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Dimensions of MOOCs for Quality Design: Analysis and Synthesis of the Literature

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Designing Massive Open Online Courses (MOOCs) involve new challenges for instructional designers. In particular, the unknown number of participants and the range of diverse needs are major sources of difficulty. Currently, there is little research available informing the quality of MOOC design in order to support learners' active engagement. A theoretical MOOC design model has not yet been defined from a pedagogical or technological perspective. This study comprises an analysis of the current MOOC-related literature with a particular focus on the course design of MOOCs. Synthesizing the findings of previous studies, important and common design dimensions are highlighted for future course design. Accordingly, the taxonomy of MOOC types is first analyzed and then followed by an investigation of the design framework. Notable results include the critical elements of MOOC design across unique MOOC learning environments, from the basic structure of MOOCs to those incorporating innovative technological affordances.

Keywords: Affordances, Design, Learning environments, MOOCs

Introduction

It has been less than five years since Daniel (2012) described "Massive Open Online Courses" (MOOCs) as an "educational buzzword of 2012". During this short period of time, the number of MOOCs has continuously grown, and according to Class Central (2015), 4200 courses have been created at 550 universities. As an example of enrollment, numbers reached 35 million in 2015 which was almost double from the previous year. These high numbers appear to indicate that MOOCs draw a great interest in both educational institutions and with learners around the world (Yousef, Chatti, Schroeder, Wosnitza, & Jacobs, 2014).

With regard to challenges, "research in MOOCs is still an emerging field" (Yousef et al., 2014, p. 9). For example, the "quality design of MOOC environments has not yet been clearly defined" (Yousef, et al., 2014, p. 44) and theoretically grounded guidelines are needed for better decision-making (Alario-Hoyos, Pérez-Sanagustín, Cormier, & Kloos, 2014). Furthermore, the large class size and unique affordances associated with new technologies can potentially generate difficulties for instructors when they design and teach lessons (Conole, 2013). The challenges include difficulties in evaluating students, absence of immediate feedback, and a lack of student participation (Hew & Cheung, 2013). The design of MOOCs inevitably involves a focus on complex pedagogical, technological, and organizational issues (Conole, 2013; Alario-Hoyos et al., 2014). However, despite these issues, many researchers continuously search for new models for MOOCs. Therefore, the current situation necessitates a comprehensive design framework underpinning the quality of MOOCs. For this reason, the purpose of this study is to synthesize current research into MOOC design dimensions in order to highlight what is important for the future quality of such courses.

Method

The researchers initially analyzed past systematic reviews of the MOOC literature. We first reviewed the systematic review from Valetsianos & Shepherdson (2016) closely. Published as of April 2016, it was the most recent systematic literature analysis when we started this study. Valetsianos & Shepherdson (2016) listed five papers as the previous systematic literature review on MOOCs. We included all of these five studies. In addition to those six articles, we also included a conference paper by Yousef, Chatti, Sheroeder, Wonsnitza & Jakobs (2014).

Previous researchers conducted systematic reviews using multiple sources including (a) academic databases such as

ERIC and Scopus, (b) relevant academic journals such as Distance Education, and International Review of Research in Open and Distributed Learning (IRRODL), (c) Google Scholar and (d) other relevant sources such as Educause Library. Seven papers, comprising of systematic literature reviews covering between 2008 to 2015, were located in this study. MOOC-design related topics were then synthesized and summarized. Comprehensive synthesis of framework was not fully addressed by the previous papers. Our study focused on synthesizing the conceptual framework for MOOC design, as a foundation to correspond to the challenges addressed from the previous MOOC instructors.

Next, a "forward referencing process" was conducted as used by Liyanagunawardena, Adams and Williams (2013) and Veletsianos and Shepherdson (2016). All papers that were cited in the original seven studies were examined, and papers studying MOOC design were further analyzed. Additionally, a Scopus database search between 2008 and April 2016 was undertaken, using the keywords of " MOOC" and "design". 159 journal publications written in English were returned through this search, with the search words of "MOOC" and "design." Their key words and abstract were examined first, and if they were relevant, full texts were read. Among the 159 publications from the Scopus database, 18 papers were selected as relevant with regards to design principles, theoretical concept, mapping, and taxonomies.

Kennedy (2014) used qualitative analysis framework for interpretation of literature sources in rigorous way (Onwuegbuzie, Leech, & Collins, 2012). Following this approach, we used the frameworks of Onwuegbuzie, Leech & Collins (2012). During the synthesis process, we manually located all the key information about characteristics and domains using the original terminology used in the literature. Then we compared and contrasted components. The results are discussed below.

Results

Types of MOOCs

"xMOOCs" and "cMOOCs". Daniel (2012) and Rodriguez (2013) classified MOOCs into two groups, namely "xMOOCs", which stands for "extend" and "cMOOCs", which stands for "Connectivism" (Hew & Cheung, 2014). Ebben and Murphy (2014) analyzed MOOCs using a chronological framework, and identified cMOOCs, launched in 2008 (Rodriguez, 2013), as the first phase of MOOCs, and xMOOCs as the second phase, which was when MOOCs gained rapid popularity. The two models are often contrasted by their degree of openness, flexibility and interactivity (Ebben and Murphy, 2014; Kennedy, 2014). Grounded in connectivism (Downes, 2012), cMOOCs make use of the affordances of networked online technology in which learners take a central role in activity design, assessment, and self-organized learning (Ebben & Murphy, 2014; Kennedy, 2014; Yousef et al., 2014). Through learning activities in c-MOOCs, learners decide their own objectives, share their knowledge and collaboratively build their ideas and artifacts. Unlike traditional learning management systems that centralize instruction and resources in a single platform, course contents are located in the daily email, social media, Learning Management Systems and multiple sources within the world-wide-web. Learners often create their learning networks with other learners in social media such as blogs, Google Hangout, Twitter and Facebook (Yousef et al., 2014).

In contrast to cMOOCs, xMOOCs are associated with behaviorist and cognitivist approaches (Conole, 2013; Yousef et al., 2014; Rodriguez, 2013), using didactic and transmission models of teaching. Course content tend to be delivered as sets of lecture videos and concept check online tests, such as multiple choice quizzes (Hew & Cheung, 2014). Instructional content, tests, assignment submission, and discussion boards are built into the MOOC platforms (Hew & Cheung, 2014). Rodriguez (2013) analyzed that teaching methods of xMOOCs "rely on information transmission, computer marked assignments and peer assessment" (p.71). xMOOCs helped generate the expansion of MOOCs when the first Stanford xMOOC was launched and "extended" traditional lectures to online courses (Jacoby, 2014). The MOOC initiatives, such as Coursera, edX and Udacity accommodate participants on a massive scale. The learning analytics data informs instructors about the learners' behavior and learning patterns on the MOOC platforms (Ebben & Murphy, 2014).
An additional distinctive feature is in the openness of the two models. cMOOCs are open in a broad sense: copyright of the content, curriculum design, delivery methods, registration, and open technology (Jacoby, 2014; Kennedy, 2014). Whereas researchers pointed that the openness in xMOOCs were limited in the material use, but open in accessibility to everyone (Rodoriguez, 2013: Ebben and Murphy, 2014).
Although multiple papers compared the distinctions between xMOOCs and cMOOCs, Veletsianos and Shepherdson (2016) argued that the distinction between the two categories has become unclear due to the ongoing exploration of new MOOC designs. Furthermore, they discussed that MOOCs could not be classified simply into two groups as a simple classification between xMOOCs and cMOOCs would fail to take into account the differences of the individual course design.

Alternative MOOC types. There have been increasing attempts to experiment with new MOOC models. Even under the two main categories of x and c MOOCs, multiple types of new forms of MOOCs have emerged. For example, among cMOOCs include a course, using mobile learning (mLearning) format that is a combination of mLearning and connectivism (Rodriguez, 2012). There are a variety of MOOCs including smOOCs (small open online courses), bMOOCs (blended MOOCs), aMOOCs (alphaMOOCs), and pMOOCs (project-based MOOCs) (Yousef et al., 2014).
Yousef et al., (2014) compared case studies of different types of MOOCs, by learning theory, assessment, openness, form and learning tools. Table 1 presents an analysis of Yoursef et al. (2014). Additional findings from the current review are presented in the last column.

Table 1

MOOC Types and Comparison of Key Design Features

Case study of Yousef, Chatti, Schroeder, Wosnitza, & Jakobs (2014) and findings of the current review

Comparison from Yousef et al., 2014						Additional information from the review
Types	Learning Theory	Openness	Form	Assessment	Learning Tools	
cMOOC	Connectivism	Open registration	Informal learning (Formal learning)	Peer-assessment, (E-assessment)	Video lecture, Blog, forums, social networks Lecture note, Power Point slides and PDF	Openness, Autonomy, Diversity, Interactivity, Complexity Participatory
xMOOC	Behaviorism Cognitivism	Profit(Coursera) Open registration Download material(edX)	Informal learning (Formal learning)	E-assessment (Peer-assessment)	Video lecture, Blog, forums, social networks Lecture note, Power Point slides and PDF	Limited openness, Certificate Corporate startups, Pre-set content
bMOOC	Social constructivism,	Open registration (Download material)	Informal learning (Formal learning)	E-assessment (Peer assessment)	Face-to-face Video lecture, Blog, forums, social networks Lecture note, Power Point slides and PDF	Blended model, In-class and online instruction, Self-paced and scheduled
smOOC	Social constructivism (Connectivism) (Cognitivist)	Open registration Download material	Informal learning	E-assessment, (Self-assessment)	Lecture video, blog, forum, social network, lecture note, Power Point slides, PDF files	Small open online course

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Comparison from Yousef et al., (2014) stated that there are common features across the cMOOCs, xMOOCs, bMOOCs, smMOOCs. These include elements like open registration, informal learning forms, and the use of video lectures. In terms of design of MOOCs, their analysis described that common learning tools, such as video-based lectures, blogs, forums, social-networks, lecture slides and PDFs, which are used by all four types of MOOCs. The authors pointed out that most of the MOOCs relied on traditional e-assessment, whereas cMOOCs and bMOOCs mainly utilized peer-assessment. Despite the many similarities between the different types of MOOCs in this analysis, there are minor differences in the use of the learning tools.
On the other hand, various learning theories were used as the foundations of the courses examined by the Yousef et al. (2014). Our review found characteristics in the concepts and feature of each MOOC types, that are indicated in the last column of the Table 1.

In summary, there were many new forms of MOOCs endlessly emerging. In addition, comparison and classification by types of MOOCs did not inform the details of differences in course design, such as the ways how learning tools

are used and facilitation and delivery methods, fully enough to guide instructors and designers. The typology by itself could not help the designers make in-depth decisions. Therefore, we further investigated the basic constructs of MOOCs that can be applicable across all types of MOOCs.

Dimensions of MOOCs Design

In addition to the classifications involving grouping MOOC types, a deeper examination and understanding of their design is also needed. Information gleaned would hopefully prove valuable in the future enhancement of such learning environments. However, criticisms of MOOCs exist with regards to instruction and learning design which demonstrate "a gap between the reality and practice; teachers lack the skills needed to harness the power of new technologies" (Conole, 2013, p. 13). Other critics point out problems like high dropout rates, learner confusion and frustration, a heavy workload and a didactic pedagogy (Conole, 2013). MOOC instructors also need to address the challenges of teaching an unknown number of students in the open online environment (Grover, Franz, Schneider & Pea, 2013). Furthermore, some researchers claim that no clear definition of the design of MOOCs exists (Yousef, et al., 2014). Recently, a number of studies have been conducted in relation to MOOC design; however, many focus on the experience of creating MOOCs, and make suggestions based on case studies. Only a small number comprehensively examine concepts and approaches for the instructional design of MOOCs. Table 2 summarizes the key findings.

Conole (2013) proposed twelve dimensions for MOOC classification, including openness, participation, multimedia use, communication, collaboration, type of learner pathway, quality assurance, reflection, assessment, formality, autonomy, and diversity that designate the pedagogical characteristics of MOOCs. In addition to these dimensions, Conole (2013) suggested a design framework that informs the process of design decisions for course development.

Another early attempt of conceptual mapping of MOOC design was made by Schneider (2013) who categorizes two main structures. The first comprises general MOOC structure regarding basic components such as, Name, Platform, Level, Target Audience, and Accreditation. The second structure comprises the elements of the learning environment that could potentially affect the design including instruction methods, module and pace, assessment, and community.

Conole (2013) and Schneider (2013) feature pedagogical elements of MOOCs. Alario-Hoyos, et al. (2014) argue that other issues are inevitably involved in the design of MOOCs, such as technological, logistical, and financial considerations. Alario-Hoyos et al. (2014) have developed a design guide tool, in which the designers fill in their decisions by answering the questions related to 11 issues shown in Table 2.

Resulting from a dynamic analysis, Grover et al. (2013) focus on distinctive elements of MOOCs from the regular online course designs. Their design and evaluation framework is based on a distributed intelligence perspective, which consists of interaction between the individual and collective learning, enhanced by participatory knowledge distribution. The key attributes are that instruction, learners, technology and learning analytic data mutually shape each other. Learners choose instructional resources distributed in the interactive learning environment to suit their unique needs. The innovative affordance of new technologies associated with MOOCs, such as learning analytics and social media, are included as the key design elements. These can possibly accommodate the diverse needs of learners.

Table 2
Synthesis of the Design Framework of MOOCs

Conole(2013)'s Learning Design Framework	Shneider (2013)'s Taxonomy	Alario-Hoyos et al.(2014)'s MOOC Canvas	Grover et al.(2013)'s Framework	MOOC Design Dimensions (Synthesis)
Conceptualize vision of the course Capture resource audit Communicate mechanisms for communication	General Structure 1.Name 2.ID 3.Author 4.Publisher 5.Platform 6.Domain(about) 7.Level 8.Target Audience 9.Use(educational use/event) 10.Pace 11.Accreditation	Available Resources 1.Human 2.Intellectual 3.Equipment 4.Platform	Interactive Learning Environment 1.Content 2.Instruction 3.Assessment 4.Community Learner Background and Intentions 1.Purposes for course engagement	General Structure 1.Name, ID, Publisher 2.Platform 3.Domain(about) 4.Level 5.Target Audience 6.Use(Public/Blended/Flipped etc.) 7.Pace 8.Accreditation Resources 1.Human 2.Intellectual 3.Equipment 4.Platform Vision 1.Objectives 2.Competences
Collaborate mechanism for collaboration Consider assessment strategies Combine views of the design Consolidate implementing and evaluating the design	Interactive Learning Environment 12.Instruction 13.Assessment 14.Content 15.Community	Design Decisions 5.General description 6.Target learners 7.Pedagogical approaches 8.Objectives and Competences 9.Learning Contents 10.Assessment activities 11.Complementary Technologies (You Tube, Facebook etc.)	Technology Infrastructure 1.MOOC platform 2.Social media 3.Learning Analytics Engine 4.Communication tools 5.Access methods (downloading/streaming) Evidence-Based Improvement 1.Data Analytics 2.Design decisions	Learner Background and Intention 1.Purposes for course engagement 2.Autonomy Pedagogy 1.Pedagogical approaches 2.Learning Contents 3.Instruction Communication 1.Mechanism 2.Collaboration 3.Community Assessment 1.Strategies 2.Activities Technologies 1.MOOC platform 2.Social Media 3.Learning Analytics 4.Access methods Learning Analytics Data Support

Previous studies have comprised of valuable analysis on the frameworks of MOOCs; however, each analysis focused on different aspects. Our review of the past literature claimed a need in a comprehensive framework, incorporating all the aspects inherent in MOOC design. Thus, in our study, elements addressed by the previous four models were identified, and a comprehensive model that covered all the underlying elements of the design of the various MOOCs was constructed.

In total, nine key features of MOOC design were identified as shown in the right-most column of Table 2. Key dimensions identified in the design of MOOCs include the general structure, resources and the vision of the course designer. As Grover, et al. (2013) suggested, additional dimensions, with regards to constructing MOOC learning environments include an interrelation of learner background and intention, pedagogy, communication, assessment, technologies, and learning analytics data. Although the four studies in the Table 2 did not list learner support in their frameworks, we included support as an important component (Fournier and Kop, 2015). Learner support, which would be an additional dimension to be addressed, was added as the last element of the synthesized list of dimensions. Therefore, the model proposed here comprises a total of 10 dimensions of MOOC design as exemplified in Figure 1.

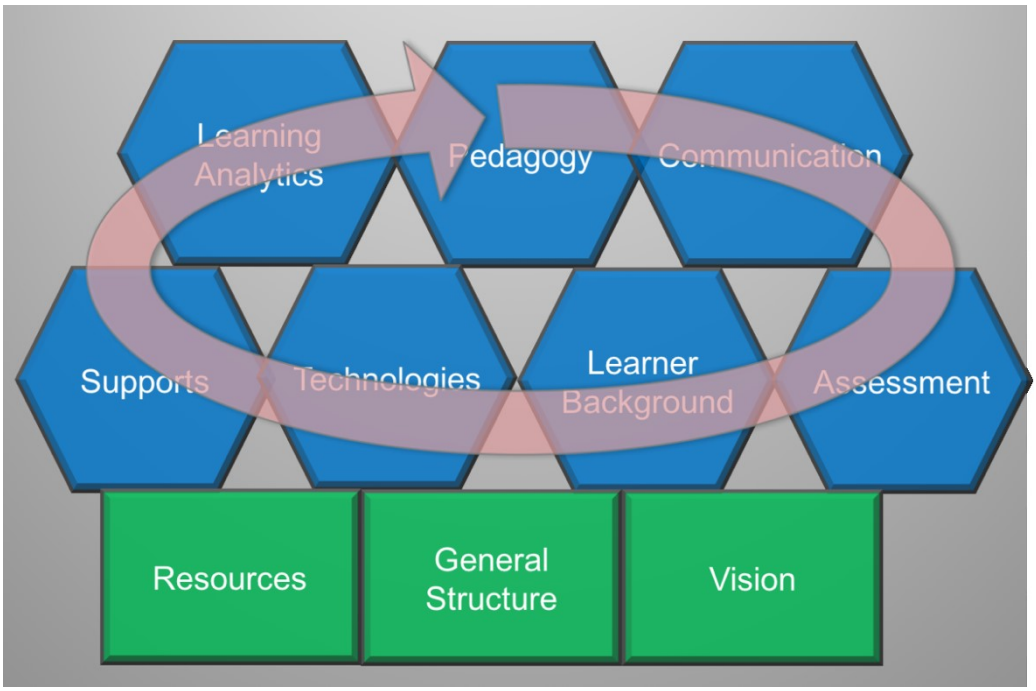

Figure 1. Ten Dimensions of MOOC Design

In the model of the 10 dimensions as shown in Figure 1, the three elements on the bottom layer consist of "Basic Design Decisions", including "Resources", "General Structure" and "Vision". Each dimension includes multiple subcategories that should be considered during MOOC design. For example, "General Structure" (Schneider, 2013) includes sub items, which include course name, platform, target learners, language of resources, domain, describing about a course, level, educational use or purpose, pace, and accreditation. "Vision" conceptualizes the objectives and competency of the courses. "Resources" represents human and intellectual resources, equipment, and platform available for course designers. These three dimensions and sub categories are included in the "Basic Design Decisions", which are the foundations of course design.

Above the basic design dimensions are the seven elements, which are "Interactive Learning Environment" (Grover et al., 2013), including "Learning Analytic", "Pedagogy", "Communication", "Supports", "Technologies", "Learner Background" and "Assessment". These seven dimensions are interactive and act reciprocally. For instance, "Learner Background" would shape how learners participate in and "Communicate" with others in course discussions, that mutually influences "Pedagogy", as well as "Supports". In addition, "Learner Background" and learners' intentions are diverse in the openly accessible nature of MOOCs. Grover et al. (2013) suggest that learning analytics and behavioral data enable us to customize an approach that accommodates different learners' motivations. Inevitably, "Technology", which is another interactive dimension, enhances the availability of analytic data, as well as the instruction in the course. The interactive acts of the dimensions help in the improvement of the courses, which should be the ultimate goal of designers and instructors. In the same way as the three basic design dimensions on the bottom layer, each of the seven interactive dimensions is made up of subcategories. For example, "Learner Background" includes learners' purposes for course engagement and their autonomy for learning. "Pedagogy" includes pedagogical approaches, learning contents, and instruction. "Communication" includes communication methods, such as discussion boards and use of social media, collaboration between participants, and the community created in a course by the all related parties. "Assessment" includes assessment design, such as strategies and activities when and how assessment is conducted. "Technological Infrastructure" includes the MOOC platform, social media, technical platform of learning analytics, and access methods for course contents, video lectures and resources.

Conclusion

In this study, previous research was synthesized and the elements of MOOC design were mapped in search for a deeper understanding of effective design decisions. First the classification of various types of MOOCs was investigated. A wide variety of MOOC types, reflecting the unique intentions of course providers were discovered from the review. On the other hand, classification comparing types of MOOCs did not clearly inform the details of design differences. The reason is due to the emerging new forms of MOOCs and the complex design combinations and choices that are not addressed by simple comparison.

To date, only a small number of studies have focused on conceptual models that help in the design process of MOOCs. Resulting from the review of four previous models, no comprehensive model that covers the whole process of MOOC design was identified. Based on previous researchers' efforts, the current study has proposed a synthesis of critical MOOC elements to better comprehend the MOOC design processes from the basic design foundations to the unique learning environments. However, the proposed model is yet to be evaluated according to actual course-design practices. From the review of the past literature, we are urged to develop our model into a set of design guidelines and tools, ensuring and improving the quality of MOOC learning. In particular, a design guide that corresponds to the combination of massiveness and openness, as investigated by Dennen & Bong (2015), will be our future scope of investigation. The proposed ten dimensions model was based just on reviews of MOOCs, and not yet checked with regular online learning design. It is still unknown that the proposed model would work well for helping design of regular online learning, or just for MOOCs; The 10 dimensions may work well, but detail guidelines within each dimension may be different. This is also limitation of the study, which calls for further investigation.

Aiming at creation of a design guides to assist MOOC developers and instructors, our current paper unraveled the fundamental consists of MOOC, that is our first step. The proposed 10 dimensions model will be further developed into a model, equipped with design choices and design tips in each dimension. Instructors' choice or the way making connections between the dimensions proposed in this paper would compose the final product of MOOCs.

Many researchers suggest that implementing the principles of instructional design, which have been well established in traditional online learning, will help in the effective design of MOOCs (Alario-Hoyos et al., 2014; Grover, et al., 2013). Based upon the proposed synthesis of 10 dimensions, future research will focus on building strategies and criteria, and adopting and adapting the instructional design principles into the MOOC design.

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