Title: The New Age of STEM Teaching and Learning - How active learning, online technologies and research have transformed STEM education."

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Motivation and Summary: This book chronicles the revolution in STEM teaching and learning that has arisen from a convergence of educational research, new technologies, and new ways of structuring both the physical space and classroom activities in STEM higher education. The rise of active learning is transforming the learning gains in physics and other fields, and has been validated by extensive quantitative research. This book chronicles this revolution in science education, with specific and easy-to-use steps for implementing active and peer learning in the classroom. The use of clickers and other technologies in the classroom have revolutionized the student experience in classes in Mathematics, Biology, Physics, Astronomy, and the book provides guides to resources such as clicker quizzes, concept tests, and peer learning activities. New formats such as "flipped" classes and Team Based Learning have been used to increase student performance a wide range of STEM fields, and the book documents these techniques through case studies, quantitative experiments, and descriptions of site visits where these techniques are being used. Entirely new institutions are being created with interdisciplinary and experiential learning at their core, such as Olin College of Engineering and Yale-NUS College in Singapore, and these bold experiments are described through site visits and interviews with their founders. The book also takes the reader into innovative new labs where students are empowered by new technologies such as 3D printing and laser etching to design and create as the centerpiece of their STEM education, such as at Yale's Center for Engineering, Innovation and Design and Stanford's school. Equally innovative are new conceptual frameworks for course design and learning, and the book explores the concepts of Scientific Teaching, Backward Course Design, and Learning Taxonomies in a systematic and easy-to-use way. Finally, the rise of new online courses, MOOCs, SPOCs and blended learning, have upended many of our paradigms of higher education. The book takes the reader into the leading centers for online education, including Udacity, Coursera and EdX, and describes these centers, the visions of their leaders (based on interviews) and gives a sense of how these new technologies are evolving and what this means for STEM education. The book provides an entry point for any STEM faculty adopting the new approaches to teaching science, engineering and mathematics, and includes guides on how to get started with project, team or problem-based learning. The book explains how to design courses using new techniques of scientific teaching, such as backwards course design, with outlines and guides for both techniques. The book is rallying call to faculty who are interested in these new approaches, that also provides a "starter kit" on taking action and becoming part of this new age of STEM teaching and learning.

Table of Contents:

Chapter 2 - *Active Learning and Peer-based Learning.* This chapter would explore the early initiatives in peer and active learning that are in my chapter - the work of Eric Mazur, Tom Moore, and Carl Weimann; with a bit more detail from new work at Colorado and Stanford.

Chapter 3- *Theories of Science Teaching and Learning.* This chapter would expand a bit on my discussion about pedagogy and the various taxonomies of learning, and include new research on psychology and cognition.

Chapter 4 - *Technology-enhanced STEM teaching - blended and flipped classes.* This chapter would include work I am doing now for LACOL, and would summarize some of the very interesting research here at Harvey Mudd College, and elsewhere assessing flipped classes, and discovering the optimal "blended" environment that includes a mix of active learning and online lectures.

Chapter 5 - *Engineering Education Reconsidered.* This chapter would include the work at Olin College and Cal Poly San Luis Obispo, the new Yale Center for Engineering Innovation and Design, and new material on Stanford's school. I also have some notes from conversations with Larry Buccarieli, MIT engineering professor and friend of David Drew's, that I could use.

Chapter 6 - *Experiential Education in Science.* This chapter would include Yale's Microbes to Molecules Course, their Rainforest Course, new courses at Yale-NUS that I have been working on, and other innovative programs for international science education.

Chapter 7 - *MOOCs and online courses in STEM.* This chapter would review the development of MOOCs (drawing some from the existing chapter on this subject), and would point to new developments in MOOCs in STEM - master's degree programs online in Engineering, new courses from Udacity, Coursera and EdX in science and engineering fields (including a review of the SJSU experiment which I know well as I have met with Ellen Junn, their provost). It could include future courses that use virtual experiments, and interfaced robots and science equipment as part of the environment.

Chapter 8 - *The Future of STEM teaching and learning.* This would be a chance to extrapolate 50 years into the future and think about where these present-day innovations are leading us. I could include some of the very interesting work at the dSchool at Stanford, and at MIT that is reconsidering College all together, and how these new ways of structuring classroom and co-curriculum and work experience could create entirely new models for higher education based in STEM fields.

Length: 200-250 pages

Timeline: Should be completed by January 2015!