How Ideas Shape Innovation and Reshape Education

Lynn Ilon
Seoul National University, Korea

Abstract

This paper outlines the emerging theories which underlay the incorporation of innovation into substantially different conceptualizations of education – into learning societies. School represents only a part of the total learning that must take place during a lifetime. Workplaces, for many, will become places of learning. Thus, education will need to focus on learning-to-learn skills. As social and industrial problems become more complex, learning to innovate within a collaborative environment will become an important skill. Incorporating innovation within education demonstrates how it changes the entire nature of how education is structured, produced, and even defined. This transformation is far from happenstance. This paper outlines the framework of an emerging global learning system which is defined by learning linkages and moves away from infrastructure and institutions. The paper describes four major shifts that underlie the dynamic links of education and economy: movement from an economic-driven system to one of dynamic learning; movement from education as "capital" to learning as innovation and exploration; movement from industrial production to human development; and, movement from schools to lifelong learning societies.

The framework espoused by Porter famous work in 1990 (Porter, 1990) posited that it national competitiveness spanned far beyond natural resources and was, in fact, a product of the human ability to innovate within a specific context, that determined national wealth. Even this relatively new idea has been eclipsed by the notion such innovation crosses borders, industries and sectors. It requires collaboration, learning networks and cooperation across and between industries as a means of staying competitive – of being able to innovate successfully. Yet, while the notion is becoming more widespread (Tsai, 2002; Nalebuff, & Brandenburger, 1993; Loebecke, Van Fenema, & Powell, 1999), industrial researchers have yet to explore much of the implications for education. Since much of this literature is coming from the industrial sector, it also neglects the real "value-added" to societies of social innovations. Such innovations, at the present time, have a difficult time being valued within a market framework, but their contribution to societies can be measured and is large.

This article demonstrates that innovation emphasis leads to a substantial change in the way that educational systems will be structured, funded and how learning will be delivered. To understand the longer-term consequences of this trend, one must begin with an understanding of the new thinking of how value is created within societies. That new value is thought to be shaped by ideas – innovations. The emerging theory, still in its infancy within the field of economics, has far-reaching implications for education. The paper begins by linking new emerging literature and trends between innovation and learning.

1. Innovation and Learning

The most profound change in education occurs as a response to new need within industries and countries. Schooling has patterned industry in that it requires mastery of skills and rewards individual high achievers. But the new importance of innovation reshapes these parameters of industry and so will, in turn, reshape education. It requires collaboration and cooperation. It requires diverse thinkers who can work together. Also, economic gains from innovation are not all industrial in nature.

"Coopetition," a relatively new word in the English language, captures the notion that competition requires cooperation. That trend implies that the means of staying competitive is, at least in part, done through collaboration with other firms (Luo, 2007). Patel & Pavitt (1994), among others, link this trend to a new emphasis on innovation systems which they underlie the ability of businesses to innovate. Innovation, they suggest, requires national systems which support innovation and involve "learning activities that promote and manage technical change" (p. 78). Manley (2002) ties this in with educational institutions by emphasizing that "[i]nstitutions are the 'rules of the game' which govern how knowledge moves between system participants and the way in which subsequent learning and innovation takes place" (p. 98). She lists both education and training institutions as central to the institutional framework that supports the learning and innovation potential of a country. Yet, the substance, shape, and delivery of education is not dealt with throughout this literature. Patel and Pavitt (1994) show that diversity among countries is not uniformly helpful in coopetition. When the human resource potential of countries is too divergent, the country with the lower level of education and learning can drag down the innovation potential of their counterparts in a more learning-oriented setting. Although this literature is important and begins to frame critical issues – a systems approach, institutional policies, human resources and the importance of learning – it does not touch on the changes this will foster in education.

Other literature is beginning to frame the importance of another set of innovations – social innovations. Among the many issues faced today which challenge productivity, human potential and social well-being, are social issues. These include, at a global level, disease, environment, security, disaster response, gender rights and civic participation. Within any given locality, equally compelling issues affect lives fundamentally – often far more than the small market participation of local areas. If innovation and ideas shape the ability of society's to improve their lives, then it is likely that social innovations will begin to rise in importance and will, thus, impact our expectations of education.

An innovation which helps to control the spread of malaria is one example of how social innovations can impact a society's well-being and improve lives. Every year, about one million people die of malaria. Yet, its spread and control are entirely in human hands. In order for malaria to spread, a mosquito must bite an infected person. It passes on the parasite when an uninfected person is subsequently bitten. When existing malaria cases are reduced, so are future cases. For the cost of less than five US dollars, a net can protect a group of children or spouses from these mosquito bites which generally occur during sleeping hours. Yet, each year in Africa,

some 300 to 500 million cases of malaria occur each year ("Malaria: What is Malaria?," 2009). Malaria can be treated with drugs and largely prevented with mosquito nets, but the method of choice for prevention and reduction of malaria by organizations worldwide is education – learning communities. The United Nations cites education as their primary strategy in reducing malaria in Africa ("Insecticide-treated mosquito nets,"). The MACEPA Learning Community was established by a global health organization to exchange information among African countries on how to educate communities and use local knowledge to get mosquito nets in wider, more consistent use ("MACEPA Learning Community," 2009). Doctors Without Borders uses its own learning community to spread the word on how effective malaria prevention strategies (Carroll, 2003).

Another example of an innovation that adds value to lives without going through a market is the "recipe" for rehydration of small children who have diarrhea. Until the medical research was done, such children routinely died if they couldn't be transported to a hospital and given intravenous drips to rehydrate their bodied. Today, a simple solution of salt, sugar, potassium (found in raw sugar or bananas and other fruits) and water saves, by one estimation, over a million lives a year (Rehydrate.org, 2009). Although the *idea* was a result of substantial research, [39] once discovered, it could be used throughout the world to save lives. The idea itself has value for improving lives.

The formula for rehydration is freely available and, unlike a good or service, can be used simultaneously by anyone. A frying pan, in contrast, may make some people's live better, but any given frying pan can only be used by one cook at a time. This difference – between goods (and services) that are inherently privately owned and controlled and those are inherently usable across a wide spectrum of people without any one person's use detracting from another is the difference that economist generally use to divide public from private goods. The fact that ideas can generally be distributed without cost and can be used to improve the lives of many simultaneously makes ideas not only a primary source of innovations in our lives, but also is inherently public good – not a market good.

Industrial notions of innovation are beginning to bleed into areas that appeared "social" in nature only a few years ago – equity, collaboration, learning, policy and systems. Social innovation is rising in importance and demonstrating it substantial impact on the quality of lives. Education will respond to these changes not just because money and value are embedded in them, but because the define and shape the parameters of a linked, global and dynamic world which we share. We can accept these new realities, but in order to be participants in directing them and, as educators, to take responsibility for the education response, we need to know the forces behind these systemic, linked changes.

---

[39] "THE discovery that sodium transport and glucose transport are coupled in the small intestine, so that glucose accelerates absorption of solute and water, was potentially the most important medical advance this century." (Lancet, 1978)

2. An Economic Revolution

In 1992 Paul Romer addressed the World Bank's Annual Conference on Development Economics and introduced a new theory of economic growth (Romer, 1993)[40]. The theory posited that "ideas" were the fuel of economic growth. The idea of vaccines had allowed human populations to eliminate polio and other devastating diseases. The idea of electricity had spawned a revolution in how products were moved and produced. Typewriters, internal combustion engines, computers, rehydration salts and water pumps radically changed the ways that people live and their quality of life (Bresnahan & Trajtenberg, 1995). The theory challenges some of the primary tenants of older theories of economic growth. It moved the focus from "what is known" to "what can be learned." It questioned the notion that the world grows primarily by consuming resources (natural resources and labor) to a notion that the world primarily grows by creating resources (new ideas). It challenged the notion that education best results in "human capital" owned by individuals to the notion that education best results in "ideas" that are often created by people working together, across borders and often with fluid rules of ownership.

Romer (1993) followed the early work of Solow (1957). He speculated that the ability of humans to think of new ideas and change their world based on those ideas went far beyond human capital theory.

> Ultimately, all increases in standards of living can be traced to discoveries of more valuable arrangements for the things in the earth's crust and atmosphere . . . No amount of savings and investment, no policy of macroeconomic fine-tuning, no set of tax and spending incentives can generate sustained economic growth unless it is accompanied by the countless large and small discoveries that are required to create more value from a fixed set of natural resources (Romer 1993, p. 345).

The speculation was based on particular characteristics of knowledge. First, knowledge can be used cheaply, even freely, once it is developed. This stands in contrast to physical goods which require raw materials or processed goods to create. When materials are required to produce a good, then its production depends upon using, ultimately, resources that become increasingly scarce. Over time, the demand for scarce resources, raises their price and makes their availability and stability decrease – a rather poor way to build a stable, happy society. Knowledge, on the other hand, once developed, takes few or no resources to be used again and again.

The centerpiece of New Growth Theory is the role knowledge plays in making growth possible. Knowledge includes everything we know about the world, from the basic laws of physics, to the blueprint for a microprocessor, to how to sew a shirt or paint a portrait. Our definition should be

[40] Although he had posed the idea some years earlier and first formally published it in 1990 (Romer, 1990). See Warsh (2006) for the history of the development of the theory.

very broad including not just the high tech, but also the seemingly routine. (Cortright, 2001, p. 4)
An important difference between ideas as economic goods and human capital is that ideas are generally "non-excludable." That is, it is easy to distribute ideas and hard to keep others from using them. Workers, however, can only labor at one thing at a time – usually for someone who pays them or an activity that sustains them. Also, ideas are "non-rival." That is, my community's of the idea of recycling garbage does not exclude your community from adopting the same idea or even improving on it. The concept behind human capital theory was that it was invested in, one human being at a time. The educated person "owned" their knowledge, could sell it (for higher wages) and could choose when and how to use it. Ideas can be owned, but they are difficult to own – through patents and copyrights. But most ideas are adopted freely and become widespread if they have general utility. Even copyrighted and patented knowledge has a difficult time being owned and controlled in today's digital world although, at least nominally, it is possible to have some control.

These differences are not trivial to the field of economics nor to how we understand and organize our world. The formulas by which economists have traditionally tested theories do not apply when a good is created freely – does not generally have the characteristics of scarcity. The underlying assumptions of free markets – that supply and demand will take care of distribution and growth (the invisible hand of economics) – may not apply to ideas. If ideas are expensive to create (say, pharmaceuticals or better batteries for cleaners vehicles) but cheap to adapt once they are formed, then some kind of public intervention is required in order to balance between assuring that there are incentive for expensive research but also that society can benefit from the widespread use of the ideas once they are fully developed. Market mechanisms, in other words, cannot be left to themselves to regulate production and distribution.

The theory is not yet fully articulated[41]. But the broad brushstrokes of the theory are being widely used to develop strategies, explain growth and guide sectors (see for example, Archibugi & Lundvall, 2003; Cortright, 2001; Kahin & Foray, 2006; Kim, 1999; Kennedy & Li, 2008). The theory of innovation economics is far-reaching, fundamentally changes how we understand economics and repositions the field of education.

The theory is new enough that it is still in the process of acquiring a consistent name.

Fortunately within the last decade a new theory and narrative of economic growth grounded in innovation has emerged. Known by a range of terms – "new institutional economics," "new growth economics," "evolutionary economics," "neo-Schumpeterian economics," or just plain "innovation economics": – collectively, this new economics reformulates the traditional economic growth model so that knowledge, technology, entrepreneurship, and innovation and are now positioned at the center... (Information Technology and Innovation Foundation, 2009, p. 2)

[41] In fact, it remains controversial. As Warsh (2006) concludes, there is a general acceptance that knowledge plays a central role in development but traditional neo-classical theorists are unlikely to fully embrace the theory because it challenges their primary methods and tenants. Mirowski (2009) does an excellent job of explaining this impass.

Lundvall has also used the term "learning economy" to characterize the phenomenon (Lundvall & Johnson, 1994; Archibugi & Lundvall, 2001). Initially, the theory was called the "endogenous growth model" within the field of economics because it included innovation as a key component of an economy (endogenous) rather than external to that economy or irrelevantly located. Many now use the term "knowledge economy" synonymously with this theory. But, for purposes of this article, the theory will be called "innovation economics."

3. The Interplay of Economics and Education

The Economics profession is in a quandary with what to do with "ideas" as a good that produces value. The problem is not that economists cannot conceive of an "idea" as a good. Such concepts have been proposed for some time – generally traced to the work of Robert Solow (Solow, 1957). The problem is that the characteristics of ideas are so fundamentally different from goods or services where resources are consumed with each unit of production (land, labor, machinery, materials) and ideas which can save resources (witness the power of cell phones versus yesterday's mainframe computers; solar energy or recycling of garbage) and, once developed, are free to spread and can be used by lots of people at the same time. Philip Mirowski's exception review of these epistemological, methodological and theoretical challenges concludes, after reviewing several aspects of information as an economic good that "one must relinquish any commitment to the neoclassical orthodoxy." (Mirowski, 2009). He goes on to say:

"Everyone seems to believe that knowledge is the key to economic success, and yet our most developed schools of economic thought are mired in the most frightful muddles when it comes to modeling knowledge in an economic setting." (Mirowski, 2009)

Joseph Cortright (and many others) have similar observations. When economist tried to model the economic characteristics of ideas, "the equations blew up, leaving the greater part of mathematical economics in wreckage" (Cortright, 2001, page 4). These mathematical problems are indeed vexing for the Economics profession but might be potentially solvable if they did not lead, inevitably, to the conflicts with assumptions underlying neo-classical theory that Mirowski (2009) refers to. So, even as the world accepts the notion of a "knowledge economy," and the importance of innovation, it struggles to find a cohesive theory of how it works to improve lives. Agreement is reached only that learning is importantly throughout life and that "schooling" is now secondary to this lifelong learning thrust.

Ideas, however, are not inherently owned and controlled by individuals even if such ideas derive from an individual. Witness music today. Although it derives from the creativity of an individual or group, once invented, it can be used simultaneously by many people without cost of replication and one person's use does not detract from the pleasure of another person's use. The value produced through of these ideas, while sometimes captured as wages, profits or government

influence, is largely with the contribution they have for improving the lives of people. The value of education is moving away from the private ownership of knowledge[42] towards the public value of building on ideas.

This does not mean, however, that investment in human capital (by individuals, families, communities or nations) not longer has returns. Fortunately, it does such that individuals and collectives will still choose to make the investment and increase educational levels. What is does mean is that simply *holding the information* no longer is the highest value that education can be put to. Rather, information (or knowledge) needs to be used creativity in order for a society to reap the benefits of its creative resource. This substantially changes the way we think about education. Keith Sawyer outlines the older vision and new vision of learning:

Knowledege is a collection of facts about the world and procedures for how to solve problems…. The goal of schooling is to get these facts and procedures into the student's head… This traditional vision of schooling is known as instructionism. Instructionism prepared students for the industrialized economy. (Sawyer, 2009b) page 1

<Table 2> Comparison of efficiency and innovation goals of education

Education as Efficiency	**Education as Innovation**
Student master facts and skills	Students use core competencies to build new ideas and analyze existing situations
Students follow instructions	Students work collaboratively toward a goal of discovery or invention
Teachers provide materials	Teacher organize learning environment
Lessons are planned	Learning processes are defined and tentative starting point is provided
Curriculum changes infrequently	Learning direction changes occur frequently and naturally in response to what is learned and what is known
Outcomes are measured through tests	Student groups and teachers are engaged in constant feedback on progress with knowledge shared each direction
Students have no say in setting learning processes or goals	Students help redefine learning environment constantly as they find successes and constraints
Fear of failure on tests or for school dominates schooling environment	Fear cripples learning environment, limits options and detracts from learning process. Fear in minimized
Success if measured through tests	Success is measured through contribution to learning process and group success in creating new ideas and exploring existing frameworks.

He goes on to explain the types of learning that will need to take place in an innovation economy including the abilities to work creatively to build new ideas, to critically evaluate what is read, and to take responsibility for learning throughout their lifetime (Sawyer, 2009b). Page 2. Table 2 contrasts the goals of education under an industrial model (efficiency) and under an innovation model (creativity).
The table demonstrates that the entire approach to learning is changing. Regardless of the impetus behind the changes, few educators would deny that the resultant learning goals are substantially improved over that of today – more creative thinking, evaluating and integrating information and collective design of new ideas. One fundamental requirement will be that learners "understand the process of dialogue through which knowledge is created, and they examine the logic of an argument critically" (Sawyer, 2009b) page 4. These types of educational approaches have been long advocated by prominent educators such as Paulo Freire (Mayo, 1999).
Sawyer has edited a book out of Cambridge University on what is called "The New Learning Science" which speak to this improved method of learning and to which is links directly to innovation (Sawyer, 2009a). He emphasizes the need for students to work collectively and among people who do not have the same background as themselves. Diverse thinkers understand complex problems better and bring more creative ideas to the learning process. This stands in contrast to the thinking of educators during the industrial era when the needs of the economy (rote memorization, homogeneous thinkers, prescribed procedures) were in conflict with at least some of the social goals of education which derived from dialogue, reflection, collective design, creativity and exploration.

Yet, there is a temptation to view the future through the eyes of the previous logic:

Making the case, at the outset of the industrial revolution, that agriculture would become a marginal activity was probably impossible. Even at the beginning of the 21st century our agrarian past still lies heavily on our thinking, school calendar, nursery rhymes and political map. It is therefore not surprising that it is difficult to get our institutions and imaginations beyond the much more recent memories of an economy and society dominated by mass-production and mass-consumption.(OECD, 2003)

It is not clear that educators and economists are on their way to a happy marriage. What is clear is that the economics behind some of the worst educational practices that supported industrial production are giving way to educational practices that support creativity. What is clear is that the worst practices of educational systems today may be incompatible with the needs of future societies and an innovation economy. OECD assesses these oldered educational practices as one of Korea's primary weakness in meeting an innovation economy:

High school curricula place too much emphasis on preparation for the national university entrance exam and rely heavily on rote learning. This leaves little room for creative thinking and the emergence of an exploratory spirit. Page 14 (OECD, 2009).
Producing students who know a lot of information, have integrated knowledge but who do not know how to build new ideas, work collectively, learn from dialogue and know how to use learning skills throughout their lives may have worked in an industrial economy, but needs to be rethought as innovation becomes a primary means of improving the lives of people – a major

source of value.

4. "Value-added" moves to the public arena

Nobel prize winning economist Amartya Sen maintains that one of the bases of social welfare[43] is the ability of the society to create new knowledge around the complex problems it faces. The theory was developed around the structures of the poorest societies and long before it there was a capability of broad-scale creation and dissemination of knowledge through technology-aided networks. Nevertheless, he maintained, that if a society could build collective understandings of complex problems and then take action on that knowledge, its overall welfare would be increased. "May of the more exacting problems of the contemporary word – varying from famine prevention to environmental preservation – actually call for value formation through public discussion" (Sen, 1995, p. 18).

Sen's work has focused on the need to develop human capabilities – "on creating human potential and showing how this leads to greater well-being in society and within the household. He has viewed the development of human capabilities as the real end of economic growth and the real goal of economics" (Pressman & Summerfield, 2000, p.102). Given that collective knowledge creation is viewed as central to social well-being, far from traditional views of economic productivity, a central question emerges. Will the new focus on learning and collective "value creation" (in Sen's words), in turn, change the way in which societies are structured. Could an innovation economy lead to a social transformation?

While Sen's work focused on how particularly poor nations gained initial ground in economic growth and emerged from the bottom of international economies, his work provides some insight in how innovation may lead to economic growth vis-à-vis ideas and innovation. He knew that people can produce new ideas, given the right environment. But, how do ideas generate actual economic value?

It has entirely different economic characteristics that make it cheap, easy to have large impact, and broadly available. Unlike raw materials, machinery, electricity and other utilities, transportation or even labor, knowledge is relatively free to reproduce. In other words, once it exists, it can be used again and again and again with little or no cost. When electricity was discovered, that knowledge could be applied in Einstein's lab, in metropolitan New York City and in rural Mali. There is a cost of infrastructure but no cost for the knowledge. When the research was completed on a re-hydration formula which mitigated deadly dehydration due to diarrhea, the formula could be applied everywhere for no cost and save thousands of lives. Although many new ideas can and are patented or copyrighted and may have a cost associated with their use, in fact, the reproduction of that idea is essentially free. The cost is in the development of the idea.

[43] "Social welfare" is the term economists use to mean that well-being of a society. It derives from the notion of maximizing total society happiness. Since not all "happiness" factors can be measured, the classic notion is that the "happiest" society is the one where wealth has been maximized. Thus, old growth theory is built on the notion of maximizing economic growth.

The second characteristic that sets knowledge apart from other economic goods is its ability to be used by many people/ communities/ societies at the same time without degrading the quality of the usage (Cortight, 2001; Warsh, 2007) If electricity, jet planes or watermelons are in demand by too many people at the very same time, either someone will go without, the price will rise until fewer people want it or the quality/quantity available will be degraded. Knowledge, on the other hand, can be duplicated again and again and used simultaneously by many, perhaps millions of people, and still have the same quality as its first use. The knowledge contained in this article can be shared by hundreds or thousands of people without any one of them getting a poorer quality of article. The same is true for music, software, medical advice, development technologies, understandings about our universe.

For economics, these two characteristics are difficult to handle – both theoretically and mathematically.[44] Most notably, it sets it apart from Human Capital Theory which is based on the notion that knowledge is embodied in individuals – its use controlled by the people who "own" the human capital[45]. It does mean that knowledge, once developed, acts more like a public good and a private good. That is, it can and should be broadly shared for the good of a society.

The conundrum lies in how it is developed for the development is often expensive. In the current economic system, development is generally rewarded with "ownership" (copyrights and patents) – at least for a time. This allows for an economic incentive for development. But that system is breaking down as knowledge, by definition, can be digitized and its spread is fast and easy. If there are wide-spread benefits then it behooves a government to find a balance between development incentives and public benefits of knowledge use.

This government "balance" is one of the most important features of innovation economics. Unlike industrial-age economics (or knowledge economy applications), the notion of social benefits lies with government policies rather than private profit-motives. The "invisible hand" that is assumed to guide the economy towards its optimally socially-beneficial point (i.e. minimum government interventions) gives way to guidance from government policy. Even development of knowledge is not (economically as well as socially) best left to the private sector. Take sustainable, green growth. In the huge, broad spectrum of where to put creative thinking energies, green technologies could be a high priority, for example. The researchers, communities, school children and learning networks that could be directed toward knowledge's ever broadening range of topics, could choose to direct their energies toward this green, sustainability. Government policies are likely to define the incentives that guide knowledge growth.

Thus, a final important characteristics of innovation economics is that, while it is a system, much

[44] Thus, its traditional exclusion from growth theory (exogeneity). See Mirowski (2009), Cortright (2001) and Warsh (2007).

[45] An clear distinction between "knowledge economy" approaches and the theory of "innovation economics."

like that of neo-classical, industrial economics, it is a system that is best shaped by government policies[46]. The system characteristics of innovation economics means that it develops from a complex set of linkages and networks that mutually reinforce eachother and build systemic strength and resilience. That is, it is not going away any time soon. But systems can be shaped by policies and innovation economics, given its public goods aspects, can and should be shaped (through policies and incentives) by collectives of people (governments, world bodies, social movements) (Lundvall & Borras, 1997; Cortright, 2001).

5. Schooling Infrastructure Gives Way to Learning Societies

The fact that the system of economics influences education was not something that policy makers or educators got to vote on. Rather, it was enforced by legions of parents worldwide who are directly their money, energy and influence toward what they view as the lifetime welfare of their children. Later, the children direct their own resources with the same goal in mind. Such parents and students (along with policy makers and educators as parents and, formerly, as students) pressure politicians, create public debates and make independent decisions on educational expenditures that are in line with their view of the future economy and their child's life chances within that economy.

This impetus is a central link in a growing global system of learning which is shaping itself to encompass all ages, all professions, all communities and all regions. This system of learning is as diverse as a rural teacher hired through international donor funds, a father looking up a recipe on the internet for a healthy meal or a bio-technology researcher sharing ideas with a researcher across the globe whom he has never met in person.

As schools, universities, learning networks and informal groups increasingly become the source of new ideas (not just the consumer of existing information), then education, broadly conceived and define more in terms of lifelong learning rather than schools, not only is a primary producer of social value, the work of these institutions actually *expands* the resource base for society. New ideas become the means by which societies improve their lives whether it is through the idea of a new way to decrease our use of fossil fuels or whether it assists a community to conceptualize of learning systems that help it grow.

Two aspects of innovation economics have particular meaning for education. First, the emphasis on learning means that education becomes much more than simply a producer of "human capital." It is no longer a producer of an industrial input, it is, rather, the very essence of how a society learns. Second, what we know about learning means that culture and, in particular, cultural diversity moves from a "constraint" of human capital production to a resource for creative learning.

[46] Amartya Sen would argue that such policy needs to be shaped by collective ethnics and value formation. Thus, innovation economics begins to dovetail with his theory of social welfare more seamlessly than it links with neo-classical economic theories of social welfare (Sen, 1995).

The progression away from knowledge (what you know) to learning (your ability to think creatively) moves innovation economics away from the knowledge economy view that knowledge is an instrument of production. Rather, the ability to learn and create, while contributing to productivity, has broad implications for social change. For example, it may well mean a different view toward diverse thinkers – including people who put their logic together in a culturally specific way. Even within a work environment, mixing people with diverse thinking is now viewed as central to the creative process[47] (Finegold, 2006; Mohrman, Cohen & Mohrman, 1997). Kim (1997) attributes much of Korea's rise to a global competitor in innovation to special cultural characteristics. "How have Koreans acquired knowledge so quickly… [and] why have Koreans worked so hard?" (Kim, 1997, p. 59). His work attributes the first to the education system and the second to sociocultural factors

Lin (2007) emphasizes that notions of a knowledge economy are still mired in the thinking of industrial production. "Both the Austrian analysis of the knowledge subject and the mainstream exposition of the knowledge economy have been grounded on the concept of market competition." He proposes, instead, that diverse cultural views are the base from which social innovations occur. "Indigenous knowledge is… particularly abundant in the knowledge of the natural environment and is critically important to the sustainable use of resources and balanced development." (Lin, 2007, p. 584).

Sawyer (2006) and Florida (2002) take this a step further and assert that the innovation economy is really about the rise of creativity. Yet, it is rarely linked to changes in education. Sawyer, a learning psychologist in the field of education, views the changes implied by an innovation economy as far broader than productivity of industry. "The most pressing problems that face our world are large in scale and complex in nature, far out of the realm of any one person to resolve—poverty, pollution, hunger, disease, armed conflict. The creativity that matters in today's world is the creativity of teams and organizations with the capabilities to make a difference (Sawyer, 2006, pg. 42). His leap, in a single paragraph from the needs of industry for innovation to the social implications of a broad spectrum of people who are diverse and good learners demonstrates a crucial link between education and innovation. The innovation process, albeit being spurred by industrial and national desires for growth, require sets of skills that have broad applicability for social progress – often aimed at the reduction in use of scarce resources and in cooperative knowledge building.

The question, then, needs to be asked whether a theory that, in and of itself, challenges basic tenants of neo-classical growth theory, does not lead to changes in the way society organizes itself. If Sawyer is to be believed, creative thinking by a broad spectrum of people (not just a few "knowledge workers") is necessary to tackle large-scale global problems. From an economic perspective, tackling these types of problems leads to large-scale value creation. What, then, leads? The economy or education (learning)?

[47] Finegold also emphasizes the need for diversity of curriculum, higher education institutions and higher education students and faculty.

6. Conclusion

Education serves an increasingly central function in today's societies. It is the main vehicle by which the society advances itself and through which members seek their own growth. As such, it is part of a larger social system that is national, regional and global in nature. As the larger world changes in and around the individual and the country, education changes in response. These changes in education, in turn, change the way that individuals and groups interact with their society and environment and, thus, education shapes its own environment. It reshapes the very context in which is exists and adapts.

The emergence of ideas as a primary force in advancing societies and defining social progress is a fundamental shift in the larger social context. Although the notion that ideas shape social progress is not entirely new, the emergence of knowledge as a primary economic force moved the notion of ideas (innovations) from the backwaters of thinking to the forefront. (Hence, the first name for the theory was "endogenous" growth theory – implying that *ideas* could no longer be "outside" of growth theories).

Initial thinking about the role of ideas has centered around how industry competes and creates value. The fact that there is no final consensus on the theory that underlies innovations is because industry requires an understanding of how to (practically) move forward even before economists can agree on how innovation and knowledge work in an economy. Hence, it is useful to follow industry's thinking as it foretells likely parameters of a final theory. It emphasizes, diverse thinking, collective and collaborative work, networks of knowledge and learning rather than education. In effect, industry is reshaping how we think of education – from schooling to lifelong learning.

But industry's view is, necessarily, narrow. It defines only what is needed in today's competitive environment. The contextual changes implied by a focus on ideas goes much deeper and the bare outlines are beginning to be revealed. The challenges within the Economic's profession imply that productivity itself is being redefined. The nearly universally accepted measure of a society's standing is gross domestic product (GDP) per capita. In a world where ideas shape social progress, GDP has meaning only as a measure of "old industrialization," not "new knowledge productivity." OECD's attempt to find an alternative measure, despite the challenges and nearly impossibility of such a measure as currently conceived, demonstrates how central this issue is to wealthier countries.

Sen's work concerning development appeared first as a challenge to existing development theory. His singular insight into where the theoretical problems lay, provided legitimacy to his views even when it threatened conventional economic theory. Despite his Nobel prize award for this work, his ideas have, up until recently, only impacted the subfield of Development Economics. But the rise of ideas as a primary economic force creates the need to rethink social progress – away from conventional notion of counting industrial value-added (GDP). In so doing, his theory that it is the capability of humans to create and recreate their environments that informs new growth theory.

How this capability works vis-à-vis education is the subject being tackled by a new strain of learning psychology work – new learning theory. That theory stems from a careful read of the economic trends and begins to delineate how groups, learning networks, diversity and collaboration shape our ability (our capability) to create, build new ideas and innovate.

Finally, the very notion of innovation is being rethought. Once largely the province of industry – specifically technology – its impact on a social world is being redefined. Since people own their ability to create and innovate they can and will carry forward this ability into their personal, social, spiritual, and political worlds even as they (sometimes temporarily) apply their abilities for employers. This shifts the focus from industry to the society because, using the older views of human capital theory, employers "bought" their labor forces' productivity and it largely stayed within the work environment. The central focus of neo-classical economics, "value added" now applies across human lives and society. The ability of ideas and human capability to reshape society covers the full spectrum of human existence – from birth to death, from poor to rich, from social to economic, from personal to collective. And so, its initial emphasis apparently emerging within industrial circles, is only the leading edge.

While schooling systems take modest steps to adapt to new technology, to incorporate knowledge networks such as the internet and to build new structures using privatized incentives, the world of learning is being fundamentally reshaped around them. People are learning to learn, build new understandings through vast global, social, community and cross-disciplinary networks. Industry is rethinking learning in terms of collaboration and new knowledge is being generated before even the first author can develop a new book outline. Children are teaching adults and professors are scrambling to learn faster than their students. New online classes reshape the structures of schooling even as they reshape how knowledge is delivered and, more importantly, how it is created. Vast, sophisticated computer systems learn from our very online inputs and reshape knowledge faster than we can request it by typing into a keyboard.

Ideas shape innovation. Education is reshaped. Now, the challenge for the education profession is, how does education reshape society?

References

Archibugi, D. and Lundvall, B.A. (2003) *The Globalizing Learning Economy*. Oxford University Press.

Bresnahan, T. and Trajtenberg, M. (October 1995) *General Purpose Technologies "Engines of Growth?"* . NBER Working Paper No. W4148. National Bureau of Economic Research.

Carroll, R. (2003, 18 December 2003). How rice farming and refugees brought malaria to vulnerable corner of Burundi. Guardian. Retrieved from http://www.guardian.co.uk/.

Cortright, J. (2001) "New Growth Theory, Technology and Learning: A Practitioner's Guide." Impressa Inc.: Portland, Oregon.

Dave, R. (1976). *Foundations of Lifelong Education*. UNESCO Institute for Education.

Finegold, D. (2006) "The Role of Education and Training Systems in Innovation." Chapter 17 in Jerald Hage and Marius Meeus (eds.) *Innovation, Science and Institutional Change*.

Oxford University Press pp. 391-412.

Florida, R. (2002). *The rise of the creative class and how it's transforming work, life, community and everyday life*. New York: BasicBooks.

Hunnam, E. and Buchmann, C. (2003). *The Consequences of Global Educational Expansion*. Occasional Paper Series. Cambridge, Massachusetts. American Academy of Arts and Sciences. http://www.amacad.org.

Kahin, B. and Foray. D. (2006) *Advancing Knowledge and the Knowledge Economy* . MIT Press.

Kennedy, K. and Li, Z. (2008) *Changing Role of Schools in Asian Societies : Schools for the Knowledge Society*. London: Routledge.

Kim, L (1997) *Imitation to Innovation: The Dynamics of Korea's Technological Learning*. Cambridge, MA: Harvard Business Press.

Kim, L. (1999) *Learning and Innovation in Economic Development.* Edward Elgar Publishing.

Lancet (1978) "Water with Sugar and Salt." *The Lancet*. 312(8084): 300-301.

Lateef, S. (1995) *The Evolving Role of the World Bank: The First Half Century*. Washington, D.C. The World Bank. http://www-wds.worldbank.org.

Lin, B. C. (2007) "A new vision of the knowledge economy. " *Journal of Economic Surveys*. 21(3): 553-584.

Loebecke, C. Van Fenema, P.C. and Powell, P. (1999) "Co-opetition and knowledge transfer." Data Base for Advances in Information Systems. 30(2): 14 – 25. DOI: http://doi.acm.org/10.1145/383371.383373

Lundvall, B. A. and Johnson, B. (1994) "The Learning Economy." *Journal of Industry Studies,* 2(1): 23-42.

Mayo, P. (1999). *Gramsci, Freire, and Adult Education: Possibilities for Transformative Action*. New York: ZED Books.

MACEPA Learning Community. (2009). Retrieved 20 August 2009, 2009, from http://www.macepalearningcommunity.org/whatwedo.php.

Malaria: What is Malaria? (2009). Retrieved 20 August 2009, 2009, from http://www.cdc.gov/Malaria/faq.htm.

Manley, K. (2002) The Systems Approach to Innovation Studies. *Australia Journal of Information Systems*. 9(2):94-102.

Mirowski, P. (2009) "Why There is (as Yet) no Such Thing as an Economics of Knowledge," in *The Oxford Handbook of Philosophy of Economics*. Harold Kincaid and Don Ross (eds.). Oxford University Press. Pp. 99-156.

Mohrman, S., Cohen, S. and Mohrman, A. (1997) *Designing Team-Based Organizations*. San Francisco: Jossey Bass.

Nalebuff, B.J. and Brandenburger, A.M. (1993) "Co-opetition: Competitive and cooperative business strategies for the digital economy", Strategy & Leadership, Vol. 25 Iss: 6, pp.28 - 35

OECD. (2003). Schools and the Future: OECD Forum on Schooling for Tomorrow. Paper presented at the International Futures Programme.

OECD. (2009). *OECD Reviews of Innovation Policy: Korea 2009*. Geneva: OECD.

Patel, P. and Pavitt, K. (1994) 'National Innovation Systems: Why They Are Important, And How They Might Be Measured And Compared', *Economics of Innovation and New Technology*, 3(1): 77-95.

Porter, M. (1990) *The Competitive Advantage of Nations*. New York: Simon & Schuster.

Pressman, S. and Summerfield, G. (2000) "The Economic Contributions of Amartya Sen."

Review of Political Economy, 12(1):89-113.

Rehydrate.org. (2009). Rehydration Project. Retrieved 4 October, 2009, from http://rehydrate.org/ors/#

Romer, P. (1993). "Two strategies for economic development: using ideas and producing ideas." Proceedings of the World Bank Annual conference On Development Economics, 1992. http://www-wds.worldbank.org/.

Sawyer, K. (2006) "Introduction: The New Sciences of Learning." Chapter 1 in R. Keith Sawyer (ed.) *The Cambridge Handbook of the Learning Sciences*. Cambridge University Press.

Sawyer, K. (2009a). *The Cambridge handbook of the learning sciences*. Cambridge: Cambridge University Press.

Sawyer, K. (2009b). Introduction. In Keith Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 1-16). Cambridge: Cambridge University Press.

Sen, A. (1995) "Rationality and Social Choice." *American Economic Review*. 85(1):1-24.

Solow, R. S. (1957). "Technical Change and the Aggregate Production Function." *Review of Economics and Statistics* 39(3): 312-20.

Tsai, W. (2002) "Social Structure of 'Coopetition' within a Multiunit Organization: Coordination, Competition, and Intraorganizational Knowledge Sharing". *Organization Science. 13(2):179-190.*

Warsh, D. (2007) *Knowledge and the Wealth of Nations: A Story of Economic Discovery.* W.W. Norton & Co.