

The Meaning of Learning in the Perspective of Rapid Technological Change

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Content, Community, Context and the Meaning of Learning

My own research has gone through three phases as I've worked to understand the meaning of learning. The first phase dealt with the creation of learning content or "educational objects" that were created by easy to use authoring tools (e.g., <http://www.stagecast.com/>). For example, a pendulum simulation can be created with an authoring tool that allows students to run simple experiments to determine the relationship between the length of the string and the period of the pendulum. The second phase dealt with creating on-line communities that allowed stakeholders in the "educational object economy" to share and improve content rather than creating it from scratch every time. For example, the EOE (e.g., <http://www.eoe.org/>) and MERLOT (e.g., <http://merlot.csuchico.edu/>) are on-line communities that are directories to large libraries of educational objects that support learning conversations in a learning community. Another value of an EOE type community is that instructors teaching programming could give students assignments to go in and make improvements to educational software in the EOE, thus allowing students' efforts to actually add real value to the world rather than simply be rote exercises that are graded and then thrown away. The third phase dealt with learning in context by proposing a new planetary information infrastructure that could allow "putting information in its place" to support anytime, anywhere mobile learning. For example, WorldBoard (<http://www.research.ibm.com./journal/sj/384/spohrer.html>) is a proposal for a planetary augmented reality system that would allow people using hand held devices or heads up displays to look up into the night sky and see the lines connecting stars into the constellations, as well as many other types of information where it would be most useful for learning. The WorldBoard URL describes each of these phases in more detail.

What is Happening to the Meaning of Learning

Earth is home to about six billion people who learn as a natural part of life. We learn because our genes, brains, bodies, and social groups change over time to optimize for survival in a sometimes hostile environment. Hence, we can see how we as people have been changed by natural and social processes over time. We learn because people working together through the ages have co-created cultural environments that support, demand, and value learning. Hence, we can see how we as people have changed the environment over time. We learn because we choose to learn for social acceptance, economic advancement, opportunity expansion, recreational satisfaction, and as a means to satisfying personal goals and life themes we choose to pursue. Fundamentally, learning is about change. Changes to ourselves and changes to our environment. Our generation has further optimized our technological systems and social systems thus accelerating our abilities to change ourselves and our environment extremely rapidly relative to our life span and on a global scale. To get a sense for the rate of acceleration consider this – in 1995, less than \$10 billion was invested by VC's in start-up companies in the US, but in 1999, this amount is approaching \$100 billion. A factor of ten increase in funding of new ventures in only five years has occurred. Indeed, Silicon Valley accounts for 25% of all venture investment in the US and is a hotbed of change.

In the remainder of this paper we will primarily focus on learning as a conscious mental process that requires focused effort and results in new competencies that are manifest as measurable improvements in performance on specific tasks. This is a very narrow definition of learning but lies at the core of what most people think of when they talk about learning in schools, learning on the job, or learning by doing. Learning of course can also be an unconscious mental process that seems to take very little mental effort, and may merely result in changes in behavior rather than measurable improvements. However, no learning occurs when there is no mental process and no change in possible behaviors under specified circumstances. If there are no biochemical changes that occur, then learning has not occurred. Often successful learning requires both biological changes in a person, but also changes in the environment that the person operates in. In

fact, learning is often triggered by changes in the environment. Learning typically involves both internal and external changes.

Technology and the Meaning of Learning

It is not surprising that at this time of rapid change we choose to ask the question "What is the meaning of learning?" By the middle of this century we may well be asking "What is the meaning of being human?" as our grandchildren develop the capabilities to create new intelligent species of biological, digital, and hybrid life-forms. By 2010 alone, mobile phones will be able to store a terabyte or a million megabytes of digital information in their memories. A terabyte is enough storage to record all the audio in someone's life, with room to spare for key visual images along the way. By 2010, wireless bandwidth will allow mobile phones to display real-time video images and lasers will allow for the projection of the images onto any wall or flat surface. By 2020, the processor in a mobile phone will execute almost as many instructions per second as the number of neural firings in the human brain. By 2020, we will have devices that can sequence any individual's genome in hours compared to the years it would take today. We may be enhancing biological processes with wearable or implantable artificial organs that are connected to the internet and providing us with the equivalent of our own personalized pharmacy for dispensing everything from pain killers to sleeping aids. Our ability to augment our biological and mental processes with information technology will only increase the rate of change, further changing what we think the meaning of learning is except in the most general terms. Learning to set responsible goals and learning to use technology wisely to achieve those goals will both continue to be important meta-learning skills. Without an ability to see the future, we will have to take chances and gamble on the outcomes of our actions. Insurance today as in the past is when multiple threads of culture run in parallel – failure of one thread is a lesson to the other threads.

Knowledge and the Meaning of Learning

Changes in the knowledge state of a person or changes in the "knowledge" state of the environment are usually only deemed to be learning if human performance improves on

some task. When we think about changes in the knowledge state of a person, three possibilities are possible:

1. Remind & Remediate: The knowledge has existed in the person's brain before, but been forgotten or made inaccessible. In this case, the person must be reminded of what they once knew or be remediated (lots of practice) to allow the person to again perform a task competently.

2. Receive & Reconstruct: The knowledge has existed in someone else's head, but never in the particular person's head. In this case, the person must receive the information (training is doing this receiving as fast as possible) or reconstruct the information (education is learning to flexibly reconstruct knowledge either by following the ways others obtained the knowledge or obtaining the knowledge in novel ways).

3. Research & Reflect: The knowledge has never existed in any human's brain, and so the learner must discover it on their own. Often times this may require the learner to research questions and find their own answers. Often, the learner must "reflect" in order to create the question that research will eventually answer. Asking the right questions then becomes the highest level of learning meta-skill to be developed.

Similarly, there are three possibilities for knowledge in the environment – it has existed in the learner's environment before, it has existed in someone else's environment before but not the learner's, or the knowledge has never existed in any environment before.

Again, rapid change has an impact. Knowledge that led to superior performance in the past, may actually lead to inferior performance in the future. We all know people who were successful in their day and age, but have developed beliefs and perspectives that are maladapted when the world changes too much. We can refer to the half-life of knowledge – knowledge is only valuable for particular limited periods of time, and then is useless or counter productive.

Two Future Paths and the Meaning of Learning

As technological advances change us and our environment making the half-life of knowledge shorter and shorter, we can expect to see a shift in the meaning of learning. In the early stages of human history, learning allowed us to cope with a physically hostile environment. In this stage of human history, learning is allowing us to cope with a rapidly changing environment. Ultimately, we will either discover ways to make the environment seem more stable, or we will redefine the human condition to allow us to learn and evolve more rapidly than natural biological processes can sustain. In one scenario the rate of change is controlled allowing us to learn more like we do today, and in the other scenario the rate of change continues to accelerate requiring that we re-invent ourselves and thus the meaning of learning. Or we pursue these two possibilities in parallel, creating both a stable and satisfying path for people as we are physically today, and a path with a new species able to learn in an environment that continues to change at an accelerating rate. It is likely that both paths will be explored in the next hundred years. The former path may focus on established values (probably not like the Amish exist, but allowing advances in only certain areas and not others – energy reduction, weight reduction, strength of materials). The latter path will place no barriers on advancement of knowledge, but will require a new species fit enough to live with hyperchange.