

CO-EVOLUTION OF LEARNING, NEW MEDIA, AND NEW LEARNING ORGANIZATIONS

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ABSTRACT

Our research at the Center for Lifelong Learning & Design (L3D) over the past two decades has been focused on creating a new understanding of learning, new media, and new learning organizations. Our co-evolutionary perspective explores the dialectical relationship between:

- how a deep understanding of learning (specifically: lifelong learning, self-directed learning, and informal learning) creates innovative demands and design criteria for future generations of social-technical environments;
- how the unique potential of computational media (specifically: meta-design, distributed cognition, context-aware environments) impacts and transforms learning by transcending "gift-wrapping" and "technology-centered" approaches; and
- how new learning organizations (specifically: cultures of participation, learning webs, niche communities in Long-Tail environments) contribute to reinvent learning and education in the 21st century.

The conceptual framework is illustrated by specific developments of social-technical environments that we have designed and evaluated including: courses-as-seeds; collaborative, domain-oriented design environments, context-aware systems, courses with massive enrollments, and course environments for large number of topics.

KEYWORDS:

Lifelong learning, self-directed learning, meta-design, cultures of participation, long tail, socio-technical environments

1. INTRODUCTION

Our research has been centered for many years on creating human-centered socio-technical environments empowering humans to think, work, design, learn, and collaborate in new ways. These environments have explored (1) multiple perspectives of learning [Fischer, 2009]; (2) new and different relationships between humans and computers [Fischer & Sugimoto, 2006]; and (3) alternative learning organizations [Fischer & Ostwald, 2005]. We have explored, designed, and evaluated innovative approaches to learning in different social infrastructures including schools, universities, work environments, homes and social networks and we have focused on individuals (being interested and knowledgeable in different domains) and different communities (including communities of practice and communities of interest [Fischer & Sugimoto, 2006]). Our research has been influenced by a variety of different philosophies and visions of learning including:

- Dewey's and Bruner's [Bruner, 1996] notion that students should be actively engaged participants in learning, sharing their knowledge with each other rather than competing to get good grades;
- Illich's Learning Webs (articulated 25 years before the Internet came into existence [Illich, 1971]) represent an early vision based on two objectives: (1) provide all who want to learn with access to available resources at any time in their lives; and (2) empower all who want to share what they know to find those who want to learn it from them;
- Kay's design requirements of the "Dynabook" [Kay, 1972] serving as a computer for children of all ages (which influenced more recent developments such as "One Laptop per Child (OLPC)," <http://one.laptop.org/>);
- Brown's emphasis on complementing "learning about" with "learning to be" [Brown, 2005]; and
- Collins' rethinking of education in the digital age [Collins & Halverson, 2009].

These philosophies and visions of learning transcend many of the traditional frameworks (as emphasized and practiced in the majority of current school and e-learning environments) in which learners learn what curricula determine and teachers teach rather than pursuing their own interests and passions.

2. E-LEARNING: A CO-EVOLUTIONARY PERSPECTIVE

e-Learning (as defined and understood in the context of this article) subsumes all forms of learning and teaching supported by information and communication technologies. It includes specific forms such as online learning and distance learning in networked and ubiquitous environments, allowing learners to access information not only in formal learning environments such as schools, but at any place where they might be. Equally important transformations that should be supported by e-Learning are:

- people can pursue their own interests and goals (self-directed learning) and they can get feedback on their understanding from computational critics and from their peers [Fischer & Sugimoto, 2006];
- content is personalized with context-aware systems [Fischer, 2012a];
- new information can be acquired and learned when it is needed (learning on demand) [Fischer, 1991];
- people can learn with and about technology (thereby greatly diminishing the traditional goals of memorizing facts and learning to carry out routine operations) [Collins & Halverson, 2009]; and
- web-based technologies can reach more people, engage them actively (Web 2.0), and make education more affordable by using technology to refigure the economics of higher education [Brown, 2005].

To achieve these objectives, the co-evolution between learning, new media, and new learning organizations (see Figure 1) is necessary.

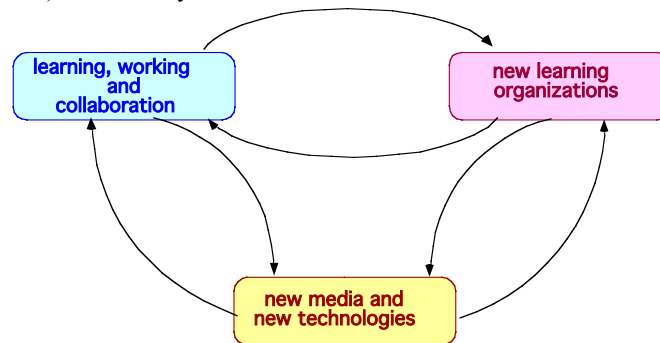


Figure 1: The co-evolution between learning, new media, and new learning organizations

Many e-learning approaches are too timid and fail to think radically enough by (1) by accepting too many established approaches (e.g.: a theory of human learning based solely on school learning is too limited) [Engeström & Sannino, 2010] and (2) by not embracing new learning opportunities (e.g.: exploiting the unique opportunities of social production in which all learners can act as active contributors in personally meaningful problems) [von Hippel, 2005].

New information and communication technologies (specifically the Internet and the cyberinfrastructure) have been heralded as the major driving forces behind innovation in learning and education. But many approaches have had only a minor impact based on the following limitations:

- *Technology-centered developments*: Technology alone does not determine social structure but it creates feasibility spaces for new social and cultural practice [Benkler, 2006]. Changes in complex learning environments are not only dictated by technology; rather, they are the result of an incremental shift in human behavior and social organization and as such require the co-design of social and technical systems.
- *Gift-wrapping*: Many uses of new media can be characterized as “gift-wrapping” [Fischer & Sugimoto, 2006]: they are used as add-ons to existing practices rather than a catalyst for fundamentally rethinking what education should and can be in the next century. They change the medium, but leave the content unchanged and contribute little to introducing new epistemologies. Old frameworks, such as instructionism, fixed curricula, memorization, decontextualized learning and so forth, are not changed by technology itself. This is true whether we use computer-based training, intelligent tutoring systems, multimedia presentations, or the World Wide Web.

3. TRANSFORMATIVE FRAMEWORKS FOR LEARNING

Phenomena such as the information technology revolution [National-Research-Council, 1999], globalization, increasing trends to outsource high-level cognitive tasks, and the need to participate effectively in diverse collaborative organizations addressing complex world problems are changing learning goals. Requirements

increase for educated people (1) to enter work environments requiring collaboration with experts from multiple fields, (2) to pursue several career paths addressing different problems, and (3) to interact and work with people of diverse backgrounds including those from outside academia. Such changes create new demands: learners must be able to have a meaningful life in a diverse, technical, problem-oriented world that does not yet exist, which makes it imperative that they become self-directed, lifelong learners who can thrive and participate in collaborative environments with ever-changing disciplinary boundaries.

3.1 Innovative Multi-Dimensional Aspects of Learning

As the demands for learning undergo a period of profound transformation, there is a need for exploring innovative multi-dimensional aspects of learning: people need to learn (1) more things (“*what*”); (2) in different ways than before (“*how*”); (3) everywhere instead only in formal learning environments (“*where*”); (4) throughout their lives and at times when the information is needed (“*when*”); and (5) with peers and not only from teachers (“*with whom*”) [National-Research-Council, 2009].

WHAT to Learn: Exploring Personally Meaningful Problems and Acquiring Basic Skills and Core Competencies. In formal learning environments, students’ learning is determined to a large extent by a curriculum. Learners encounter few opportunities to gain experiences by exploring personally meaningful problems that need to be identified and framed. By cutting across disciplinary boundaries, these problems are often complex and ill-defined [Simon, 1996] requiring (1) the integration of problem framing and problem solving, (2) the communication and collaboration among people from different disciplines and educational levels, and (3) the intelligent use of technologies and resources that support collective knowledge construction and extend human problem-solving capabilities.

This engagement with personal meaningful problems should be complemented with learning opportunities to acquire the basic skills and core competencies for the 21st century [Collins & Halverson, 2009]. These competencies do not primarily consist of learning and memorizing facts, but should be focused on (1) acquiring and using information; (2) identifying, organizing, planning and allocating resources; (3) collaborating with others; and (4) working with a variety of technologies.

HOW to Learn. Learning in today’s world needs to explore many types of learning other than traditional curriculum-based classroom learning. It must conceptualize learning as an inclusive, social, informal, participatory, and creative lifelong activity. The learning goals and the content of the learning activity should not only be determined by curricula but by interest-based, self-directed learning objectives. Many problems (specifically design problems) are unique and ill-defined and the knowledge to address them is not “out there” requiring contributions and ideas from all involved stakeholders. Learners in such settings must be *active contributors* rather than passive consumers and the learning environments and learning organizations must foster and support mindsets, tools and skills that help learners become empowered and willing to actively contribute [Fischer, 2002; von Hippel, 2005].

WHERE to Learn: At the Right Places. Historically, schools provided the setting where people engaged in learning. The seeds of a new education system can be seen in the explosive growth of home schooling, workplace learning, distance education, adult education, and a variety of design spaces (museums, zoos, environmental centers, educational television and videos, computer-based learning environments, and Internet cafes). Research on everyday cognition demonstrates that the formal learning in schools and the informal learning in practical settings have important differences [National-Research-Council, 2009]. What we discover about learning in schools is *insufficient* for a theory of human learning: schools are often focused on individual cognition, on memorization and on learning general facts whereas learning in the world at large need to rely on shared cognition, use of powerful tools and external information sources, and situation-specific competencies [Resnick, 1987].

WHEN to Learn: At the Right Time. Information overload and the rapid change of our world have created new problems and new challenges for learning and education. People will have to keep learning new knowledge and skills throughout their lifetimes as their lives and jobs keep changing. New approaches are needed to circumvent the unsolvable problems of *coverage* and *obsolescence*. *Learning on demand* [Fischer, 1991] is a promising approach for addressing these problems because: (1) it contextualizes learning by allowing it to be integrated into work rather than relegating it to a separate phase, (2) it lets learners see for themselves the usefulness of new knowledge for actual problem situations, thereby increasing the motivation for learning new things, and (3) it makes new information relevant to the task at hand, thereby leading to more informed decision making, better products, and improved performance. In today’s world, when people are stuck, they can explore insight from a vast network of information and use social networks to discuss with others their opinions on what to do and what to study. This process is made more effective through *peer-support communities* [Gorman & Fischer, 2009] and *niche communities of special, idiosyncratic interests* [Brown & Adler, 2008; Collins et al., 2009; Fischer, 1991].

WITH WHOM: Transcending to Individual Human Mind. Systemic problems require more knowledge than any single person possesses because the knowledge relevant to either frame or resolve these problems is usually distributed among stakeholders coming from different disciplines [Fischer & Sugimoto, 2006]. The “Renaissance Scholar” (meaning the person who is knowledgeable in all relevant fields) no longer exists [Csikszentmihalyi, 1996]. To deal with complex multi-disciplinary problems, people need to use the powerful tools technology provides for finding, analyzing, manipulating, and communicating knowledge bringing different and often controversial points of view together to create a shared understanding among these stakeholders can lead to new insights, ideas, and artifacts.

3.2 Long-Tail

Long-Tail learning [Anderson, 2006; Collins et al., 2009] refers at least to two aspects: (1) learning about exotic topics outside the mainstream education curriculum, and (2) the opportunity to communicate with people who share similar idiosyncratic interests somewhere in the world on a regular basis. Long-Tail learning represents a *fundamentally different objective* to cultural literacy [Hirsch, 1996]. The Web gives children and adults the ability to pursue topics they are particularly interested and feel passionate about and which they will have no opportunity to encounter in schools. Nor are they likely to find people among their acquaintances who share their interests and would study the topics together with them. Such exotic topics remained as lone pursuits for most people until the web came along.

Rethinking and reinventing learning and education from a “Long-Tail” perspective is based on the following assumptions: (1) individuals learn more and better when they learn in areas they choose and for which they are motivated; (2) all people are interested in something (Viking ships, dinosaurs, gambling, Nuremberg trials, White Rose, castles in northern Germany, etc.); (3) whatever someone’s particular interest is, there is some niche community already formed on the net that the person can join. Long-Tail learning requires a new synergy (to be supported by rich learning environments) between themes residing

- in the *head* of the long-tail curve focused on basic knowledge and skills for learning to learn, learning on demand, preparation for future learning, soft skills, digital fluency; and
- in the *tail* of the long-tail curve focused on personally meaningful problems, interest and passion, self-directed learning, intrinsic motivation, and local knowledge in a globalized world.

3.3 Meta-Design

Learners need to be educated for a diverse, technical, problem-oriented world that does not yet exist. *Meta-design* [Fischer, 2012b] represents a theoretical framework, supported by innovative information and communication technologies, in which learners of all ages can pursue topics of interest and take responsibility for their own learning and education by empowering them to thrive and participate as co-designers in collaborative environments with ever-changing disciplinary boundaries.

Meta-design supports fluency with IT and it is instrumental for “*the ability to reformulate knowledge, to express oneself creatively and appropriately, and to produce and generate information rather than simply to comprehend it*” [National-Research-Council, 1999]. It appeals to a diverse audience to engage in interest-driven, self-directed learning by supporting them in designing and building their own socio-technical environments by situating computation in new contexts and by developing tools that democratize design, innovation, and knowledge creation.

Supporting Meta-Design with the Seeding, Evolutionary Growth, and Reseeding (SER) Model. The *SER model* [Fischer & Ostwald, 2005] is a descriptive and prescriptive model for creating systems that best fit emerging and evolving contexts. Instead of attempting to build complete systems, the SER model advocates building *seeds* that can evolve over time. It postulates that systems that evolve over a sustained time span must continually alternate between (1) periods of planned activity and unplanned evolution, and (2) periods of deliberate (re)structuring and enhancement.

A *seed* is built based on an initial understanding and framing of a problem. It is created by meta-designers (e.g.: teachers) acting as environment developers for future users (e.g.: learners) to be as complete as possible. However, the understanding of a problem cannot be complete due to the situated and tacit nature of knowledge work. The *evolutionary growth* phase is one of decentralized evolution as the seed is used and extended by users to do their work or explore new problems. In this phase, the original developers are not directly involved because the focus has shifted to the problem framing and problem solving activities of the users. Instead, the development is performed by participants who have a direct stake in the problem at hand [von Hippel, 2005]. *Reseeding* is a deliberate and centralized effort to organize, formalize, and generalize solutions and artifacts created during the evolutionary growth phase. The goal of reseeded is to create an information space in which useful solutions can be easily found, reused, and extended. As in the seeding

phase, developers are needed to perform substantial system and solution space modifications and users must participate because only they can judge what solutions are useful and what structures will serve their work practices.

3.4 Cultures of Participation

The rise in social computing (based on social production and mass collaboration) [Benkler, 2006] has facilitated a shift from consumer cultures (specialized in producing finished goods to be consumed passively) to cultures of participation (in which all people are provided with the means to participate actively in personally meaningful problems).

Cultures of participation [Fischer, 2011] offer important and interesting possibilities to cope with major problems our societies are facing today including: (1) problems of a *magnitude* which individuals and even large teams cannot solve (example: to model all buildings in the world in 3-D as addressed by “Google SketchUp and 3D Warehouse”); (2) problems of a *systemic nature* requiring the collaboration of many different minds from a variety of background (example: urban planning problems as addressed by the Envisionment and Discovery Collaboratory); and (3) problems modeling changing and unique worlds being dependent on open, living information repositories and tools.

Cultures of participation are facilitated and supported by a variety of different technological environments (such as the participatory Web 2.0, table-top computing, domain-oriented design environments); all of them contributing in different ways to the aims of engaging diverse audiences, enhancing creativity, sharing information, and fostering the collaboration among users acting as active contributors and designers. They democratize design and innovation [von Hippel, 2005] by shifting power and control towards users, supporting them to act as both designers and consumers (“prosumers”) and allowing systems to be shaped through real-time use. But being able to act as active contributors creates numerous demands for learning that need to be supported by powerful learning environments.

4. EXAMPLES OF SOCIO-TECHNICAL ENVIRONMENTS IN SUPPORT OF THE CO-EVOLUTION

Courses-as-Seeds. Courses-as-seeds [dePaula et al., 2001] is an educational model that explores meta-design and cultures of participation to fundamentally change the nature of courses taught in universities. Traditionally, the resources provided by an instructor such as lectures, readings, and assignments define the content of a course. By involving students as active contributors, courses do not have to rely only on the intellectual capital provided by an instructor. Our courses (a large number of them being available at: <http://l3d.cs.colorado.edu/~gerhard/courses/>) are conceptualized based on the seeding, evolutionary growth, reseeding model and are supported with wiki-based course information environments in which the instructor provides the initial seed rather than a finished product and the content of a course evolves over time through contributions of the students. In such an environment, learners are not just passive recipients of knowledge, but active contributors.

The Envisionment and Discovery Collaboratory (EDC) [Arias et al., 2000] is a socio-technical environment in support of *collaborative learning*. The EDC facilitates the creation of shared understanding among various stakeholders, contextualizes information to the task at hand, and creates objects-to-think-with in collaborative design activities. It is applicable to different domains; our specific efforts have focused on the domain of *urban planning and decision making*. Creating shared understanding requires a culture in which stakeholders see themselves as reflective practitioners rather than all-knowing experts [Schön, 1983].



Figure 2: A community of interest using the EDC for a design session

Figure 2 shows the current realization of the EDC environment. Individuals using the EDC convene around a computationally enhanced table (shown in the center of the figure). This table serves as the action space for the EDC [Schön, 1983]. Realized as a touch-sensitive surface, the action space allows users to manipulate the computational simulation projected on the surface by interacting with the physical objects placed on the table. The horizontal table is flanked by a second computational whiteboard, which drives another touch-sensitive surface (shown vertically in Figure 2) serving as the EDC's reflection space. The EDC emphasizes the creation of shared interaction, common ground, and social structures between communities of learners forming a collaborative environment that builds on both distributed and face-to-face collaborations in classrooms or public sites. The EDC contributes in preparing the next generation of knowledge workers for lifelong learning and innovation in a world in which the traditional boundaries between formal educational institutions and the world at large will dissolve.

Education for Everyone and for All Interests. One of the "hottest" topics these days is creating Higher-Ed Courses with massive enrollments. There is currently a substantial hype based on developments such as: (1) MIT's and Harvard's *edX project* offering online learning to millions of people around the world (<http://www.edxonline.org/>); (2) *Coursera*, offering free courses for everyone by an alliance between Stanford, Princeton, Michigan, and Penn (<https://www.coursera.org/>); (3) *Udacity*, a private company with the goal creating and offering classes to hundred thousands of students (<http://www.udacity.com/>). Interesting questions to ask based on these developments are: (1) *what is covered* by these educational experiences (by being free, open, and large-scale; by containing rigorous content; and by offering learning analytics opportunities based on very large numbers of participants)?; and (2) *what is not covered* (by being focused on a traditional model of an instructionist classroom, there is little support for self-directed learning, debate and discussions, and reflective conversations)?.

Interesting complementary developments (covering a very large number of idiosyncratic topics and thereby being supportive of the Long-Tail framework for learning) are: (1) the *Khan Academy* that advertises its role as "*Watch. Practice. Learn almost anything for free with over 3,100 videos*" (<http://www.khanacademy.org/>); (2) *iTunes U* (organized by Apple) supporting the design and distribution of courses to allow students to "*learn anything, anywhere, any time*" (<http://www.apple.com/education/itunes-u/>); and (3) the *One Laptop per Child (OLPC)* initiative focused on the \$100 computer, which so far has been delivered to over 2.4 million children and teachers primarily in developing countries (<http://one.laptop.org/>).

5. IMPLICATIONS

The developments briefly discussed in this paper create and illustrate many *design trade-offs* for e-Learning. This comes as no surprise as learning and education are complex and critically important objectives and there are no simple best solutions. While schools will not disappear, schooling and e-Learning should not be primarily focused on one-way knowledge transfer models.

In the emerging knowledge society, *lifelong learning* is a necessity. Given the explosion of knowledge, people simply cannot learn in school all they will need to know in later life. Seen from this perspective, lifelong learning is more than "adult education"—it is learning carried out in the context of personally meaningful problems. In contrast to schools, where the education establishment has tried to control what

people learn by defining the curriculum, *self-directed learning* is of critical importance in lifelong learning. To be maximally effective, however, self-directed learning needs to be supported with opportunities to explore *systematic bodies of knowledge* that are contextualized to the task at hand as well as to the learner's needs and interests. This fundamental design trade-off results in the dual objective of giving learners enough *freedom* to become active in the process of pursuing personally meaningful problems, and giving them enough *guidance* so that their activity results in the construction of useful knowledge and artifacts.

e-Learning centered on commoditizing contents sharpens the focus on the substantive values of residential schools and universities: moving away from large lectures with learners listening to teachers towards active learning environments characterized by personal attention from teachers and opportunities for participation, and thereby looking beyond the simplicities of information to the complexities of learning.

6. CONCLUSIONS

The design of innovative information and communication technologies to support learning and education has to potential to change *what* we learn, *how* we learn, *where* we learn, *when* we learn, and *who* we learn with. The approaches briefly described in this paper provide a framework for making learning a part of life and thereby characterize learning (1) of being a social and an individual process; (2) of not having a beginning or an end; (3) being integrated into human lives; and (4) not being completely dependent on teachers. The fundamental transformation derived from the emerging framework supported by the co-evolution of learning, new media and new learning organizations is to empower learners to be co-designers and active contributors engaged in self-directed learning activities thereby complementing and transcending their role as consumers of ideas and knowledge provided to them by teachers and restricted by curricula.

7. ACKNOWLEDGEMENTS

The ideas, concepts, arguments, and system developments described in this papers have been jointly developed over the last two decades with former and current members of the Center for Lifelong Learning & Design (L3D) at CU Boulder (<http://l3d.cs.colorado.edu>). Financial support for our research was provided by a large number of research grants from the National Science Foundation.

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