-secondary institutions. While this book is therefore directly intended for university faculty and administrators who are interested in improving the quality of undergraduate STEM education, the findings reported from the SEI may also be equally informative for professors and university leaders from any discipline who aim to create large-scale improvements of their academic programs. Graduate students and faculty from any field with a specific interest in scholarship in teaching and learning (SoTL) will also benefit from this book as it presents several experimental tools, appendices, and resources for initiating evidence-based studies in diverse disciplines.

The initial sections of this publication focus on the rationale, vision, and model of the SEI. Central to the SEI was its focus on the academic department as the entity for promoting large-scale change in STEM education as it is the structural unit within research-intensive universities that define the curriculum and organization of undergraduate science programs. Through a competitive grant program, SEI-funded departments were called to progressively transform their courses over a six-year period in order to adopt DBER methods of instruction and assessment. One of the major successes of the SEI, and of interest for those pursuing careers in undergraduate pedagogy, was the departmental use of SEI funds to hire Science Education Specialists (SEs). SEs were PhD graduates with expertise in the departmental discipline and undergraduate pedagogy who worked collaboratively with faculty to facilitate course transformations by asking three key questions: “What should students learn? What are students learning? What instructional practices will improve student learning?” (p. 68). SEs also helped faculty to identify measurable course learning goals which, in several cases, allowed education specialists to conduct quantitative studies to assess the efficacy of SEI efforts. In regard to the latter, Weiman presents representative examples of over 120 SEI-based studies that measured the impact of the initiative on pedagogical outcomes such as student learning, course evaluations, and application of research-based instructional

practices. Faculty interested in SoTL will likely draw inspiration and practical advice from this discussion (particularly on the unique lessons learned from the SEI ethics approval process) on how to conduct similar studies at their home institution. In addition to SoTL, readers are provided with in-depth appendices that outline practical tips regarding how to initiate comparable course improvements; for example, how to create self-directed learners, practices for promoting student engagement, how to effectively design and deliver in-class activities, and suggestions for promoting course alignment. Appendices also provide departments and faculty with useful examples of advertisements for SES positions, sample questions for conducting SES interviews, and general suggestions for how to interview faculty and students when assessing the educational value of transformed courses.

The latter sections of this book focus on the major findings and challenges of the SEI and provide the reader with practical suggestions about what to do or what to avoid when initiating SEI-related projects. Faculty and administrators interested in implementing comparable initiatives at their institutions will likely find these sections engaging as they do not read simply as a list of static “dos and don’ts,” but rather as an evolving discussion of what aspects of the SEI worked, what elements were ineffective, and what strategies that were employed to overcome unexpected challenges. Of the many lessons learned from the SEI, Weiman discusses strategies for achieving top priorities such as maximizing faculty buy-in, setting specific project timelines and deliverables, providing faculty with direct incentives for improving undergraduate teaching, and enhancing departmental management of SEI efforts.

The overall utility of this publication is therefore two-fold. First, at its most basic level, this text provides individual faculty with evidence-based suggestions on how to improve the design, structure, and implementation of their undergraduate courses within (but not limited to) STEM fields. Second, and more broadly, this publication equips faculty and leaders at research-intensive universities with the fundamental know-how for implementing large-scale changes in their departmental culture in order to improve attitudes and practices regarding undergraduate education. While short-term data reveals that course transformations may be retained over time, it will be interesting to learn whether the educational changes produced by the SEI at both participating institutions will persist in the long-term and, if so, what strategies are applied to facilitate sustainability.

Overall, *Improving How Universities Teach Science: Lessons from the Science Education Initiative* by Carl Weiman (2017) makes an important contribution to advancing the field of undergraduate pedagogy, particularly in the context of Canadian SoTL in higher science education. More specifically, as the SEI was conducted, in part, at the University of British Columbia, its applications may likewise be extended to other research-intensive universities across Canada that exhibit similar departmental structures, traditions, and attitudes toward post-secondary STEM programs. Assessing the efficacy of any future initiatives modeled after the SEI methods suggested in this text may therefore ultimately expand the perspectives and strategies for improving undergraduate science education in Canada and beyond.