2-2016

Crowdsourcing the Curriculum: Redefining E-Learning Practices Through Peer-Generated Approaches

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Keywords: crowdsourcing, social technologies, e-learning, online learning, open education, peer-based learning

Abstract

Inclusion of open resources that employ a peer-generated approach is changing who learns what, from whom, and via what means. With these changes, there is a shift in responsibilities from the course designer to motivated and self-directed learner-participants. While much research on e-learning has addressed challenges of creating and sustaining participatory environments, the development of Massive Open Online Courses (MOOCs) calls for new approaches beyond the existing research on participatory environments that is centered on institutionally defined classes. We de-center institutionally defined classes and broaden the discussion to the literature on the creation of open virtual communities and the operation of open online crowds. We draw on literatures on online organizing, learning science and emerging educational practice to discuss how collaboration and peer production shape learning and enable "crowdsourcing the curriculum."

Crowdsourcing the Curriculum:

Redefining E-Learning Practices Through Peer-Generated Approaches

Introduction

The last decade has seen a remarkable transformation in information location, allocation, contribution and control. Online software applications and their use have made posting, sharing, reading, voting on and evaluating personal and mainstream information not just easier but more popular. Blogging and microblogging platforms, social networking sites, and social media combine with the ubiquity of wired and wireless infrastructures and devices to create a massive, dynamic, user-generated information landscape. Educational practice is among the many areas of social endeavor engaging with the transformations these technologies enable. Changes affect all levels of educational operation: administration, classrooms, programs, libraries. Challenges in university education include infrastructure choices about wired and wireless communications, learning management systems, e-learning for distance programs, blended learning for on-campus classes, e-resources, and institutional repositories. To date, such challenges have largely been bound by university operations: courses, programs, and degrees set by university authorities, and university-based computing facilities owned and operated by university employees under university policies. Yet, as the call for this special issue stated, the next challenge extends educational considerations beyond campus control: "We are fast moving away from clearly demarcated technologies and arenas for information sharing or learning, and instead, evolving toward blended realms of public, peer-oriented interaction made possible by new social norms and technological affordances." These challenges and issues can be explored through the examination of Massive Open Online Courses (MOOCs), which in many ways embody both traditional approaches used by universities, and the open, public and peer-based approaches that web-based learning environments proffer.

This paper addresses how the openness of the web changes how, where and with whom we learn, and the opportunities and challenges this raises for the future of educational practice. As our title suggests, we address in particular how the structures and resources of the web may be brought to bear on aiding education through ‘crowdsourcing the curriculum’. This characterization directs our attention to learner-participants’ roles in creating the content of their learning, as well as what constitutes the practice of the re-invented, open classroom. Change in who takes and/or maintains authority in an online community has been the subject of much research on online interaction as business and education come to terms with peer production (Benkler, 2006), virtual and distributed communities of practice (Rheingold, 2000, 2003), open source software (Raymond, 1999), open knowledge (e.g., Wikipedia), and crowdsourcing (Howe, 2006b).

As education now also comes to terms with these trends, crowdsourcing and participative, peer-based approaches are affecting teaching and learning and the development of curricula in many ways. A vast wealth of accessible, high quality open resources and content is available online, produced by crowds of experts, educators, and learners. However, widespread inclusion of these crowd-produced resources into curriculum is a challenge because both learners and curriculum developers may find themselves “adrift in an ocean of information” (Buckingham Shum & Ferguson, 2012, p. 9), with little guidance on what to include in the curricula, or how it fits together.

Yet, we are seeing examples of crowdsourced, open resources being included in programs of study, from traditional institutionally-based courses (Hilton, Gaudet, Clark, Robinson & Wiley, 2013) to open, online courses. Some of these resources find their way into the curriculum through instructor vetting and selection as core, required materials. In other cases, instructors add open resources to the curriculum as remedial, supplemental, or advanced content. In many learning contexts, the crowds of learners recommend or comment on external resources via course discussions, bringing those resources into the curriculum for themselves and others.

Crowdsourced approaches that embrace open educational practices and facilitate flexible learning are gaining traction in both open online and traditional learning contexts.

While many distance, online, and e-learning environments have long since adopted more collaborative approaches, the newest wave of Massive Online Open Courses (MOOCs) has sparked new interest in achieving collaborative learning on a massive scale (Brown & Adler, 2008; Pappano, 2012; Ripley, 2012; Siemens, Irvine & Code, 2013). While what is known about building engagement and participation in online learning environments can potentially be applied to MOOCs, the challenges of massive numbers suggests the need for a renewed view of what, where, and how collaboration, community, and crowdsourcing can be brought into the service of MOOC-based teaching and learning. Since these new forms of participation and information sharing cohere around communities and crowds, successful implementation of online educational initiatives is likely to require consideration of motivational and dynamic structures associated with both crowd and community forms of organizing (Haythornthwaite, 2009; Budhathoki & Haythornthwaite, 2013). The confluence of massive online participation and massive online courses drives the need to develop and adopt models of teaching and learning that draw more from the creation of virtual communities and the operation of online crowds than from the operation of classes.

To build these new practices requires exploring the synergies between information science, the learning sciences, and educational practice. Here, we draw on literature in online organizing, learning sciences, e-learning, and education to discuss how what we know about online communities and crowds applies to online education. While there are various forms of learning that engage with the openness of the web, we emphasize here the way this is taking form in Massive Online Open Course (MOOC) environments, and address how crowdsourcing has been and can be applied to support content and curricula, conversation, learning, analytics-based evaluation, and assessment and feedback. The discussion offers insights from existing practice as well as suggestions on new ways to approach the challenge of massive open online learning.

Why MOOCs and why now?

Online learning, and most recently the MOOC delivery model, has raised the possibility of accessible educational experience for vast numbers of learners in a way that the traditional university classroom is unable to match. While there have been a number of educational environments created for open learning (such as the MathForum, Khan Academy), and many years of educational practice built around the delivery of online courses and degree programs, MOOCs seem to have captured the imagination (Pappano, 2012). Perhaps this is because MOOCs blend the familiarity of a formal course structure with the openness of online resources. But, today's MOOCs also arrive on the heels of many initiatives in open information; for example, open access publishing initiatives (Kaiser, 2013; Tamburri, 2014) have led the charge to make academic research more open and available online and have generated changes in academic practices to encourage publication in open access venues. MOOCs thus accord with general sentiment to provide greater access to the teaching and expert resources held on university campuses. MOOCs also co-exist with a greater societal acceptance and understanding of the reach and validity of online information, and an expectation that information can and should be found (Horrigan & Rainie, 2006). MOOCs co-exist with a generation raised on social media who consider it quite normal that not just information, but also human resources can and should be found online.

Embedded in this confluence of resources and practices, learning on and through the web becomes a different kind of experience from learning bound by institutional frameworks. E-learners carry into the learning experience not just their existing subject knowledge, but also their participatory practices. Thus, learning environments are molded and formed in relation to contemporary online practices. Haythornthwaite and Andrews (2011) highlight this larger socio-technical context in their redefinition of the term 'e-learning':

> First, we see e-learning as a transformative movement in learning, not just the transfer of learning to an online stage, and we use the prefix 'e-' in keeping with use in the emerging areas of e-research and e-science. Second, we do not see e-learning as bounded by institutional structures of courses, programs or degrees, but instead embracing the way learning flows across physical, geographical, and disciplinary borders. Third, we see e-learning as perpetual, sustained over a lifetime, and enacted in multiple, daily occurrences as we search for information to satisfy our learning needs and contribute content that promotes our and others' understanding. This kind of learning is mobile, in the sense of learning from and in new and different locations as needed and on the devices at hand. Fourth, we see e-learning as an engaged act created through both technical and social decisions. A technology does not make e-learning, but rather teachers and learners use technology to create the social space in which learning occurs. (Haythornthwaite & Andrews, 2011, p. 2).

This wider understanding of e-learning leads to the need to consider the way new techniques of online interaction – blogs, social networking, social media, open access, participatory culture – flow over and into learning and educational practice. We turn now to considering MOOCs from this perspective, beginning with a discussion of crowdsourcing, to explore how crowdsourced techniques and organizing practices can be brought to bear on MOOCs as new, open forms of education.

Crowdsourcing

Howe (2006a) defines *crowdsourcing* as the act of taking a function once performed by employees and outsourcing it to an undefined (usually large) network of people. Other initiatives, such as citizen science and citizen journalism, look to the web of contributors as a global source of information that can enhance understanding of contemporary conditions and issues. Collectively, crowdsourcing may draw on the wisdom of the crowd, which can be smarter, more effective, and more reliable than the best individuals in that crowd (Surowiecki, 2005). Crowdsourcing can also access a greater range and diversity of locations, opinions, and problem solving options. It can provide means of voicing opinions that otherwise would not be shared, and bring together communities of interest and concern that exist only in small numbers distributed around the globe. The ability to assemble such ‘communities of interest’ was considered one of the early benefits of the Internet (Sproull & Kiesler, 1991), and find their expression in recent examples of support communities for rare diseases (https://www.rarediseases.org/).

While crowdsourcing provides newer approaches for education and other domains, it is not without criticism and potential problems. Greater availability of resources may diminish their value as privileged information. Scarcity and time asset specificity still pertain: the value of knowledge about a rare opportunity decreases rapidly with increased exposure (for more on information value, see Shapiro & Varian, 1999). Where use is not the issue, contribution can be. Participants may not contribute due to worries about intellectual property, concerns about reputation, or lack of motivation. Some users may make use of materials without contributing, a form of schwarzfahren (literally ‘black riding’ or using public transit without paying). Online communities can suffer from an imbalance in the number of contributors to the number of lurkers, failing to sustain a critical mass of participants. In learning environments, lack of participation is particularly critical since contribution and negotiation of meaning is vital to social learning processes (LaPointe & Gunawardena, 2004; Stacy, Smith & Barty, 2004).

Invalid, inaccurate or biased contribution is another concern about crowdsourced information. As in online communities where trolls behave badly, crowds may also behave badly, enacting mob mentality, exhibiting a lack of reason (Le Bon, 1895), posting rumors, spreading false information, heckling, etc. Yet, the crowd is also a viable counter to such events. Studies of Wikipedia show how quickly incorrect or biased perspectives can be taken down and corrected

(Viegas, Wattenberg, Kriss & van Ham, 2007; Kraut & Resnick, 2011). Beyond Wikipedia, there is still room for crowdsourcing processes to add a measure of discernment. Crowdsourcing can also support sorting, filtering and synthesizing information for users. For example, aggregators Digg or Reddit employ crowdsourcing by and for their readers to filter information for their specific audiences.

Another concern is the reinforcement of homogeneity. On the contribution side, online information may come only from dominant voices (mainstream media, youth, technology literate, western nations) and fail to accommodate a wider range of opinion. On the retrieval side, search engines prioritize results based on others' viewing and thus lead individuals only to familiar sites and trending topics.

Massive Open Online Courses

MOOCs can be understood as "systems that leverage openly available, adaptable, and networked settings to engage learners from a diversity of backgrounds" (Lin, Roque, Wardrip, Ahn, & Shapiro, 2014, p. 328). The three largest MOOC platforms, Coursera, edX, and Udacity have affiliated with more than 30 universities to offer hundreds of free online courses to over 200 million students in 196 countries (Coursera, 2012; Glance, Forsey, & Riley, 2013). While most MOOCs[1] share characteristics of large-scale interaction and participation numbers, open access and online delivery, there is considerable variance in both pedagogical approaches and interaction modes for students and instructors. Two main forms are discussed: the xMOOC, where the 'x' stands for extension, as in an extension of the core offerings from traditional

[1] Note that the massive, open, online nature of MOOCs has been contested; hence not all MOOCs necessarily share these characteristics (Wiley, 2012; Carr, 2013; Cheverie, 2013).

educational institutions; and the cMOOC, where the ‘c’ stands for Siemen’s (2005) ideas about connectivism, as discussed further below.

xMOOCs and cMOOCs

xMOOCs are characterized by a conventional learning design. The curriculum is developed by the instructor. Course learning goals are pre-defined, pathways through content and learning activities are planned and structured, and courses are delivered in a single environment. Traditional educational delivery practices are carried over into large-scale, open platforms (Downes, 2013a; Rodriguez, 2013). Students watch videos, complete objective quizzes that rely on predetermined response options and automated grading, and follow a step-by-step sequenced progress that is meant to engage students in mastery learning and behaviorist pedagogies (Koller, 2012; Rodriguez, 2013). The MOOCs that have gained media prominence and large-scale participation are primarily xMOOCs. Offerings from Coursera, edX, and Udacity can generally all be considered instances of such xMOOC.

xMOOCs exhibit a teacher-centric knowledge transmission model, and interactions between learners are relatively limited. The instructor, and the materials created, vetted, and shared by the instructor, are the primary source of knowledge or skills. While this approach is particularly well suited for information transfer, and learning facts or procedures, it addresses less well the development of critical thinking and creativity – essential skills for learners in a knowledge-based society (Bates, 2012). Although xMOOCs have garnered the bulk of public attention focused on MOOCs, they do not fully embrace the potential of ‘Learning 2.0’ and distributed knowledge networks (Brown & Adler, 2008). They are based on an instructivist hub-and-spoke model, with expert faculty at the center who hold the knowledge and learners at the periphery who replicate or duplicate that knowledge (Siemens, 2012).

In terms of development cMOOCs actually preceded xMOOCs. The term MOOC itself was coined during an such a course offered by Siemens, Downes, and Cormier in 2008 (Downes, 2008). cMOOCs are constructed based on Siemens' (2005) notion of *connectivism*. This perspective views course materials as no longer solely in the hands of instructors, but instead constructed across networks of learners and resources. cMOOCs are characterized by learning goals defined by participants, open pathways through content, and loosely defined course structures. Learners rather than instructors, initiate and drive expectations for interaction, participation across social networks, and social learning activities (Downes, 2006; Siemens, 2008). Readings and other materials are generally open and available online.

While cMOOCs offer more opportunities for social, experiential, and problem-based learning that are well-suited for development of critical thinking and creativity, they also expect much more from learners. A self-directed learning strategy is employed in cMOOCs, and self-motivation, autonomy, and self-evaluation are expected in these communities (Littlejohn, Milligan, & Margaryan, 2011). To learn effectively in a cMOOC environment, students must be digitally literate, fluent in e-learning technologies and social practices, familiar with a number of different online environments, and aware of online, collaborative, collectivist learning processes, and engaged their role as a learners in such environments (Fini, 2009; Haythornthwaite, 2008, 2013; Kop, 2011).

With an emphasis on self-motivation, students in cMOOCs are offered a substantial amount of freedom to explore a knowledge domain, to shape their own learning experience, and to use the online environments they feel are best suited to their own learning processes. They are able to determine the extent of their participation and the pace at which to proceed with their learning. In this way, the cMOOC student plays a very different role from that of a student in a conventional course; cMOOC students embrace the opportunities of participatory culture and peer production, and the practices of transformative learning. cMOOCs enable learners to develop their own learning path in concert with a social context for working out their ideas and testing their knowledge.

cMOOCs accord with a number of ideas and theories about learning. The self-motivation in a cMOOC accords with ideas of andragogy (adult learning; Merriam, 2001; Bransford, Brown & Cocking, 1999) and heutagogy (self-determined learning; Hase and Kenyon, 2000), and with expert (Scardamalia & Bereiter, 1996) and entrepreneurial learning (Senges, Brown & Rheingold, 2008). The self-directed use of resources and self-determination of learning direction accords supporting the creation of user-generated contexts for learning (Luckin, 2010). Working with others on learning accords with theories of collaborative learning (Bruffee, 1993; Miyake, 2007; Brown, Collins & Duguid, 1989), and social learning – particularly on the social contexts in which learning can take place and the implications that differentiate a social learning environment from other online spaces (Buckingham Shum & Ferguson, 2012; see also Haythornthwaite & Andrews, 2011).

Learning Together Online

xMOOCs and cMOOCs share in common the need to engage with others online. As such, participants join a social network of individuals tied by learning interactions and common exposure to course materials (whether instructor determined or user generated). In the same way as for online learning environments, aspects of group, community and identity formation are played out through online means with important consequences for the success of online learning environments (Preece, 2000; Renninger & Shumar, 2002; Barab, Kling & Gray, 2004; Haythornthwaite, 2006; Haythornthwaite & Andrews, 2011; Fischer, 2014; Goodfellow & Lea, 2013; Carvalho & Goodyear, 2014). Communities of e-learning practice emerge, and their character reflects the crowd, group and/or community dynamics established through technical, social and pedagogical means (Haythornthwaite, 2002b, 2006; Haythornthwaite & Andrews, 2011).

Although it is beyond the scope of this paper to cover in detail, the modeling and mechanisms provided by or paid attention to by course organizers set the tone for the development of group attention. In this way, course organizers help to set social norms and mores within the group by demonstrating effective behaviors or approaches towards learning, and by embedding pedagogical models in the curricula. A general understanding of group processes indicates that learning collectives develop by stages, choosing and negotiating their interaction practices, commitment to goals, and commitments to others. What happens in development and maintenance of the collective affects trust and commitment to the particular course or project. Commitment does not start out fully formed; thus, awareness of stages of development helps inform when and what kinds of modeling or support are needed to effect the appropriate community and/or learning outcomes. Research on group processes points to some key stages in group development, such as Tuckman's (1965) well-known 'forming, storming, norming, performing', and the 'generate, choose, negotiate, execute' phases defined by McGrath (1984). In an online learning context, students have been found to follow stages of coming together, maintaining presence online, and disengaging from the online world (Haythornthwaite, 2007; Haythornthwaite, Kazmer, Robins and Shoemaker, 2000; Bregman & Haythornthwaite, 2003; Kazmer, 2007; 2012). Modeling has been found to be of particular importance to new learners as they gain knowledge and comfort about how to 'be' online in a learning context, and also to retain their online presence as they near the end of course or degree completion and look to commitment in other social worlds (Haythornthwaite, Kazmer, Robins and Shoemaker, 2000; Kazmer, 2007, 2012).

Modeling contributory behavior sets the tone for the type of MOOC, i.e., for interaction between instructor and student, or for interaction among students as well as with a wider range of participants. xMOOC instructors could spur interaction on course discussion boards by maintaining a presence and communicating with students through this medium; cMOOC course facilitators can model course and public participation by initiating Twitter discussions with a course hashtag as well as a popular hashtag to emulate and encourage students and public discussants.

Motivating Contribution

Interaction requires motivating individuals to contribute, and understanding what motivates contribution in various online venues can help understand the options for 'crowdsourcing the curriculum'. Open source projects are known for addressing a 'personal but shared need' (Raymond, 1999), e.g., a personal need to solve a problem, or create a resource that is also a need shared by others. Research on groups also stresses a dual engagement that involves commitment to the common enterprise as well as commitment to others in the group (McGrath, 1984; for a review in the context of learning, see Haythornthwaite, 2006). MOOC participants are likely to also share this kind of motivation. Learners who contribute to knowledge through discussion or other contributions address not only addressing their own personal need for learning, but also contribute to a larger shared need of co-construction of knowledge and the learning experience of a crowd of learners.

Haythornthwaite (2009, 2011a, 2011b), drawing on research on group theory, virtual community, and social networks presents another view of dual commitment, based on considering the social network ties among participants. Her model posits a continuum from lightweight to heavyweight engagement in peer productions, where weight refers to the commitment and engagement with the production (not to the significance of the product itself). Crowd-based project design exemplifies the lightweight end of the continuum, characterized by small, discrete, similar units contributed by unconnected individuals whose knowledge and status has no impact on others' contributions. Individuals can drop in and make a contribution without engaging deeply with the community. Motivating participation for such initiatives needs to be generated by commitment to the enterprise as a whole, e.g., to the knowledge base it is generating, or to open source ideals. This kind of motivation to contribute was found in a study of OpenStreetMap, an open source geographical information system. The study revealed that top motivating factors also included an orientation to open source ideals, e.g., providing free digital map data, and to helping others by providing this free information (Budhathoki & Haythornthwaite, 2013).

Community-based project design exemplifies the heavyweight end of the continuum, characterized by larger, interconnected, variable contributions, dependent on individual specialties, contributed with attention to and consideration of others' contributions, the knowledge and status of others, and the impact of their contribution on their own reputation. Individuals become committed to the persistence of these communities, finding it important to support the overall project goal but also to engage in production and group management processes (McGrath, 1984; Smith, McLaughlin, & Osborne, 1996). Motivation in such cases is generated by commitment to others in the community *as well as* to the overall enterprise. Haythornthwaite (2011a) describes academic peer production as exemplary of the heavyweight end of the continuum.

Note that these models refer to contributor behavior, not to specific projects. Aspects of both light and heavyweight design and behavior can be present in many open source initiatives, and thus can be expected in x- and c-MOOCs. The relevant point is design, i.e. whether the courses are designed and modeled to provide lightweight engagement – individual-based assignment and engagement, primarily based on unconnected contributors and contributions, cooriented primarily to the common topic or purpose, or to heavyweight engagement – community-based assignment and engagement, organized to encourage connection among contributors and contributions.

Engagement in dual roles and participatory practice is not limited to students enrolled in a subordinate role to instructors. Open source initiatives often entail learning as a key characteristic of the community (e.g., in learning about geographic information, or gaining programming skills). Reward structures can be established to bring new participants along to become community leaders (e.g., as done in *Mirandanet*, an online community of teachers; Preston, 2008). Learners may take on new roles such as becoming ‘learner-leaders’ (Montague, 2006) or knowledge ‘braiders’ (Preston, 2008). Instructors can modify their authority role and become expert-learners, facilitating and engaging in learning alongside other learners in the community. (See also Haythornthwaite, Bruce, Andrews, Kazmer, Montague & Preston, 2007.)

Many cMOOCs operate under a ‘teacher as learner as teacher’ model, where connections in the learning network provide information that is current, relevant and contextually appropriate (Siemens, 2006). The role of the instructor is that of facilitator – to manage knowledge coherence, and alongside other learners, to shape and reshape knowledge through deeper exploration and negotiation of meaning (Rodriguez, 2013). This is not an abdication of the instructor role, but an adaptation to address the realities of learning online, by adult and self-directed learners, in an age of rapid knowledge development. The instructor still retains responsibility for engagement and ‘presence’ as described by Garrison and Anderson (2003): teacher, learner and cognitive presence. However, the scope of their engagement changes as the open nature of the courses provides the potential for conversations that include a wider range of experts than normally available in structured educational settings. In this way, MOOCs tap into what traditional educational institutions cannot offer: massive interconnectedness in many-to many relations across open networks of learning.

While differing greatly in structure and approach, both xMOOCs and cMOOCs take advantage of crowdsourcing, although in different ways. They both represent a new form of education that relies on open resources, participatory learning practices, and a massive scale of participants with a shared focus on learning. But, at this point, it is worth asking what are all these resources we are contributing, and what are we ‘sourcing’?

What Are We 'Sourcing'?

While much attention in crowdsourcing, information resources, and education has been on the product – the answer, the content, the blog essay, the video 'how to', the tweet reference – there are more options for sourcing that can be considered for learning. The following addresses some current and potential crowdsourcing practices and how they may serve the x- and c-MOOC environments.

Content. As noted, in an educational context, we tend to think of content first. *Lists of resources* (the typical 'reading list' for a course) and *syllabi* are often crowdsourced through academic listservs and websites. *Readings and resources* are sourced from physical or digital libraries, institutional repositories, blogs, video sites, news articles and websites. In both xMOOCs and cMOOCs, crowdsourced open educational resources are brought into the curriculum as core or supplemental materials, by instructors, the participative crowd of learners, or external experts, before or after the start of the course. Shared learner-created digital artifacts and learning objects become content of the course. This 'class-sourcing' approach also helps learners develop digital literacy, design, and collaboration skills, all while improving the collection of relevant content in a given course and to the broader public (Tsipursky, 2014).

Discussion. Through discussion and observation of others' *experiences, thinking processes, and knowledge*, learners come to understand how content is translated, synthesized and made relevant to local understanding. Through observation of presentation of points and discussion, elements of *argumentation* are crowdsourced. While discussion is often relied on heavily as a vehicle for learning in both cMOOC and xMOOC contexts, generally xMOOCs house discussions in a private Learning Management System visible only to those involved with the MOOC. cMOOCs encourage discussions to take place on a number of public platforms such as Twitter, blogs, or open discussion boards that are visible to people beyond the MOOC, and allow discussions to include external participants. Where the crowd is learning together as experts, this process adds to knowledge construction in the area as a whole, building the identity and character of the collective, but also the knowledge available openly online.

Evaluation. Assignments and evaluation of contributions is a key part of the education process. But the huge number of assignments from students of an xMOOC can grind it to a halt. In response, a number of initiatives have begun to address crowd-based grading schemes (discussed further below). Evaluation may also be done on a simpler level, e.g., with voting that promotes a particular source or opinion, or rating on scales of relevance for evaluating materials. Citation, long the currency of academic work, can be used to see what resources turn up in assignments. Other strategies include the development of evaluation and assessment by learners, either through self- and peer-evaluation, or through learner-produced assessment tools (e.g., PeerWise: Denny, Hamer, Luxton-Reilly, & Purchase, 2008; Purchase, Hamer, Denny, & Luxton-Reilly, 2010).

The self-directed, learner-focused nature of cMOOCs challenge traditional notions of individual evaluation by a course authority (i.e., the instructor). As students are expected to determine their own learning objectives and learning pathways within a networked crowd of other learners, self-evaluation of their own learning is also required. While individual assessment and evaluation is not typically covered by course facilitators, Downes (2013b) has provided some thoughts on evaluating a cMOOC at the collective level on the basis of 4 factors that contribute to network success: autonomy, diversity, openness, and interactivity. Downes (2013b) also proposes that cMOOCs be evaluated as a networked whole, rather than by the learning outcomes for individual learners. This perspective highlights collective learning success, such as the development of new insights or knowledge that was produced through interactions within the cMOOC network, rather than trying to attribute them to individual experiences.

Behavior. Continuously emergent learning environments require continuously emergent development of behavior. In online learning this includes establishing the norms that make a particular course function – from how often to post, to tone of voice, to adoption of writing genres. Behaviors also include monitoring, policing and sanctioning, each of which needs to be determined for the practice of MOOCs. How, for instance, will MOOCs deal with disruptive participants? Will the crowd determine sanctions, or will these go back to the authority (teacher, institution) governing the MOOC? How will the structural and authoritative differences between cMOOCs and xMOOCs influence the outcome of these types of situations?

Practices. Similar to behavior, practices can be driven by the affordances (sometimes referred to as the 'materiality') of the objects at hand. In MOOCs these are the technologies that facilitate (or inhibit) communication. Practices develop around the use of technologies, such as the number and range of media used, the kinds of communication posted via different media, and the routines and shorthands that reduce the joint work of participants. There are clear differences between cMOOCs, which rely on an open, learner-determined set of platforms and communication media, and xMOOCs, which typically provide learners with a predetermined set of options through which to communicate with other learners. On an institutional level, legal and ethical concerns will be addressed based on shared understandings of privacy, security, and ownership of crowd-sourced work products.

One further question about MOOCs and educational crowdsourcing is: Who is doing the crowd work – humans or machines? Emergent practices for big data analytics and human computation already are at play in crowdsourcing, and are coming to education. The next section addresses current and future potential for learning environments.

Human and/or Machine

Human or Machine? Recent developments in big data, analytics, crowdsourcing, and assessment and evaluation suggest that the sensible answer to this question is "both." The next section address how the large scale of data from MOOCs and other learning environments, generated and analyzed by both humans and machines, provide another view of crowdsourcing the curriculum.

Learning Analytics

Analytics are the use of data, statistical analysis, and explanatory and predictive models to gain insights, act on complex issues, and aid in decision making (Bischel, 2012). Applied to the context of learning, analytics are being used to inform instructional practice and decision-making by identifying patterns, relationships and trends in the processes of learning, and as a means to identify factors that may impact achievement of learning objectives and student success (Haythornthwaite, De Laat & Dawson, 2013; Siemens & Gašević, 2012; Swan, 2012). Learning analytics relies on data that is amassed through the activity of crowds of e-learners, and as such is another learning practice that is built on crowdsourcing.

The application of analytics has become possible in the educational domain largely due to recent emergent practices in formal learning contexts (see Cooper, 2012; Ferguson, 2012). First, there is a shift towards blended learning and inclusion of online environments and tools, even in places that still maintain a focus on face-to-face classes and traditional instructional models. Second, the practice of collecting and storing a range of student data, and tracking student activity across an array of online environments has become widespread among educational institutions. This has allowed developers, administrators, and educators to focus on the measurement, analysis and reporting of collected data about learners and their contexts, towards the purposes of understanding and optimizing learning, and the environments in which learning occurs (Siemens et al., 2011).

Through learning analytics tools and approaches, crowdsourcing methods can be leveraged towards the improvement of content presentation. For example, a learning community's use of online learning content can be analyzed with clustering algorithms and experimental group comparisons to determine which content, activities, pathways, and presentation modes have been most effective for learning gains (Weld et al., 2012). Learning analytics systems can also be used to evaluate and measure quality and trustworthiness of crowdsourced information (Moturu & Liu, 2011; Jo, Stevens, & Tan, 2012). These systems exemplify the use of a combination of human-sourced knowledge and machine-based algorithmic and analytic systems to optimize offering of learning materials and, potentially, improved learning performance. Machine-human combinations can work together to address problems of quality control and filtering for the overwhelming amount of content that can emerge from crowdsourcing processes. This may also signal a change in instructor role as analytics inform practice. The instructor, now informed through insights offered through analytics, may be pivotal in directing the discourse and activity of learners towards generating discernment about resources, and facilitating the dissemination of peer-recommended materials across a learning community.

Relying on data that emerges from large-scale learning communities, learning analytics also allows for content and curriculum to be personalized. Information on how, in what context, and by whom resources are used, can supplement educational metadata and can provide additional contextual weight to learning resources (MacNeill, Campbell & Hawksey, 2014). Such 'paradata', along with other data emerging from online learning environments, can be leveraged towards personalization that provides tailored learning for individuals, but also potentially for learning communities. Research has examined several ways that data can be employed to address learning styles. In activity data collected from over 140,000 students across four edX MOOCs, Guo and Reinecke (2014) found that difference by age, region and goals. Older students tend to navigate content in a more non-linear way than younger students; North American and Western

European students tended to review and repeat prescribed sequenced learning activities (for example, watching a video, then completing a quiz assessing comprehension) more than students from other parts of the world; and students interested in certification tend to work opportunistically moving backward from assessments to content. Using demographic information alongside these insights, a tailored structure and sequence of content could be offered to learners and/or learning communities that supports their preferences and learning goals. Similarly, Desire2Learn's LeaP platform relies on activity data collected over time from learners, assessment of comprehension of content, and a combination of reinforcement learning and semantic mapping, to provide users with a recommended, personalized sequence of study through a body of content, tailored to their individual conceptual strengths and deficiencies (Ali et al., 2014).

Learning analytics, and the crowdsourced data that learning analytics-based systems rely on, are providing solutions and improved experiences for large-scale learning platforms. However, it should be noted that data collection is not always a simple task, and is highly dependent on the environments and tools that learners are using, and the types of data that result. For example, the data resulting from cMOOC activity is much more difficult to collect, clean, and process than that of its xMOOC counterpart, as cMOOCs often involve numerous social networks and platforms (Gruzd, Haythornthwaite, Paulin, Absar, & Huggett, 2014). This makes improvements via crowdsourcing and algorithmic analyses much more difficult for cMOOCs.

Assessment and Feedback

Another major issue relating to both x- and c-MOOCs, and addressed by both human and machine input, is management of the grading challenge presented by large-scale enrolments. Assessment and feedback are both complex challenges that large-scale online courses face. With many MOOCs attracting enrolments in the thousands, assessing learning performance and providing meaningful feedback becomes a daunting task. The effort and time required to grade student work at this scale can be overwhelming, even for a team of instructors and teaching assistants. Assessment and the provision of feedback to learners in MOOCs are problems that are currently being addressed through several strategies.

Objective, automatically graded tests that rely on closed-set, multiple choice questions or easily identifiable fill-in-the-blank terms are relatively simple to implement and administer and can provide students with simple feedback. These types of assessments are ideal for confirmation of knowledge, are appropriate for learning facts and procedures, and can be used effectively towards formative assessment. However, they do not offer the same value and learning opportunities for students as does personalized feedback; nor do they offer insight into student understanding, or their ability to apply or synthesize knowledge and to think critically. These higher order cognitive processes are developed through discussion-based learning activities and qualitative written work, both of which require a great deal of time and effort to assess manually.

Automated grading systems for qualitative work hold the promise of decreasing the effort required for assessment and feedback for large classes, but these have some drawbacks: they do not handle well ambiguity in phrasing or unusual structure or language; and they rely on textual features of writing rather than a semantic understanding of what is being expressed by the student (Yannakoudakis, Briscoe, & Medlock, 2013; Zhang, 2013; Kulkarni, Socher, Bernstein, & Klemmer, 2014). Algorithms that rely on textual features may also be gamed by students who understand the patterns that such systems seek (Winerip, 2013). Furthermore, many automated grading systems (such as LightSide's LightBox, or Pearson's WriteToLearn) require advance human work – in itself, a potentially crowdsourced process – to 'train' the system to recognize and assess textual features. For these reasons, many have turned to peer assessment as a means to distribute the grading burden amongst the course participants.

Peer assessment strategies reduce grading and feedback burdens for course facilitators, and also expose students to new ideas and approaches used by peers. This further allows individuals to reflect critically on their own work in comparison to others' work. While, humans are able to handle ambiguity in phrasing and semantic understanding better than automated algorithmic grading systems (Zhang, 2013), there are other issues with peer assessment strategies. Peer assessment shifts the grading burden from the instructor is reduced to learners who are now faced with the additional work of assessment, and shift grading to individuals who may not (yet) have developed good evaluation skills. Learning to assess becomes another skill that must be modeled, taught, learned and exercised; and it may also be a practice that itself needs to be assessed.

A recent innovation presents another option for instructor-based learner assessment, one that takes a middle road between humans and machines. This alternative is a 'cluster-based' interface that allows instructors to grade and provide feedback once for a large volume of work (Brooks, Basu, Jacobs, & Vanderwende, 2014). Student responses to short answer questions are automatically grouped and organized according to similarity based on answer length, words with matching base forms, string matches and Wikipedia-based latent semantic analysis similarity measures (for more on this, see Basu, Jacobs & Vanderwende, 2013). The interface allows for feedback to be provided for all student responses in a given cluster, or for individual feedback. The clustered interface allows instructors to grade a large number of responses quickly, to give feedback to more students at once, and to gauge student comprehension at an aggregated level that can then inform their teaching.

Another option is to combine peer assessment with algorithmic scoring to preserve the benefits of peer assessment and improve efficiencies in the grading burden placed on learners. Kulkarni and colleagues (2014) proposed a hybrid approach in which a grading algorithm performs a first pass of student work to predict a grade and provide a confidence score for each submission. Based on the confidence score, the system assigns a suitable number of peers to grade the submission using a rubric to identify characteristics and features that the work contains or lacks.

Next, peers are asked to verify the identification of features submitted by other peer reviewers. This process ensures that the peer assessment burden is reduced by almost half. These researchers found that this method still retains 80%-90% of the accuracy obtained from peer assessment alone while providing more detailed feedback on each individual submission (Kulkarni, Socher, Bernstein, & Klemmer, 2014).

Beyond automated evaluation and peer evaluation of qualitative assessment, another potential solution for dealing with assessment in large-scale courses is self-assessment. Self-grading can result in increased student learning relative to peer grading strategies (Sadler & Good, 2006). In a study focused on the implementation of a self-evaluation process in two MOOCs facilitated by Google, a large majority of final qualitative projects were accurately evaluated, and scored within a few points of evaluations performed by course instructors, teaching assistants, and content experts (Wilkowski, Russell, & Deutsch, 2014).

As learning opportunities move away from the traditional approaches of education towards open online networks of learners at a massive scale, the approaches and strategies we use to assess learning gains and provide meaningful feedback to learners must also evolve. The characteristics of these new approaches often involve a reduction or redistribution of time and effort between instructors and learners, and humans and machines. The benefit is that learners are not only exposed to more and different perspectives, but they also become more integrated in the whole process of education, and they can see this at a community level. Overall this instigates new practices for learning, and a different perspective for students that allow new ways of learning and new skills to develop, and offer opportunities for self-reflection and critical thinking.

Conclusion

The aim of this paper has been to explore how participatory practices lead to a new perspective on learning, one that takes advantage of crowdsourcing potential to create and manage large scale learning enterprises. In this area, MOOCs have become the focal point for large-scale online learning, and are the result of a culmination of increased production and sharing of open content and resources online, increased interest in achieving collaborative learning on a massive scale, and a desire to provide learning opportunities freely to all those who want them. The result has been crowds, gathered in unprecedented and massive scale, with a shared motivation of learning.

The power of these crowds has only just begun to be leveraged to address many of the scale-related issues that emerge in MOOCs and similar online learning communities. Content, discussion, evaluation, behavior, practices, learning analytics, and assessment and feedback are all elements of curricula that can be addressed by crowdsourcing. To do so requires an equivalent social change in the traditional roles of teachers and learners if they are to take up the transformative opportunity of these new learning 2.0 environments: teachers to become expert-learners, knowledge synthesizers, and facilitators of new crowd- and community-based learning practices and architects of productive learning environments; and learners to become self-directed, self-reflective citizens in online learning communities, engaged in all facets of the learning process – reading, discussing, evaluating, giving feedback, working with the crowd and learning with the community.

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