Draft of a Chapter in the International Handbook of the Learning Sciences —Edited by Frank Fischer, Cindy E. Hmelo-Silver, Susan R. Goldman & Peter Reimann

Massive Open Online Courses (MOOCs) and Rich Landscapes of Learning: A Learning Sciences Perspective

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Abstract

Access to affordable education to achieve printed and digital literacy helping all learners to acquire knowledge, coping with change, and seeding mindsets for creativity and intellectual curiosity are considered major indicators and measures of quality of life worldwide. The emergence of MOOCs promising new, scalable models that can provide an "education for everyone" has generated a new and broad interest in rethinking learning and education. Frames of reference (identifying underlying assumptions, conceptualizations, and perspectives) are needed to conceptualize the meaning and the implications of MOOCs in the context of rich landscapes for learning. Most of the discussions and analyses about MOOCS have been based on *economic perspectives* and *technological* perspectives. This contribution critically assesses MOOCs from a learning sciences perspectives.

Massive Open Online Courses (MOOCs)

MOOCs have generated a world-wide interest in learning and education. This interest has transcended narrow academic circles (e.g.: the NY Times declared 2012 "The Year of the MOOC"; http://www.nytimes.com/2012/11/04/education/edlife/massive-open-online-courses-are-multiplying-at-a-rapid-pace.html?pagewanted=all&_r=0).
As the *costs* of a residential university education have been growing dramatically, the promise of MOOCs to be "free" represented an exciting development. The different attributes used in the name provide a characterization of the objectives of MOOCS:

- *"massive"* because they are designed to enroll very large number of students (e.g.: thousands, often tens of thousands and in some instances more than one hundred thousand);
- *"open"* because anyone with an Internet connection can sign up;
- *"online"* being available on the Internet and referring not just to the delivery mode but to the style of communication;
- "courses," referring not only to content delivery (as it was the case with MIT's Open Courseware) but including other aspects (lectures, forums, peer-to-peer interaction, quizzes, exams, and credentials) associated with courses.

The name MOOC was created in 2008 by Dave Cormier and the first examples were cMOOCs followed by xMOOCs in 2011. The two approaches are grounded in two different design models: cMOOCs are based on connectivism and networking and give learners an active role, whereas xMOOCs are based on an instructionist, transmission-based approach augmented with additional components (a detailed comparison between the two models can be found in [Bates, 2014]. At this point of time, xMOOCs are the focus of interest and attention and the arguments and examples discussed in this paper are focused on them.

Some of the initial objectives articulated for MOOCS were:

- represent *first class courses* from the best professor coming from elite institution;
- bring the best education in the world to the *most remote corners* of the planet;
- help professors to improve their classroom teaching by providing them with *more data* what and how students in a course are doing;
- support *communities* among the students participants thereby expanding their intellectual and personal networks; and
- provide students with insightful *feedback* in case they went wrong or got stuck in a problem solving attempt.

Ancestors of MOOCs. The opinions about how innovative MOOCs vary greatly. The Wikipedia article provides a good history section (https://en.wikipedia.org/wiki/Massive_open_online_course) of distance learning that predates e-learning with correspondence courses. Radio and television as new technologies at the time were used for educational purposes to overcome distances and reach larger audiences. Many universities starting in the 1980'es created special classrooms with video access for providing convenient and flexible education for working professionals by offering graduate degree programs and certificates in an accessible, online format.

The Open University (OU) in the UK (http://www.open.ac.uk/) started in 1969 has been the pioneer of distance learning. It was *"founded on the belief that communications technology could bring high quality degree-level learning to people who had not had the opportunity to attend traditional campus universities"*.
The OpenCourseWare (OCW) of MIT (http://ocw.mit.edu/) started in 2002 has been an initiative to put all the educational materials from MIT's undergraduate- and graduate-level courses online, partly free and openly available to anyone and anywhere. More than 3000 courses are available online, some of them limited to reading lists and discussion topics, others including lecture notes, homework problems and exams, and some of them including interactive web demonstrations and streaming video lectures.

MOOCs Platform Providers. Over the last few years, numerous *MOOCs platform providers* have emerged as companies and non-profit organizations that partner with different universities and organizations worldwide to offer courses for anyone. Some of the most prominent providers are:

- Coursera (https://www.coursera.org/) (offering over 1500 courses from 140 partners across 28 countries in 2016);
- MIT's and Harvard's edX project (http://www.edxonline.org/) (offering over 1100 courses in 2016);
- Udacity (http://www.udacity.com/) (focusing recently on nanodegree programs in which a certification can be earned in less than 12 months);
- FutureLearn (http://futurelearn.com/) (a private company in the UK owned by The Open University including non-university partners);
- Iversity (https://iversity.org/de) (a European platform working within the existing legal and administrative infrastructure of European countries).

MOOCs in the Context of Open, Online Learning Environments. Figure 1 provides an overview of open, online learning environments. MOOCs represent *one specific approach* in the "open, online courses" domain by having at least some of the attributes defining a course (such as: lectures, forums, peer-to-peer interaction, quizzes, exams, and credentials). In contrast, open, educational resources serve different purposes; they offer information about specific, independent topics and questions requiring little cohesion between individual components.

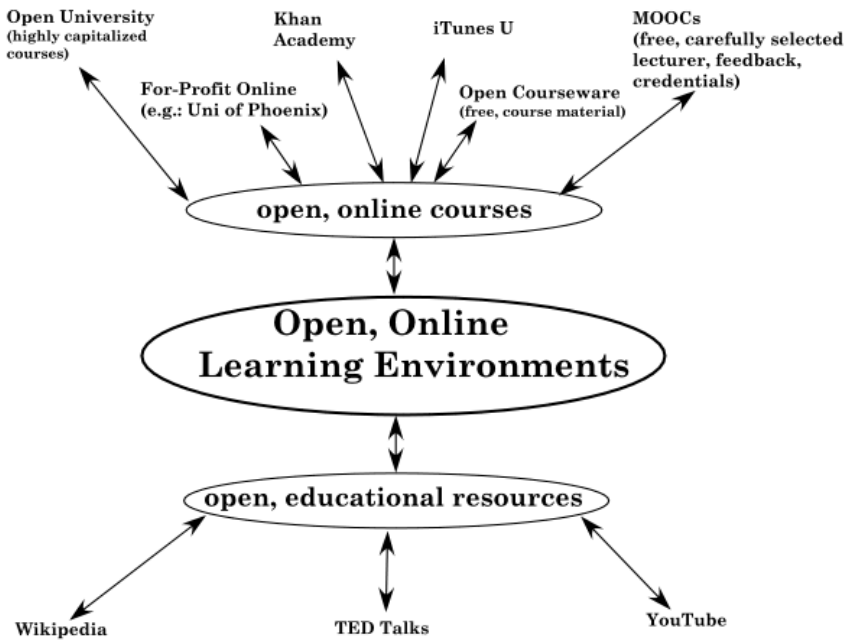

Figure 1: MOOCs in the context of open, online learning environments

MOOCs and the Learning Sciences. Most of the discussions and analyses about MOOCS are based on *economic perspectives* (scalability, productivity, being "free") and *technology perspectives* (platforms supporting large number of students in online environments, enrichment components such as forums, peer-to-peer learning support, automatic grading).

Few contributions have analyzed MOOCs from a *learning science perspective* and put them into a larger context with other approaches to learning and education. Some of the major expectations associated with MOOCs have been to enrich the landscape of learning opportunities and to reduce the digital divide by providing education for everyone by "making the knowledge of some of the world's leading experts available to anyone free of charge".

In their short time of existence, MOOCs deserve credit because they have woken up not only academia but also the media at large to bring online learning and teaching to the attention of the public. A special impact of MOOCs is their challenge to "force" residential, research-based universities to reflect, define, and emphasize their core competencies.

The special emphasis of this paper is to assess MOOCs from a learning science perspective by locating them as *one component in a rich landscape of learning*. The expectations associated with this approach is that a symbiotic relationship can provide dividends and progress to two challenges: (1) that the future development of MOOCs can be grounded in insights from the learning sciences: and (2) that the research of the learning science can be enriched by exploring MOOCs as a specific and unique context for learning and teaching [Eisenberg & Fischer, 2014].

Rich Landscapes of Learning

One of the shortcomings of research in the learning science is that many *approaches are too timid and not thinking radically enough* by focusing too much on schooling and not paying enough attentions to the multi-dimensional aspects of learning [Collins & Halverson, 2009; Resnick, 1987].

Multi-Dimensional Aspects of Learning and MOOCs

Figure 2 provides an overview of the multi-dimensional aspects of learning — and the following paragraphs briefly describe the essential issues related to the different aspects.

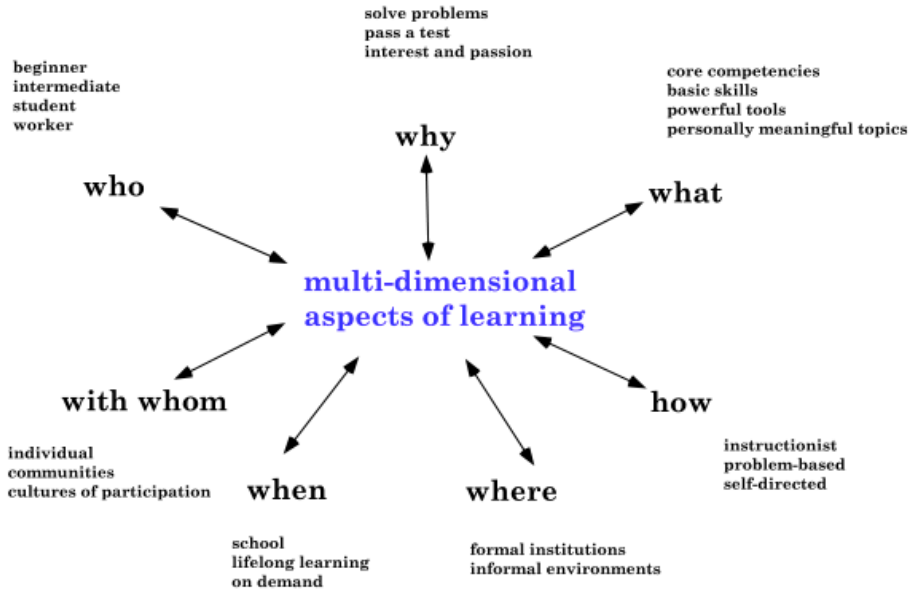

Figure 2: Multi-Dimensional Aspects of Learning

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 (and general and uniform introductory courses will serve them well) whereas

other may have a rich knowledge background and very specific objectives requiring more individualized instruction.

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 (e.g. [Collins & Halverson, 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 [Resnick, 1987]. 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. 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 [Jenkins, 2009; 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 (e.g.: museums, zoos, environmental centers, etc.). 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.

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* 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: 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. 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. In the past, most computational environments have focused on the needs of individual users.

MOOCs have the potential (some of it realized today, many aspects serving as design challenges for future MOOCs) to contribute to these different dimensions of multi-faceted aspects of learning.

Rich Landscapes for Learning

Learning needs and learning objectives vary greatly requiring rich landscapes for learning [Fischer, 2016]. Figure 3 provides an overview and establishes frames of references for the future sections of this paper. It illustrates:

- formal learning in schools needs to be complemented by informal learning [National-Research-Council, 2009];
- "knowledge in the head" needs to be complemented with "knowledge in the world," emphasizing the importance of distributed cognition [Salomon, 1993];
- supply-oriented models (in which learners are presented with knowledge that later may become relevant for them) need to be complemented by learning on demand [Collins & Halverson, 2009];
- consumer-oriented cultures need to be complemented by participatory cultures [Jenkins, 2009];
- "learning about" needs to be complemented by "learning to be" [Brown, 2005];
- "learning when the answer is known" needs to be complemented by "learning when the answer is not known" (and exploring problems that have no answers) [Engeström & Sannino, 2010].

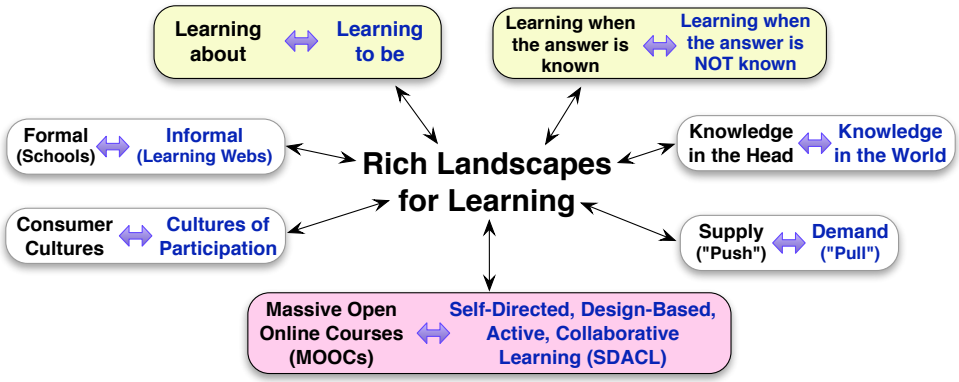

Figure 3: Overview of Rich Landscapes for Learning

Learning About versus Learning to Be. *Learning about*, as an objective for learning and education, is focused on the accumulation of intellectual capital realized in a curriculum that stresses the communication of culturally central theories, facts, and skills [Hirsch, 1988]. This curriculum is identifiable and structured as a coherent and fine-grained sequence of educational objectives. Instructionist approaches can be effective and are often well suited for "learning about" (e.g., learners getting introduced to domains of knowledge that are new to them, e.g., Math 101, Physics 101, Design 101, etc.).

Learning to be [Brown, 2005] is focused not as much on teaching about mathematics, physics, or design, as on what it means and takes to be a mathematician, a physicist, a designer or a "Wikipedian". Important dimensions of *learning to be* include: (1) learning by being engaged in personally meaningful problems; (2) teachers engaging in problem-solving activities in front of their students rather than lecturing; and (3) enculturation into communities of practice with legitimate peripheral participation [Lave & Wenger, 1991].

Learning When the Answer is Known versus Learning When the Answer is Not Known. In many introductory courses (particularly in disciplines belonging to the natural sciences [Simon, 1996] such as mathematics and physics), the answer to the problems discussed in courses exists and is known by the teacher, and the core challenge is *"for learners to learn what the teacher knows"*. But in many other situations (e.g., exploring wicked, ill-defined design problems), answers are not known by any stakeholder; instead, all participants engage in collaborative knowledge construction and evaluation processes. In many of these problem-solving situations, a correct, final "answer" does not exist. In these contexts, learning is not a commodity to be consumed but

is collaboratively designed and constructed, emphasizing innovation, continuous learning, and collaboration as important processes in which workers as stakeholders create new knowledge as they carry out their problem framing and problem solving activities.

Identifying and Analyzing Antinomies. The different objectives illustrated in Figure 3 represent *antinomies* (or design trade-offs) [Bruner, 1996]: pairs of truth, each worthwhile to pursue in different contexts, but also contradicting each other at a certain level, depending on the material to be learned, the students, the setting, and many other factors. The essential goal of the learning sciences in the face of new technology is to identify the various sides of the antinomies latent in the technology; once identified, we can use the technology in an informed way, research its role in learning, and design alternative or complementary technologies that mitigate the problems of one-sidedness. Where MOOCs (and online education) are concerned, we are faced with a potentially powerful technology–especially powerful in economic terms. It is plausible that not only higher education, but also K-12 education, professional training, vocational education, and graduate work may be increasingly defined by the characteristics that we see, in embryonic form, in MOOCs today.

State of the Art

Internal versus External Views of MOOCS

An internal view of MOOCs. The internal view analyzes topics that are focused on MOOCs as a specific teaching and learning activity, rather than seeing them as a component of rich landscapes of learning. The internal view focuses on the following topics:

- distinguishing *cMOOCs* (fostering connections and collaborations among learners) and *xMOOCs* (efficiently delivering content to large audiences) [Bates, 2014];
- differentiating *basic services provided for free* (e.g.: access to courseware) from *premium services that require payment* (e.g.: access to projects, code-review and feedback, personal coaches, and verified certificates);
- identifying *number of participants* and calculating the *completion rates* for specific courses;
- analyzing *the educational background of participants* (uncovering the surprising finding that the largest group of participants in xMOOCS have already a Master's degree);
- findings ways (by automating the process or by supporting peer grading) to *assess the achievements* of large number of participants;
- taking advantage of capturing large amounts of data for *learning analytics research*;
- supporting *local meet-up groups* (allowing participants in the same location to meet in person); and
- establishing *nanodegree programs* in which people (mostly from industry) can acquire specific knowledge and targeted skills without extended time requirements.

An external view of MOOCs. Postulating the need for rich landscapes (as discussed in the previous section) for learning puts the main emphasis on an external view of MOOCs. A learning science perspective needs to provide frames of references for identifying the following themes:

- *different forms of learning* (lifelong, blended, collaborative) need to be supported and practiced [Bransford et al., 2001];
- *formal learning* in schools needs to be complemented by *informal learning* [National-Research-Council, 2009].
- *supply-oriented* ("push/delivery") models in which learners are presented with knowledge that later may become relevant for them need to be complemented by *"pull/learning on demand"* approaches [Collins & Halverson, 2009].
- *consumer-oriented cultures* need to be complemented by *participatory cultures* [Jenkins, 2009];
- *"learning about"* needs to be complemented by *"learning to be"* [Brown, 2005];
- *"learning when the answer is known"* needs to be complemented by *"learning when the answer is not known"* (and exploring problems that have no answers) [Engeström & Sannino, 2010].

Motivation for Participation

Why are MOOCs such a hot topic? One way to analyze this question is to explore the motivations of all the different stakeholders who are affected by the development of MOOCs: providers, teachers, students, parents, politicians, university administrators, and researchers in the learning sciences and in technology-enhanced learning.

Providers articulate a multitude of different reasons for being involved including (1) altruistic motivations (such as "education for everyone"); (2) addressing an exciting problem; (3) bringing fame to their institutions; and (4) exploring unique business opportunities.

Professors are interested in teaching MOOCS (http://chronicle.com/article/The-Professors-Behind-the-MOOC/137905/#id=overviews) based on some of the following motivations: (1) the reach and impact which they can achieve by reaching very large number of students; (2) to face a new challenge and learn from it; (3) to avoid being left behind; (4) to increase their visibility and fame (maybe successful MOOC professors of the future will be treated like movie and sport stars?); and (5) to reap new rewards and benefits (e.g. getting tenure for the reputation and social capital that they earned by teaching a highly successful MOOC).

Learners (being students of all ages or working professionals) are motivated to participate in MOOCs (1) based on intellectual curiosity; (2) to engage in lifelong learning; (3) to gain an understanding of specific knowledge relevant to problems which they face; (4) to exploit them as their only educational opportunities; and (5) to become members of interesting intellectual communities (maybe comparable to why people join book clubs?). As it is trivial to join a MOOC, many learners will sign up with no intentions to ever finish a course — so that only a small fraction of students will finish the course or get a certificate has a different meaning compared to drop-out rates in current universities courses.

Parents (in most cases paying substantial amounts of money for the children's education) are interested to find out whether their children can get the same quality education for a fraction of the money that they have to pay for a conventional university education.

Politicians for public universities (or fund raisers for privates ones) will welcome any change that will reduce the financial commitments needed by universities. University administrators will similarly welcome cost savings, but many at this moment are very concerned not be left behind, rather than to deeply understand the impact of these developments on their own institutions.

Researchers in the learning sciences and in *technology-enhanced learning* are often sharply divided in their opinions about MOOCs but may also use MOOCs as very relevant development to rethink learning, teaching, and education (an attempt made with this paper).

Big Data and Learning Analytics

The data revolution ("Big Data") provides insight to analyze and document human behavior to an extent considered impossible a few decades ago (but feared by some visionaries [Orwell, 1950]). Google, Facebook, Amazon, Netflix, banks and supermarkets (leave alone the National Security Agency) know a lot about all person, their behavior, the information they have looked at, the stuff they have bought, and the places that they have visited.

MOOCs provide rich data sets about interactions, collaborations, and engagement that computational processes can exploit. *Learning analytics* focuses on measuring, collecting, analyzing, and reporting data about learners and their contexts. It attempts to understand the background knowledge of learners and it adds to online education as a dissemination method an important data-gathering resource. Learning analytics has its own society (http://www.solaresearch.org/) and its own conference series (http://www.solaresearch.org/events/lak/).

To overcome the initial enthusiasm that MOOCs will be a unique opportunity to gain a much deeper understanding of learning based on the insights drawn from data, the following issues related to learning analytics need be pursued and investigated further:

- what are the fundamentally new aspects of learning analytics? The idea of collecting data about student behavior and actions is not new: it has been pursued with dribble files in LOGO, user modeling in intelligent tutoring systems, and artifact analysis in designing activities;

- how valuable will the insights be that learning analytics environments are able to collect and analyze — e.g.: how can we infer from low-level, quantifiable events (such as material looked at, how long and how often, errors made, help requested) infer the intentions, problems encountered, and objectives of the learner?
- learning analytics will provide us with insights to understand the past and the present ("how things are"), but how much will it help us to envision and design alternatives to improve our approaches to learn and teach something ("how things could/should be")?
- are the potential misuses and privacy violations of the data gained with learning analytics (e.g.: some MOOCs companies plan to sell data about their students to companies as part of their business model to make money)?

Opinions: Hypes and Underestimations

Will MOOCs end up to be *elixir* or *snake oil*? The learning, teaching, and education domain has been populated by claims (1) from *info-enthusiasts* promising that technology would revolutionize "education" and computers will replace teachers, and (2) from opposite claims by *info-pessimists* that computers in classrooms foster isolation, lack of creativity, rigid and sloppy thinking, and an overemphasis on abstract thinking (and consequent undervaluing of real world experience).

The *hype* [Fischer, 2014] and myths [Daniel, 2012] around MOOCs is articulated in statements like:

- "There's a tsunami coming" — President John Hennessy of Stanford
- "2012: the year of the MOOC" — NY Times
- "Technology is remaking every aspect of education, bringing top-notch courses to the world's poorest citizens and reshaping the way all students learn"; http://www.scientificamerican.com/editorial/digital-education/
- The advertisement for a $6,600 master's degree of Georgia Tech (http://omscs.gatech.edu) marking an attempt to realize the tantalizing promise of the MOOC movement: *"a great education, scaled up to the point where it can be delivered for a rock-bottom price."*

The underestimation of MOOCs (as expressed for example in the following opinion: *"In fact, the absence of serious pedagogy in MOOCs is rather striking, their essential feature being short, unsophisticated video chunks, interleaved with online quizzes, and accompanied by social networking."* …….. *"If I had my wish, I would wave a wand and make MOOCs disappear, but I am afraid that we have let the genie out of the bottle."* [Vardi, 2012]) may be a dangerous mistake in response to their undeniable impact: attracting more than a 100,000 students in many classes, being a subject of discussion in all media, and creating actions by university administrators.

Future Challenges, Trends, and Developments

Co-evolution: Beyond getting stuck in "gift-wrapping". New information and communication technologies have been heralded as the major driving forces behind innovation in learning and education. While the Internet, smartphones, Apps, 3D printers, etc.) have caused an explosion of opportunities to improve learning and education by making established practices better and enabled new approaches and created new frameworks that were not possible or even conceivable before, many approaches have had only a minor impact for learning and education based on the reduction to:

- *technology-centered developments* ignoring that technology alone does not determine social structures but only 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* in which new media are used as add-ons to existing practices rather than as catalysts for fundamentally rethinking what education should and can be in the next century; the "moocifying" of existing courses represents the prime example of "gift-wrapping" rather than exploring the consequences of the fundamental assumption that distant learning is not classroom learning at a distance;

- a focus on *existing learning organizations* (such as schools and universities) thereby not exploring new possibilities such as e-learning environments (including MOOCs), peer-support communities, niche communities of special, idiosyncratic interests, etc..

Finding the Needle in the Haystack: Personalization and Task Relevancy. The rapidly increasing number of open, online learning environments (see Figure 1), specifically of MOOCs, has created a unique and growing opportunity for learners to engage in self-study with individually tailored curricula. At the same time, this large and constantly evolving space has created the challenge how learners will find the best-matched learning resources (artifacts and humans) to their personal interest, and how they can be supported with guidance and advice by mentors and peers. While directory style environments for courses provided by individual MOOCs platform providers and global directories of MOOCs (e.g.: MOOC List (https://www.mooc-list.com) and Class Central (https://www.class-central.com)) are important steps in the right directions, more support is need to assist learners in finding and assessing courses that are relevant tot heir tasks and compatible with their background knowledge.

Core Competencies of Residential, Research-Based Universities. Early visions about MOOCs predicted that they would eliminate a large percentage of residential universities. There is little evidence so far that this will happen and most of the more recent research activities are focused on complementing residential with online learning by identifying the core competencies of the two approaches. The appearance of MOOCs have created opportunities and necessities to reflect on the true value of residential university experiences provided by teacher-student and student-student interactions. In these emerging hybrid models, MOOCs could serve as the textbook of the 21st century and could support "flipped classroom" models. They could help residential universities move away from large lectures with learners listening to teachers towards active learning environments characterized by personal attention from teachers and opportunities for participation. They could make a contribution to *improve education outcomes in measurable ways at lower cost.*

Conclusions

There is substantive evidence that the most important contribution of MOOCs is that they generated a broad and (so far) lasting discourse about learning, teaching, and education in which not only narrow, specialized academic circles participate, but the global media, universities administrators, and politicians got involved.

Rather than ignoring MOOCs and only grounding and evolving them in economic and technological perspectives, the *research community in the learning sciences* should get seriously involved with MOOCs and influence their evolution. Even the loudest critics of MOOCs do not expect them to fade away. More likely, they will morph into many different shapes (e.g.: the "basic services" provided by MOOC 1.0 will be complemented by the "premium services" developed and envisioned in MOOC 2.0).

Researchers from the learning sciences should not only collect data about existing practices, but they should develop visions, explore important open issues, and investigate the pro and cons of fundamental design choices faced by learning in the digital age including: what are the trade-offs between (1) an *inexpensive* educational infrastructure in which students can afford at least a minimal education or (2) an *expanded* infrastructure in which MOOCs are complemented not only by residential universities, but by all the other components contributing to rich landscapes of learning.

Major challenge for the Learning Sciences in the years to come that are grounded in the advent of open, online learning environments and MOOCs specifically are: (1) to create frames of reference to understand the role of MOOCs specifically from a learning science perspective (in addition to economic and technological perspectives); (2) to identify the unique contributions of MOOCs to a rich landscape of learning; (32) to move beyond the exaggerated hype and total underestimation surrounding MOOCs; and (4) to analyze MOOCs as a forcing function in identifying the core competencies of residential, research-based universities. Lots of experimentation will be needed to successfully integrate online education with residential education.

Researchers from the learning sciences should not only collect data about existing practices, but they should develop visions, explore important open issues, and investigate the pro and cons of different design choices. For example: what are the trade-offs between (1) an *inexpensive* educational infrastructure (in which students can easily afford at least a minimal education, and in which the resources associated with residential universities are scaled back) or (2) an *expanded* infrastructure (in which online education is complemented not only by residential universities, but by all the other component contributing to a rich landscape of learning as indicated in Figure 1?

The learning science should thereby not only make a contribution to understand the MOOC phenomena better, but contribute to fundamental challenges such as: (1) what does it mean to be educated in today's world?; and (2) how can interests, motivations, and collaborations be stimulated to create socio-technical environments in which people *want* to learn rather than *have* to learn.

Five Commented References

(1) Collins, A. and R. Halverson (2009), Rethinking Education in the Age of Technology: The Digital Revolution and the School, New York, NY: Teachers College Press

This book provides a vision for the future of learning. By transcending the narrow view of learning focused on school learning, the book illustrated which rich landscapes of learning can and should be pursued. It does not get caught up in hype, but presents a balanced view by contrasting the enthusiasts' and the skeptics's vision of the impact of digital media on learning and edcuation.

(2) DeCorte, E., Engwall, L., & Teichler, U. (Eds.) (2016) ***From Books to MOOCs? Emerging Models of Learning and Teaching in Higher Education,*** **Portland Press (Wenner-Gren International Series Volume 88), London.**

In this book, researchers from the field of the learning sciences, MOOCs developers, and MOOCs users critically analyze and discuss the state of the art of MOOCs from its beginning to the year 2015. Some contributions in the book present visions of possible future developments of learning in the digital age. Most of the contributions come from different European countries providing evidence that the MOOCs development represents an international phenomena.

(3) Cress, U., Jeong, H., & Moskaliuk, J. (Eds.) (2016) ***Mass Collaboration and Education,*** **Springer, Heidelberg.**

While MOOCs reach the masses, they are less successful in promoting and supporting mass collaboration. This book offers a comprehensive overview of mass collaboration by analyzing different theoretical approaches, by describing a variety of case studies, and by investigating different methods to analyze processes.

(4) Shah, D. (2015) MOOCs in 2015: Breaking Down the Numbers, https://www.edsurge.com/news/2015-12-28-moocs-in-2015-breaking-down-the-numbers.

This article provides quantitative empirical data about number of students who signed up for MOOC courses, number of MOOC courses offered, distribution of subjects of MOOCs courses, providers of MOOCs courses, and ratings of courses offered. These data points provide some objective measure about different aspects of the MOOCs development in 2015. These numbers will continue to change substantially as new activities, new contributors, and new participants will make existing numbers obsolete in a relative short time.

(5) Hollands, F. M., & Tirthali, D. (2014). ***MOOCs: expectations and reality. Full report.*** **Center for Benefit- Cost Studies of Education, Teachers College, Columbia University, NY.**
http://cbcse.org/wordpress/wp-content/uploads/2014/05/MOOCs_Expectations_and_Reality.pdf

This report investigates the actual goals of institutions creating MOOCs or integrating them into their programs, and reviews the current evidence regarding whether and how these goals are being achieved, and at what cost.

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