Stanford | ONLINE

2013 IN REVIEW

Harnessing New Technologies and Methods to Advance Teaching and Learning at Stanford and Beyond

Published May, 2014

Stanford University is pioneering new ways to harness technology to advance teaching and learning at Stanford — and beyond. We are thinking broadly about how we will best educate students in the 21st century, and seeding fundamental changes to higher education.

John Mitchell, vice provost for online learning; Photo: Judith Romero

Stanford has been associated with the advent of massive open online courses (MOOCs), but our efforts to improve teaching and learning are much broader. Experiments in technology-driven and experiential education are occurring in every corner of the university and are strategically led by the Office of the Vice Provost for Online Learning (VPOL).

In the process, we are asking important questions: How can we help students learn more effectively? How can we better leverage classroom time? How can technology enable educators to better meet the needs of particular learners? And we are beginning to answer these questions: Stanford faculty from all seven schools are experimenting with creative uses of technology to improve course material for on-campus students, distance learners in professional education programs and lifelong learners around the world. VPOL is building data-driven research capacity, and faculty and graduate students across campus are conducting research on technology-mediated instruction. A dedicated team of Stanford engineers is collaboratively developing an open-source platform (Stanford OpenEdX) that supports research and experimentation in interactive instructional design. In addition to sharing open-

source platform features and code, VPOL is fostering collaboration with other education organizations by sharing course material and research.

We are proud of our contributions. Since the first three Stanford MOOCs were offered in fall 2011, VPOL has awarded **66 faculty seed grants** and has helped more than **145 faculty** members from all seven schools deliver **246 online courses and blended campus courses** hosted on three different platforms. More than **1.9 million people**, from almost every country in the world, have registered for one or more free public online courses taught by Stanford faculty. And since the fall of 2012, our global community of learners has interacted with Stanford Online courses for more than **4 million hours.**

We've heard very positive feedback from course participants, such as "**Thank you Stanford Online for making the impossible possible."** We also receive requests for information about our technology-enabled learning initiatives from many educational institutions around the world. This report is meant to offer a snapshot of the research–driven approach we are taking at Stanford.

Profiles of Innovation in Teaching and Learning

Faculty/Instructor: Clinical Assistant Professor Kristin Sainani (Health Research and Policy)
Course: *Statistics in Medicine* (MOOC)

Clinical Assistant Professor Kristin Sainani and TA Michael Hurley

Clinical Assistant Professor in Health Research and Policy Kristin Sainani wanted to provide learners with a foundational understanding of probability and statistics. She also wanted to teach them the critical thinking skills they would need to evaluate statistics in medical studies, as well as how to analyze data and avoid common statistical pitfalls with their own research.

With a Faculty Seed Grant from VPOL, she created the *Statistics in Medicine* course, which was initially offered as a flipped course at Stanford — a course in which the typical lecture and homework model are reversed — and then offered to the public as a MOOC.

Sainani incorporated real-world examples from medical literature and the popular press into her content. She began each week with a teaser question about a topic (e.g. "Should you be worried about lead in lipstick?"), and then guided participants through the data to help them learn how to read, interpret and critically evaluate statistics in medical research.

The MOOC was offered as a nine-week course, with one unit of content per week. Each unit contained short instructional videos of narrated PowerPoint slides with digital "inking" that were paired with embedded "knowledge check" quizzes and online homework assignments. The teaching assistants for the course produced a series of supplemental videos in which they demonstrated the proofs for the questions in the embedded quizzes and homework assignments.

When analyzing the course participation data, the instructional design team found that this course maintained a much higher percentage of active users than many other MOOCs. Participant feedback from the course was very positive.

"I am a retired epidemiologist (30+ years ago) and pediatrician (15 years ago). My wife, an oncologist, and I have been spending 3 months a year in Vietnam for the past 7 years teaching medical professionals — in my case teaching epidemiology and research methods. Over the past year I have taken a number of MOOCs as a student, many of them on statistical topics....Your course is one of the best courses I have ever taken on the topics covered, in any format, and is a model for using the MOOC approach specifically. The careful organization, precise and upbeat delivery, and the interrelated mix of theory and application create an ideal learning environment."
   - Course participant

A Rich History of Using Technology to Advance Learning
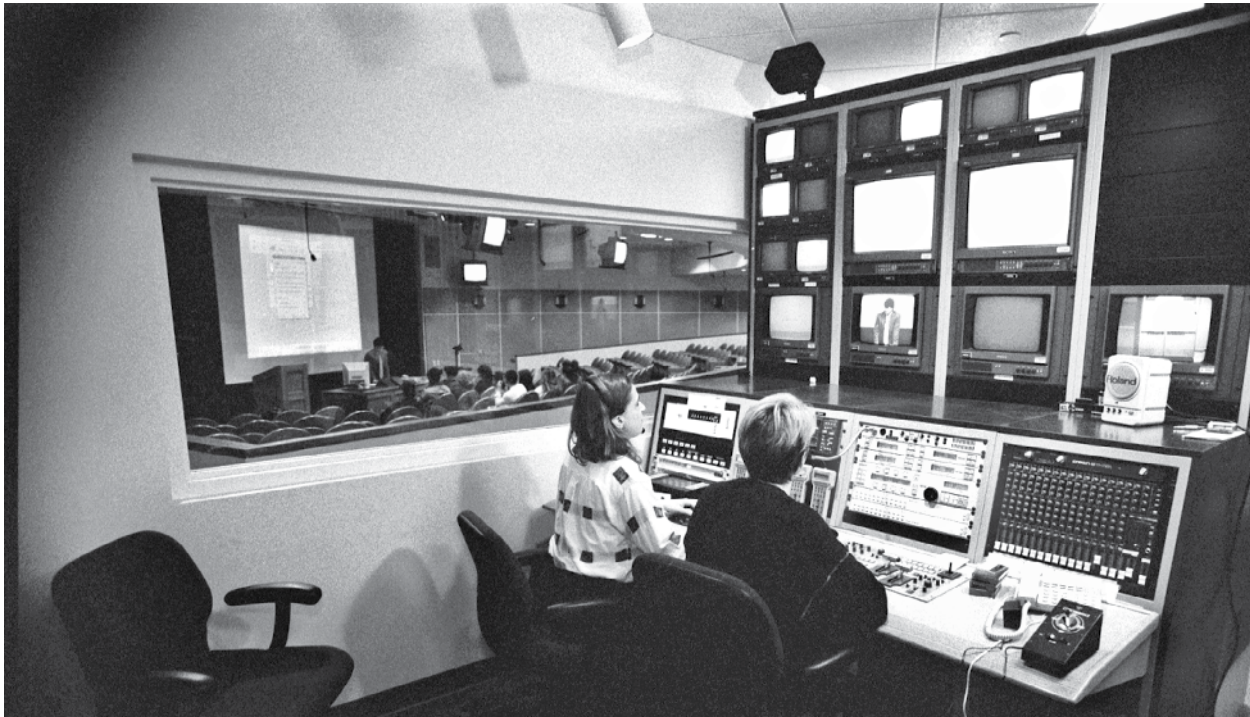
The control room of the Hewlett-Packard Auditorium in the Gates Building offers state-of-the-art facilities for distance learning (1997).
Photo: Sasha Mitelman / courtesy Stanford News Service

Stanford has used innovative technologies to deliver coursework for decades. In 1969, Stanford began broadcasting graduate engineering courses to technology professionals in Silicon Valley using microwave television. The university first used the Internet to deliver courses in 1996. In 2005, Stanford was the first university to partner with iTunes U to provide public access to courses, concerts and lectures. Videotaped coursework has been available on platforms such as Entrepreneurship Corner, Stanford Engineering Everywhere and Stanford's YouTube channel. The university also operates an Online High School for academically talented students around the world. The Stanford Center for Professional Development offers a variety of School of Engineering certificate and degree programs.

In 2009, computer science Professor John Mitchell worked with six students to build Stanford CourseWare, an innovative platform that later expanded to support interactive video and discussion. CourseWare served as the foundation for the initial flipped classroom experiments at Stanford and helped inspire the first MOOCs in 2011: *Artificial Intelligence*, *Machine Learning* and *Introduction to Databases*. Stanford professors garnered worldwide attention for those three inaugural MOOCs: They were free, open to the public and attracted hundreds of thousands of learners from around the world. A dozen more MOOCs followed closely on their heels.

In 2012, the university created the Office of the Vice Provost for Online Learning, headed by John Mitchell, to coordinate online learning efforts throughout the university. Under Mitchell's leadership, VPOL's mission is to advance the understanding and use of new technologies and pedagogical methods in support of Stanford students and faculty, in service to higher education and to promote lifelong learning.

Profiles of Innovation in Teaching and Learning

Faculty/Instructors: Professor Amir Eshel (Humanities, German Studies and Comparative Literature) and PhD Candidate Brian Johnsrud (Modern Thought and Literature)
Course: *Futurity – Why the Past Matters* (Flipped and Blended)

"What struck me the most from the very beginning was the idea of collective scholarship. Modern-day scholarship is by no means individual as people keep building on other people's ideas (think JSTOR), but this was my first time being introduced to a platform that promotes a real-time discussion within a community in a productive way."

- Stanford student

Stanford Professor Amir Eshel and instructor Brian Johnsrud, along with their team, sought to foster truly comparative academic work, to encourage the teaching of these skills in university classrooms and to gather quantitative and qualitative data about the use of the platforms and tools they create in order to better inform technology design, pedagogical practice and theoretical understanding of learning with technology.

"Our goal is to teach students the skills needed to be true comparativists, whether they are comparing different novels, texts or media on a given topic," says Johnsrud.

The teaching team sought to support critical thinking, close reading and theoretical synthesis skills that are central to humanist inquiry; to assess students' reading, engagement and participation in a "flipped" humanities course; to understand how digital reading, engagement and annotation practices differ in and out of the classroom and influence work produced by students; and to teach and assess new skills and literacies such as poetic thinking and historical thinking, as well as navigating, interpreting and creating transmediated narratives.

Funded in part by a VPOL Faculty Seed Grant, the pilot course *Futurity — Why the Past Matters* provided the teaching team with the opportunity to utilize Lacuna Stories — an exploratory, online interactive ecosystem where people can research and discuss significant historical events using a wide array of resources, which include governmental, professional, academic, literary and popular documents — to increase the relevance of in-class discussions. The teaching team logged on to Lacuna Stories in advance of class and saw the texts that students read and annotations they made. The instructors were able to identify "hot spots" in the text that were ripe for discussion and deeper learning. By allowing instructors and students to collectively share the parts of the readings that were particularly rich, problematic, or relevant to the course goals, the humanities class could immediately begin tackling shared questions and themes.

The Lacuna Stories platform fostered an inclusive, empowering and engaging open environment for students to collect, assess and create narratives about key events in the contemporary period. It will continue to prove a valuable resource for faculty and students at Stanford.

VPOL Production Team working on an online course: behind the scenes at the Packard Studio.

VPOL advances faculty-driven online learning initiatives and research. VPOL offers services in course design — including flipped classes, blended learning experiences, MOOCs and SPOCs (small private online courses); audio and video production; and platform evaluation and hosting. VPOL runs its own data research efforts. VPOL also administers **Stanford Online** as the gateway to online learning at Stanford.

VPOL is divided into functional teams:

Leadership: Provides operational oversight including strategic governance, capacity planning, fiscal management and legal guidance on emerging issues.

ID and Pedagogy: Provides services including consulting with faculty on instructional strategies for online and blended teaching, exploring and recommending digital tools for learning, providing feedback on course assets and design, advising on assessment and connecting faculty and teams to other VPOL and campus resources.

Production: Offers a broad range of audio and video services to help faculty create multimedia content including consultation, studio production, field production and post-production. The team produces over 43 terabytes (TB) of raw video assets annually and operates two studios on campus — one with a self-service option that can be made available as needed. The team also provides web development support to VPOL and Stanford Online.

Platforms & Engineering: Evaluates and supports delivery of digital course content on three platforms: Stanford OpenEdx, Coursera and NovoEd (formerly Venture Lab). Stanford University also offers online courses through the Stanford Center for Professional Development. Faculty members also make certain videos available on YouTube and iTunes.

Research: Is building capacity for data analysis by collaborating with faculty who are conducting research, and by partnering with external organizations to advance our understanding of teaching and learning in the digital age.

Communications: Oversees VPOL web content and social media feeds, including the online.stanford.edu and vpol.stanford.edu websites. The team also manages public and press inquiries regarding Stanford's online initiatives, and plays a centralized support role for communications teams across campus to help raise awareness of online learning initiatives, drive course registration and publicize research.

VPOL Structure

@stanford: VPOL is collaborating with the Hasso Plattner Institute of Design ("the d.school") on its @Stanford initiative to re-imagine the experience of learning and living on campus and design the future of Stanford for generations to come. Offered as an experimental class, students are invited to "transform the place that's transforming their lives."

An Open Online Ecosystem

Stanford OpenEdX Platform: In addition to supporting delivery of digital course content, the VPOL engineering team is working to expand the features of OpenEdX, the open-source release of the edX platform developed by the nonprofit organization founded by Harvard and MIT. In April 2013, Stanford and edX agreed to collaborate on future development of the platform. In June 2013, Stanford launched its own instance, Stanford OpenEdX, and by July, the platform was released as open source for developers everywhere to use, improve and share. In September 2013, Google committed to the development of OpenEdX. As part of a vibrant, open-source community, Stanford engineers have already contributed new functionality including on-campus authentication, bulk email, new installation scripts, operations tools and integration with external survey tools.

Because this open-source platform is highly customizable, its flexibility allows our faculty to envision and create new and innovative interactive learning experiences for students. And because it's infinitely sharable, it provides a public base for an emerging online learning ecosystem: Other universities and educational providers can use it freely to support their own online learning initiatives. They can host courses using their own installation of OpenEdX within their own IT infrastructure, or by using a third-party hosting service. Organizations running OpenEdX retain control of their own branding, of their relationships with their own students and other users, and of their data. Universities and other organizations using OpenEdX also control the license for their content. They may release or redistribute that content in a variety of forms — original, revised, remixed — to multiple audiences without special permissions from a platform owner. This flexibility gives educators the freedom to experiment and greatly extend the reach of their instructional materials.
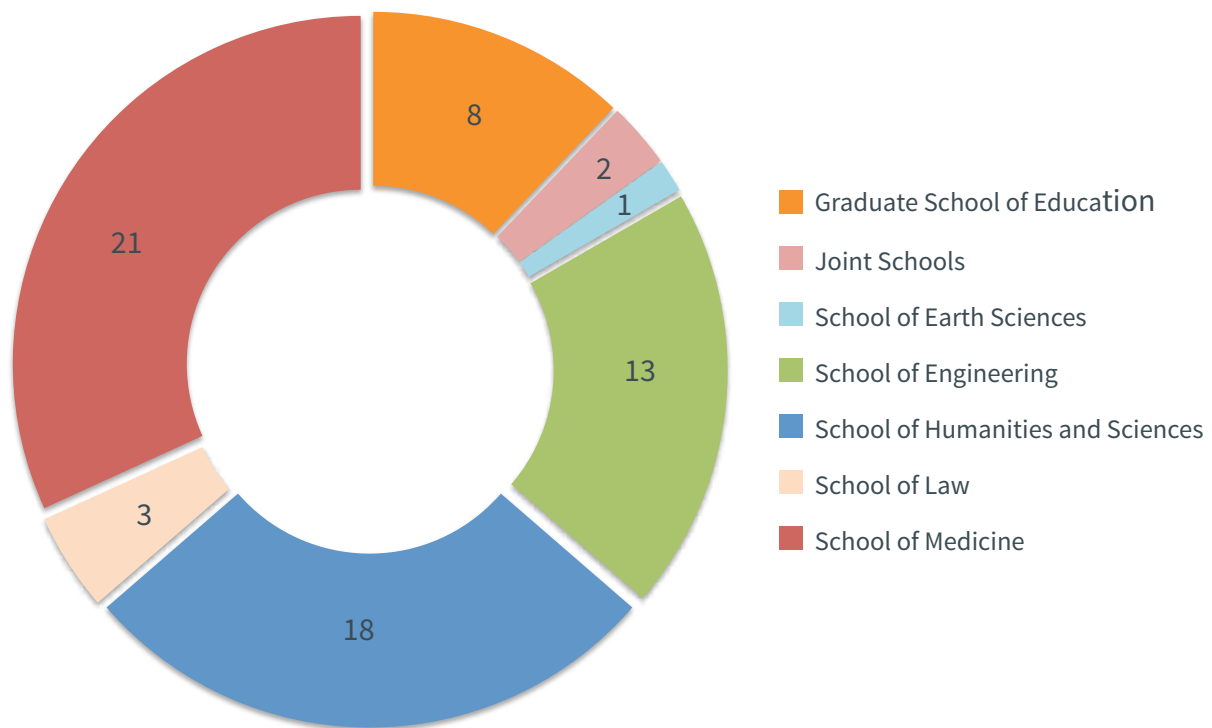
Stanford OpenEdX as a Research Tool: Online courses are generating educational data at a historically unprecedented rate and scale. By having control over the data collection for Stanford courses delivered on Stanford OpenEdX, our researchers are rapidly accumulating usable knowledge in new data sciences of teaching and learning. Stanford faculty and instructional designers can develop online courses as controlled research experiments and are using course data to iteratively improve their teaching and the university's learning environment more broadly. Stanford OpenEdX also facilitates collaboration between Stanford and other institutions in joint efforts to improve education.

Faculty Seed Grants

Each quarter, VPOL offers funds in the form of **Faculty Seed Grants** to support design and development of innovative online and blended courses and tools. The goals of these grants are to challenge the understanding of what's possible in online learning and leverage emerging technologies and teaching strategies to promote deep learning experiences for learners at Stanford and beyond.

66 FACULTY SEED GRANTS AWARDED

Graduate School of Education
Joint Schools
School of Earth Sciences
School of Engineering
School of Humanities and Sciences
School of Law
School of Medicine

Through this program, VPOL has awarded **66 seed grants** across **6 schools** (including two joint school awards).

Seed Grants Issued:
- Summer 2012
- Fall 2012
- Winter 2013
- Spring 2013
- Fall 2013

VPOL Activity and Contributions

Since the first three Stanford MOOCs were offered in 2011, VPOL has helped more than **145 Stanford faculty** from all seven schools produce **246 online offerings** for campus or public use, delivered through three different online platforms. Of these **246** offerings, **171** represent distinct courses or course components; the remainder represent repeated courses or course components that were iteratively improved with each run. Of the **171** distinct offerings, **94 (55%)** were offered to Stanford students as flipped or blended classes, 51 were offered free to the public as MOOCs, and 26 were offered as course components, or as courses for Continuing / Professional Education or other specialized audiences.
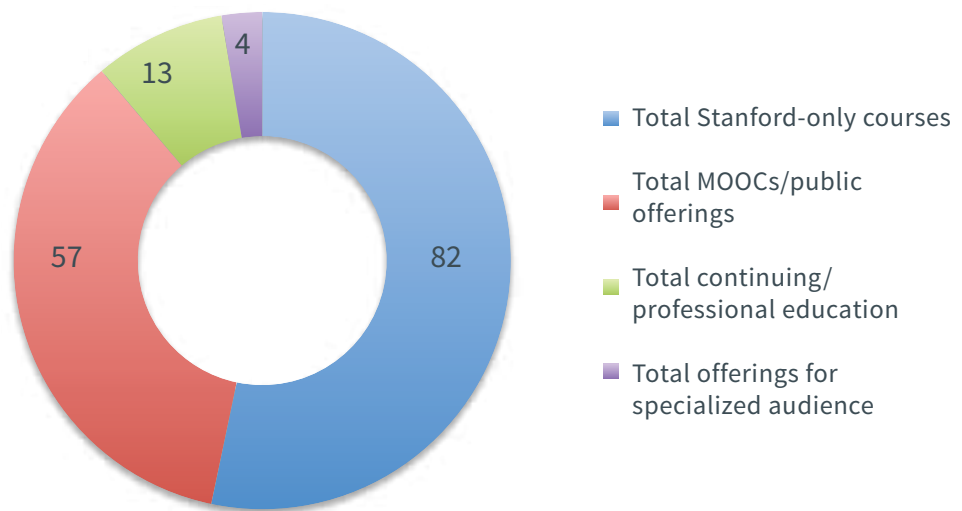
Distinct Courses (does not include components/modules):

2012
Spring, summer, fall

2013
All quarters

2014
Winter quarter only
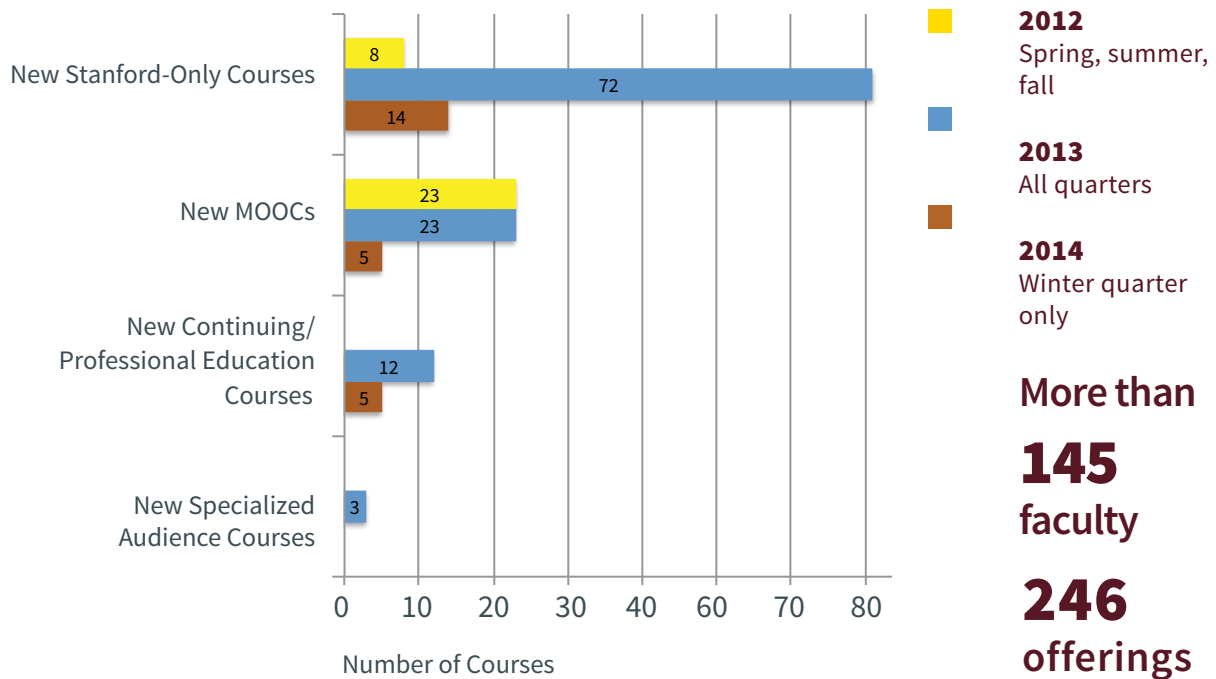
More than

145
faculty

246
offerings

Number of Courses and Components by Population Served for 2013
(repeats included):

In **2013** alone, VPOL helped deliver **156 total** course and component offerings, (distinct and repeated) of which **82** were designed for Stanford students.

- Total Stanford-only courses
- Total MOOCs/public offerings
- Total continuing/ professional education
- Total offerings for specialized audience

Participation, Engagement and Reach

Since the first three MOOCs were offered at Stanford, **1.9 million** people have registered for one, or more, free public online course taught by Stanford faculty and offered through NovoEd, Coursera, Class2Go (Stanford's initial platform, now retired), or Stanford OpenEdX.

These 1.9 million learners account for more than **2 million enrollments** for courses taught by Stanford faculty, of which more than **1.6 million enrollments** were through Coursera (of their total reported 5 million enrollments) and more than **200,000** were through NovoEd (of their reported 500,000 enrollments).

Since the launch of Stanford's instance of OpenEdX in June 2013, there have been approximately 232,000 enrollments in online courses taught by Stanford faculty offered through this platform; approximately 4,500 (about 2%) of these enrollments represent Stanford students.

The 2 million + enrollments reflect participation from almost every country across the globe. (This pattern of comprehensive global reach is also true for courses hosted on Stanford OpenEdX, with enrollment from almost every country since launch in June 2013.)

Demographics

The countries with the highest rates of enrollment (in order of highest to lowest) are: the United States, India, United Kingdom, Canada, China, Germany, Spain, Brazil, Russian Federation and France. These 10 countries represent 81% of all global enrollees.

Nationally, the 10 states with the greatest number of enrollments for free courses (in order of highest to lowest) are: California, New York, Texas, Washington, Illinois, Virginia, Florida, Pennsylvania, Maryland and Colorado (with California representing almost half of the total number). These 10 states represent 70% of total U.S. enrollees.
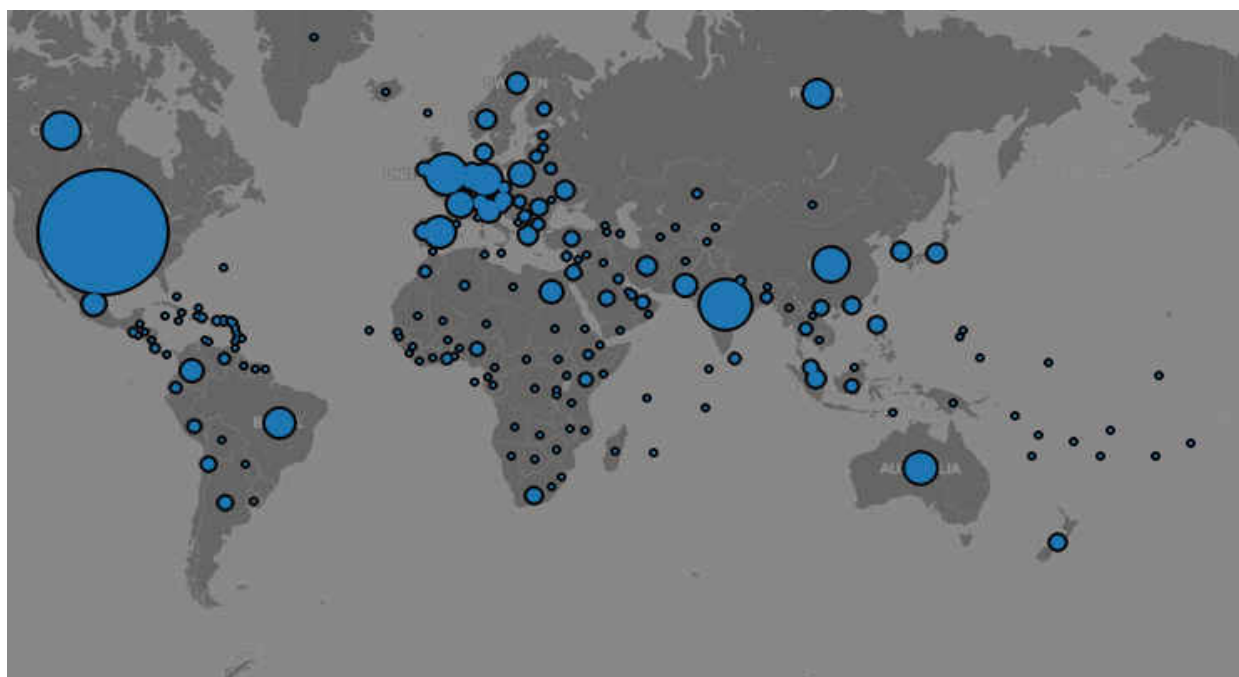
Stanford University is required to comply with U.S. export control and trade sanctions regulations, and some course materials may not be available to all learners. These restrictions apply to non-introductory science, technology, engineering, and mathematics (STEM) courses.
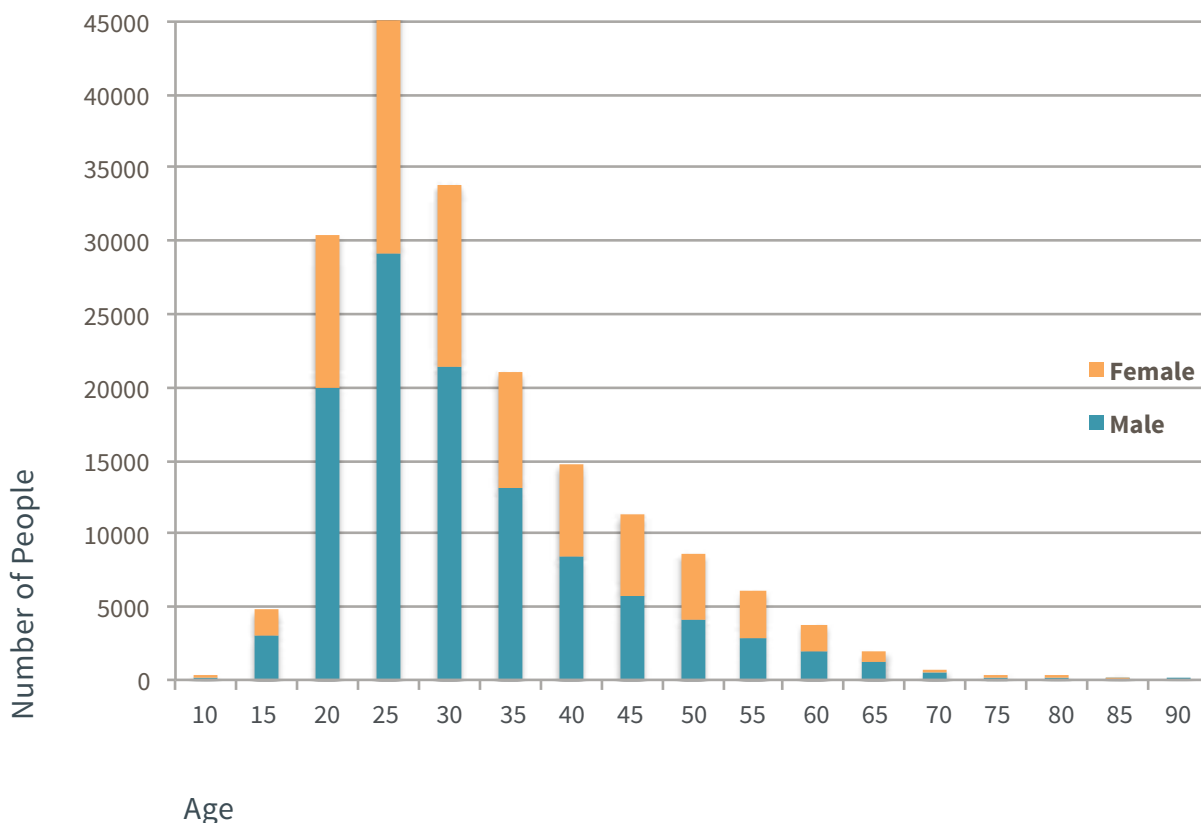
Participation, Engagement and Reach

A Snapshot of Participants

Using sample survey data from the Stanford OpenEdX course enrollment population, we found that approximately **73%** of enrollees were male and **27%** were female. Enrollment reflects participation from all age groups (from 10 to 90 years of age), but the four age groups with the greatest participation were **21**-to **25**-year-olds at **25%**, **26**-to **30**-year-olds at **18%**, **16**-to **20**-year-olds at **16%** and **31**-to **35**-year-olds at **11%**. As the demographic groups advance in age, we find increased relative participation by women.

Our sample survey data is based on voluntary reporting of age and gender, and includes a subset of the 4,500 Stanford students included in the total Stanford OpenEdX course enrollment population. The greater percentage of online engineering courses relative to all other fields of study likely impacted demographics, and we expect that as online courses cover more fields of study, participation will shift in terms of gender and age too.

Number of People by Age:

Participation, Engagement and Reach

Sample survey data from the Stanford OpenEdX course enrollment population also indicates that education levels were similar for national and international participants. The largest percentage of participants had **master's degrees (39% nationally** and **40% internationally**) followed closely by **bachelor's degrees (32% nationally** and **33% internationally**). The third largest percentage of enrollees had **PhDs (12% nationally** and **internationally**) and the fourth had earned their **high school diplomas (10% nationally and internationally**).

Legend:
- Other
- Elementary
- Junior High School
- High School
- Associate's Degree
- **Bachelor's Degree**
- Master's Degree
- PhD

Values: 592, 2,968, 1,927, 24,269, 19,296, 5,503, 78,884, 64,665
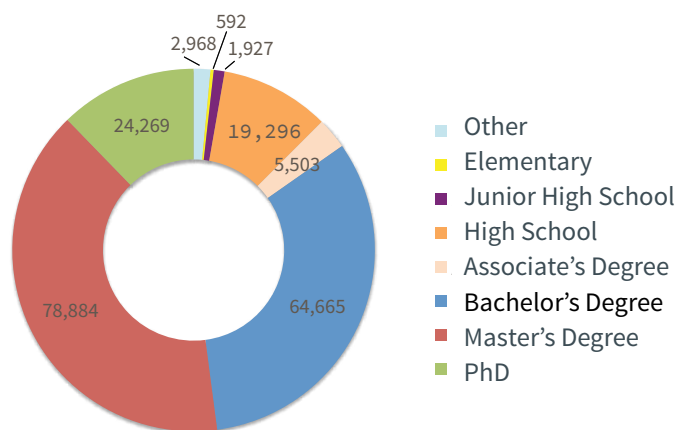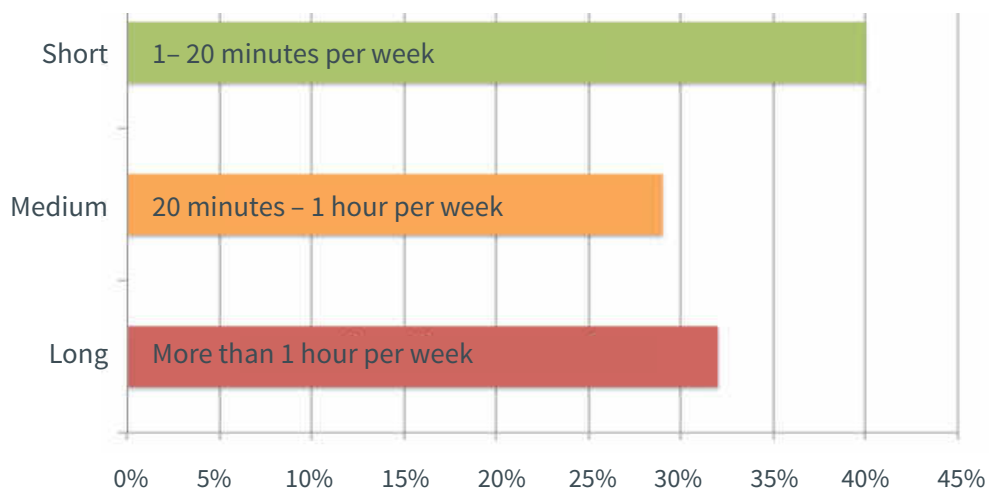
Engagement (Measured by Time)

Since the fall of 2012, participants have interacted for longer than 4 million (4,272,204) hours with Stanford courses hosted on three platforms (Coursera, NovoEd and Stanford OpenEdX). While early analysis of learner activity related to MOOCs has focused almost exclusively on completion rates, VPOL is looking at participant engagement to better understand learner needs, behaviors and participation patterns.

For this report, we examined how much time participants spent engaging with our courses in individual sessions during the week, across the three platforms we support (Stanford OpenEdX, Coursera and NovoEd). We examined the distribution of typical median engagement session lengths among our participants to establish a baseline that will be useful for longitudinal studies, and we excluded enrollees with zero to little time engagement. We found that of the total engagement hours for 1.4 million enrollees, participants invested 40% in sessions of 1 to 20 minutes, 29% were engagement sessions lasting between 20 minutes and one hour, while the remaining 32% were expended in sessions exceeding one hour.

While we are further evaluating our data for longitudinal, comparative studies, we immediately recognized that there is a benefit to designing instructional content that is modular.

Short	1– 20 minutes per week
Medium	20 minutes – 1 hour per week
Long	More than 1 hour per week

0% 5% 10% 15% 20% 25% 30% 35% 40% 45%

Research

Stanford's Learning Analytics group, the Lytics Lab. Graduate students Emily Schneider (Learning Sciences and Technology Design program), René Kizilcec (Department of Communication) and Chris Piech (Department of Computer Science). The lab is under the auspices of the Office of the Vice Provost for Online Learning and the Learning Sciences and Technology Design (LSTD) program in the Graduate School of Education. Photo: Linda A. Cicero / Stanford News Service

VPOL is committed to enabling data-driven research to advance the new sciences of teaching and learning across many academic fields of inquiry. To this end, VPOL is building capacity for data analysis of course usage, engagement and outcomes to support iterative instructional research and to lay a foundation for data-driven research that is underway throughout the university. By taking on teaching and learning's most challenging problems, bringing imaginative new approaches to solving them and working collaboratively to make meaningful contributions to our world, Stanford faculty are serving to advance education at Stanford — and beyond. As part of this effort, VPOL is developing protocols for research collaboration nationally and worldwide.

VPOL Data Portal

VPOL's Data Portal offers access to *anonymized*, raw data that is collected as participants worldwide interact with online courses. The Data Portal also transforms this raw material, enabling instructors or learning researchers to examine it with help from widely available analysis and visualization tools. The data can thereby be explored as tables, charts, or overlaid on maps.

Lytics Lab

A research laboratory at Stanford that is jointly supervised by Vice Provost of Online Learning John Mitchell and Professor Roy Pea of the Graduate School of Education, the Lytics Lab is a catalyst for innovation and collaboration in educational data science. The Lab conducts user-driven research and data-driven design to approach and improve online learning.

Building on the foundations of multiple disciplines and methodologies, the Lytics Lab hosts an open, interdisciplinary space for discourse among researchers, technologists, designers, educators and administrators from fields that include **Computer Science**, **Learning Sciences**, **Communication**, **Psychology**, **Statistics**, **Design** and **Sociology**.

Open Learning Initiative (OLI) at Stanford: Transforming Higher Education through the Science of Learning

Originally established at Carnegie Mellon under the directorship of Assistant Professor Candace Thille, the Open Learning Initiative (OLI) is a grant-funded organization that is designed to simultaneously improve learning and facilitate learning research. OLI offers innovative online courses to anyone who wants to learn or teach, and contributes original research to improve learning and transform higher education. Collaborating closely with VPOL, OLI at Stanford is using the Stanford OpenEdX platform to support course design and delivery, and to support data collection and research.

OLI's key goals are:

• To support better learning and instruction with high-quality, scientifically- and classroom-tested online courses and materials. (OLI courses are designed based on learning science research, and in turn, contribute to that research.)

• To share courses and materials openly and freely so that anyone can learn. (OLI courses are often used by colleges and universities to support classroom instruction, but they are designed to support the individual learner who does not have the benefit of an instructor.)

• To develop a community of use, research, and development to allow for the continuous evaluation, improvement, and growth of courses and course materials.

OLI on Stanford OpenEdX:

OLI at Stanford is currently working with the Office of the Vice Provost to port the existing library of openly licensed OLI courses onto the Stanford OpenEdX open-source platform so that these materials can be made publicly available in an open-source environment and easily re-

Candace Thille, founding director of the Open Learning Initiative; assistant professor of education, Graduate School of Education; and senior research fellow, Office of the Vice Provost for Online Learning. Photo: Judith Romero

usable by other educational organizations. OLI's team is also working with the VPOL Platform and Engineering team to develop new Stanford OpenEdX functionality, including: the ability to serve the learner targeted feedback and hints; a robust learning analytics dashboard with instructor reporting; semantic tagging of content with learning outcomes; and version control of courses to enable management and iterative improvement. What's more, the data-reporting capabilities of Stanford OpenEdX are being used to support OLI's collaborative research efforts, and support the new data science of teaching and learning underway at Stanford.

One unique power of contemporary educational technology is its ability to embed assessment into virtually every instructional activity and use those activities to collect fine-grained learning data. Traditional MOOCs collect massive amounts of learner data, but the data often lack the fine–grained information that is needed to provide insight into learning. OLI and VPOL are bringing together individuals and institutions whose work typically does not intersect, but whose collaboration is essential to designing effective learning environments and data analysis systems. We are forging new partnerships among learning scientists, education researchers, computer scientists and faculty who teach in a variety of disciplines across multiple institutions.

Profiles of Innovation in Teaching and Learning

Faculty/Instructor: Consulting Assistant Professor Aneesh Nainani (Electrical Engineering)
Course: *Nanomanufacturing* (Flipped)

"A combination of guest speakers presented the most recent, relevant and innovative developments dealing with subject matter that we had studied that week in class. This helped me gain an immediate sense of context about how crucial and impactful the material we were going through could be in real industrial and technological innovation. Also, it gave us access to perspectives derived from decades' worth of work in the field, which is invaluable to an engineer looking to enter the industry/research himself." - Stanford student

Consulting Assistant Professor Aneesh Nainani

Nanotechnology is a relatively new field at the confluence of physics, science, and engineering, but its impact on our lives is astounding. Nanotechnology has resulted in some of the most important technological advancements in the last few decades — from the phones and computers we use to the solar cells that convert sunlight into electricity. Nanomanufacturing refers to the production of nano-scaled materials — meaning a billionth in size — and is used in a multitude of electronics and other non-biological technologies.

Nanomanufacturing (EE292L) is a very popular course in Stanford's School of Engineering, and this past fall it was delivered for the second time as a flipped-style course. Students were presented with Discovery Channel-like video lessons, and class time was used for guest lectures by Silicon Valley innovators and experts, and for thought-provoking in-classroom demonstrations using real products from cutting-edge industries.

According to instructor Aneesh Nainani, the course is designed to provide students an opportunity to explore the field of nanotechnology and "to see how developments at nano-scale are impacting the elec-

tronics they use in everyday life."

Nainani received a Faculty Seed Grant from the Office of the Vice Provost for Online Learning. By "flipping" the traditional lecture format (students watch the videos on their own time), he maximized class time for those activities that were most engaging for his students. "The grant enabled us to develop techniques to improve the baseline content of the course, enhance the in-class experience and test the effectiveness of the teaching method," Nainani says.

The grant has paid off. The videos are more than recorded lectures: They are digital learning experiences that use innovative production and postproduction techniques. "As a result of the grant," Nainani says, "we have been able to enhance the second iteration of the course in two critical ways: using the video component to take students on virtual field trips — something that would be too logistically complex to do otherwise — and moving some of the course content to be accessible on mobile or tablet devices." In addition, "Students also used tablets to create screencast videos for their final project that they graded using a peer evaluation system," he notes.

Signal Blog

The **Signal Blog** serves as an informal online forum for VPOL team members and associated faculty to share their thoughts and discoveries about online learning. The blog supports discussions of the design and teaching of online courses for faculty, instructional designers and educational technologists.

Research Projects

Stanford faculty, post-docs and graduate student researchers are making important contributions to the latest research on teaching and learning in the digital age. Some areas of focus are:

- Designing Additional Technology to Support MOOCs and Classroom Instruction
- Randomized Experiments to Determine Best Practices for Instruction and Pedagogy
- Data Analysis and Modeling to Characterize Kinds of Learner Behavior in MOOCs and Blended Instruction
- Learning Innovations at Scale

The highlighted research findings that follow provide meaningful guides for future teaching, learning, assessment and evaluation activities to advance teaching and learning in higher education.

Teaching/Instruction/Course Design

Social Cues in Video Instruction: Effects of the Instructor's Face as a Picture-in-Picture
René Kizilcec and Emily Schneider

Abstract: Homer, Plass, and Blake (2008) found the presence of the narrator's face to induce differential effects on viewers' cognitive load, depending on their cognitive preference for visual or verbal information. This paper reports findings from a 10-week controlled field experiment conducted in a massive open online course on the effects of consistent (throughout the video lecture) compared to intermittent (face intermittently present for about half the lecture time) presentation of the instructor's face on cognitive load, social presence, exam scores and attrition. The intermittent presentation induced higher cognitive load and faster attrition in those who prefer verbal information. No difference in cognitive load between conditions for learners who prefer visual information was found in the first three weeks, but the progression over time revealed significantly lower cognitive load for the intermittent compared to consistent presentation. Higher levels of cognitive load were associated with lower exam scores and a worse overall experience. Social presence increased over time for all learners. The findings suggest that accounting for learning preferences is critical, emphasizing the importance of adaptive systems for video instruction.

Encouraging Forum Participation in Online Courses with Collectivist, Individualist and Neutral Motivational Framings
René Kizilcec, Emily Schneider, Geoff Cohen, Daniel McFarland

Abstract: MOOCs have swept through higher education like wildfire since Stanford University launched three open-access computer science courses to the world in fall 2011. The predominant instructional model for MOOCs to date is one that emphasizes instructionist, individualized learning, structured around regularly released video lectures and individual assessments. However, as

Research

demonstrated by decades of research and theory in the learning sciences, learning with others is a central mechanism for supporting deeper learning (Brown & Cocking, 2000; Stahl et al., 2006; Vygotskiĭ, 1978). Social learning requires individuals to articulate and externalize their ideas, learn through teaching and engage in dialogue with others who may have different perspectives or greater expertise.

Online discussion forums have been shown to contribute to the trust and cohesion of groups, and their use has been associated with more overall engagement in online courses. We devised two experimental interventions to encourage learners to participate in forums. A collectivist ("your participation benefits everyone"), individualist ("you benefit from participating"), or neutral ("there is a forum") framing was employed to tailor encouragements to motivations for forum participation. An email encouragement was sent out to all enrolled users at the start of the course (study one: general encouragement) and later in the course to just those who had not participated in the forum (study two: targeted encouragement). Encouragements were ineffective at motivating learners to participate, but the collectivist framing discouraged contributions relative to the other framings and no encouragement. This prompts the question to what extent online learners experience a sense of community in current implementations of online courses.

Learning/Learners

Deconstructing Disengagement: Analyzing Learner Subpopulations in Massive Open Online Courses
René Kizilcec, Chris Piech, Emily Schneider

Abstract: The relatively low completion rates of learners have been a central critique as MOOCs grow in popularity. This focus on completion rates, however, implies a monolithic view of disengagement that fails to acknowledge alternative forms of participation in MOOCs. Identifying subpopulations of learners based on their longitudinal engagement with the course allows MOOC designers to target interventions and develop adaptive course features. We develop a simple, scalable and informative classification method that identifies four prototypical engagement trajectories: completing learners, who complete the majority of the assessments offered in the class; auditing learners, who do assessments infrequently (if at all) and engage instead by watching video lectures; disengaging learners, who do assessments at the beginning of the course, but then have a marked decrease in engagement, generally in the first third of the class; and sampling learners, who enter and exit the course quickly, watching a minimal number of videos.

These trajectories appear consistently across three computer science MOOCs from Stanford faculty on Coursera; future work will extend the analysis to courses in other subjects. In a paper presented at LAK '13 (International Learning Analytics & Knowledge Conference), we compare learners in each trajectory and course across demographics, forum participation, video access, and reports of overall experience. Observable differences allow us to suggest potential interventions or designs in pedagogy or interfaces. For example, completing learners use the course discussion forum at higher rates than other subpopulations, hinting at the need to enhance the community aspect of MOOCs, as we test the effects of these enhancements in order to investigate the causal link.

Assessment

Peer and Self Assessment in Massive Online Classes
Chinmay Kulkarni, Koh Pang Wei, Huy Le, Daniel Chia, Kathryn Papadopoulos, Justin Cheng, Daphne Koller, Scott R. Klemmer

Abstract: Peer and self-assessment offer an opportunity to scale both assessment and learning to global classrooms. This paper reports our experiences with two iterations of the first large online class to use peer and self-assessment. In this class, peer grades correlated highly with staff-assigned grades. The second iteration had 42.9% of students' grades within 5% of the staff grade, and 65.5% within 10%. On average, students assessed their work 7% higher than staff did. Students also rated peers' work from their own country 3.6% higher than those from elsewhere. We performed three experiments to improve grading accuracy. We found that giving students feedback about their grading bias increased subsequent accuracy. We introduce short, customizable feedback snippets that cover common issues with assignments, providing students more qualitative peer feedback. Finally, we introduce a data-driven approach that highlights high-variance items for improvement. We find that rubrics that use a parallel sentence structure, unambiguous wording and well-specified dimensions have lower variance. After revising rubrics, median grading error decreased from 12.4% to 9.9%.

Evaluation

The MOOC as Distributed Intelligence: Dimensions of a Framework & Evaluation of MOOCs
Shuchi Grover, Paul Franz, Emily Schneider, Roy Pea

Abstract: In all the hyperbole surrounding the rollout of MOOCs over the past year and a half, much has been said and written about the "campus tsunami" (Brooks, 2012) that is purportedly poised to change the face of higher education. Interestingly, while much of the positive feedback has focused on the noble sentiments behind making world-class courses (mostly from elite universities) freely available to anyone, anywhere in the world, a fair amount of the negative press aimed specifically at instructionist MOOCs or xMOOCs (as characterized by Daniel, 2012) has revolved around the quality of the courses themselves. We believe that often both the praise and criticism of MOOCs is founded on historical assumptions about learning environments and outcomes that do not necessarily apply (at least without some reconsideration and reframing) to this new phenomenon.

As a start, we reframe the question "What makes a good MOOC?" to "How can we make a MOOC work for as many of its diverse participants as possible?" MOOCs attract a global set of learners with an extensive range of goals and prior knowledge. Framing design and evaluation in this way emphasizes the potential for optimization for different participants or groups of participants — and the possibility of defining different learning outcomes for these different groups of learners. Furthermore, it helps to view a MOOC as a designed object (Simon, 1969) whose creation should ideally be influenced not only by faculty and instructional designers, but also by technologists, data scientists and learning researchers. A framework for the design and evaluation of MOOCs must reflect the complex nature of these interrelationships. It must also encapsulate principles from the learning sciences to guide the creation of a robust set of criteria for the design and evaluation of MOOC learning experiences.

Profiles of Innovation in Teaching and Learning

Faculty/Instructor: Associate Professor Daniel McFarland (Education)
Course: *Organizational Analysis* (MOOC)

It is hard to imagine living in modern society without participating in or interacting with organizations. The ubiquity and variability of organizations means there is ample room for complexity and confusion in the challenges organizations face. Through this course, participants consider cases that present various organizational struggles: school systems and politicians attempting to implement education reforms; government administrators dealing with an international crisis; technology firms trying to create a company ethos that sustains worker commitment; and even two universities trying to gain international standing by performing a merger.

Initially offered at Stanford as a blended learning course and supported by a Faculty Seed Grant, *Organizational Analysis* was developed into a MOOC. Over the span of 10 weeks, Associate Professor McFarland presents 10 organizational theories — or ways of interpreting organizational behavior — coupled with relevant case studies, as a framework for course participants to comprehend and manage organizational challenges.

McFarland and the instructional team posted forum questions each week that helped focus the conversation. They read participant reactions and then customized weekly reflections and responses to the most salient threads. They developed in-video quizzes to check learner comprehension and engage-

Associate Professor Daniel McFarland

ment, and the team developed a final exam that assessed recall of the course material and a capacity to compare and contrast different organizational theories.

The *Organizational Analysis* MOOC implemented a variety of new features that the instructional team learned a great deal from: peer assessment of term papers, A/B testing, free and reduced cost readings via the Stanford Intellectual Property Exchange (SIPX) and highly interactive forums.

In future iterations, the instructional team plans to render the course as a foundational, professional development course that can be taken repeatedly or used over time to groom new skills and expertise. For example, course participants would be able to take higher tracks, complete more videos and increase "reputation" points as contributors. The course has the potential to serve the alumni community, and the course team is considering adding a social network feature to see how the learning process would be further mediated.

Critical Discourse: The Larger Conversation

In addition to the creative work underway in Stanford classrooms, studios and labs, our faculty and students are asking large questions about what digital learning means for education in modern society more broadly. To convene the larger conversation, VPOL hosts public events including conferences and open-dialogue "open houses"; we send members of our faculty and staff to speak at conferences around the country and overseas, and we hold VPOL forums on campus for the Stanford community to discuss changes underway that will transform the Stanford educational experience for generations to come.

VPOL Public Events

From Machine Learning to Optimized Learning
(June 5, 2013)

As part of a series about virtual learning systems and big data analytics, Jace Kohlmeier spoke about his work as the lead data scientist at Khan Academy. The talk addressed how Khan Academy conceives of and operationalizes a cycle of data-driven improvement. Kohlmeier discussed measurement and objective frameworks, design considerations for an optimized system, modeling of the user's knowledge state and experimentation and iteration.

Surviving the "End of Higher Education" – Technology & Pedagogical Innovation
*(*November 13, 2013)

Candace Thille spoke about the opportunities and challenges involved in the use of technology to advance the teaching mission as part of an initiative by Amherst's Dean of the Faculty's Office and the Department of Information Technology. Thille is assistant professor of education, Graduate School of Education; and senior research fellow, Office of the Vice Provost for Online Learning; and founder of the Open Learning Initiative.

Education Reimagined (November 14, 2013)
Sal Khan, founder of Khan Academy, spoke about the future of education and the concept of the "One World Schoolhouse."

The Art & Science of Online Learning Environments (November 19, 2013)

Candace Thille, assistant professor of education, Graduate School of Education; and senior research fellow, Office of the Vice Provost for Online Learning; and founder of the Open Learning Initiative, spoke as part of a small panel of international leaders in the field of online learning. The purpose of the panel was to create a dialogue about the technical and creative skills required to craft meaningful learning environments online.

White House Data Jam – "Open Data Standards and Privacy-Appropriate Sharing of Online Learning Data" *(*December 15, 2013)

Federal policy specialists, educators from around the nation, private-sector technology experts and Stanford researchers met on campus Dec. 15, 2013, to brainstorm ways to increase the benefits of higher education. The event was designed to promote innovation through new approaches, including the use of data to advance teaching and learning.

The daylong Education Data Jam, sponsored by the U.S. Department of Education and the White House Office of Science and Technology Policy, and co-sponsored by the Stanford Graduate School of Education, drew about 100 participants.

Critical Discourse: The Larger Conversation

Online Learning Summit (March 7-8, 2014)

Sponsored by UC Berkeley, Harvard University, the Massachusetts Institute of Technology (MIT), and Stanford, the summit brought together presidents, provosts and other leaders of higher education to exchange knowledge and ideas on the challenges and opportunities for residential campuses during this time of rapid transformation in new modalities of teaching and learning.

Titled "How Technology Impacts the Pedagogy and Economics of Residential Higher Education," the summit was built upon a highly successful conference sponsored by Harvard and MIT in March 2013. More than **250** leaders in higher education and industry (from the United States, Scotland, Israel,

Stanford President John Hennessy, right, joins UC Berkeley Chancellor Nicholas B. Dirks for a conversation about online learning. Photo: Peg Skorpinski Photography

the Netherlands, India, and Hong Kong) from more than **50** institutions came together at the event held at UC Berkeley.

VPOL Speaking Engagements

World Academy Forum on Global Higher Education (Oct. 2-3, 2013)
Vice Provost John Mitchell and Assistant Professor Candace Thille spoke at the forum, which focused on new models and creative solutions for establishing a world-class open-source system of higher education.

Global Engineering Deans Council Conference– "Online Digital Education and Transformed Faculty Roles" *(Oct. 21, 2013)*
Assistant Professor Candace Thille spoke at the conference, which was focused on the use of hybrid/blended learning to enhance engineering education, and on evidence-based practices in making engineering education more effective and efficient.

The Boards of Higher Education Summit – "The Future of Digital in Higher Education"
(Oct. 17-18, 2013)
Vice Provost John Mitchell spoke at the summit in a keynote panel titled "Digital in Higher Education:

Future Worlds & Current Choices."

EDUCAUSE Learning Initiative 2013 (Nov. 5, 2013)
Online Learning Vice Provost John Mitchell spoke at the conference in a focus session titled "MOOCs and Beyond: A University Perspective."

Sloan-C International Conference on Online Learning in Orlando (Nov. 19-22)
Amy Collier spoke with colleague Mike Caulfield (Washington State University – Vancouver) on reuse of MOOCS in local learning communities.

The MOOC Research Conference
(Dec. 5-6, 2013)
Held at the University of Texas, the conference was chaired by VPOL's Director of Digital Learning Initiatives Amy Collier, and Tanya Joosten of the University of Wisconsin, Milwaukee. Collier spoke with Joosten and Bonnie Steward (a PhD at the University of Prince Edward Island) on a keynote panel on what's next for MOOCs, highlighting the challenges and opportunities for connected learning.

Critical Discourse: The Larger Conversation

2014 VPOL Faculty Forum at the d.school

Across Campus: VPOL Faculty Forums & Instructional Design Special Interest Group (ID SIG)

VPOL regularly conducts Faculty Forums to provide the academic community with new approaches and innovative practices to advance online learning. These forums draw an average attendance of 80 Stanford faculty and instructors. In 2013, VPOL also launched an online teaching- and learning-focused special interest group, called ID SIG, for people involved in instructional design at Stanford. The goals of this group include:

1. Bringing people together from across campus to share ideas and resources for instructional design
2. Increasing communication across campus groups
3. Launching projects that experiment with and assess new online and blended teaching and learning designs.

Topics for 2013 included:

- Faculty Forum on Online Learning (January 2013)
- Overview of Stanford Online Learning Platforms and Navigating an Institutional Educational Shift: The Stanford Medicine Interactive Learning Initiative (SMILI) (March 2013)
- Creating Online and Blended Teaching Materials — a Production Primer (March 2013)
- Research Opportunities in Online and Blended Learning (May 2013)

VPOL Open Houses

To date VPOL has hosted eight open-house information sessions, sharing innovative online teaching and learning models with internal and external audiences from all over the world. Some attendees in 2013 included:

CooCoolu; Santa Clara University; Fujitsu Laboratories of America; Singapore Ministry of Education; Hubei University, China; Singapore Institute of Technology; Nividium Corporation; SRI International; University of Notre Dame, Vilynx; Sana'a University, Yemen; and Yale University

- Learning and Assessing in Massive Online Classrooms (August 2013)
- Designing Online Learning for Stanford Students (October 2013)
- Designing Online Learning for MOOC Learners (November 2013)

Public forum: Is Higher Education a Business?

Education's Digital Future

Convened by Professors Mitchell Stevens, Roy Pea and Candace Thille from the Graduate School of Education, Education's Digital Future (EDF) is part of Stanford's larger ambition to host the most porous, plural and iconoclastic discussions about teaching and learning in the world through coursework, the Web, and lively sessions and public forums.

Critical Discourse: The Larger Conversation

Mitchell Stevens, center; Education's Digital Future

Stanford Classes

Education's Digital Future (EDF) Course (EDUC 403x)

Education's Digital Future Course provides a broad introduction to the recent past, present and future of digitally-mediated teaching and learning by combining the classroom experience with a speakers series and online forums on the Piazza platform for enrolled students. According to Associate Professor Mitchell Stevens, who co-created the course along with Professor Roy Pea, the idea is to simulate a low-barrier town square where all relevant players can gather, talk, listen and sift out the substance from the hype.

Lytics Seminar (EDUC 407x)

The Lytics Seminar is supported by the Stanford Graduate School of Education and the Office of the Vice Provost for Online Learning. The course instructors are John Mitchell, Mitchell Stevens, and Candace Thille, and the focus is on research about online learning as an evolving interdisciplinary enterprise. The seminar prompts such questions as: How can investigators best integrate the inherited knowledge, theory and methods from multiple intellectual domains to build this new science? The seminar also supports the ongoing empirical work of the Lytics Lab through presentations of work-in-progress and informal check-ins during lab meetings and hosted presentations by visitors worldwide, whose work can inform and enrich Stanford's own. In winter 2014, the seminar covered major topics in online learning research from an interdisciplinary perspective, particularly epistemological, computational and methodological aspects with the goal of gaining traction on key questions in this evolving field.

Stanford Digital Learning Forum

At the beginning of 2014, VPOL launched the Stanford Digital Learning Forum to engage companies and other organizations interested in the future of learning in a digital world. To facilitate strong relationships between academia and industry, the program brings together members with Stanford faculty, students and staff throughout the university who are involved in online learning initiatives.

The program supports research, curriculum and platform development, course production, policy study and outreach related to online learning and digital education. In addition, the program provides an opportunity for member organizations to not only directly support our activities, but also be involved in the process of discovering the future of digital education that is unfolding at Stanford.

Content Sharing

Stanford's MOOCs have been used by university faculty and other instructors around the world to support their own learners. This activity is often difficult to track, but the following are some examples of national and international reuse of Stanford online learning material. (The numbers correspond to the map on page 25.)

1. University of Western Australia (David Glance)
The University of Western Australia was the first university to seek a content and platform partnership with Stanford. Associate Professor David Glance began using Professor Jennifer Widom's course materials as part of his UWA course in a format we now call a "distributed flip." A distributed flip is a course that uses structured open educational resources — including MOOCs — as part of flipped and blended learning experiences.

2. University of Puerto Rico (Patti Ordóñez-Rozo)
Assistant Professor Patti Ordóñez-Rozo used Professor Jennifer Widom's *Introduction to Databases* MOOC in a distributed flip model, requiring her students to watch video lectures and complete assignments before attending class each week. Ordóñez collaborated with VPOL's Amy Collier

and Mike Caulfield, a colleague at Washington State University – Vancouver, to survey students in her class and analyze their activity on the platform. The results of this inquiry are outlined in an article for Educause Review Online, entitled: "Rethinking online communities in MOOCs used for blended learning."

3. San Jose State University (Tran Duc Thanh)
Assistant Professor Tran Duc Thanh began using an archived version of Professor Jennifer Widom's *Introduction to Databases* MOOC in September 2013. Like Ordóñez at the University of Puerto Rico, Thanh asked his students to watch videos and complete online assignments. In class, Thanh led additional lectures and discussions on course topics and did demonstrations of various database systems.

Collaboration

Content Sharing

4. University of North Carolina-Charlotte (Celine Latulipe)

Associate Professor Celine Latulipe used archived *Human-Computer Interaction* content from former Stanford Associate Professor Scott Klemmer, assigning one to two of Klemmer's videos for her graduate HCI students to watch before class, then leading discussions and hands-on activities during class time. She supplemented the MOOC videos with her own videos to offer multiple voices/approaches to the content. Subsequently, Klemmer's archived MOOC was used by an undergraduate HCI course at UNC-Charlotte.

5. Princeton University (Keith Devlin)

Keith Devlin, a senior researcher in Stanford's H–STAR Institute, is a visiting professor at Princeton University in the winter/spring of 2014. Devlin has offered a Stanford MOOC titled *Introduction to Mathematical Thinking* on the Coursera platform. He will run the MOOC at Princeton while he is visiting.

6. University of California-Davis (Bertram Ludäscher)

In fall 2012, UC Davis professor Bertram Ludäscher assigned his students to review Professor Jennifer Widom's archived MOOC materials. He liked the online workbenches in Widom's course because they offered immediate feedback to students. Though he encouraged his students to use the online materials and activities, he made their use supplemental rather than mandatory.

7. Vanderbilt University (Doug Fisher)

Associate Professor Doug Fisher used Professor Jennifer Widom's archived MOOC video lectures in spring 2012 and again in spring 2013. In the 2012 version of his course, he required students to view Widom's materials before class and quizzed them at the beginning of each class. In the following year, he made the videos optional, redesigned the format of his course from lecture to project-based and eliminated the full-class meeting every week in favor of shorter projects-focused meetings with teams of students.

8. National ICT Australia (Karyn Knowles)

National ICT Australia — an organization established by the Australian government to "build capacity and strengthen investment in strategic information and communications technology (ICT) research" — invites its postgraduate students to complete Stanford MOOCs as part of their curriculum. The students may apply to their home institutions for credit.

9. Universidad Galileo (Adrian Catalan)

Universidad Galileo has been working with MOOCs in order to offer courses that are not part of other academic programs. In fall 2013, they used a compilers and programming language course on Coursera and MIT OCW materials to flip the classroom. They used this approach for five weeks in a 15-week course, using surveys and weekly quizzes to measure learning among the flipped and non-flipped course groups.

10. University of Central Florida-College of Medicine (Asha Balakrishnan)

A fourth-year medical student at the University of Central Florida (UCF) College of Medicine in Orlando is using content from the *Antimicrobial Stewardship* continuing medical education (CME) course. She is incorporating this content into modules she is developing to strengthen UCF's curriculum on antimicrobial stewardship. The modules she is developing are self-learning online modules aimed at third-year curriculum.

11. University of Alberta (Russ Greiner)

Computer Science Professor Russ Greiner is using the *Probability Graphical Modeling* and *Machine Learning* courses as part of a flipped or blended class at the University of Alberta. He is assigning students to watch specific lectures in these MOOCs and then meeting with them to discuss the material. He is also using the problem sets, assignments and questions, which are matched to the presentation content in each of the MOOCs.

12.Sabetha High School (Carol Spangler)

High school teacher Carol Spangler is using the *Child Nutrition and Cooking* MOOC as part of her advanced composition class. Her students watch Maya Adam's videos and complete the weekly quizzes. They are also required to write journals and summary articles for the materials in the course.

13. National University of Singapore (Jason Kai Wei Lee)

Professor Jason Kai Wei Lee is teaching a course on environmental physiology at the National University of Singapore. He is including some materials from Anne Friedlander's *Your Body in the World* MOOC to supplement the materials in his course. His course is part of a fourth-year undergraduate module for which he supplements his and Friedlander's materials with local research data, field visits, hands-on practical and debates on controversial topics.

14. Ege University, Turkey (Reci Meseri)

Professor Reci Meseri is using videos from Maya Adam's *Child Nutrition and Cooking* MOOC in his fall semester course in the Nutrition and Dietetics Department at Ege University in Turkey. The videos will be used in the first-year curriculum on "fundamentals of nutrition."

Profiles of Innovation in Teaching and Learning

Faculty/Instructor: Professor Lambertus Hesselink (Electrical Engineering)
Online Course Resource: *iLab Virtual Labs* (for MOOCs)

Professor Lambertus Hesselink

The virtual labs are Professor Lambertus Hesselink's latest effort to bring advanced laboratory access to the masses online, an approach he pioneered in 1996.

The most recent "lab in a box" generation of iLabs involved automated hardware that students could access through the Internet and control remotely from anywhere in the world. The labs took up only a few cubic feet of space, which significantly lowered operating costs compared to traditional setups.

The overwhelming popularity of MOOCs, however, made this arrangement challenging. Professor Hesselink says scalability is a key component of his iLab. Although remote-access automated labs work well for courses with small enrollment, Hesselink wanted to find a way to scale that experience to accommodate courses of 100,000 or more students and to retain the cost efficiencies that made the labs attractive in the first place. The solution, Hesselink came to realize, was to eliminate the moving parts. With the support of a VPOL Faculty Seed Grant and a stellar team consisting of Hesselink, Lars Thorben Neustock (a summer research fellow from Germany), and George Herring (a visiting summer researcher),

they designed a small diffraction experiment that fits in a box the size of a picnic basket. Then, they ran an automation program that moved the devices into each possible configuration, and tested them at every possible power level. As this occurred, a built-in LabVIEW unit took a snapshot of each experimental setup and the corresponding result. These images and data were annotated and logged into a database.

Now, users can log into the database and interact with the same controls and video view as would be used during a real experiment, but when students change the laser color from blue to red, they're observing the prerecorded state. "They're seeing the exact same diffraction experiment and controlling it the same way as they would with the widely used LabVIEW program," Hesselink says. "It's the same experience if you're sitting in a lab here at Stanford or at a computer in Africa."

By making important technological resources available at scale, the iLab virtual labs for MOOCs is a good example of Stanford's continuing support for broad access.

An Eye Toward the Future: Research-Driven Innovation

Higher education will change significantly over the next five to ten years. The transformation may be incremental, jarring, or episodic. But in all cases, it will open new opportunities for faculty and academic institutions to plunge into the current with curiosity and enthusiasm.

No institution can singlehandedly address the vast challenges affecting higher education. Stanford is taking a research-driven approach to pioneering advances in teaching and learning and fundamentally transforming the way that our students will be educated for generations to come. As we transform our own campus, we are committed to collaborating openly with all institutions in the higher education ecosystem to help address the monumental demand for increased access to educational opportunities.

For the near term, VPOL will continue to stimulate research and facilitate the identification, development and adoption of new teaching and learning techniques at Stanford by:

- Serving as a laboratory for faculty research and experimentation with new instructional forms that take advantage of digital media

- Providing seed grants to faculty

- Offering services to support course design and production, including flipped classes, blended learning experiences, MOOCs, continuing education and other online learning courses and modules

- Continuing to develop an open-source online course delivery platform which supports research and experimentation, incorporates the functionality needed to advance promising teaching and learning models, and extends Stanford's academic contributions beyond campus with both free public content and other academic materials

- Building a data collection and distribution infrastructure to facilitate research at Stanford and collaboration with other institutions

- Serving as a hub for the collection and dissemination of information and research about new technologies and their influence on teaching methods and learning models for lifelong learning

To this end, here are few trends at our institution that we think might be useful to share:

Instructional Design and Pedagogy

Faculty are increasingly devoting more time developing new online course material for Stanford student courses and re-purposing the course material afterward for public learners or specialized audiences, rather than starting with a MOOC. Instructional designers are working with faculty to develop courses as controlled experiments—as part of our broad research effort and to iteratively improve the design of courses and modules. Systematic assessments quickly inform instructors about the impact of their instruction on student understanding; this pedagogical feedback loop will be used to greater degrees in the future. Faculty are also using a wider variety of online tools and approaches, and have increased their use of automatically-graded assessments and are opting for highly-produced lectures (using studios instead of classrooms for recording).

An Eye Toward the Future: Research-Driven Innovation

Departments and programs, such as English and Biology, are developing online course modules (as opposed to entire courses). This approach will enable them to ensure core content is accessible while focusing key faculty resources on specialized and in-depth knowledge transfer.

Production

VPOL is focusing its production resources on fundamentally transforming teaching and learning in- and outside of the classroom. We are producing more flipped and blended learning content specifically tailored to provide rich, digitally-mediated learning experiences. We are re-contextualizing the concept of a lecture while at the same time providing unique interactions with experts and environments otherwise unavailable to students.

We are establishing a scalable, enhanced model for supporting faculty and instructors in producing high-impact, high-quality digital media modules for their courses. And we are investing in new video technologies and facilities, offering full-service and self-service production studios in several locations across campus.

Platforms

VPOL has advanced the use of an open source platform for designing and delivering online course content. Stanford OpenEdX enables faculty to experiment with course design more freely than commercial platforms, and to design controlled research experiments. Using Stanford OpenEdX gives Stanford greater control over course participant data that is used to advance research and identify best practices in online learning.

Most of the newly designed online courses and course components are now being hosted on Stanford OpenEdX. This trend enables the institution to openly share content and advance collaborative opportunities. To further support this effort, VPOL is in the process of developing a deeply linkable and ultimately Google index-able archive of courses and course components available on Stanford OpenEdX.

Additional platform improvements are underway to better support teaching and learning: improved peer assessment tools; collaborative group work features; improved authoring user interface; improved instructor analytics / data exports for researchers; enabled embedding of content; manual grading for on-campus courses; flexible email (to target audiences); and structured MOOC use for defined cohorts.

Research/Critical Discourse

While we have analyzed a high volume of online learning experiences and experimental courses and learning tools, we have initiated relatively few controlled experiments and this is our next area of focus. Additionally, our research efforts will also concentrate on designing for meaningful connections at scale to better support peer and community-based learning in the online arena. We are shifting our focus, too, from how information can best be presented to online participants, to how learners can be actively engaged. Overall, we believe the entire technology-driven teaching and learning conversation will shift to one about research-driven innovation; it already has at Stanford.

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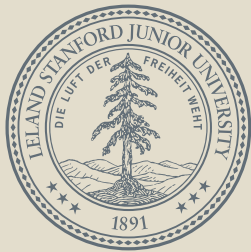
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