

Economics of the Ed Tech Revolution

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Abstract

Rapid changes in technology, including advances in augmented and artificial intelligence, machine learning, and mobile, are paving the way for significant changes not only in the channels through which education is delivered, but in how education itself is structured. This paper identifies eight ways in which education technology can change how learning is facilitated and who will facilitate that learning. Basic economic principles then provide a framework for thinking about how these changes will be embedded over time as education increasingly becomes a durable good providing increasing returns through network effects.

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Technology in education (Ed Tech) is changing rapidly. But many sectors of the economy have become more digital without significant restructuring in how the market is organized or what outcomes the sector achieves. Separating hype from substance is critical, and some basic economic principles help us do that. A key idea of this paper is that in education, technology changes like digitization are likely to be disruptive when they change the “product,” and are unlikely to be if they don't. By changing the product I mean change in how education itself is structured. Digitization without product change is often more about distribution through a new channel.

My focus is on the higher-end, currently rather expensive-to-develop areas of Ed Tech. Perhaps the simplest example is synchronous delivery of live content with two-way interactivity (e.g., an online case discussion in a business school). Many of these developments are helping us rethink how best to support how students learn. In contrast, this paper is not principally concerned with Massive Open Online Courses (MOOCs). MOOCs are important for democratizing certain elements of education, i.e. they currently represent a different distribution channel, and for sorting individuals into different educational pathways, e.g., by identifying talent. But they are not in themselves significant changes in the education product. This helps explain the market's transition from infatuation with MOOCs just a few years ago to the more realistic expectations of them currently.

The next presents eight examples of technology-enabled change in education that are in my judgment true changes in the product. Section 3 turns to broader economic issues like the transition of education from largely non-durable information good to one that is largely durable, the result being additional network effects and increasing returns. Section 4 concludes.

EIGHT WAYS EDUCATION CAN CHANGE

Each of the eight examples I will outline identifies a distinct dimension of product change. I group them into two categories — four relating primarily to *how* learning is facilitated and four relating to *who* is doing the facilitation. These eight examples are not intended to be exhaustive, but rather to communicate the notion of product change. Note too that these categories, who and how, contrast with the *when* and *where* elements of EdTech that have received so much more attention (e.g., popular press attention on “anytime, anywhere”).

Four examples of product change: How learning is facilitated

I refer to this first example of product change as Learning Engines. The central idea here is that learning occurs best when feedback loops to the learner are closed, rich and fast. This is often not the case in traditional classrooms. My favorite example of this product change comes from a 100% online course in the coding language MatLab that was taught at U.C. Berkeley. The faculty who taught the course had taught the traditional on-campus version of the course many times so they knew what elements of it

students tended to find hard and how, through traditional teaching methods (when office hours would allow) they were able to advance students through these hard parts. They designed what at first was a grading engine: students would submit code that had as a goal, say, five outcomes and the engine would run the code and assign a grade. What they added as it evolved was a capability to iterate: students would write the code, submit it, and instantly get feedback that, say, three of the goals were fully achieved but not all five. The engine would suggest some questions to consider, or a reading to review, or a related problem to consider. Students could then adjust their code, resubmit, and get more automated coaching. Only when students finally hit “send” would a final grade on the problem set be assigned. The upshot: students so loved this iterative part of the course that the engine is now used to teach the traditional on-campus versions of the same course. This is a different product, not the same product distributed through a new channel¹.

This second example of product change is Retention of Learning. Ask a professor or K-12 teacher what percentage of their students would be able to achieve even a B on their final exam six months after taking it. If they are being honest, the answer will be surprisingly low. And if the final exam is testing the learning outcomes we feel are most important, doesn't this mean we are missing the mark horribly over time? Put differently, it is as though the goal was to assign a grade as opposed to durable learning. What if instead, six months after a course is over, a student received a diagnostic for the each of the big ideas of the course, with refresher material if needed? At the very least, this would promote an awareness of where concepts have dissipated. More aspirationally, it would help them to apply the knowledge in subsequent courses/work. If the course isn't over when it's over, and instead becomes something more like learning-as-a-service, to parallel the software-as-a-service transformation in that industry, then outcomes over time will look very different. This is a different product, one enabled by technology that makes it truly feasible.

The third example of product change relates to Faculty Preparation. Online course formats that involve some synchronous delivery allow faculty to engage with students in more informed ways because they can see in advance of a live class or discussion which students are struggling with which elements of the content. The same is true of hybrid formats that use flipped classroom formats. Feedback from online quizzes is one source of this information. Information on which students have accessed readings and other materials is another. The opportunity to review student-to-student discussion-tool records is yet another. The fundamental idea here is that information about learning effectiveness is flowing two-ways, and is doing so at a scale that is not possible in traditional course formats — a different product².

The fourth example of product change relates to Course Connections. A strong curriculum is not just a collection of strong courses, but instead an integrated collection of strong courses. Instructors of traditional courses within a given curriculum can and do make efforts to integrate their material so that the result for students is more than the sum of the parts. This is important, for example, in helping students think in a more integrative way. But the degree to which this is done successfully within traditional-course curricula is suspect. One has syllabi and other print materials for doing so, but these

¹ For an example of a learning engine in the Humanities, see Mehrotra (2015); that young people might soon be learning to write by getting instantaneous feedback on the depth of their thesis statement or the intellectual coherence of a paragraph show that learning engines will not be limited to scientific and technical fields.

² Two-way information flow and other elements of adaptive learning are addressed in Tyton Partners (2013) and Carnegie Mellon University (2015).

materials are not easily searched, and exactly how the material is presented is often not known unless a teacher sits in on another's course — doable once or twice, but not as scale. With digital-format courses this cross-course integration can be done much more purposefully. And when courses change, the need for changing links with other courses is much more easily updated. Faculty learning will be affected too: faculty will get better at using bite-sized modules of content from prior courses more effectively. The difference in outcomes from traditional curricula to digital curricula can be large enough that I consider this a different product.

Four examples of product change: Who is facilitating learning

The fifth example of product change is Flipping. When a faculty member does not have to give the same lecture four times in the same week, but instead can use in-class time for higher-level discussion, it is a better use of the comparative advantage of faculty talent. My favorite example is Janet Yellen, current chair of the US Federal Reserve Bank, who for decades at Berkeley-Haas gave the same lecture in macroeconomics multiple times each week. This is not the best use of Professor Yellen's time. If instead students could have used her time to discuss the applications of the material, the nuance in the policy decisions, and the judgment that ultimately needs to get exercised, this would have been a better outcome. When a faculty member like Janet Yellen is facilitating learning in these other ways to a much greater degree, the result is a different product.

The sixth example of product change is less about using existing teaching talent differently and more about accessing New Categories of Teaching Talent. For this example, imagine a synchronous class session that connects a faculty member in Berkeley with a group of students assembled in the same room in Shanghai to present the latest tools in quantitative marketing. Two of the people in the Shanghai room are senior-executive alums of the school who work in Shanghai in the area of quantitative marketing and who want to hear the lecture material as a "booster shot." After the synchronous lecture, the two senior executives then facilitate the case discussion — alumni as instructors. Can this kind of think happen in a traditional classroom? Yes, but the reach and scale of this accessibility to new categories of teaching talent is what qualifies it in my judgment as a different product.

The seventh example of product change is the way that Faculty Roles are Unpacked. Generally, the workload for instructors is metered by the course. But that is a construct that comes out of the way that courses have been traditionally taught. In the more digital world we are heading into, a faculty member's strength in teaching might be focused much more of one or a few components of what it takes to deliver a great course, rather than having to deliver the whole course as a unit. For example, what if faculty could specialize in specific components of education delivery, e.g., the academic design of a course, by which I mean the assurance of academic robustness? Faculty who focus more on research might be particularly good at this element of teaching, while at the same time, for example, being less adept at facilitating discussion among students. The load for a faculty member like this might be a 6-course academic-design load rather than a three course teaching load. Using faculty in this richer, more unbundled way is a product change.

The last example I offer here of product change relates to Addressable Market. I include this in the "who" category because it is most fundamentally about who is delivering the learning. The idea that digital learning has global reach is an old one and by itself hardly novel. What has been missed, it seems to me, or at least under-appreciated, is how this affects the pattern of competition in our sector and the

sustainability of many providers in our sector. I have in mind for this example the part-time MBA programs that are so important to the financial sustainability of so many business schools, and by extension, so many universities who rely heavily on business-school-generated resources to sustain themselves. The pattern of competition in this segment has historically been quite local: working professionals who enroll in these programs tend to live within fifty miles of the offering school. The advent of digitally-delivered part-time MBA programs of high quality is delocalizing competition in this important segment. The pattern is not yet global as it is in the full-time MBA program, nor even fully national yet, but it is moving in that direction. This change in who is able to compete and deliver may be the single most disruptive element of digital education in the world of business school deans.

DURABILITY, NETWORK ECONOMICS AND INCREASING RETURNS

Dependable economic principles can help us think about how Ed Tech will play out. There are two principles in particular that non-economists are less familiar with that deserve note: (1) Information Goods and (2) Network Economics.

Traditional education can be described as an information good, but a non-durable one, in that the good itself — the lecture for example — does not last beyond the event of its delivery. While it is true that the student's notes of the lecture persist, they are in fact a poor facsimile of the lecture itself. (Note that the secondary-market for your old lecture notes is not exactly vibrant.) Of course, hopefully the impact of the lecture lives on in its effect on the mind, but that is no longer a good that remains for others to enjoy (unless one chooses to provide that good/service for others, which requires incremental "production"). As the lecture is digitized, however, it takes on a reusable nature—it becomes durable.

Here's a story about how education as a durable information good creates a completely different mindset. Recently over lunch an alumna of the business school at which I am dean asked me, "What is your content strategy?" In a traditional world of non-durable education goods, this question would not naturally be posed. And it was one that I had never considered prior to that point. And yet, it is one that anyone in an industry involved with durable information goods would ask routinely.

For network economics, the basic idea is that "increasing returns" result when the value to one user depends on how many other users there are. There are many ways that this network effect becomes more operative as an information good becomes more durable.³ Five examples of this include:

- 1) Learning analytics: generating more data on learning outcomes as a function of the learning environment. Put differently, the kinds of controlled experiments that define great science are increasingly available to the education sector. And those who establish early leads in access to data and the ability to deliver insights from it will enjoy increasing advantages.

³ Not every part of a 100% digital course is durable: think, for example, of video interaction between students that is uncaptured to protect privacy. And even great courses have a need for updating as empirical circumstances and the state of understanding within the field evolve. We can expect the more settled content within courses to be codified first into more durable formats.

- 2) Peer-to-peer learning: supporting more opportunity for student-to-student learning. Students have always learned from one another. But the degree to which digital formats run at scale can facilitate this more effectively will stem from, for example, the ability to match learners who can learn from one another especially effectively.
- 3) Freemium pricing models: learning at higher scales makes room for pricing strategies that allow users to sample at a price of zero. The network effects that come from consolidating learners on a given platform will be accelerated by providing access to new users at low or zero prices. Scale is important for making these pricing strategies economically attractive.
- 4) Alumni as installed base: having some customers who consider themselves alumni and for whom switching to another provider would be costly. Network effects become particularly strong in this setting. What an "alum" means as the sector expands beyond traditional university providers will be an important element of the evolving picture.
- 5) Convergence of the education and work worlds: as "just in time" education for practical use becomes stronger, the durability of the information good creates additional opportunity for scaling. An example of this is what we see in the area of executive education where firms often want a high-touch premium delivery of content to their senior executives, whereas a lower-touch, more economical cascading of the same content deeper into the institution depends on a more digital format.

CONCLUSION

Ed Tech is already changing the education product. Therein lies its disruptive potential. The eight product-change examples outlined above are all at varying degrees of execution, and all have plenty of room for further development. Together, they point to a dynamic that is unmistakably different than any in education during our lifetimes. When, for example, learning engines allow a 10th grader to feed in an essay draft and get instant, substantive feedback on the depth of the thesis statement, the intellectual coherence of paragraphs, and the degree to which the essay is compelling, we will all be learning to write in a radically different way. We are not there yet. But in ten years? The learning networks that will result from this transition to a more durable form of information good will shape education's future, including putting economic pressure on institutions that are dependent on local geography.

A final comment on networks and durability: One of the challenges of this changed economic environment is "lock in": the idea that sometimes the technology that wins out by benefitting from increasing returns is not the best one by other standards (e.g., the one that produces the very best learning outcomes). Well-known examples of this challenge in other sectors include VHS overtaking BETA and the QWERTY keyboard. We are currently in a phase within the education sector of mass experimentation with Ed Tech. And we know from experience that the first mover does not necessarily benefit from the lock-in – think Netscape in browsers. But if players are not in a position to at least fast follow, elements of the Ed Tech marketplace may well race away from their grasp.

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