# From Renaissance Scholars to Renaissance Communities: Learning and Education in the 21st Century

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## Abstract

The understanding, framing, and support of learning, working, communicating, and collaborating is *media-dependent*: tools, materials, and social arrangements have always been involved in defining and conceptualizing these activities. Historically the emphasis has been to educate and support individual "Renaissance scholars". In today's world, most of the significant problems are *systemic problems* that transcend not only the individual human mind but cannot be addressed by any one specialty discipline. To cope with these problems requires not only "Renaissance Scholars" but "Renaissance Communities" in which stakeholders coming from different disciplines can collaborate.

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* creates innovative demands and design criteria for future generations of socio-technical environments;
- how the *unique potential of computational media* impacts and transforms learning by transcending "gift-wrapping" and "technology-centered" approaches; and
- how *new learning organizations* contribute to reconceptualizing and reinventing learning and education in the 21st century.

This paper describes conceptual frameworks and socio-technical environments to foster, nurture, and support Renaissance Communities.

## Keywords

Renaissance Scholars; Renaissance Communities; meta-design; seeding and evolution; social creativity; cultures of participation; ecologies of participation; distances and diversity; socio-technical environments; life-long learning; Massive Open Online Courses (MOOCs)

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## 1 Introduction

The complexities of *systemic problems* transcend not only the individual human mind but cannot be addressed by any one specialty discipline. Based on the constraints on human abilities what we can learn during a lifetime, we cannot expect individuals to maintain the prerequisite knowledge in their technological discipline, and at the same time to have the needed competence in the social sciences and in domain-specific application domains (e.g., a computer scientist knowing about a variety of tools and at the same time understanding relevant issues in cognitive science, sociology, anthropology and having acquired substantial knowledge in specific domains). Being a "Renaissance Scholar" (such as Leonardo da Vinci, who was equally adept in the arts and the sciences [Shneiderman, 2002]) was a realistic possibility in the 15th century, the objective of learning and education in the 21st century should be focused on "Renaissance Communities".

## 2 Renaissance Scholars, Problems of the 21st Century, and Renaissance Communities

**Renaissance Scholars.** The Renaissance refers to the revolution in cultural and artistic life that took place in Europe in the 15th and 16th centuries causing a transformation from the religious world of the Middle Ages to the beginning of the modern world of science, and technology. *Leonardo da Vinci* is widely considered as the archetype of a "Renaissance Scholar" being a painter, sculptor, mathematician, engineer, inventor, anatomist, architect, musician, geologist, cartographer, botanist, and writer [Shneiderman, 2002]. Many universities (e.g.: http://www.usc.edu/programs/ugprograms/renaissance/) still postulate the education of "Renaissance Scholars" as one of the most desirable objectives and many new media are designed to augment the individual human mind [Engelbart, 1995]. This article argues that providing as many educational opportunities as possible and rewarding people for the learning efforts in multiple disciplines is still a laudable objective today but the model derived from the 15th century needs to be fundamentally rethought and extended to fit the needs and challenges of the 21st century.

**Problems of the 21st Century.** Major problems our societies are facing today including:

- problems of a *systemic nature* requiring the collaboration of many different minds from a variety of backgrounds
- problems of a *magnitude* which individuals and even large teams cannot solve;
- problems being *poorly understood and ill-defined* and therefore requiring the involvement of the owners of problems in cycles of improvement and refinement over time;
- problems modeling *changing and unique worlds* being dependent on open, living information repositories and tools.

To cope with these problems requires extensive background knowledge in different disciplines and the use of powerful tools representing immense demands for learning. These "facts" of modern life underlie the following claims:

- *"As cultures evolve, it becomes increasingly difficult to master more than one domain of knowledge. Nobody knows who the last Renaissance man really was, but sometime after Leonardo da Vinci it became impossible to learn enough about all the arts and the sciences to be an expert in more than a small fraction of them. Domains split into subdomains, and a mathematician who has mastered algebra may not know much about number theory, combinatorix, topology — and vice versa."* [Csikszentmihalyi, 1996];
- *"Too often we attempt the production of multidisciplinary scholars, professionals who have mastered two or more disciplines, rather than interdisciplinary specialists. This orientation I parody as the 'Leonardesque aspiration': the goal of creating current-day Leonardos who are competent in all of science."* [Campbell, 2005];
- *"While the Western belief in individualism romanticizes this perception of the solitary creative process, the reality is that scientific and artistic forms emerge from the joint thinking, passionate conversations, emotional connections, and shared struggles common in meaningful relationships" [John-Steiner, 2000].*

The following illustrations are based on these claims and the interdisciplinary collaborative work between researchers and developers in information technologies and specific application domains (such as: urban planning [Arias et al., 2001], and supporting people with cognitive disabilities [Carmien et al., 2005]).
Figure 1 shows the desirable, but unrealistic "superhuman": a person who is equally knowledgeable in both areas (computational tools and application domain) as indicated by the two heads.

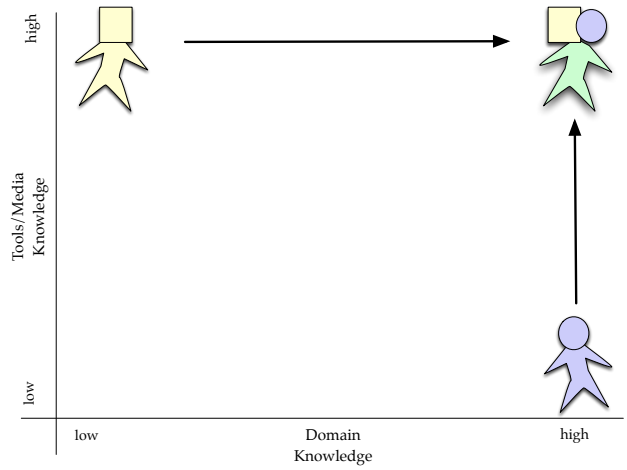


**Figure 1: Unrealistic — The Superhuman (being deeply knowledgeable in two or more major domains)**

A more realistic approach is indicated in Figure 2: the knowledgeable people in one of the domains grow a "little head" in the other domain that is relevant for the collaboration.

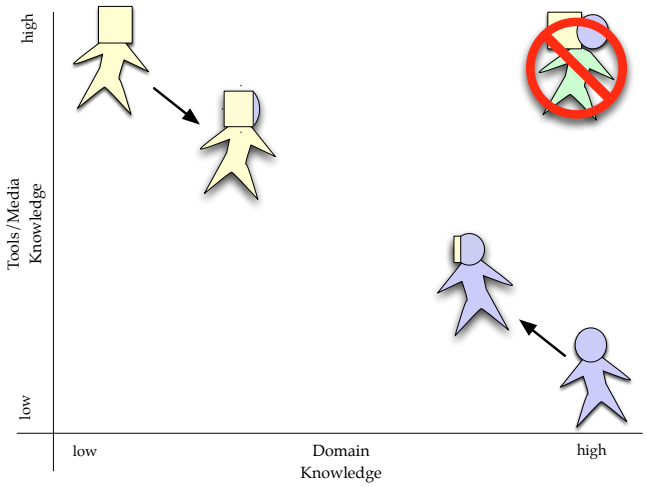


**Figure 2: Realistic — Disciplinary-Grounded Interdisciplinary Collaborators (learning something about other domains)**

**Renaissance Communities.** Much human problem solving, activity, and creativity is social, arising from activities that take place in contexts in which interactions with other people and the artifacts that embody collective knowledge are essential components to address the problems of the 21st century as described above. Acquiring the "little heads" (illustrated in Figure 2) provides the necessary (but by no means sufficient) condition that stakeholders are empowered to act as a Renaissance Community. To do so, they have to communicate and collaborate with each other as indicated in Figure 3.

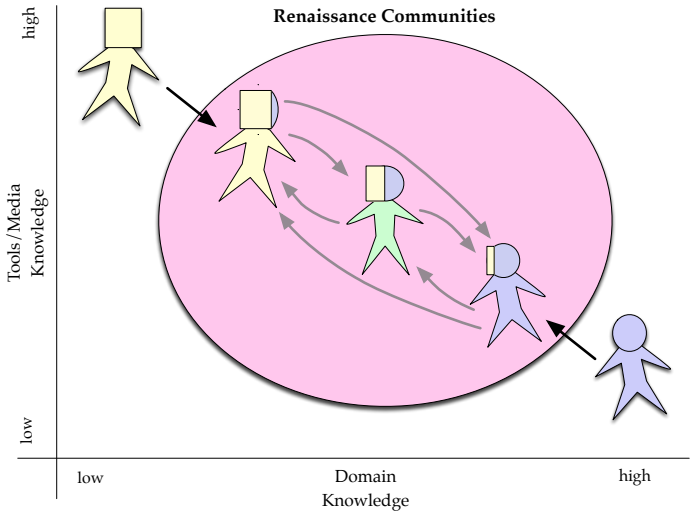


**Figure 3: A Graphical Illustration of a Renaissance Community**

## 3 Learning and Education in the 21st Century

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 & Sugimoto, 2006]; (2) new and different relationships between humans and computers [Fischer, 2011]; 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 special domains) and different communities (including communities of practice and communities of interest). Our research has been influenced by a variety of different philosophies and visions of learning including:

- 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 [Illich, 1971] *Learning Webs* (articulated 25 years before the Internet came into existence) that 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.

Our research was grounded in the objective to support the *co-evolution* between learning, new media, and new learning organizations (see Figure 4).

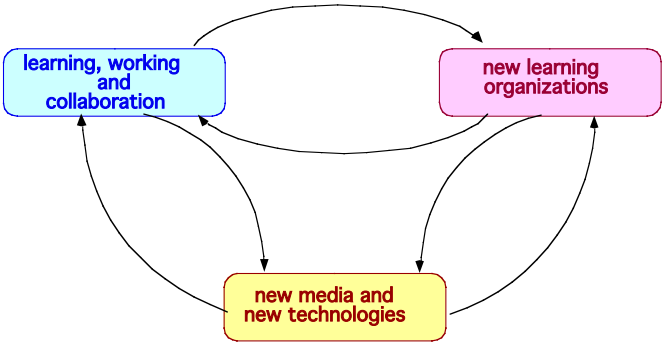


**Figure 4: The co-evolution between learning, new media, and new learning organizations**

New information and communication technologies 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 reduction to:

- *technology-centered developments* (sole focus on the yellow component in Figure 4)*:* 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 organizations and as such require the co-design of social and technical systems.

- *gift-wrapping* (taken the blue component in Figure 4 as a given): Many uses of new media can be characterized as "gift-wrapping" [Fischer, 1998]: 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. Existing 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, or multimedia presentations.
- a sole focus on *existing learning organizations* (not exploring new possibilities of the red component in Figure 4): e-learning environments including massive open online courses (MOOCs), peer-support communities [Gorman & Fischer, 2009] and niche communities of special, idiosyncratic interests [Brown & Adler, 2008; Collins et al., 2009] have provided new opportunities for collaborative learning, but have often been reduced to "gift-wrapping" approaches by conceptualizing *"distance learning as classroom learning at a distance"*.

### 3.1 Learning and Education in Renaissance Communities

Learning in "Renaissance Communities" explores rich ecologies 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 [National-Research-Council, 2009]. To become stakeholders in "Renaissance Communities", learners should be able to interact with people of diverse backgrounds and participate in collaborative environments with ever-changing disciplinary boundaries.

The following objectives should be taken into account to support learning and education in Renaissance Communities:

- 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 to a user's situation with context-aware systems [Fischer, 2012];
- 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];
- unique opportunities of social production are exploited in which all learners can act as active contributors in personally meaningful problems [Benkler, 2006; von Hippel, 2005]; 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 [Benkler, 2006; Brown, 2005].

### 3.2 Rich Landscapes of Learning

As the demands for learning and education undergo a period of profound transformation, there is a need for exploring innovative multi-dimensional aspects of learning. Figure 5 provides an overview of the different dimension of a rich landscape of learning.

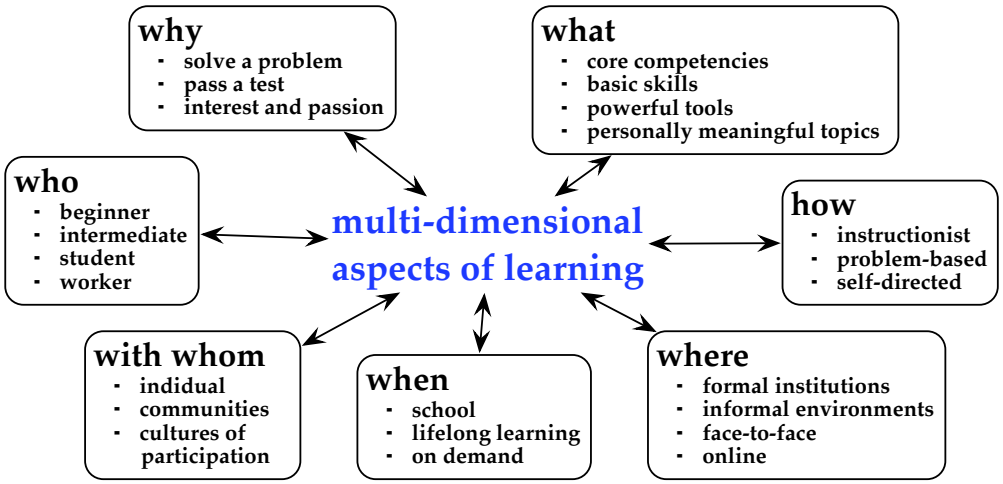


**Figure 5: Rich Landscapes for Learning**

**Why Learn: Different Objectives.** Some people learn because they need to pass a test, fulfill the requirements of a course in school or university, and others learn because they are passionate about some activity.

**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. The 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 Different Ways.** Learning in today's world must conceptualize learning as an inclusive, social, informal, participatory, and creative lifelong activity. 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 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 individuals 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.

**With whom: Collaborative Human-Centered Systems.** As argued above, to deal with complex multi-disciplinary problems, individuals need socio-technical environments for finding, analyzing, manipulating, and communicating knowledge bringing different and often controversial points of view together in creating a shared understanding among all participating stakeholders that can lead to new insights, ideas, and artifacts. In today's world, when individuals are stuck, they can explore a vast network of information and use social networks to discuss with others their opinions on what to do and what to study.

**Who Learns: People at different stages.** The learner may be a student in different grades and institutions (ranging from K-12 to university education), a person working in industry, or curious citizens attempting to understand more about the world surrounding them. Some of the learners may be beginners whereas other may have a rich knowledge background and very specific objectives requiring more individualized instruction.

## 4 Conceptual Frameworks for Renaissance Communities

To explore rich landscapes of learning, we have developed *conceptual frameworks* over the last two decades to understand, foster, nurture, and support "Renaissance Communities". Figure 6 provides an overview of these conceptual frameworks and they are individually discussed in this section. Corresponding socio-technical environments supporting and illustrating these frameworks are described in Section 5.

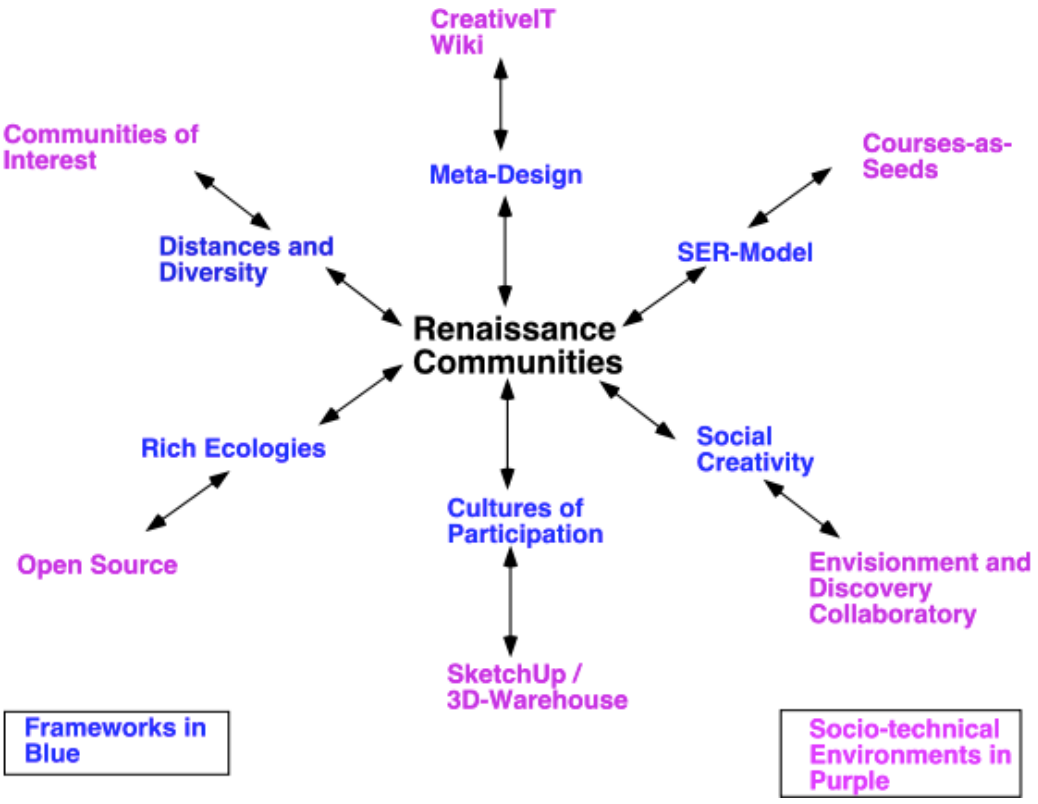


**Figure 6: Overview of Conceptual Frameworks and Socio-Technical Environments for Renaissance Communities**

### *4.1 Meta-Design*

*Meta-design* [Fischer & Giaccardi, 2006] characterizes objectives, techniques, and processes for creating new media and environments that allow "owners of problems" to act as *designers*. A fundamental objective of meta-design is to create socio-technical environments [Fischer & Herrmann, 2011] that empower users to engage actively in the continuous development of systems rather than being restricted to the use of existing systems. Meta-design aims at defining and creating not only *technical infrastructures* for the software system but also *social infrastructures* in which users can participate actively as co-designers to shape and reshape the socio-technical environments through collaboration.

Meta-design requires some fluency with information technologies and it is instrumental for the ability to reformulate knowledge, to express oneself creatively, and to create information rather than simply to comprehend it. It supports stakeholders 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.

### 4.2 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 periods of planned activity and unplanned evolution, and 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 acting as environment developers for future users 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 reseeding 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.

### 4.3 Social Creativity

Our focus on *social creativity* [Fischer et al., 2005] is grounded in the basic observation that the power of the unaided individual mind is highly overrated. Much human creativity is social, arising from activities that take place in contexts in which interaction with other people and the artifacts that embody collective knowledge are essential components.

Social creativity does not necessitate the development of environments in which the interests of the many inevitably supersede those of the individual. Individuality makes a difference, and organizations get their strength to a large extent from the creativity and engagement of their individual members. Social creativity derives its strength from

- *externalized shared artifacts* (specifically in the form of boundary objects) which can be critiqued and incrementally improved by all stakeholders [Bruner, 1996];
- *conceptual collisions* [Bransford et al., 2006], symmetry of ignorance [Rittel, 1984], and epistemological pluralisms [Turkle & Papert, 1991], which allows new viewpoints and concepts to emergence thereby avoiding group-think [Janis, 1972]; and
- engaging more minds and broadening participation with the support of *meta-design* (see Section 4.1).

### 4.4 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] 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"; [Tapscott & Williams, 2006]) and allowing systems to be shaped through real-time use. Being able to act as active contributors creates numerous demands for learning (as indicated in Figure 5) that need to be supported by powerful learning environments.

### 4.5 Rich Ecologies of Participation

Individuals have different motivations for doing things, and those motivations create different levels of participation. To understand, foster, and support cultures of participation requires differentiating, analyzing, and supporting distinct roles that can be found in cultures of participation [Preece & Shneiderman, 2009].

For cultures of participation to become viable and be successful, it is critical that a sufficient number of participants take on the more active and more demanding roles. To encourage and support *migration paths towards more demanding roles*, mechanisms are needed that lead to more involvement, motivation, and that facilitate the acquisition of additional knowledge required by the more demanding and involved roles. Grounded in a "low threshold and high ceiling" architecture that allows new participants to contribute as early as possible and experienced participants to cope with complex tasks by offering broad functionality, mechanisms are needed to address the following requirements:

- scaffolding to support migration paths;
- special interaction features for different levels of participation;
- supporting different level of granularity of participation to account for different time and effort investments; and
- rewards and incentives to reduce the funnel effect from one level to the next [Porter, 2008].

### 4.6 Distances and Diversity

In extended and distributed projects addressing the complex and systemic problems of the 21st century (see Section 2), stakeholders from many different domains must coordinate their efforts. In such projects, collaboration is crucial for success, yet it is difficult to achieve. Complexity arises from the need to synthesize different perspectives, exploit conceptual collisions between concepts and ideas coming from different disciplines, manage large amounts of information, and understand the design decisions that have determined the long-term evolution of an artifact. Renaissance communities thrive on the spatial, temporal, and conceptual distances between the participating stakeholders and by diversity of their idiosyncratic perspectives [Fischer, 2005]. They require constructive dialogs between individuals negotiating their differences while creating their shared voice and vision.

The *fish-scale model* (see Figure 7) [Campbell, 2005] illustrates an interesting structure for competencies that cannot be embodied in a single mind. The inevitably incomplete competence of an individual requires Renaissance Communities in which there is the right mixture between sufficient overlap and complementary competence. The model is structured in a way to achieve *"collective comprehensiveness through overlapping patterns of unique narrowness".* Each fish-scale represents a narrow specialty in depth and the overlap of one fish-scale with another provides the foundation for common ground and shared understanding between individuals being knowledgeable in different domain. Breath ("collective comprehensiveness") is achieved by collaboration. The model provides a viable architecture for the design competence of Renaissance Communities.

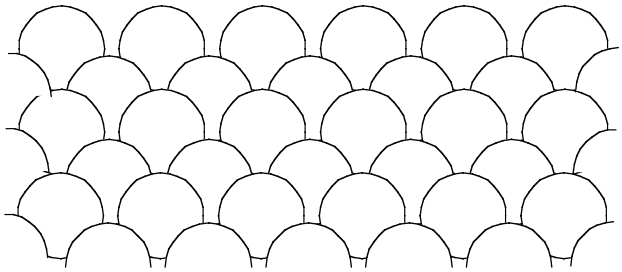

**Figure 7: The Fish-Scale Model**

## 5 Socio-Technical Environments Supporting Renaissance Communities

We have explored the conceptual frameworks described in the previous in a variety of different application contexts. Specific examples will be described in this section.

### 5.1 CreativeIT-Wiki

Synergies and collaborations between researchers and practitioners coming from the sciences, the arts, and technology domains are considered to be of fundamental importance for the creative innovation economies of the future

[National-Research-Council, 2003]. Numerous workshops jointly supported by the National Science Foundation (NSF) and the National Endowment for the Arts (NEA) and the specific NSF program CreativeIT have explored ideas and models to address these challenges.

Our research (supported by the CreativeIT program) was focused on creating a Wiki-based collaboration environment to support all interested stakeholders working the emerging field of Creativity and IT. Our research (1) examined limitations of current environments compared with what is needed to support creative practices; (2) explored support for specific media (such as mind maps, videos, anecdotes, and stories); (3) developed varied "modes" of interacting with such an environment; and (4) utilized new paradigms (such as *meta-design*; see Section 4.1) for developing systems that are *open and extensible*.

Our first prototype of the CREATIVEIT-WIKI (see Figure 8 and http://l3dswiki.cs.colorado.edu:3232/CreativeIT/) had some minimal degree of success, with the creation of 290 pages, 80 literature/resources references contributed by community members, workshop proceedings published as part of the wiki, a gallery of project exemplars with an interface to support addition of new material, community member profiles, and hosting over 100 registrants since its inception.


**Figure 8: The CreativeIT-Wiki**

While the prototype served well as a content management system it fell short in creating and fostering an active Renaissance Community focused on Creativity and IT. The perceived value and benefits to participate needed to be substantially increased to make participation attractive and to overcome media and attention competition. The prototype did not reach the *"tipping point"* [Gladwell, 2000] of broad-based participation.

The objective of the second prototype of the CREATIVEIT-WIKI was to find ways to engage the community by supporting *processes and activities* surrounding the creation of content itself. Participants need to be encouraged to find, create, explore, and participate in communities of interests. To do this, they need to be able to find out who other participants are, what their interests are, what pages they contribute to, what community activities are happening, and to communicate with each other seamlessly.

The CREATIVEIT-WIKI research provided evidence that the following mechanisms are needed to support a "Renaissance Community":

- increasing participation by improved utility;
- supporting visualizations of community relationships and encouraging the development of examples, models, and tutorials;
- motivating participants to visit regularly;

- supporting direct peer-to-peer communication between participants inside the wiki;
- fostering a community of committed contributors; and
- supporting migration paths for contributor involvement.

### 5.2 Courses-as-Seeds

*Courses-as-seeds* [dePaula et al., 2001] is an educational model that explores the seeding, evolutionary growth, and reseeding (SER) model (see Section 4.2) in the context of fundamentally changing the nature of courses taught in universities. Its goal is to create cultures of participation that are situated in the context of university courses by supporting a community of learners model [Rogoff et al., 1998]. 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. In these courses (a large number of them being available at: http://l3d.cs.colorado.edu/~gerhard/courses/), instructors provide an initial seed rather than a finished product and the content of a course evolves over time through contributions of the students. Courses-as-seeds are focused not on delivering predigested information to individuals, but providing opportunities and resources for learners to (1) engage in authentic activities, (2) participate in social debates and discussions, (3) create shared understanding among diverse stakeholders, and (4) frame and solve personally meaningful problems. Courses-as-seeds are grounded in socio-technical environments in which communities of mutual learners act simultaneously as learners and as active contributors (based on the assumption that being a teacher or a learner is not an attribute of a person but an attribute of a context); peer-to-peer learning is supported; and teachers act as "guides on the side" rather than as "sages on the stage".

### 5.3 The Envisionment and Discovery Collaboratory (EDC)

The EDC [Arias et al., 2001] is a socio-technical environment fostering *social creativity* (see Section 4.3) by supporting collaborative learning and knowledge construction. It 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*.

**Figure 9: Using the EDC for a design session**

Figure 9 shows the current realization of the EDC as a table-top computing 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 additional computational whiteboards, which drive other touch-sensitive surfaces (shown vertically in Figure 9) serving as the EDC's reflection space. 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 individual and social creativity and between formal educational institutions and the world at large will dissolve.

### 5.4 *SketchUp and the 3D Warehouse:* Modeling the World in 3D

Having the whole world modeled in 3D and allowing users to explore this virtual world on their computers is the objective behind the effort to integrate the following three systems: SketchUp, 3D Warehouse, and Google Earth. The amount of work and local knowledge needed to achieve this is beyond the scope and capability of any locally operating development team. It requires the contributions of a large user base, and as such represents a unique, large-scale example for assessing the conceptual framework underlying *cultures of participation* (see Section 4.4).

***SketchUp*** (http://sketchup.com/) is a highly interactive, direct manipulation 3D-modeling environment. Figure 10 shows a model of the Denver Public Library developed with SketchUp. Being a high-functionality environment with a "low threshold and high ceiling," developing sophisticated and highly creative models with SketchUp requires a *nontrivial learning effort*. Powerful learning mechanisms for SketchUp are critical to allow everyone to contribute to learn how to do so. These mechanisms, together with the added value of participation are important to motivate enough stakeholders to contribute to creative collaborations.

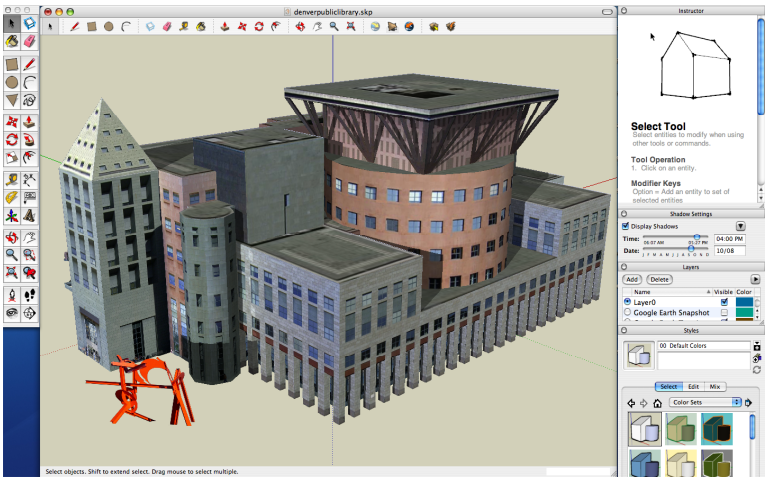


**Figure 10: A 3D Model Developed in SketchUp**

The ***3D Warehouse*** (http://sketchup.google.com/3dwarehouse/) is an information repository for the collection of models created by all users who are willing to share their models. It contains ten thousands of models from different domains, including buildings, houses, bridges, sculptures, cars, and so forth and it supports *collections* organized by curators (see Figure 11). In addition, the environment supports tagging, ratings, and reviews by the participating community. Interested users can utilize the 3D Warehouse for creative collaborations by sharing, downloading, modifying, extending, and reusing existing models.

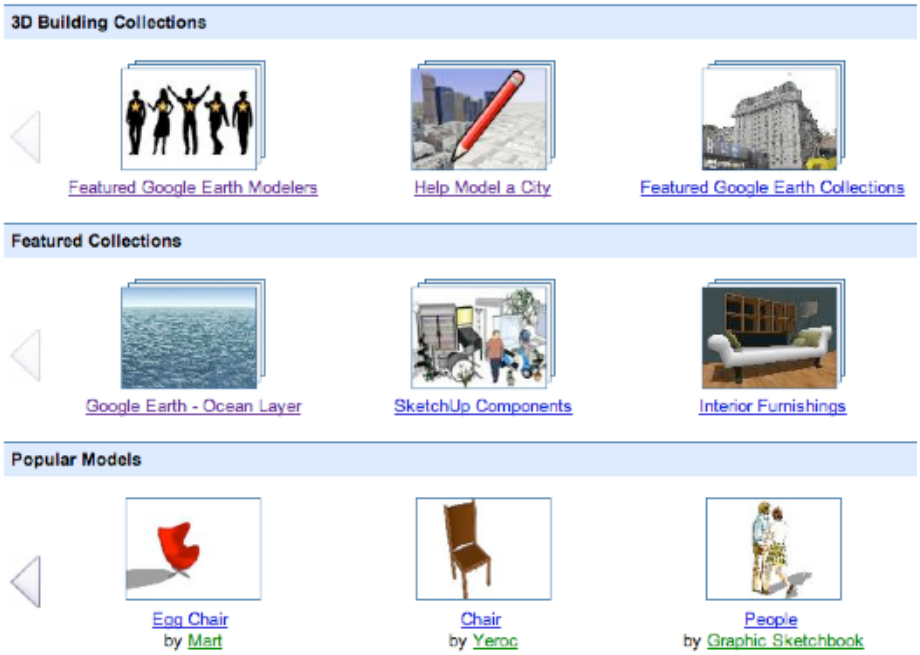


**Figure 11: Collections of Models in the 3D Warehouse**

***Google Earth*** has the capability to show 3D objects that consist of users' submissions that were developed by using SketchUp. Figure 12 shows an example illustrating the interplay of the three systems: the downtown area of the city of Denver in Google Earth, populated by 3D buildings created by users of SketchUp and stored in the 3D Warehouse. The three systems are integrated in the following way: 3D models can be shared by uploading them from SketchUp to the 3D Warehouse, where they can be searched, shared, and re-stored. Models can be downloaded from the 3D Warehouse to SketchUp (for further modification and evolution) and to Google Earth (if the models have a location on Earth) to be viewed by anyone.


**Figure 12: Downtown Denver in 3D**

### *5.5 Open Source Communities*

*Open-Source Software (OSS)* communities and practices actively seek the participation and contributions of developers and users at different levels. There are abundant lessons in OSS to be discovered and learned for the

success of Renaissance Communities, especially in the aspects of understanding what motivates so many people to dedicate their time, skills, and knowledge to OSS systems, and how users of OSS system become developers.

Our conceptual framework of *rich ecologies of participation* (see Section 4.5) has been empirically evaluated with OSS systems. Participation in these systems starts out with developers (acting as meta-designers) who want to solve their own particular problem and make the system available to others for free. It often attracts many users who have a similar problem, and because of the free access of source code, some interested users become co-developers by extending or improving the initial system. OSS grants not only developers but also all users, who are potential developers, the right to read and change its source code. Figure 13 illustrates different roles in OSS communities that we have identified in our studies [Ye & Fischer, 2007]. Participants start as passive users and a certain percentage of these do migrate over time to more demanding roles. Not every participant must contribute, but all participants must have opportunities to contribute when they want to.

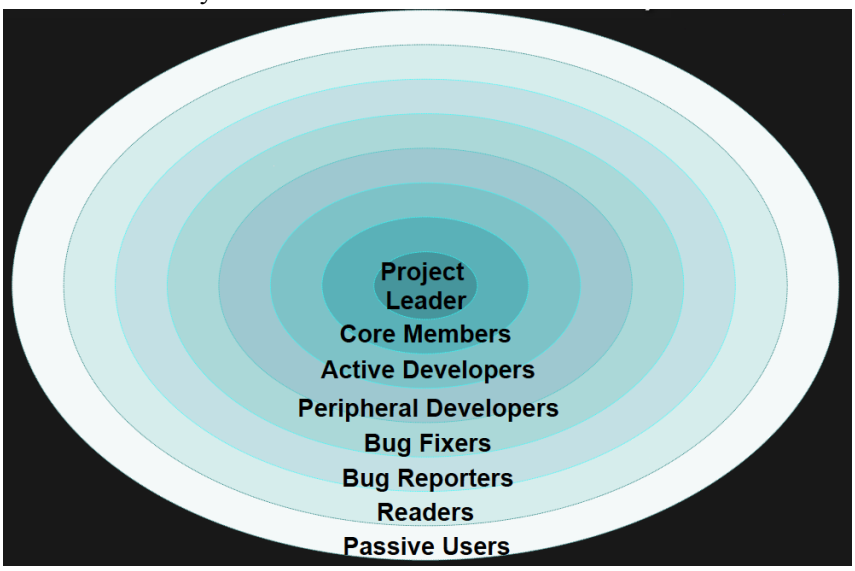


**Figure 13: Ecologies of Participation in an Open Source Software Community**

### *5.6 Communities of Interest*

Renaissance Communities are social structures that enable groups of people to share knowledge and resources in support of collaborative design. Different communities (such as communities of practice and communities of interest) grow around different types of design practices. Homogenous *Communities of Practice (CoPs)* [Wenger, 1998] consist of practitioners who work as a community in a certain domain undertaking similar work. Examples of CoPs are architects, urban planners, research groups, software developers, and end-users. CoPs gain their strength from shared knowledge and experience. However, they face the danger of *group-think* [Janis, 1972]: the boundaries of domain-specific ontologies and tools that are empowering to insiders are often barriers for outsiders and newcomers.

To exploit *distances and diversity* (see Section 4.6) to foster opportunities for Renaissance Communities to be more creative, heterogeneous *Communities of Interest (CoIs)* [Fischer, 2001] bring together stakeholders from different CoPs to solve specific design problems of common concern. They can be thought of as "communities-of-communities" [Brown & Duguid, 2000]. Examples of CoIs are (1) a group of citizens and experts interested in urban planning (such as the EDC); and (2) representatives of the creative practices and new media designers to create new shared visions and artifacts between art and technology (as supported by the CREATIVEIT-WIKI). Fundamental challenges facing CoIs are found in building a shared understanding of the task-at-hand, which often does not exist at the beginning but is evolved incrementally and collaboratively and emerges in people's minds and in external artifacts. Members of CoIs must learn to communicate with and learn from others who have different perspectives and perhaps different vocabularies to describe their ideas and to establish a common ground.

CoIs have a greater creativity potential by exploiting diversity not as a constraint to deal with but an opportunity to generate new ideas, new insights, and new environments. The challenge to foster and nurture social creativity is often

not to reduce heterogeneity and specialization, but to support it, manage it, and integrate it by finding ways to build bridges between local knowledge and by exploiting conceptual collisions and breakdowns as sources for innovation.

# 6 Implications

To foster, nurture, and support "Renaissance Communities" requires conceptual frameworks and socio-technical environments as described in the previous two sections. This section briefly explores a couple of implications for lifelong learning and Massive Open Online Courses (MOOCs).

## *6.1 Lifelong Learning*

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 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.

The long-term research objectives of our Center for Lifelong Learning & Design (L3D) have been grounded in the following proposition: "*If the world of working and living relies on collaboration, creativity, definition and framing of problems and if it requires dealing with uncertainty, change, and intelligence that is distributed across cultures, disciplines, and tools—then learning and education should foster transdisciplinary competencies that prepare students for having meaningful and productive lives in such a world."* The core message behind this paper is that to have a meaningful and productive life in the 21st century implies to learn and to be educated not only as a Renaissance Scholar, but to be an active participant in Renaissance Communities.

## *6.2 Massive Open Online Courses (MOOCs)*

One of the "hottest" topics these days are 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 (http://www.edxonline.org/); (2) Coursera (https://www.coursera.org/); and (3) Udacity (http://www.udacity.com/), both of them for-profit educational technology companies.

MOOCs can be characterized as one specific approach in the context of *open, online learning environments* providing resources (mostly available on the Internet) associated with courses. Figure 14 provides an overview and a classification about the rich landscapes of open, online learning environments repesenting places and institutions that complement traditional unversities.

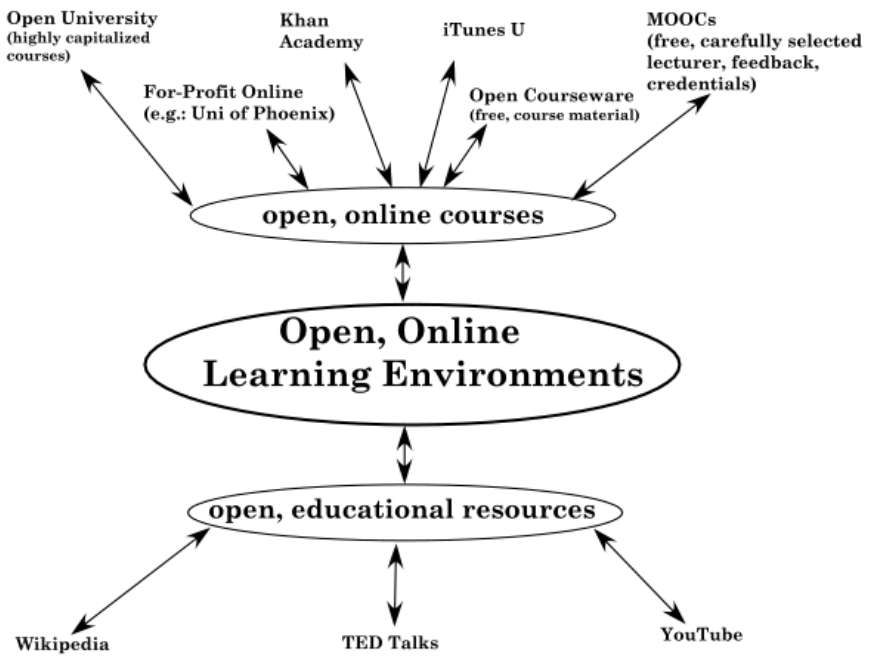


**Figure 14: MOOCs in the context of open, online learning environments**

Interesting questions to ask based on these developments are:

- *what is covered by MOOCs?* (being free, open, and large-scale and offering learning analytics opportunities based on very large numbers of participants); and
- *what is not covered by MOOCs?* (being focused on a traditional model of an instructionist classroom, and thereby providing little support for self-directed learning, debate and discussions, and reflective conversations).

Important potential *strengths* of MOOCs are:

- they represent an innovative, new effort that is shaking up learning institutions;
- they generated a discussion transcending the narrow confines of academic circles by getting the world at large involved and excited;
- they make the knowledge of some of the world's leading experts from the best universities available to anyone free of charge thereby attracting and affecting large numbers of people;
- they allow teachers to experiment with different approaches (e.g.: standalone versus hybrid courses, courses with fixed time duration versus courses to be taken anytime, etc.);
- they support for learners the ability "to pause, rewind, and replay" in online instruction;
- they empower researchers by recording students interactions to analyze large amounts of data measuring how specific experiences and interactions will affect students' learning; and
- they force residential, research based universities to reflect and focus on their core competencies.

Potential *weaknesses* of MOOCs are that they are focused on lectures and other enrichment activities are still quite limited. The technology component makes lectures appear innovative, but this is often only a change in form, not in content; i.e., they are often stuck in "gift-wrapping" (see Section 3). Participating in a MOOC is not too different from "traditional" teaching: teachers talk and students listen. This is only *one* form of "learning" in the rich landscape of learning (see Figure 5).

MOOCs enrich the landscape of learning opportunities and they have the potential to reduce the digital divide by providing education for everyone. They also challenge residential, research-based universities to reflect, define, and emphasize their core competencies: 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. If the basic assumption of this paper — a focus on Renaissance Communities — is the critical challenge for learning and education in the 21st

century, then an important research objective will be to explore the potential and the limitations of MOOCs from this perspective.

## 7 Conclusions

In the past, most computational environments have focused on the needs of individual users. The world has become too complex for individuals (even when they are educated and act as Renaissance Scholars) to have enough knowledge to tackle complex problems by themselves. The necessary and viable alternative is to support, foster, nurture, and sustain *Renaissance Communities*. Bringing people with different background knowledge and different value systems together, overcoming the biases and barriers of their separate languages, integrating different educational experiences, and rewarding participants for collaborating with others will not be an easy undertaking. But there is little choice: unless we meet these challenges, we will be unable to cope with the complexities and needs posed by the problems of the 21st century.


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