Just Imagine: New Paradigms for Medical Education

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Abstract

For all its traditional successes, the current model of medical education in the United States and Canada is being challenged on issues of quality, throughput, and cost, a process that has exposed numerous shortcomings in its efforts to meet the needs of the nations' health care systems. A radical change in direction is required because the current path will not lead to a solution.

The 2010 publication *Educating Physicians: A Call for Reform of Medical School and Residency* identifies several goals for improving the medical education system, and proposals have been made to reform medical education to meet these goals. Enacting these recommendations practically and efficiently, while training more health care providers at a lower cost, is challenging.

To advance solutions, the authors review innovations that are disrupting higher education and describe a vision for using these to create a new model for competency-based, learner-centered medical education that can better meet the needs of the health care system while adhering to the spirit of the above proposals. These innovations include collaboration amongst medical schools to develop massive open online courses for didactic content; faculty working in small groups to leverage this online content in a "flipped-classroom" model; and digital badges for credentialing entrustable professional activities over the continuum of learning.

> Big breakthroughs happen when what is suddenly possible meets what is desperately necessary.
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> —Thomas L. Friedman, "Come the Revolution," *New York Times*, May 15, 2002

The 2010 publication *Educating Physicians: A Call for Reform of Medical School and Residency*,[1] often referred to as the "second Flexner Report," points out the substantial challenges facing medical education today. These challenges broadly relate to the quality of the education provided as well as the ability to offer this education to the number of students required to meet the future health care needs of the United States. In light of these challenges, we propose a new paradigm for medical education. We begin with an account of the challenges and shortcomings of the current medical education model. These shortcomings set the stage for a discussion of disruptive innovation in the current medical education delivery system, and we then present our proposal.

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Acad Med. 2013;88:1418–1423.
First published online August 21, 2013
doi: 10.1097/ACM.0b013e3182a36a07

Shortcomings of the Current Model of Medical Education

A stark inventory of the shortcomings of the current model of medical education includes inefficiency, inflexibility, and lack of learner-centeredness. Current teaching models often depend on arcane assessment methods (e.g., multiple-choice examinations), and learning often focuses on test performance rather than developing professional competencies. Students' grades in basic science courses and on clinical rotations, though a key factor in their selection for residency training, may not be based on direct observation or assessment of knowledge application and problem-solving ability. Thus, these grades likely do not reflect true skills, behaviors, and attributes needed to be an effective physician. Faculty assessments of students are highly variable and often reflect interpersonal characteristics[2] rather than problem-solving and critical thinking skills.

Also, realities of the modern academic clinical environment can challenge faculty's commitment to recruitment and teaching. For example, basic science faculty face increasing pressure to obtain research funding in a highly competitive environment with declining funding resources. Productivity pressures limit clinical faculty members' teaching time. Providing small-group instruction in either area is challenged by financial constraints on faculty growth. Strikingly, many students go through the required clinical rotations without once being observed taking a history or examining a patient.[3]

Graduate medical education (GME) is challenged as well. For example, the quality of peer-to-peer teaching, an important element of GME, is compromised by inattention to improving residents' teaching skills and an unfavorable imbalance between the service and education missions of the teaching hospital.[2] Finally, clinical exposure during rotations can be "hit-or-miss," leaving gaps in trainees' exposure. These gaps may be exacerbated by limitations on clinical exposure due to resident duty hours restrictions.

Medical education faces challenges at a societal level as well. There is a clear but

unmet need to train more physicians to meet a massive projected physician shortage.[4] As the baby boomer generation ages and more patients live longer with chronic medical problems, more geriatricians and primary care providers will be needed to care for them. The shortage of primary care physicians will likely be exacerbated by the influence of financial need on graduating medical students' specialty choices. Because the debt level of most students graduating from medical schools exceeds $150,000,[5] choices to pursue primary care specialties may be undermined by the need to seek more remunerative specialties to pay off debt.[6]

Reforming Medical Education

Taken together, these unfavorable forces that affect how students learn and how the new health care workforce will develop invite a disruptive innovation for training health care providers. Such innovations might aspire to an ideal state for undergraduate medical education and GME, in which students would learn basic science in small groups, teaching methods would be learner-centered, and students would be assessed on their ability to apply and integrate knowledge. In an ideal future state, all students would experience every essential inpatient and ambulatory clinical experience, would be observed during these encounters, and would receive formative feedback on such interactions to guide them in improving their knowledge, skills, and socialization to the profession.

Among past major reforms in medical education is Flexner's[7] 1910 report, which had a huge impact on health care education in the United States and Canada. To improve the standards of medical education, Flexner recommended that minimum admission standards should be established and that all medical schools should be affiliated with a university. Flexner criticized didactic teaching in lecture halls and wanted students to learn by doing. He believed that curricula should be flexible and should allow for integration of formal learning with clinical experiences and research. In the years following the report, several medical schools closed because they did not meet these recommendations, leading to decreased access to medical education. Although this report was transformational for the medical education system at the time, little has changed in the basic training model in the 100 years following the report. Flexner realized that his recommendations were for "the present and the near future—a generation at most."[8]

Today, efforts are under way to reframe and enhance medical education once again. The Accreditation Council for Graduate Medical Education (ACGME) Milestone Project is attempting to move from a time-based to a competence-based framework for progression through medical training. The goal of the project is to define specific achievement criteria for advancement to the next level of skill or knowledge development, independent of the amount of time it has taken to achieve the standard.[9] In 2007, ten Cate and Scheele[10] proposed the concept of entrustable professional activities (EPAs) and statements of awarded responsibilities (STARs) to bridge the gap between the competency framework and practical clinical practice. They have proposed that medical education be organized into discrete, essential activities that require demonstration of adequate knowledge, skills, and professionalism. The Association of American Medical Colleges (AAMC) and National Board of Medical Examiners are working with other accrediting agencies to develop a tool for tracking learning across the continuum of medical training and practice.[11,12] Although the goals are laudable, these initiatives are hampered by the challenges of operationalizing recommendations in a practical and efficient manner while training more health care providers at a lower cost.

Disruptive Innovations

Taken together, current challenges invite radical new paradigms, which have been dubbed "disruptive innovations." Specifically, Bower and Clayton have introduced the concept of disruptive innovations to describe how new radical paradigms can produce simpler, more convenient, more customizable, or cheaper ways of benefiting consumers who are currently being ignored by industry leaders.[13] These disruptive innovations can provide a whole new population of consumers with access to a product or service that was historically only accessible to more privileged or skilled consumers. Academic medicine must recognize the urgent need for medical education reform that will help solve the nation's problems. Innovations must be rooted in sound pedagogic models that can help create a larger health care workforce at a lower cost. In this context, William Bennett,[14] the former U.S. secretary of education, has pointed out that the "mecca of the technology universe (Silicon Valley) is in the process of revolutionizing higher education in a way that educators, colleges and universities cannot, or will not."

Flipped classrooms and massive open online courses

In nonmedical education, a number of powerful disruptive changes already under way are changing the educational landscape. For example, the Khan Academy[15] started in 2006 as a series of short YouTube videos created by an individual with a laptop and an Internet connection. Since then, the Khan Academy has grown into a series of over 3,300 video lessons that cover K–12 topics. Over 180 million lessons have been delivered to date. The site offers practice tests for skill building and resources for teachers to monitor their students' progress and intervene if students get stuck. The Khan Academy recently announced an iPad app that allows students to view content offline.[16] The resource is free and has been adopted by over 36 school districts nationwide.[17] This education model allows educators to create a "flipped classroom" in which students receive and master new knowledge outside the classroom, and teachers use classroom time to reinforce learning and address students' questions.

Open access online courses have been available for at least two decades,[18,19] but the concept of massive open online courses (MOOCs) was popularized by a group of learning researchers when a course on "Connectivism and Connected Knowledge" in 2008 attracted over 2,300 worldwide participants.[20] The model of this MOOC was based on learners generating content by working collaboratively in social networks. However, MOOCs did not take the world by storm until Sebastian Thurn ceded his tenured position at Stanford University in January 2012 to start Udacity, a start-up

offering MOOCs at low or no cost.[21] Thurn was motivated by an experience in the fall of 2011 when a Stanford course on artificial intelligence that he was teaching was made available online. Thurn himself was amazed by the size of the class: "Usually I reach about 200 students and now I reach 160,000. In my entire life of education, I didn't have as much an impact on people as I had in these two months."[14] Udacity's model is one of knowledge duplication; it certifies the skills of participants using online and live, in-person testing, and enables students to share these certificates with partner companies.

Stimulated and possibly threatened by the fear of losing their traditional role in education by initiatives like the Khan Academy and Udacity, universities are now collaborating to offer free online courses. Shortly after Udacity launched, Coursera[22] was founded by two Stanford faculty members with expertise in machine learning and artificial intelligence and their application to biomedical sciences. Coursera's first university partners were Stanford, the University of Pennsylvania, the University of Michigan, and Princeton University. Currently, over 1.5 million students from 190 countries are enrolled through Coursera in 198 MOOCs from 33 universities.[23] Soon after Coursera began, Harvard University and the Massachusetts Institute of Technology announced their edX collaboration,[24] which will offer free content from the two universities to anyone in the world. Both Coursera and edX will offer certificates of mastery.

Although previous generations of learning management systems faltered because they focused more on tracking and managing instruction and content, these new systems are student-centered and are based on sound pedagogic principles. They aim to promote active, retrieval-based learning; customized feedback based on analysis of vast amounts of data created by students' performance; real-time collaboration; and peer learning while also creating an experience mimicking one-on-one tutoring. As evidence of the traction of MOOCs, traditional universities are embracing online courses and investigating ways of making them more effective. Although the initial focus has been on courses related to computer sciences, Coursera already offers courses on medical sciences topics like vaccines, public health, biostatistics, and pharmacology.

Although formal studies evaluating the effectiveness of MOOCs are lacking and some problems have been identified,[25] MOOCs are already disrupting higher education and putting at risk some smaller and less well-recognized universities and colleges.[26] As we learn from the early outcomes and combine teaching methods into hybrid or blended learning models with flipped classrooms and student-centered learning models, MOOCs clearly have the potential to deliver less expensive and better learning experiences.

Digital badges

Digital badges are another disruptive innovation in the education world[27] with implications for medical education. Digital badges are electronic images that follow learners through their lifetimes and can be included in applications and resumes or displayed on Web sites and blogs. The concept originated in 2010 at a conference in Barcelona, Spain, to help capture learning that occurs in multiple formal and informal learning spaces. Soon thereafter, digital badges received a substantial endorsement when the MacArthur Foundation funded a $2 million "Badges for Lifelong Learning Competition."[28]

Badges encode metadata containing information such as the badge recipient's name, the institution (or individual) awarding the badge, information about the endorser (i.e., the organization that certifies or approves the badge or the badge provider), information about what the recipient had to do to get the badge, and evidence that the recipient met the criteria to earn the badge. Thus, digital badges can provide concrete evidence of skills, achievements, and qualities in a more granular manner than traditional grades and degrees. They reflect mastery of real-life skills and are valued by employers looking for evidence of expertise not often reflected by college degrees.[28] Collecting and displaying electronic badges can be motivating for a generation that has grown up with technology. Standardized online platforms have been developed (e.g., Openbadges.org) for badge sponsors, badge issuers, and badge earners, allowing the issuing, collection, management, and sharing of badges across multiple Web sites and learning management systems. These tools enable students to create custom experiential pathways and stitch together multiple badges to document their learning and mastery.

Vision for a New Model for Medical Education

How can these two movements—MOOCs and digital badges—help solve the resource problems facing medical education today? We begin to answer this question by imagining a *tabula rasa* for medical education, permitting us to envision an ideal structure for our medical education system. Given a new start, we could separate learning the principles of basic and clinical sciences, factual knowledge, and early application of knowledge from more complex problem-solving and clinical reasoning. We could also separate specific, basic skills, such as obtaining or interpreting an EKG and placing peripheral and central lines, from more complex activities, such as leading a team during a resuscitation effort after a cardiac arrest, that depend in part on these skills.

We could develop a central online collaborative learning environment similar to Coursera for didactics, peer learning, and assessment of knowledge, instead of multiple medical schools teaching the same content at multiple sites. We could ensure multidisciplinary collaboration by building communities of learning. The vast numbers of students in these MOOCs would ensure that they would always have other students online at the same time helping to build a virtual, and most likely multidisciplinary, collaborative environment. For example, a lesson on interpreting arterial blood gas reports in a course on acid–base physiology could also include students training to be respiratory therapists, clinical nurse anesthetists, or emergency room physician assistants. Such a virtual learning environment would help build an interprofessional community of practice that could lead to improved communication and collaboration in a team-based practice model of the future. The content could be available to the students for subsequent review 24

hours a day, 7 days a week, and students could refer back to their basic science and clinical skills lessons during their clinical rotations. Learners at any level could discuss clinical questions with the communities of practice they formed early in medical school, thus developing a strong foundation for lifelong learning in knowledge communities extending well beyond graduation.

Massive online learning could also affect faculty practices. For example, faculty members freed from providing didactic sessions could be available for face-to-face, online small-group, or online one-on-one discussion. This would "flip the classroom"—that is, students could learn basic didactic material on their own before and after class, and valuable (and expensive) faculty time could be used for collaborative learning or problem-solving.[29] Using case-based, problem-based, or team-based learning strategies, faculty members could spend more time facilitating higher-order application of knowledge rather than delivering didactic sessions, thereby enhancing faculty satisfaction and impact, as Thurn experienced with Udacity.[14]

Digital badges could enhance the system by capturing learning in less formal and nondidactic settings focused on more discrete tasks. The badges could be issued by basic science and clinical educators who would be certified badge providers. These educators would be self-selected and self-motivated to help students learn based on the same intrinsic rewards that drive faculty now.

Students would be provided a list of knowledge, skills, attitudes, and behaviors that are required to demonstrate knowledge and mastery of skills at different levels through medical school and for graduation. Students could choose their badge providers and schedule their advancement through the curriculum guided by the parameters set by the medical school and ultimately by the accreditation bodies. Students could create custom paths for progressing through and augmenting their training. Thus, a student could complete the lesson on arterial blood gases and then perform arterial blood gas procedures during an intensive care unit experience with a respiratory therapist who would be a badge provider certified by the student's medical school. The clerkship schedules would be modified to ensure that students spend more time with house staff, allied health personnel, and faculty who are certified badge providers for the learning objectives of the rotation. The role of the medical school would be to ensure rigorous training, certification, and continuing faculty development for the badge providers as well as close monitoring and advising of students throughout the curriculum.

Digital badges could be used to record and display mastery of specific skills as defined in EPAs and thus would be the digital equivalents of the STARs. Badges are seamlessly and transparently tagged with metadata that make them very useful and relevant in medical education. A badge could indicate that Jane Smith is certified to do a Pap smear; that Dr. Jones, a gynecologist at a Clinic X, provided the badge; and that Dr. Jones is endorsed by ABC College of Medicine. As a specific example, a badge could indicate that Jane Smith had explained the procedure to the patient, done the procedure under observation, demonstrated knowledge about how to handle the specimen, and could relate the guidelines for cervical cancer screening. Dr. Jones' name would be tied to Jane Smith's badge and would be visible to anyone clicking on the digital badge display (see Figure 1). This accountability would add more value to a digital badge than a "mini-CEX" certified in a paper log book. Similarly, Jane Smith could earn badges for performing a breast exam, ordering appropriate screening and avoiding inappropriate screening tests, and ordering appropriate treatment of osteoporosis, such that a collection of badges would lead to certification in women's health. To support maintenance of skills, the specific badges could carry expiration dates. Also, as new processes and procedures become standard of care, the certification in women's health would be updated with a need for additional badges. Thus, Jane may need to get new badges for ThinPrep testing and HPV vaccination to maintain her certification. Learning could take place in a live workshop or grand rounds or by completing a course in a MOOC. In this process, badges can be used to capture learning across the continuum of medical education and potentially enable tracking for the purpose of maintenance of licensure.

Students could maintain an electronic portfolio with data from MOOCs and digital badges they earn during their medical training. They would share this with employers, privileging hospitals, colleagues, patients, and state licensing boards. The focus would shift from teacher-centered to student-centered learning and from linear, temporal-based teaching to mastery-based progression. In this new world, students would learn to take ownership of their learning process supported by a technological platform that would provide the necessary organizational and pedagogic framework.

Lest this scenario seem too far-fetched, some current experience offers a proof of principle. A model for establishing an online learning community focused on Parkinson disease has been set up in the Netherlands.[30] The program, called ParkinsonNet, is a nine-step process to help provide multidisciplinary care for patients with Parkinson disease in a cost-effective regional community network. This model includes ongoing education via digital newsletters and a certification system supported by professional societies to guarantee quality of therapy. In a visionary move, the AAMC, the Khan Academy, and the Robert Wood Johnson Foundation are collaborating to create videos as a free online resource for students preparing for the Medical College Admission Test. This is an effort to help students from diverse and economically and educationally challenged backgrounds to enter the medical profession.[31]

Imagine the Possibilities

The "second Flexner Report" identifies four laudable goals to improve medical education: (1) standardization of learning outcomes and individualization of the learning process, (2) integration of formal knowledge and clinical experience, (3) development of habits of inquiry and innovation, and (4) focus on professional identity formation.[1] Current demographic and economic challenges to implementing these goals can be averted by a new vision of medical education that is transformed by disruptive technologies such as MOOCs and digital badges. No longer will a limited number of medical schools or faculty constrain our ability to educate medical students. Learning

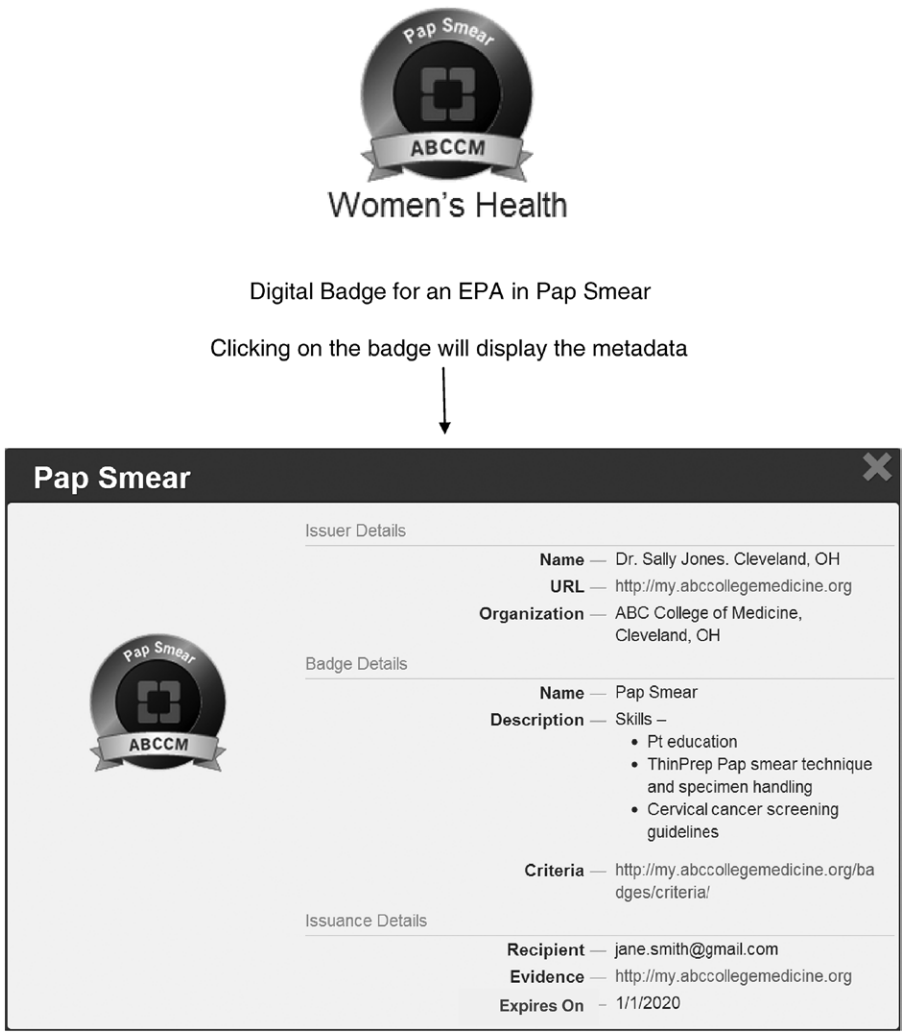

Figure 1 Mockup of a digital badge for a Pap smear. Digital badges can be used in medical education to track learners' mastery of entrustable professional activities (EPAs) toward, for example, medical school graduation or maintenance of certification.

communities will form naturally, and students will need to take ownership of their education.

To realize this new vision, medical educators must embrace the new technologies and innovate around them. With this, we can better effect the reforms in medical education that have been espoused by the "second Flexner Report," the ACGME Milestone Project, and the EPAs proposed by ten Cate. Just imagine.

Acknowledgments: The authors would like to thank Mr. Bruce Spevak and Ms. Debra Shirley for designing the digital badge graphics in Figure 1.

Funding/Support: None.

Other disclosures: None.

Ethical approval: Not applicable.

References

1 Cooke M, Irby DM, O'Brien, Bridget C. Educating Physicians: A Call for Reform of Medical School and Residency. San Francisco, Calif: Jossey-Bass; 2010.
2 Ottolini MC, Cuzzi S, Tender J, et al. Decreasing variability in faculty ratings of student case presentations: A faculty development intervention focusing on reflective practice. Teach Learn Med. 2007;19:239–243.
3 Howley LD, Wilson WG. Direct observation of students during clerkship rotations: A multiyear descriptive study. Acad Med. 2004;79:276–280.
4 Kirch DG, Henderson MK, Dill MJ. Physician workforce projections in an era of health care reform. Annu Rev Med. 2012;63:435–445.
5 Youngclaus J, Fresne J. Trends in cost and debt at U.S. medical schools using a new measure of medical school cost of attendance. AAMC Analysis in Brief. July 2012;12. https://www.aamc.org/download/296002/data/aibvol12_no2.pdf. Accessed April 14, 2013.
6 Cullen E. Health policy in medical education: What young physicians know about the Affordable Care Act. Arch Intern Med. 2012;172:1605–1606.
7 Flexner A. Medical Education in the United States and Canada; A Report to the Carnegie Foundation for the Advancement of Teaching. Boston, Mass: D.B.Updike, The Merrymount Press; 1910.
8 Ludmerer KM. Commentary: Understanding the Flexner Report. Acad Med. 2010;85:193–196.
9 Nasca TJ, Philibert I, Brigham T, Flynn TC. The next GME accreditation system—rationale and benefits. N Engl J Med. 2012;366:1051–1056.
10 ten Cate O, Scheele F. Competency-based postgraduate training: Can we bridge the gap between theory and clinical practice? Acad Med. 2007;82:542–547.
11 Association of American Medical Colleges; Accreditation Council for Graduate Medical Education; Federation of State Medical Boards; National Board of Medical Examiners. eFolio: A Secure Personal Data Manager Serving Physicians. https://www.aamc.org/download/76810/data/efolio.pdf. Accessed July 1, 2013.
12 Mann S. New efolio connector will help physicians, students track training. AAMC Reporter. October 2011. https://www.aamc.org/newsroom/reporter/october2011/262444/efolio-connector.html. Accessed July 1, 2013.
13 Bower J, Clayton C. Disruptive technologies: Catching the wave. Harv Bus Rev. January 1995:44–53.
14 Bennett W. Is Sebastian Thrun's Udacity the future of higher education? CNN.com. July 5, 2012. http://www.cnn.com/2012/07/05/opinion/bennett-udacity-education/index.html. Accessed July 1, 2013.
15 Khan Academy. A free world-class education for anyone anywhere. https://www.khanacademy.org/about. Accessed July 1, 2013.
16 Ferenstein G. Khan academy enters next era with iPad app. Fast Company. March 9, 2012. http://www.fastcompany.com/1823819/khan-academy-enters-next-era-ipad-app. Accessed July 1 2013.
17 Sengupta S. Online learning, personalized. N Y Times Web. December 4, 2011. http://www.nytimes.com/2011/12/05/technology/khan-academy-blends-its-youtube-approach-with-classrooms.html. Accessed July 1, 2013.
18 Open University. History of the OU. http://www.open.ac.uk/about/main/the-ou-explained/history-the-ou. Accessed July 1, 2013.
19 Massachusetts Institute of Technology. MIT OpenCourseWare: Our history. http://ocw.mit.edu/about/our-history/. Accessed June 21, 2013.
20 What you need to know about MOOCs. Chronicle of Higher Education Web site. http://chronicle.com/article/What-You-Need-to-Know-About/133475/. Accessed July 1, 2013.
21 Udacity Inc. How it works. https://www.udacity.com/how-it-works. Accessed July 1, 2013.
22 Coursera. About Coursera. https://www.coursera.org/about. Accessed July 1, 2013.
23 Coursera. Course catalog. https://www.coursera.org/courses. Accessed July 1, 2013.
24 edX Web site. https://www.edx.org/about-us. Accessed July 1, 2013.

25 Hill P. Four barriers that MOOCs must overcome to build a sustainable model. e-Literate. http://mfeldstein.com/four-barriers-that-moocs-must-overcome-to-become-sustainable-model/. Published July 24, 2012. Accessed July 1, 2013.

26 Azevedo A. MOOC's could hurt smaller and for-profit colleges, Moody's report says. Chron High Educ. September 12, 2012. http://chronicle.com/blogs/wiredcampus/moocs-could-hurt-smaller-and-for-profit-colleges-moodys-report-says/39864. AccessedJuly 1, 2013.

27 Eisenberg A. For job hunters, digital merit badges. N Y Times Web. November 19, 2011. http://www.nytimes.com/2011/11/20/business/digital-badges-may-highlight-job-seekers-skills.html. Accessed July 1, 2013.

28 Crotty J. Why get a pricey diploma when a bleepin' badge will do? Forbes. January 26, 2012. http://www.forbes.com/sites/jamesmarshallcrotty/2012/01/26/the-end-of-the-diploma-as-we-know-it/. Accessed July 1, 2013.

29 Prober CG, Heath C. Lecture halls without lectures—a proposal for medical education. N Engl J Med. 2012;366:1657–1659.

30 Nijkrake MJ, Keus SH, Overeem S, et al. The ParkinsonNet concept: Development, implementation and initial experience. Mov Disord. 2010;25:823–829.

31 Medical education community collaborates with Khan Academy to help prepare students for new MCAT® exam [news release]. Washington, DC: Association of American Medical Colleges; April 2, 2013. https://www.aamc.org/newsroom/newsreleases/332152/040213.html. Accessed July 1, 2013.