

## Introduction

I started blogging a year ago. I did so because I thought it would be fun, but also because this period in time seems unique. There is now palpable widespread hope that significant educational change is possible. But there is also palpable widespread concern that the world needs healing. The two are not unrelated. For me, blogging is a way to add one more voice.

This year has been a huge learning experience for me. What you see below is an attempt to explain the learning to myself.

There are three sections, each with a set of statements. Many of the statements refer to quotes, located at the end of the document, that provide additional illustration and flavor. The quotes also link to references. I've not tried to be comprehensive in the quotes or references. The ones included simply worked well for what I was writing. But others could have been chosen to equal effect.

Finally I should acknowledge two impressive works that I've not quoted but which continue to engage me deeply. One is Beinhocker's *Origin of Wealth* and the other is Benkler's *Wealth of Networks*. Even the titles segue nicely.

Comments and suggestions are most welcome.

1. Evolutionary changes in biology, economics, and other complex adaptive systems provide, by analogy, insights into educational change.
  - a. Time deserves explicit consideration. Even stasis cannot be determined without attention to time.
  - b. Adaptation implies learning over time in an evolutionary dynamic. [q1].
  - c. Complexity implies a network of connections and the interdependence of agents, with positive and negative feedback loops amid a turbulence of action, reaction, coupling, learning, adaptation, and change. [q2, q3]
  - d. Communication among agents can have dramatic effects on system behavior [q4].
  - e. Under the right circumstances, positive feedback can lead to instability in the system and emergence of discontinuous states where the macro behavior of the system cannot be understood based on the micro behavior of its components. [q5, q6]
  - f. Localized connections and interactions, externalities, and agent heterogeneity all seem related to emergence. [q7]
  - g. However, macro-level coherence across long time periods is also common. [q8, q9, q10]
  - h. At the moment there is no way to predict state shifts and, hence, no way to directly influence their occurrence or impact. Some researchers believe the search for good theory may change this. [q11]
  - i. Others believe that we are limited in our ability to understand complex systems by the randomness inherent in such systems. [q12, q13]
  - j. I find the probabilistic limitations persuasive, but not a deterrent to exploring educational change as a complex adaptive system.
  
2. Histories of technological change, business cycles, and economic growth add detail to the notion of education as a complex adaptive system.
  - a. Institutions represent the rules of the economic game. They include such things as laws, regulations, norms of behavior, and beliefs. [q14]

- b. The rate of institutional change varies by institutional type. Regulations, for example, normally change more frequently than cultural beliefs. [q15]
  - c. Culture, beliefs, and individual and organizational resistance provide the drag that creates path dependence. Today depends in part on yesterday. History matters. [q16]
  - d. At any point in time, institutions and their web of constraints and incentive structures provide much of the environment within which the economic game is played. [q17]
  - e. Organizations comprise individuals in a setting where organizational rules, norms of behavior, ethos, and beliefs are institutionalized. In this sense, a university is an institution.
  - f. Entrepreneurs and organizations are the players of the economic game. Even in non-market situations, equivalents can usually be found. [q18, q19]
  - g. The economic game itself is marked by periods of relative calm punctuated by periods of tumult. [q20, q26]
  - h. Economic change benefits some but is resisted mightily by others. It is a creative process, but also one of very real and painful destruction. [q21]
  - i. Technology represents the tools of the economic game and the manner in which the game is played. Some economists differentiate these as physical and social technologies although the terminology is by no means consistent. Nor is the distinction particularly clean. But it does emphasize differences in innovation (see below). [q22]
  - j. Technology is knowledge made explicit, specifying how goods and services are produced. Technological change represents changes in applied knowledge, either because of new knowledge or because of existing knowledge used differently. [q23]
  - k. Innovations in physical and social technologies drive economic change. [q24, q19]
  - l. Human learning is the most fundamental long-run source of new ideas, knowledge, and innovation. [q25]
  - m. Most new ideas do not adapt to the economic environment and wither. Some innovations thrive and drive small incremental change. Occasionally, large discontinuous changes occur. [q26]
  - n. Social and physical innovations coevolve.
  - o. Social innovations can unleash the full potential of physical technologies. [q27, q28, q29]
  - p. Perhaps because they are less glamorous and more difficult to affect than physical technology, social innovations seem somewhat underappreciated. Yet significant educational change depends on creative new social innovations.
3. In a networked economy, social innovations in several areas provide the potential for educational change [q30]. I am thinking here mostly of university education, but suspect that some of it applies to other educational levels as well.
- a. Price: As educational content becomes digital, the marginal cost of that content approaches zero. Giving learners free access to content becomes an option. This does not mean that education becomes free. It merely exerts downward pressure on the price.
  - b. Value: If educational content is given away freely, then what gets packaged with the content is what creates value and can be priced. This might include such things as easily finding content and judging its appropriateness, or personalized assistance in the learning process. [q31, q32]
  - c. Price redux: Value ancillary to content invites individual pricing based on actual usage. Learners differ, the services they need differ, and a la carte prices reflect that.
  - d. Who pays and how: In educational markets, we normally think of institutions and learners and their families being involved in the exchange, with subsidies from government and from businesses. In a networked economy, it is possible to substantially alter this composition (e.g., using advertising revenue). Social innovations in this area can have dramatic impact on

education. We don't have it right yet. A broader more diffuse ecology of revenue streams might work.

- e. Access: If learners and their families bear lower educational costs, then access opens up. Self-selection replaces admissions to an unknown extent.
- f. Community: Access to a community of scholars and other learners is a critical part of an educational experience. Content alone does not provide this experience, no matter how freely it is provided. Communities are now largely institution specific, with exceptions for study abroad, service learning, and other special programs. Networked learning provides much broader opportunity for participation in diverse communities of practice or some variation of these. I'll simply call them communities of learning. [q33, q34]
- g. Credentials: Certificates and degrees provide what Brown and Duguid call a "tradable token in the job market." As such, they serve students, educational institutions, and employers well. As Benkler mentions, a number of existing web sites (e.g., Amazon and Slashdot) incorporate peer-review and multiple levels of moderation to ensure what he calls the "relevance/accreditation" of content. Adaptation of these for communities of learning seems entirely possible. Credentials and degrees, or more likely their improved equivalents, seem plausible. [q35, q36, q37]
- h. Locus: Members of a community of learning need not be geographically local, yet the communities themselves can still emerge from local needs, cultural beliefs, languages or other considerations sufficiently important to supply cohesion. Scale, geography, and political boundaries partially diffuse.
- i. Pedagogy: The stereotype of teaching and learning as knowledge transmission was probably never entirely true. But networked communities of learning provide an alternative paradigm in which learners at all levels can develop or co-create knowledge. The distinctions between teaching and learning soften.
- j. Membership: Members self-select themselves into networked communities of learning. Our notions about expertise will blur and then modify. Underemployed but talented people (e.g., adjunct faculty) seem likely to find communities of learning attractive.
- k. Markets and firms: Many educational problems seem intractable given available resources and competing priorities. Current public, private, non-market, and market delivery options often seem simply overwhelmed and reform efforts provide only a patchwork of relief. Social entrepreneurs are active in education and their efforts may provide blended market models. New institutions like the Community Interest Companies in the UK also provide interesting options. Or it may be possible to tap into the apparently large reservoir of social production that Benkler describes. Or some combination, or something else entirely. The core feature is improving the global commonweal. There is huge potential here, but much creative experimentation remains.

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## Quotes

[q1] Adaptation, in the biological usage, is the process whereby an organism fits itself to its environment. Roughly, experience guides changes in the organism's structure so that as time passes the organism makes better use of its environment for its own ends. Here we expand the term's range to include learning and related processes. [Holland, p9]

[q2] The innate features of many social systems tend to produce complexity. Social agents, whether they are bees or people or robots, find themselves enmeshed in a web of connections with one another and, through a variety of adaptive processes, they must successfully navigate through their world. Social agents interact with one another via connections. These connections can be relatively simple and stable, such as those that bind together a family, or complicated and ever changing, such as those that link traders in a marketplace. Social agents are also capable of change via thoughtful, but not necessarily brilliant, deliberations about the worlds they inhabit. Social agents must continually make choices, either by direct cognition or a reliance on stored (but not immutable) heuristics, about their actions. These themes of connections and change are ever present in all social worlds. [Miller & Page, p10]

[q3] When interactions are not independent, feedback can enter the system. Feedback fundamentally alters the dynamics of a system. In a system with negative feedback, changes get quickly absorbed and the system gains stability. With positive feedback, changes get amplified leading to instability. [Miller & Page, p50]

[q4] The remarkable thing about social worlds is how quickly such connections and change can lead to complexity. Social agents must predict and react to the actions and predictions of other agents. The various connections inherent in social systems exacerbate these actions as agents become closely coupled to one another. The result of such a system is that agent interactions become highly nonlinear, the system becomes difficult to decompose, and complexity ensues. [Miller & Page, p10]

[q5] There are many canonical examples of "large events" that arise in social systems, such as stock market crashes, riots, outbreaks of war and peace, political movements, and traffic jams. These events are driven by positive feedback ... [Miller & Page, p51]

[q6] Under organized complexity, the relationships among the agents are such that through various feedbacks and structural contingencies, agent variations no longer cancel one another out but, rather, become reinforcing. In such a world, we .. embark down paths unknown. [Miller & Page, p53]

[q7] It appears that certain features of a system are more likely to lead to complex outcomes. For example, heterogeneity, adaptation, local interactions, feedback, and externalities all seem to induce more interesting patterns. [Miller & Page, p 233]

[q8] The university is the only European institution to have preserved its fundamental patterns and basic social role and functions over the course of the last millennium. [De Ridder-Symoens, pii]

[q9] It concerns the emergence of complex large-scale behaviors from the aggregate interactions of less complex agents. An ant nest serves as a familiar example. The individual ant has a highly stereotyped behavior, and it almost always dies when circumstances do not fit the stereotype. On the other hand, the ant aggregate – the ant nest – is highly adaptive, surviving over long periods in the face of a wide range of hazards. It is much like an intelligent organism constructed of relatively unintelligent parts. [Holland, p11]

[q10] Even though these complex systems differ in detail, the question of coherence under change is the central enigma for each. [Holland, p4]

[q11] While predicting and understanding complex adaptive social systems is a key goal of this research agenda, we would also like to have means for influencing the outcome of these system ... Much of the quest for good theory in this area has been driven by the desire to use it to improve the outcomes of real social systems. [Miller & Page, p235]

[q12] "People grasp that small things can make a big difference," Emanuel says. "But they make errors about the physical world. People want to attach a specific cause to events, and can't accept the randomness of the world." [Dizikes, pC4; quote from Kerry Emanuel, a professor in the department of earth, atmospheric, and planetary sciences at MIT]

[q13] Historians can explain the past pattern of technology, but cannot predict what is to come any more than evolutionary biologists can predict the species of the future. [Mokyr, p 287]

[q14] [Institutions] are made up of formal constraints (rules, laws, constitutions), informal constraints (norms of behavior, conventions, and self imposed codes of conduct), and their enforcement characteristics. ... It is the admixture of formal rules, informal norms, and enforcement characteristics that shapes economic performance. [North]

[q15] While the rules may be changed overnight, the informal norms usually change only gradually. Since it is the norms that provide "legitimacy" to a set of rules, revolutionary change is never as revolutionary as its supporters desire and performance will be different than anticipated. [North]

[q16] It is culture that provides the key to path dependence - a term used to describe the powerful influence of the past on the present and future. [North]

[q17] Institutions are the humanly devised constraints that structure human interaction. ... Institutions are not necessarily or even usually created to be socially efficient; rather they, or at least the formal rules, are created to serve the interests of those with the bargaining power to create new rules. [North]

[q18] If institutions are the rules of the game, organizations and their entrepreneurs are the players. [North]

[q19] Schumpeter begins by setting forth a general theory of capitalist evolution. In his model, recurring "Innovation" propels the economy, which exists in a state of constant tumult. The "New Men," or "Entrepreneurs," operating within "New Firms," drive Innovation. [McCraw, p239]

[q20] The historical record of technological change is uneven and spasmodic. [Mokyr, p6]

[q21] A major theme of *Business Cycles* is the extreme difficulty of changing traditional ways of doing things. More than most analysts, Schumpeter emphasized that the destructive part of creative destruction has always been quite real, and he stressed that those whose interests are being destroyed will fight hard to preserve their culture and status. [McCraw, p242]

[q22] Adam Smith also was keenly aware that the development and utilization of new "physical technologies" ... often interacted strongly with changing modes of division of labor, and new ways of organizing and governing work, what I have called "social technologies." [Nelson]

[q23] Technological change occurs through the emergence of new ideas. They may occur perfectly randomly, or "blindly" (that is, unforeseen by the players themselves), or systematically with a large

stochastic component. Like mutation, new ideas represent deviations from the displayed characteristics, and are subjected to a variety of tests of their performance against the environment. Like mutations, most are stillborn or do not survive infancy. [Mokyr, p277-278]

[q24] From the days when Adam Smith first wrestled with this question [economic development], economists have understood that the principal driving force has been the development and utilization of more powerful ways of doing things, sometimes involving new products and services, sometimes more productive ways of producing them, and sometimes both. [Nelson]

[q25] Time as it relates to economic and societal change is the dimension in which the learning process of human beings shapes the way institutions evolve. ... The most fundamental long run source of change is learning by individuals and entrepreneurs of organizations. [North]

[q26] In the history of technology there are long periods of stasis as well as major discontinuous changes that parallel macromutations. ... A macroinvention is an invention without clear-cut parentage, representing a clear break from previous technique. ... Such macroinventions constitute a tiny minority of all inventions ever made. Yet their number is not crucial. ... These macroinventions may have been few and far in between, but they were the stuff from which new "species," i.e., techniques, were made. [Mokyr, p291]

[27] The most important feature of Linux, however, was not technical but sociological. Until the Linux development, everyone believed that any software as complex as an operating system had to be developed in a carefully coordinated way by a relatively small, tightly-knit group of people. ... Linux evolved in a completely different way. From nearly the beginning, it was rather casually hacked on by huge numbers of volunteers coordinating only through the Internet. Quality was maintained not by rigid standards or autocracy but by the naively simple strategy of releasing every week and getting feedback from hundreds of users within days, creating a sort of rapid Darwinian selection on the mutations introduced by developers. To the amazement of almost everyone, this worked quite well. [Raymond, p16]

[q28] Today some of our most difficult problems involve discovering, inventing, and developing the social technologies needed to make new physical technologies effective. [Nelson]

[q29] My argument will be that society's ability to develop effective "social technologies" is more limited and more prone to frustration than its ability to advance physical technologies. [Nelson]

[q30] The journey of ubiquitous learning is only just beginning. Along that journey, we need to develop breakthrough practices and technologies that allow us to reconceive and rebuild the content, procedures and human relationships of teaching and learning. [Cope & Kalantzis, p582]

[q31] In the Network Economy, you can count on the best getting cheaper; as it does, it opens a space around it for something new that is dear. Anticipate the cheap. [Kelly, 1997]

[q32] When copies are free, you need to sell things which can not be copied. [Kelly, 2008; he also discusses eight "generatives" that are "better than free": immediacy, personalization, interpretation, authenticity, accessibility, embodiment, patronage, and findability.]

[q33] The core competency of universities is not transferring knowledge, but developing it, and that's done within intricate and robust networks and communities. [Brown & Duguid]

[q34] Learning does not occur independent of communities. Indeed, it's exactly because students can gain credentials without ever gaining access to knowing communities that the relationship between learning and credentials is highly problematic. People can and do end up with the label but without the experience it's meant to signify. Consequently, the central thrust of any attempt to retool the education systems must involve expanding access to communities not simply to credentials. [Brown & Duguid]

[q37] Why are individuals, families, states, and government agencies willing to pay so much for a university? What is it they want and universities offer that's worth so much? ... The easiest answer ... is that they give degrees. [Brown & Duguid]

[q38] What does a degree represent? What is its significance in this world of exchange? Where does it get its acknowledged value? Most commonly, we suspect, degrees are taken to be a sort of intellectual bill of lading, a receipt for knowledge-on-board. Teaching, in this view, is a delivery service ... [Brown & Duguid]

[q39] The degree doesn't look much like a bill of lading, then. And it isn't much treated like one either. Employers and clients, for whom most degrees are ultimately earned and with whom they are exchanged for status and income, usually look at a degree with infinitely less care. Where they would scrutinize a delivery rigorously, they rarely look beyond the central letters (B.A., M.Sc., etc), the name of a school, and a mumbled "major." [Brown & Duguid]