Article

Developing a Next-Generation Model for Massive Digital Learning

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Abstract: A decade ago, massively open online courses (MOOCs) were heralded as the solution to universal, global access to higher education. While they failed to reach this vision, primarily because of teaching-by-telling and learning-by-listening (a PDF of the residential classroom), MOOCs provided the foundational models and infrastructure for emergency remote learning in the pandemic. Reports of remote learning's death post-pandemic are greatly exaggerated, since the world is now irreversibly hybrid—and will stay that way because many people and organizations value the new opportunities this presents. From now on, when students leave the shelter of classrooms to interact with the world beyond schooling, they must have skills for adept performance both face-to-face and across distance. Colleges, universities, and regions that force all teaching and learning to be face-to-face are dooming their graduates to reduced agency in every other aspect of life. As discussed in recent reports from Harvard, MIT, and Stanford, innovative approaches to digital learning were developed during the pandemic that are now improving campus-based learning. Insights from these approaches offer the opportunity for student engagement at scale, taking advantage of strengths of online instruction such as collapsing time, bridging space, personalizing via rich datastreams, using AI-based instructional assistants and learning partners, delivering content and experience across universities, and sustaining online learning communities after formal instruction ends. Combined, these advances can enable next-generation massive digital hybrid learning, a means to achieve the aspirational vision of universal global access to higher education. A coalition of higher education institutions could begin to realize this vision, an essential step in enabling all learners to survive and thrive in our increasingly turbulent, disruptive global economy and civilization.

Keywords: hybrid; online; remote; MOOC; scale; massive; engagement; learning; instruction

1. Introduction

In 2022, three leading universities (Harvard, MIT, and Stanford) each independently formed internal task forces to study innovative approaches to digital learning developed during the pandemic. These groups described lessons learned that could be applied to hybrid instruction now that campuses have reopened. The Harvard Future of Teaching and Learning Task Force report, *Reimagining the Classroom, Enriching Content, and Expanding the Harvard Community* [1], articulates the lessons the university learned from COVID-19-era remote teaching that might inform its future. The MIT Ad Hoc Committee report, *Leveraging Best Practices from Remote Teaching for On-Campus Education* [2], centers on the intense and broad emphasis in pedagogies for remote learning that the pandemic necessitated. The Stanford report, *Lessons from Teaching and Learning at Stanford during the COVID-19 Pandemic* [3], discusses five insights from mandatory remote learning that could be the foundation of a future institutional digital education strategy. Overall, the reports are similar in many of their conclusions but reflect the different missions and cultures of their institutions.

In 2023, the lead author of this article brought together the heads of the three teams that produced these reports in a special Silver Lining for Learning webinar to discuss cross-cutting themes and issues [4]. This article summarizes the reflections from that dialogue, which concluded that the world is now irreversibly hybrid—and will stay that way because many people and organizations value the new opportunities this presents. This means that higher education students must graduate with skills for adept hybrid performance both face-to-face and across distance. In its conclusion, this article discusses the possible emergence of a next-generation model for massive digital hybrid learning built on the insights from these three reports and other related resources.

2. Insights from the Three Reports Produced by Harvard, MIT, and Stanford

This section describes the major conclusions from each of the three reports as a foundation for synthesizing common themes and issues. The authors independently analyzed each report for key findings, then compared and synthesized their separate findings. The webinar described in Section 2.4 was used as an additional way to assess key findings by asking the report authors which insights they each considered most important.

2.1. Harvard University

The Harvard report, *Reimagining the Classroom, Enriching Content, and Expanding the Harvard Community* [1], posits that its residential community of students and researchers is precious and irreplaceable. The individual and collective innovations in remote teaching during the pandemic are seen as offering three opportunities to advance teaching and learning both on and off campus through new initiatives.

The first initiative is reimagining the classroom via blended teaching, infusing the best of online learning into residential settings and adding a residential component to online programs. Many faculty referenced strategies from remote teaching that could increase interactive learning in both face-to-face and online settings: chat rooms during discussions and lectures, breakout rooms and real-time collaborative workspaces for peer learning, and expanded expertise through involving professionals across distance. The objective of this initiative is to understand how online instructional insights can improve face-to-face teaching and vice versa.

The second initiative is enriching content via a campus-wide strategy for digital learning experiences that leverages accumulated faculty experience during the pandemic and enables connection with all types of learners everywhere. The default format of instruction changed from hour-long face-to-face courses to short-form digital content with flexible opportunities for interaction. Digital-first experiences move beyond transferring face-to-face instructional strategies to an online format (a PDF of the classroom) to instead building on the many short-form digital assets created by Harvard during the pandemic. Hybrid experiences can draw on multiple modalities to personalize learning to students' preferred approaches.

The third initiative is expanding the community by creating a virtual Harvard campus experience that remotely conveys the richness of residential resources. Blended experiences can make learning more active and collaborative; flexible experiences can make learning more inclusive and global. These innovations will require both varying policies to meet the circumstances of non-residential students and expanding campus-based services to provide multiple forms of access. Incentives will be needed to encourage faculty to engage in activities beyond typical residential teaching responsibilities.

Overall, Harvard's report advocates strategies to meet students where they are rather than limited by place or space, resulting in a more learner-centered, innovative, and equitable experience. Internal coordination and top-down support are necessary to enable innovation at the individual, program, school, and university-wide levels. External partnerships can complement internal initiatives in content creation, instruction, mentoring and advising, grading, and certification: coordination will be top-down, bottom-up, and middle-out. The report stresses that essential in all of these shifts is preserving and en-

hancing "the Harvard experience" while enabling delivery of "the brand" beyond full-time residential experiences in Cambridge, Massachusetts.

2.2. Massachusetts Institute of Technology (MIT)

The MIT report, *Leveraging Best Practices from Remote Teaching for On-Campus Education* [2], begins by noting that how one teaches at MIT varies enormously among departments and substantially even within departments. Given diverse instruction and bottom-up decision making, the pandemic-caused challenge was for each teacher at MIT to redesign instruction from first principles, to ask: What are our learning goals for students and how can we best help them to achieve these goals? To meet this challenge, MIT relied on extensive campus-wide sharing about how to teach; the report summarizes insights gained from these discussions.

Several common threads emerged from analyzing a 2022 survey of instructors. The first is that many faculty reported using varied strategies to deepen engagement among students and between students and instructors. These included extending traditional face-to-face office hours to take advantage of the convenience and less intimidating nature of Zoom interactions. Online office hours were also structured so that students could "stay after" and keep working together. "Problem set parties" provided an engaging way of reframing office hours. Adding undergraduate teaching assistants to complement traditional instructional supports increased opportunities for peer mentoring and counseling.

A second thread is shifting ways in which faculty innovate in instruction and grading. Across the campus, organizational changes were made to increase the efficiency and effectiveness of strategies for improving teaching. Video-based materials viewed prior to lab work helped in flipping the classroom and increasing the effectiveness of remote teaching. Take-home lab kits allowed active learning outside of campus facilities. Bringing in outside experts via Zoom increased the authenticity of learning experiences, enhancing their relevancy. The report recommends creating a standing Classroom Advisory Board with representation from faculty, staff, and students to foster and disseminate these and future instructional innovations.

A third thread is a strong emphasis on helping students to build community, maintain wellbeing, and develop a sense of belonging. The shutdown of the campus undercut standard pre-pandemic approaches to foster students' belonging, community, and mutual support. In response, classroom practices were highlighted that helped each student feel that their ideas mattered and their perspectives were welcomed. Structured active, interactive, and collaborative learning were adopted in many courses. For example, faculty in the history department created partnerships with other faculty teaching similar courses at universities around the world, enabling student interactions across contexts and cultures. Innovations included new flexibility with deadlines, alternative/flexible grading schemes, ways of beginning classes with wellbeing and community in mind, and mentoring programs.

Overall, MIT's report centers on compiling and sharing the many innovative practices that its instructors are using, in order to expand those isolated innovations to common usage across the campus. The proposed Classroom Advisory Board is recommended as a major mechanism for accomplishing this. This would complement and extend MIT's current instructional infrastructure of the Teaching + Learning Laboratory, the Digital Learning in Residential Education team within Open Learning, school-based Digital Learning Labs, and the Committee on Curricula.

2.3. Stanford University

The Stanford report, *Lessons from Teaching and Learning at Stanford during the COVID-19 Pandemic* [3], describes the impact of the pandemic on instruction and learning, including its effect on different types of students. The report highlights how the pandemic suddenly fractured the level playing-field provided for students by the campus: some students had no homes to return to outside of campus housing, loss of a campus job impacted some

families' financial situation, and other students returned to new caregiving responsibilities in a stay-at-home world. Further, in a survey during spring 2020, nearly 80% of student respondents indicated difficulties with the emergency remote teaching the university was providing. Beyond having a quiet place to work and study, as well as reliable internet access, students struggled with long lectures on computer screens. To aid with these challenges, the university provided additional resources, such as shipping laptops to students in need and selectively supplementing standard financial aid.

In addition, Stanford emphasized developing compassion and empathy in the virtual classroom. Instructors utilized various types of community-building tools. Many curricular practices were reshaped to promote active, interactive, and experiential education. Departments held more widespread and extensive discussions about teaching than had ever occurred. New academic and professional communities were formed, such as a "teaching commons" website and free online workshops to share ideas about remote instruction. Both new instructors and seasoned faculty had to rebuild their courses from the ground up to teach them remotely, facing comparable academic burdens. Faculty who modeled resilience and flexibility in their teaching were inspirations to students in terms of tenacity and innovation.

Students indicated greater engagement in courses with creative instructional designs. For example, back-channel conversations in Zoom encouraged participation from students reluctant to speak up in class, enabling them to find their voices in an online community of inquiry. The fluid creation and dissolution of breakout rooms in Zoom aided in using small group discussions to balance whole class dialogues. Flexible instructional practices included organizing class time into shorter segments with a wide range of instructional modalities and more interaction than a typical lecture-based class. "Flipped learning" (asynchronous delivery of instructional materials followed by collaborative projects or discussions during synchronous class time) was helpful in both engagement and learning. Repurposing previously recorded video enabled more time for interpretative discussion and for complementary dialogue with guest speakers. Learning kits shipped to homes created opportunities for lab experiences. Some departments experimented with hybrid-flexible (hyflex) course formats, in which students could participate in class synchronously online, synchronously in person, or asynchronously online.

Many faculty shifted from high-stakes summative tests to formative, scaffolded, and lower stakes assessments. This helped students diagnostically to understand weaknesses in their current knowledge and to use support materials to remediate these. Overall, assessments became more project-driven and frequently focused on essays. However, in large courses that retained traditional high-stakes exams, cases of student cheating increased substantially over pre-pandemic levels.

Innovative types of teaching support models emerged. Students took on new roles in classrooms: learning management system administrator, peer advisor, technology expert, academic thought partner. The university's educational technology support teams were expanded. Student access to mobile devices like laptops and iPads was improved. Teaching and learning resources were digitized for easy access.

A major emphasis in the Stanford report is on supporting the whole student, such as creating new programs to enhance wellbeing, fostering positive connections among students and faculty, and developing inclusive and collaborative instructional practices. Particular emphasis is placed on helping students severely affected by the pandemic, those with low socioeconomic status, who are first generation, or who face family/life challenges. Overall, the report concludes that emergency remote instruction led to a shift in Stanford's identity, particularly in how students engage with the university's cultural traditions and how faculty and staff can foster a community of empathy.

2.4. Cross-Cutting Themes and Issues

As mentioned above, in 2023 the lead author of this article moderated a special online event, a Silver Lining for Learning episode in which the heads of the three teams

that produced these reports discussed cross-cutting insights [4]. As with the reports, this webinar's dialogue was shaped by the different missions and cultures of the three institutions. Three cross-cutting themes emerged. The themes below confirm the validity of our analysis conducted on the reports individually, as discussed earlier.

First, at each university instructors were forced to rethink their teaching. The institutions created a climate of experimentation and prosocial innovation. Inclusive classroom spaces—both physical and digital—were promoted. Faculty and teaching staff were supported in learning management system (LMS) usage, in interactive andragogy, and in blending active learning into assimilative instruction. In contrast to making incremental adaptations, strategies that enabled the transformation of conventional course models were encouraged.

Second, all these universities prioritized student engagement, both with peers and with instructors. Across multiple dimensions, meeting learners where they are was emphasized. Strategies for digital engagement were developed, including ease and equity in access to virtual learning-spaces. Empathy was highlighted, as remote interaction creates challenges in life as well as in learning.

Third, all the institutions moved toward student-centered education, focusing on learning experiences both in and outside of physical and virtual classrooms. Synchronous, asynchronous, and blended options were offered; and enriched digital content was provided. Strategies were developed to enable ideas, values, and relationships to be enhanced in ways that do not require physical co-location; the goal was virtual communities of inquiry.

An overarching theme that emerged was achieving high levels of student engagement online, at scale. In 2012, massively open online courses (MOOCs) succeeded in delivering content at scale, but failed in their aspirational visions, in part because student engagement was low compared to face-to-face settings. The pandemic underscored that motivation is the handmaiden of learning and forced instructors and institutions to prioritize student engagement and wellbeing.

Two types of initiatives may aid in achieving this goal. First, advances in online learning, described throughout this analysis, are aiding with student motivation and support. Second, these innovations now can be complemented by recent gains in generative artificial intelligence (AI), such as the emergence of large language models like ChatGPT. Recent developments in both these areas are described in the next section.

3. The Goal of Engagement at Scale

This section discusses illustrative scholarly activities across the field of higher and adult education on the crucial issue of enhancing student engagement in large online learning experiences. These sources and insights are drawn from the lead author's analyses and student-centered instructional design in teaching an online graduate course on motivation and learning each academic year.

The Community of Inquiry framework is a widely used model for developing and evaluating online education [5]. The three dimensions in this framework are social presence (each learner can express their identity in community interactions), cognitive presence (participants in the community construct meaning through sustained communication), and teaching presence (the design, facilitation, and direction of cognitive and social processes to realize personally meaningful and educationally worthwhile learning outcomes) [6]. All three of these dimensions have affordances that can heighten student engagement [7–9].

The lead author is a Co-Principal Investigator and Associate Director for Research of the National Artificial Intelligence Institute for Adult Learning and Online Education (AI-ALOE), which is funded by the U.S. National Science Foundation [10]. Its mission is "to conduct responsible use-inspired fundamental research into AI that is grounded in theories of human cognition and learning, supported by evidence from large-scale data, evaluated on a large variety of testbeds, and derived from the scientific process of learning engineering." Its aspirational vision is to develop novel AI theories, techniques, and tools to enhance the proficiency of online adult learning at scale to make that modality comparable

to similar face-to-face offerings for occupation-related learning, particularly in science, technology, engineering, and mathematics (STEM) fields.

Some of AI-ALOE's work centers on enhancing social, cognitive, and teacher presence to increase student engagement. For example, Ashok Goel at Georgia Institute of Technology is leading the development and deployment of an AI tool called SAMI that takes learners' self-introductions in an online class as inputs and analyzes these to help build connections among the learners [11]. SAMI uses natural language processing for understanding learner's self-introductions and matches knowledge graphs to identify connections among the learners. More recently, SAMI has started making recommendations for team formation and is now utilizing ChatGPT for named entity recognition and other language tasks.

To enhance students' cognitive presence, among other apps AI-ALOE is developing an interactive inquiry-based learning environment called VERA for enabling a learner to interactively construct graphical models of an ecological phenomena, evaluate the model through agent-based simulation, analyze the results, and revise the graphical model [12]. VERA provides access to Smithsonian Institution's Encyclopedia of Life, a digital biodiversity library, to help learners construct conceptual models and set parameter values for the agent-based simulations. To enhance cognitive engagement, VERA incorporates learning by doing, learning by simulation, learning by reflection, and peer-to-peer learning.

As another example, AI-ALOE is evolving an AI tool called Jill Watson for enhancing teacher presence by automatically answering questions posed by learners in online discussion forums any time, any place [13]. Jill Watson combines digital libraries for storing answers to previously asked questions, natural language processing for classifying new questions, and machine learning techniques for retrieving answers and generating a novel answer for the new question.

Across the field of online learning, other research teams are developing and studying scalable innovations to enhance student engagement. As one illustration, Victoria University in Australia has developed an innovative public–private partnership that delivers a resources-sufficient model of fully online postgraduate education with high levels of academic student support [14]. Learning analytics that track student engagement trigger responsive support by trained staff available beyond standard business hours. To aid this type of strategy, other research teams are studying which types of online behavioral indicators provide good metrics for student engagement (such as detection of instances when learners feel isolated, bored, distracted, or prone to procrastination) [15].

Student engagement has also been increased by using AI to hone the pedagogical craft of teachers. For example, Stanford researchers have used an AI tool to analyze transcripts of classes and provide timely feedback to teachers, increasing the use of an engagement strategy called "student uptake"—i.e., incorporating and building upon student contributions in class discussions—by 13%, which improved student learning and satisfaction. [16]

A recent systematic review highlights multiple approaches to analyzing student engagement including automated analysis of log, text, image, interview, and survey data [17]. Another review assesses the impact of self-directed learning on student motivation and learning outcomes, finding a medium effect size across fourteen studies [18]. Overall, the prevalence of researchers developing interventions that increase student engagement in massive online learning is encouraging.

The characteristics and capabilities of instructors are also important in increasing student engagement. A study of teacher educators as gatekeepers highlights the information and communication technology skills and attitudes needed by professors to effectively implement learning technologies for student motivation and learning [19]. The design of instructional infrastructure, such as using online simulations in teaching, can also aid student engagement [20].

Beyond incremental gains, when combined, all these enhancements could lead to transformative models for next-generation hybrid massive learning.

4. A Grand Challenge

The field of learning technologies has evolved in cycles of incremental improvements in teaching, learning, and assessment leading to occasional transformational change [21]. Infusing situated learning through immersive games and simulations is one example of this; incorporating social media to enhance collaborative learning is another. Doing things better can provide a foundation for doing better things.

A decade ago, MOOCs were heralded as the solution to universal, global access to higher education. While they failed to reach this vision, primarily because of an exclusive focus on teaching-by-telling and learning-by-listening, MOOCs provided the foundational models and infrastructure for emergency remote learning in the pandemic. This article discusses how far the field has come in providing both engagement and learning at a massive scale. Advances in engineering learning are enabling the types of infrastructure needed to achieve global delivery [22].

Today, we sit at an inflection point that represents the most rapid and significant revolution in the history of education: augmentation of human intelligence with artificial intelligence. When describing the potential synergy of human–computer interaction, the late Steve Jobs likened the computer to a "bicycle for the mind" [23]. By amplifying human ability to spectacular magnitudes, intelligence augmentation using AI can work to increase students' cognitive flexibility, creativity, and critical thinking, unlocking wholly new ways of learning and thinking. If a computer is a bicycle for the mind, a computer running AI is something an order of magnitude beyond—a human–computer synergy potential for which there is no apt efficiency metaphor.

While many forecasts chart an evolution of AI towards taking human jobs, more likely is a future where AI changes the division of labor in most jobs, driving a need for workforce development to shift towards uniquely human skills [24]. Specifically, AI is becoming increasingly proficient at calculation, computation, and prediction ("reckoning") skills. As a result, we will see increased demand for human judgment skills such as decision making under conditions of uncertainty, deliberation, ethics, and practical knowing. For example, in the Star Trek series, Captain Picard's judgment, decision making, and deliberation skills are enhanced by the reckoning, computation, and calculation skills of Data, an android lacking human abilities.

In light of this, the grand challenge for higher education is not merely to understand how remote learning and AI can scale present capabilities, but to also use this moment to reflect and reimagine the learning experiences of students. With the advent of the Internet and search engines, content knowledge has already largely become an on-demand commodity. With ever-improving telecommunication technologies, meetings with instructors and classmates can happen anytime from anywhere for little to no cost. Online collaboration tools like Google Workspace and Microsoft 365 enable remote groups to co-create and share feedback synchronously and asynchronously. And with the increasing availability and sophistication of AI-driven tools, the capacity to automate the mechanics and minutiae of typical knowledge- and skill-based tasks is growing at an exponential rate. The college experience of tomorrow need not—and, indeed, should not—look and feel like the college experience of yesterday. These technologies have untethered both the minds and bodies of students, freeing them and their institutions to focus on higher-order thinking skills while better leveraging the world around them, but their collective potential is far from fully realized.

Such a shift will require not only institutional learning, but also "unlearning" [25]. Faculty and leadership in higher/continuing education will have to let go of deeply held, emotionally valued identities in service of transformational change to a different, more effective set of behaviors. This is both individual (an instructor transforming instructional practices from presentation and assimilation to active, collaborative learning by students) and institutional (a higher education institution transforming from degrees certified by seat time and standardized tests to credentials certified by proficiency on competency-based measures). Unlearning requires not only novel intellectual approaches, but also individual

and collective emotional and social support for shifting our identities—not in terms of fundamental character and capabilities, but in terms of how those are expressed as our context shifts over time.

The earlier discussion of what leading universities learned from pandemic-era remote teaching highlights the barriers and challenges involved in making a shift to new models of instruction, assessment, and student support. In each setting, major shifts in institutional policies, practices, and investments were recommended to mitigate these hurdles. Time and further research will tell which of these improvement strategies provide the most leverage and which are generalizable beyond the specific institution at which they were implemented.

Despite numerous barriers to change, reports of remote learning's death post-pandemic are greatly exaggerated, since the world is now irreversibly hybrid—and will stay that way because many people and organizations value the new opportunities this presents. From now on, when students leave the shelter of classrooms to interact with the world beyond schooling, they must have skills for adept performance both face-to-face and across distance. Colleges, universities, and regions that force all teaching and learning to be face-to-face are dooming their graduates to reduced agency in every other aspect of life. Transformative models for next-generation hybrid learning are an important next step for higher and continuing education. Students must be prepared both with specific knowledge and skills for their first job and with cross-cutting capabilities for the multiple careers they will experience in a half century of work [26]. A coalition of higher education institutions could begin to realize this vision, an essential step in enabling all learners to survive and thrive in our increasingly turbulent, disruptive global economy and civilization.

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