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The Profession of IT
Automated Education and the Professional

Technology boffins argue the new technologies of intelligent personal learning environments will put universities out of business. Will the purported successor, an automated global virtual university, be up to the task of professional education?

THREE NEW BOOKS proclaim a coming disruption for higher education: *The End of College* by Kevin Carey,[1] *College Disrupted* by Ryan Craig,[2] and *Hire Education* by Michelle Weise and Clayton Christensen.[8] They tell variations of the following story. The common model for a university encompasses three purposes: practical training, research, and liberal education. Trying to serve all three well has driven up costs, tuitions, employer dissatisfaction, student debt, and student disillusionment to unsustainable levels. Intense competition among universities for ranking and prestige further exacerbates these issues. The new technologies of massive open online courses (MOOCs) and online competency-based modules (OCBMs) provide numerous online alternates at much lower cost. They will draw students away and cause many university bankruptcies in the next decade. A highly automated, low-cost, global, virtual "University of Everywhere" will emerge from the disruption.

Lew Perelman, who first foresaw competency-based learning technologies in his book *School's Out*,[7] recently commented: "What will really disrupt academia is not mass production of impersonal teaching but mass access to personalized learning, plus employment selection based on demonstrated competencies, not academic credentials. That is the fate that now faces academia."[a]

The disruptive threats are real and education leaders should be taking them seriously. However, these authors reflect an unwarranted faith in education technology. The envisioned automated university is unlikely to satisfy many education goals and is likely to shortchange professionals.

The faith in technology behind these predictions is based on recent advances in artificial intelligence and data analytics, which open possibilities we could hardly envision as recently as a decade ago. The headline-hogging MOOCs are the lesser threat; they are turbocharged platforms for traditional classroom courses scaled up several orders of magnitude for large student numbers. The under-the-radar OCBMs

a Perelman, L. MOOCs: Symptom not cause of disruption. ACM *Ubiquity* (Aug. 2014). A very good account of how the powers of different groups influence the shape of the disruption; http://ubiquity.acm.org/article.cfm?id=2591680.

IMAGE BY WAVEBREAK MEDIA

are the greater threat because they use new designs to explicitly help students develop job-related competencies and they offer their own credentialing systems including professional certificates and badges. The promoters of these new technologies claim these main benefits:

- Mass personal learning environments will detect and adapt to individual student learning styles by gathering and analyzing large amounts of student data, exploiting research in deep machine learning, cognitive science, and pedagogy.
- Technology-enabled collaboration and telepresence will amplify student success rates toward learning objectives.
- New credentialing systems will accurately report how well a student is able to perform at specific jobs or in specific environments.
- It will become possible to design OCBM-builders that generate the software for a particular OCBM in response to given learning objectives.
- These environments will provide a pathway to mastery.

Is computing technology up to delivering these claims? Can these technologies actually provide a path to mastery? Is the imagined post-disruption world's University of Everywhere what we really want from education?

Personal Learning Environments and Expert Systems

Artificial intelligence grew from a belief from the 1940s that a large enough network of electronic components could function like a brain: thinking, understanding, being self-conscious, and substituting for experts. This led to claims that machines could carry on natural conversations, make scientific discoveries, prove mathematical theorems, automate many cognitive tasks, understand world trends, and beat humans at chess. Except for chess, none of those claims was ever fully realized, and even the chess claim weakened when laptop-equipped chess player teams discovered they could regularly beat the grandmaster machines.

In 1972, Hubert Dreyfus, a philosopher at UC Berkeley, published a famous but controversial book *What Computers Can't Do*[5] in which he questioned the popular claim that machines would become experts in various human domains. He argued we infer expertise from the skills people exhibit when performing in a domain. He identified six levels of skill: beginner, advanced beginner, competent, proficient, expert, and master. Each is a higher level of embodiment than the previous. Embodiment means the skill is ingrained into our bodies (not just our brains) through immersive practice until it becomes so automatic that we are not aware we are doing the practice.

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Dreyfus argued that beginners and advanced beginners determine actions by following rules. Competent people, however, perform most of their actions automatically and resort to rule following only when confronted with a new situation. He argued that computing machines, which follow rules, cannot attain proficient or higher levels because human performance at those levels cannot be characterized as following rules. It took many years before Dreyfus's controversial argument was vindicated. Although some expert systems performed competently, no one thought they performed as a true human expert.

In his more recent book *On the Internet*[4] Dreyfus evaluates the capability of the Internet to host personalized learning environments. He concludes that a personal learning environment itself is an expert system that, like other expert systems, cannot rise above the level of competence at what it does—teaching. Telepresence and massive data do not add much. To say machines can now store and retrieve enormous patterns just increases the size of the rules a machine can follow but does not grant the machine new non-rule-following powers such as we embody in our biologies.

Dreyfus examines what master teachers do that machines cannot do. For example, master teachers report they can tell when a student is learning by looking for a "dawning look of understanding" in the student's eye; no one knows how teachers do this, and no one knows how to build a machine of which a student says "It looked at me with understanding." More to the point, master teachers foster learning environments in which students develop proficiency, expertise, and mastery: the traditional methods of apprenticeship, conversation, immersion, mentoring, and coaching cannot be replicated by machines. With a team of colleagues, Dreyfus recently released a movie, *Being in the World*,[b] which shows six masters from diverse fields and proposes language that allows us to talk about what they do and how they became masters. It is difficult to go away from viewing this movie with any impression that any automated learning environment can possibly cultivate mastery.

Even though personal learning environments cannot be master teachers, these environments are still a major economic threat to existing university ways. There is a huge market of people wishing to become advanced beginners or competent in well-defined domains, such as network administration or basic programming, where criteria for competence are precise and testable. Personalized learning environments can do many useful things to support this goal: bring materials such as books and videos to students, provide simulators and virtual environments to host experiments, administer tests, tailor interactions to support students where their tests indicate they are weak, and provide tools for communicating with other students. Many students report a well-designed MOOC or OCBM is more engaging and pleasurable than a typical classroom lecture course.

A practical implication of Dreyfus's argument is that designing OCBMs will never be easy and will resist automation. I can testify to this from personal experience. In 1993, in the early days of the Web, Daniel Menascé and

b The video for *Being in the World* is available from http://beingintheworldmovie.com

I at George Mason University set out to make OCBMs (then called "tutorial modules") in computer science available on the Web from our new Hyperlearning Center.[c] For each topic, we devised the learning objectives and displayed them as concept maps. We designed and built a system called Hyperlearning Meter that would generate online tests customized for each student. We carefully designed questions that would reveal whether or not the student understood a key idea. We developed a programming language to describe a test question template and a test generator that would fill in parameters of a template and present an actual question. When a student asked for a test, the generator would select a random sample of templates from the question database and present a test to the student by randomly selecting numerical parameters for the variables in each one.

We spent an enormous amount of time designing individual questions and accumulating a large enough database to enable customization of tests to individual students. We drew deeply on our extensive experience as computer science teachers to design concept maps, anticipate the ways students would veer off track, and design tests to detect when they had. We had to employ our expert knowledge on each and every question. There was no way we could automate the process of generating question templates. The same is true today.

Post-Disruption Education

It is more likely the new personal learning technologies will replace parts of universities rather than the whole institution. Universities will use automated learning environments for beginners and advanced beginners, and offer more mentored learning for embodied skills beyond competent.

Completely automated environments will be very attractive for beginners and advanced beginners, but will impose important limitations in return for their lower costs. The system's orientation toward efficiency would encourage students to take only the courses or certificates they need and "test out" of others, foregoing the opportunity to explore unknown domains in preparation for personal development and innovation. The system's use of standards would force many students into conformity with the standards rather than to develop their individual talents and selves. Students would have few opportunities to join mentored conversations of exploration of new domains where there is yet no knowledge, no concept map, and no criteria of performance.

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Much of the motivation for automated education comes from the practical training model itself. Automated environments can offer a faster, cheaper path to basic competence in known areas where jobs are available. But new areas are constantly emerging in short periods, often less than the four-year time at a university. To keep up, professionals will need the skills of detecting emerging areas, appropriating their interpretations and practices, navigating from where they are to the new areas they choose, and mobilizing their networks to shape new offers in those areas.[3] Where will they get these skills?

Here are glimpses of what education can offer to enable us to attain those skills in our constantly shifting, highly connected, technology-accelerated world[6]:

- Skills of detecting, navigating, appropriating, offering, and mobilizing.
- An understanding of how social power—political, economic, ideological, military, and trust—works so that we can detect coming changes and develop personal power to navigate and shape them.
- Cultivation of our "self"—who we are, what we stand for, what our identity in the world is, and how we project into the world.
- An understanding of how moods and emotions affect people's willingness to move and how to orchestrate moods conducive to the changes we seek.
- An opportunity to engage in ongoing conversations exploring new worlds, as part of preparing for innovations and further developing our selves.
- Access to mentors and education offers to help in times of transition, such as loss of job, learning a new skill set, or adapting to retirement.
- Access to all levels of performance up through mastery in our field.

These concerns call for practices, skills, and sensibilities that technologies such as MOOCs and OCBMs cannot provide. People yearn for them but do not know how to ask for them. Educators do not have the language to discuss them and design education that meets them. A future environment that includes masters, mentors, coaches, and students, supported by technologies, might be able to do the job.

My conclusion is that well-designed automated systems may help newcomers become entry-level professionals, but will be unable to provide professional development beyond competence. Automation does not provide an opportunity to develop the "self," an ability to explore unfamiliar worlds of which we lack knowledge, or a path to mastery. C

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c The website of the Hyperlearning center (1993–2000), which began as the Center for the New Engineer at George Mason University, is archived at http://denninginstitute.com/pjd/oldcne-home-archive.html.