Chapter 35 in Frank Fischer, Cindy E. Hmelo-Silver, Susan R. Goldman & Peter Reimann (eds; 2018): "International Handbook of the Learning Sciences", Routledge/Taylor & Francis, pp. 368-379

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 perspective.

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" (Pappano, 2012)). 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 (Daniel, 2012): cMOOCs are based on *connectivism* (the material being open, remixable, and evolvable thereby giving learners an active role) (Siemens, 2005) and *networking* (connecting learners to each other to answer questions and collaborate on joint projects), 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 (Fischer, 2014):

- represent first class courses from the best professor coming from elite institutions;
- 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 are varies greatly. Radio and television were forms of of distance learning that predated e-learning with correspondence courses that were used for educational purposes to overcome distances and reach larger audiences. Many universities starting in the 1980's 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 following two specific developments played an important role:

- The *Open University (OU)* in the UK (founded in 1969; http://www.open.ac.uk/) 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)* initiative of MIT (started in 2002; http://ocw.mit.edu/) was based on a commitment to put all the educational materials from MIT's undergraduate- and graduate-level courses online, partly free and openly available to anyone and anywhere.

MOOCs Platform Providers.

Over the last few years, numerous MOOCs platform prov*iders* 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/) (a for profit company offering over 1500 courses from 140 partners across 28 countries in 2016);

- MIT's and Harvard's edX project (http://www.edxonline.org/) (a non-profit company 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);

There are many similarities between these different platforms but there are also important differences from a learning science perspective. Over time, the companies by pursuing different strategies have contributed to a *diversification* of MOOCs (transcending the original distinction between xMOOCs and cMOOCs). Some providers focus on academic subjects and others provide vocational skills (with closer linkages to the job market), focus on everyday people or companies, and all of them experimenting with different business models and timing models.

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.

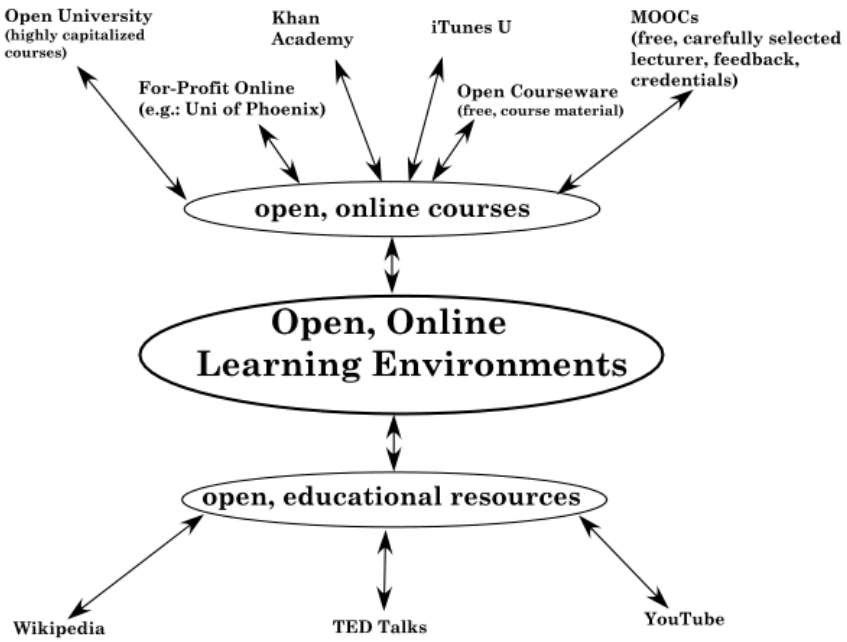

Figure 1: MOOCs in the context of open, online learning environments

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, and 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 (Fischer & Wolf, 2015).

The special emphasis of this chapter 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). Figure 2 provides an overview of the multi-dimensional aspects of learning leading to explore rich landscapes of learning — and the following paragraphs briefly describe the essential issues related to the different aspects.

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). *Individual MOOCs* by their primarily instructionist nature offer learners few opportunities for interest-driven learning. The evolving *space of all MOOCS* (approximately 7000 courses were available at the end of 2016 (https://www.class-central.com/report/mooc-stats-2016/) represent more courses than an individual university can offer thereby covering niche topics in which a small number of learners will be interested in.

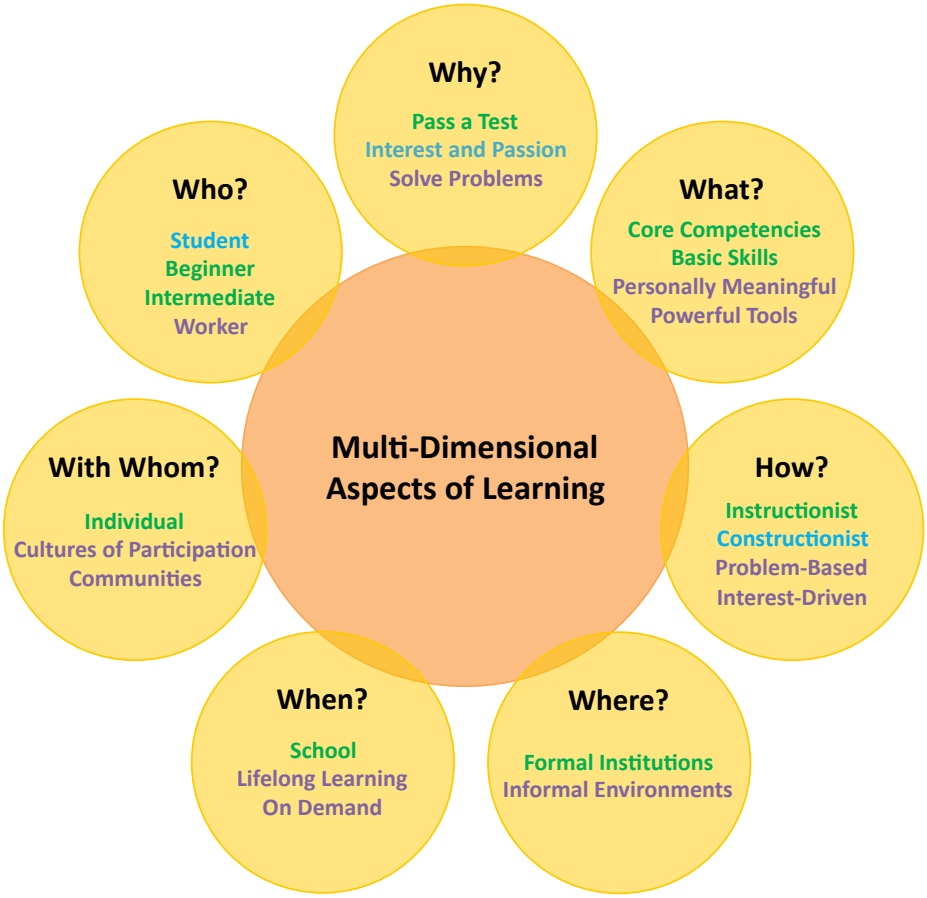

Figure 2: Multi-Dimensional Aspects of Learning

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 (Simon, 1996)) 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 (Goggins et al., 2013). 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.

In the past, most computational environments have focused on the needs of individual users. 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. This requires to bring different and often controversial points of view together to create a shared understanding among stakeholders and it can lead to new insights, ideas, and artifacts.
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.

State of the Art

Conceptualizing MOOCs as components of rich landscapes of learning provides the foundation to differentiate an *internal* and an *external* view of MOOCs (Fischer, 2016). The internal view of MOOCs addresses numerous challenges directly associated with their strengths and weaknesses whereas the external view is focused on the promise that research into MOOCs will inform *learning in all environments* and not just MOOCs.

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* (empirical research uncovered 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 (Siemens, 2012);
- 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. A learning science perspective puts the main emphasis on an external view of MOOCs. It 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).

The different objectives summarized in this list 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 technologies such as MOOCs 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.

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 (these claims are supported by initial findings in several articles contained in (DeCorte, Engwall, and Teichler 2016)).

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?).

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 are often sharply divided in their opinions about MOOCs but are provided with the opportunity to use MOOCs as relevant developments to rethink learning, teaching, and education (an attempt made with this chapter).

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 persons, 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* (for more information see Rosé, this volume) 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.

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 (Pappano, 2012)
- "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 *underestimation* of MOOCs is 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)).

Empirical Research about MOOCs

Complementing the initial assumptions and opinions in some of the most widespread public media, empirical research is emerging that analyzes different aspects of MOOCs relevant from a learning sciences perspective (for a detailed recent review see (Veletsianos & Shepherdson, 2016). Most the empirical studies so far have been focused on (1) themes centered on participants including: learner behaviors, performances,

participation and interaction, learner perceptions and preferences, learner experiences, motivation, educational background, and demographics; and (2) themes centered on the design of courses including: how can the instructionist nature of the courses be enriched with automatic and personal feedback, forums, peer-to-peer learning and grading, and the large scale facilitation and support of learning communities.
A wide-spread argument broadly discussed as the most troubling aspects of MOOCS is their *low completion rates* (in many courses below 10%) (Breslow et al., 2013; Eriksson et al., 2016). The overemphasis and fallacy of this argument is the comparison with rates of courses taught in residential universities because participation and performance in these two environments is fundamentally different. MOOCs allow free and easy registration, do not require formal withdrawals, and include a large number of students who may not have any interest in completing assignments and assessments. If we conceptualize MOOCs as the textbooks of the 21st century, the troubling aspects may be questioned, because nobody assumes that textbooks need to be read from beginning to end but they serve as a resource under the control of the learner.

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" (ignoring 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) in support of peer-support communities, and niche communities forming around special, idiosyncratic interests.

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 to their 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 (Fischer & Wolf, 2015). In future 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.

Conclusion

The most important contribution of MOOCs during their short life span 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 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).

Major challenges 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 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; (3) 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. Experimentation will be needed to successfully integrate online education with residential education. In doing so, the learning science will make a contribution not only to understand the MOOC phenomena better, but contribute to fundamental challenges such as: (1) what does it mean to be educated in the digital age? and (2) how can interests, motivations, and collaborations be stimulated to create rich learning environments in which people *want* to learn rather than *have* to learn.

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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.

(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. 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.

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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.

Acknowledgements

The author would like to thank Christian Stöhr, Pierre Dillenburg, and the editors of the handbook for suggestions and critical feedback that contributed substantially improving earlier version of this chapter.

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