From: http://www.sciencemag.org/content/339/6126/1359.full

Science 22 March 2013:
Vol. 339 no. 6126 p. 1359
DOI: 10.1126/science.1237223

Two Revolutions in Learning

Susan R. Singer[1,*], William B. Bonvillian[2,†]

CREDIT: SARA RUBINSTEIN; DONNA COVENEY/MIT

The dazzling promise of affordable, high-quality, globally accessible online courses has renewed attention to learning and teaching. The opportunity to realize the full potential of so-called MOOCs (massively open online courses) may reside in a parallel, yet often unconnected, revolution in learning. Applying our understanding of undergraduate learning to online environments will build their educational value, while the scale and speed of data generation from MOOCs can accelerate research on learning.

Approached iteratively, the outcomes can be transformative.
To improve the quality of education, U.S. universities are being called on to use a broader range of research-based practices to enhance student learning in the classroom.* These practices need to be brought to scale online. A 2012 report released by the U.S. National Research Council (NRC) summarizes what we know about undergraduate learning in science and engineering.† Across all sciences, students struggle with fundamental concepts and underlying ideas, at both large and small spatial and temporal

scales. Visual representations are crucial to conceptualizing and communicating science, but students often have difficulty interpreting the models, simulations, and graphs that are key to attaining a true understanding of science domains. And in problem solving, students too often focus on the superficial aspects of a problem, whereas experts know to focus on underlying principles. And yet, for example, research demonstrates that problem-solving skills can be developed through discussion-oriented learning environments where students collaborate, through the use of open-ended, real-world problems, and through tasks that provide students with prompts and guides. These findings must be translated into MOOCs.

CREDIT: BUBAONE/ISTOCKPHOTO

In hybrid models—online plus face-to-face—learning can be accelerated, but there are many open questions. In some "flipped classrooms," students view lectures online in advance of class, with class time reserved for engaging discussions. This strategy has drawn both praise and skepticism. Informing students about concepts and procedures before giving them practice in class undermines the type of learning needed for transferring and applying understanding; students who confront problems before the explanation are better able to use their knowledge in other contexts.‡ Thus, we still have much to learn about learning, both in brick-and-mortar classrooms and in blended or fully online environments. If meaningful learning analytics, informed by research on learning, are used to mine the mountains of online data that can be harvested from MOOCs, we can fill in many important gaps in our understanding. For example, how do students of different backgrounds and ages respond to different instructional strategies? How does learning develop over multiple courses and years, and how can students transfer understanding of cross-cutting concepts across courses? We need to tease apart which aspects of learning require face-to-face teaching, such as the development of expression, presentation, and advocacy skills. Which social features of give-and-take exchanges in the classroom are essential to build student involvement and commitment to learning? When is real “human scaffolding” required for discourse, argumentation, mentoring, and making conceptual leaps? How can online resources enhance the learning-by-doing aspects of research?

Online technology will not stand still; its interactive social and evaluation features will evolve, and the boundaries between online and face-to-face education will shift and affect the answers to such questions. Students will increasingly be learning in both physical and virtual spaces. It's the human-online symbiosis—the right blend of students, teachers, and teams with online capabilities, all informed by advances in learning science—that will be the enabler for a new generation of science learning. Let's not miss the opportunity to transform higher education by effectively integrating the online and learning science revolutions.

References:
* www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf.
† www.nap.edu/openbook.php?record_id=13362.
‡ D. L. Schwartz et al., J. Educ. Psychol. **103**, 759 (2011).

[1]Susan R. Singer is Laurence McKinley Gould Professor of Biology at Carleton College, Northfield, MN, and chair of the NRC's Discipline-Based Education Research study. She served on the NRC's Board on Science Education.
[2]William B. Bonvillian is director of the Massachusetts Institute of Technology's office in Washington, DC, and is on the adjunct faculty of the Science, Technology and International Affairs program, Georgetown University, Washington, DC. He served on the NRC's Board on Science Education.