

Ten Dimensions Model of MOOCs for Quality Design: Implications from the Instructional Design Principles

Yuki Ichimura

Research Center for Instructional Systems, Kumamoto University, Japan
yuki-ici@kumadai.jp

Hiroshi Nakano

Graduate School of Instructional Systems, Kumamoto University, Japan
nakano@cc.kumamoto-u.ac.jp

Katsuaki Suzuki

Research Center for Instructional Systems, Kumamoto University, Japan
ksuzuki@kumamoto-u.ac.jp

Since the emergence of Massive Open Online Courses (MOOCs) over a decade ago, learners appear to be growing continuously, and MOOCs have been rapidly evolving. This study proposes the addition of a design model, the 10 dimensions model, which is equipped with practical strategies, to the framework of the basic components involved in MOOC construction. This study synthesized past works of literature, quality guidelines, and empirical studies that analyzed the instruction content level, sequences, assessment level, and support functions of the existing MOOCs. These research findings were used to make prescriptive suggestions corresponding to the issues surrounding MOOC design. The design strategies and resources were developed and included in the model as the design guide, supported by instructional design principles and tools.

Keywords: *Instructional Design, Massive Open Online Course (MOOCs), Quality of Learning, 10 Dimensions Model*

Introduction

The rapid growth of Massive Open Online Courses (MOOCs) has called for instructional design that enables quality learning experiences for diverse participants around the globe. Developing MOOCs involves fundamental challenges for instructional designers, such as the unknown number of participants and the diverse range of needs. Previous researchers discussed MOOC design by typology, represented as connective (c)MOOCs and extended (x)MOOCs, amid the boom of MOOCs, when this study project began (Ichimura & Suzuki, 2017). Recently, empirical research on MOOCs has increased among instructors and designers around the world (Lu et al., 2021). Researchers have begun to value the quality of MOOCs in learning experiences and educational tools (Stracke & Tan, 2018). Conole (2014) discussed the definition of quality in learners' needs in relation to both the design and delivery of MOOCs. In addition, Hood and Littlejohn (2016) noted that "conventional measures and indicators of quality are not always appropriate" for diverse MOOCs (p. 7). MOOC quality assurance initiatives also began to be formed in Europe (Zawacki-Richter et al., 2018). However, empirical studies on instructional design (ID) and its effects on MOOCs are limited, and there is little evidence revealing how sophisticated ID can be used for MOOC design (Jung et al., 2019). It is thus imperative to develop a design model that adopts ID theories for MOOCs.

Responding to this need, Ichimura and Suzuki (2017) have suggested the 10 dimensions model with a focus on critical elements of the course design of MOOCs from the perspectives of the ID theories and principles. This study is part of a study project (Figure 1) aiming to develop a design guidance particularly to cater to the difficulties and uniqueness of MOOC design. The project includes four studies, as Figure 1 illustrates. Study 1 was a literature review. Study 2 and 3 were empirical studies, and the current paper is study 4, which synthesizes the previous results for the proposal of the model with the sets of design strategies.

In the previous study, we first developed the model framework, which builds upon 10 dimensions that are relevant to the MOOC design from the review of MOOC-related literature (Ichimura & Suzuki, 2017). We analyzed past systematic reviews of the literature on MOOCs, covering the period between 2008 and 2015, and conducted a database search. Design elements addressed by the previous four models were identified, and a comprehensive model covering all the underlying elements of design of the various MOOCs was constructed via the 10 dimensions model (Ichimura & Suzuki, 2017).

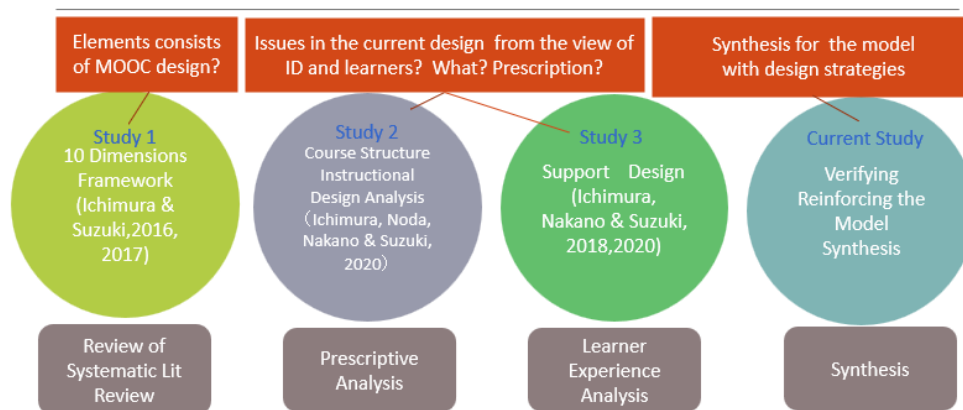


Figure 1. Overview of the Study Project (Ichimura, Nakano & Suzuki, 2021)

Figure 2 illustrates the core 10 dimensions of MOOC design proposed in our previous paper (Ichimura & Suzuki, 2017). The three elements on the bottom layer consist of “Basic Design Decisions,” including “Resources,” “General Structure,” and “Vision.” Each dimension includes multiple subcategories that were identified from the review. The above seven dimensions are the core elements of the Interactive Learning Environment (ILE) (Grover et al., 2013). The ILE is a potential MOOC design implementation, and according to Schneider (2013), it is made up of “socio-technical affordances, and instructional and community design decisions” (p.6). The ILE framework illustrates the mutual interaction of the elements. Above the seven elements are “Learning Analytics,” which support evidence-based improvement; “Pedagogy,” which is the core learning and instructional dimension; as well as “Communication,” “Support,” “Technology,” “Learner Background,” and “Assessment,” which are interactive and act reciprocally (Ichimura & Suzuki, 2017).

After the 10 dimensions model framework was built, we conducted an empirical study with the aim of enriching the framework of the models, seeking the concrete design strategies of each dimension to support designers during their course development processes. Two empirical studies, which included prescriptive course analysis and learner experience analysis, were conducted. The empirical studies investigated the “Pedagogy,” “Assessment,” “Vision,” and “Support” dimensions. The prescriptive analysis on the instructional structure of existing MOOCs examined

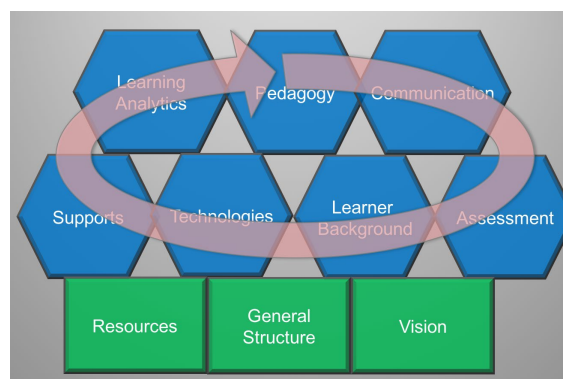


Figure 2. 10 Dimensions Model Framework

Note: This figure was retrieved from the previous study, Ichimura & Suzuki (2017).

sequential analysis, learning content, and assessment activities associated with cognitive levels (Ichimura et al., 2020b). Revised Bloom’s taxonomy (Anderson & Krathwohl, 2001) and Merrill’s Component Display Theory were used for the course analysis (Merrill & Twitchell, 1994). The study on the learning experiences of the first MOOC learners examined learning support called for by the learners (Ichimura et al., 2020a). The qualitative results revealed the basic issues experienced by beginner MOOC learners. Learners’ suggestions for MOOC support services were drawn upon for the design strategies for the multiple dimensions, including “Support” dimension.

Research Design

The purpose of this study was to confirm the 10 dimensions model with the quality guidelines utilized in MOOC practices. This study also aimed at providing concrete design suggestions and methods for the model to make it more practical and useful by synthesis of the studies. The analysis process included 1) classification into dimensions, using concept mapping analysis, and 2) synthesis into strategies of the model.

The following four quality guidelines and measures were analyzed: OpenupEd Quality Benchmarks for MOOCs (Rosewell & Jansen, 2014), MOOC Scan Questionnaire (Margaryan et al., 2015), Guidelines for Quality Assurance and Accreditation of MOOCs (Commonwealth of Learning, 2016), and Quality Reference Framework (QRF) for MOOCs from the European Alliance for the Quality of Massive Open Online Courses (MOOQ, Stracke et al., 2018). OpenupEd Quality Benchmarks (Rosewell & Jansen, 2014) includes 32 indicators in two main levels: institutional and course. The MOOC Scan Questionnaire (Margaryan et al., 2015) has three sections: 1) course details, 2) objectives and organizations, and 3) ID, assessed with Merrill's (2002) first principles of instruction. A total of 37 items are included. The guidelines from the Commonwealth of Learning (2016) cover multiple levels of guidance, including quality dimensions presented by presage, process, and product stages and a checklist for accreditation. The checklist has eight focus topics with 38 items. The QRF from MOOQ (Stracke et al., 2018) provides the Key Quality Criteria, including 154 statements separated by design phase. The items addressed in the four quality guidelines were mapped using the 10 dimensions model (Ichimura & Suzuki, 2017). They were chosen by considering the characteristics of the publishers and the underlined theories to eliminate possible bias caused by relying on a single institution. The three guidelines were published by the public institutions or the communities of universities, including quality initiatives. The MOOC Scan Questionnaire focuses on ID theory, which was scarce. In the previous literature review criteria for the framework development, these guidelines were not included.

First, all of the statements included in the guidelines were located and classified in the related dimensions. Second, the "Pedagogy," "Communication," "Assessment," and "Technology" dimensions, which included a large number of items, were exported to a concept map. Concept maps are used in qualitative research for various purposes. Past researchers have used them for reducing, organizing, and interpreting collected data (Conceição et al., 2017). Concept map analysis provides "linkages that facilitate the process of understanding interconnections and meanings in the data" (Daley, 2004, p. 33). The subcategories identified in the 10 dimensions model framework (Ichimura & Suzuki, 2017) were formulated as schema of branches. Then, the statements of criteria identified from the review of guidelines were classified under the subcategories. The data comprising the concept map were linked with subcategories, and additional common ideas identified from the connections were generated as additional subcategories. Through analysis with a concept map, a large volume of items ensuring MOOC quality were interconnected without their suggestions being eliminated, and they were interpreted as strategies (Daley, 2004). Finally, in the synthesis step, the reduced items from the quality guidelines and the strategical statements addressed in the reviewed papers were combined. The related literature was also referenced and integrated into the model. The result produced a model with a set of design strategies grounded in ID theories and associated with ID tools, specifically interpreted for MOOCs. The goal of the model is to provide a grounded design guide to enable novice MOOC designers to develop MOOCs in which quality learning experiences are assured.

Results

Findings from the Concept Mapping Analysis

First, common criteria across the multiple guidelines were summarized. The open nature of MOOCs was addressed in the guidelines associated with the "Resources" dimension. The use of materials licensed under Creative Commons and Open Educational Resources was highly recommended by the guidelines (Commonwealth of Learning, 2016; Rosewell & Jansen, 2014; Rosewell & Jansen, 2014; Stracke et al., 2018). Clear definitions, navigation, and direction were highlighted across the multiple dimensions. The guidelines all required clear communication of the basic course information, learning and assessment processes, learning materials, purpose of communication, the technological tools, and support (Commonwealth of Learning, 2016; Rosewell & Jansen, 2014; Stracke et al., 2018). In addition, a small number of statements related to the "Learning Analytics" dimension were identified.

Table 1

10 Dimensions and Subcategories

Dimension	Subcategories	Description of Subcategories	Number
1. General Structure		The “General Structure” dimension lists the basic configuration of the MOOC	10
2. Resource	2.1. Human	2.1. Available number of staff and their contribution to the design and implementation of MOOC	2
	2.2. Intellectual	2.2. Available licensed learning materials, budget for copyright clearance, permissions for external items, and open educational resources	5
	2.3. Equipment	2.3. Available hardware and software	3
3. Vision	3.1. Course Objectives	3.1. The course-level objective defines what the participants will be able to do as a result of completing the course. It is broader than the module learning objectives.	2
	3.2. Competencies	3.2. Mastery levels achieved as a result of learning	2
4. Learner Background and Intention	4.1. Purposes for Course Engagement	4.1. Purposes for course engagement: learners’ intention for course participation and learners’ information related to their self-learning characteristics	5
	4.2. Autonomy	4.2. Learners’ autonomous learning in the course	3
5. Pedagogy	5.1. Pedagogical Approaches	5.1. Teaching methods or how learning is facilitated	3
	5.2. Module Learning Objectives	5.2. Specific results of learning, broken down from the course objectives	4
	5.3. Learning Contents	5.3. Overall design of learning content, including module structure, sequencing, and design of contents format.	6
	5.4. Instruction	5.4. Presentation of subject matter, lectures, and resources delivered in multimedia formats. Provides learning guidance.	12
	5.5. Activity	5.5. Learners’ demonstration of what they have learned and their practice	13
6. Communication	6.1. Mechanism	6.1. The strategy of communication between all parties joining MOOCs and choice of interactive tools/social networking services	6
	6.2. Collaboration	6.2. Group work and collaborative activities	3
	6.3. Community	6.3. Facilitation of learners’ community building and discussion management	7
7. Assessment	7.1. Strategies	7.1. Assessment strategy includes decisions on formative or summative assessments, grading structure, and choice of assessment types	10
	7.2. Activities	7.2. Students’ performance and their achievement for obtaining feedback	2
	7.3. Peer Assessment	7.3. Strategies for peer assessment	5
8. Technology	8.1. MOOC Platform	8.1. Affordances of the given platform that are closely related to pedagogy, communication, and assessment design	3
	8.2. Social Media & Complementary Tools	8.2. The choice of tools and their integration for interaction and communication	2
	8.3. Access Methods	8.3. The way participants access the course, materials, and authentication process	3
	8.4. Operation and Maintenance	8.4. Technological facilitation to maintain secure operation	3
9. Learning Analytics	9.1. Learning Analytics Engine	9.1. The source of learning analytic data	2
	9.2. Learning Analytics Data	9.2. Data collection and use for personalization and evaluation	8
10. Support	10.1. Guidance	10.1. Initial support for self-directed learning in MOOCs	5
	10.2. Navigation Support	10.2. Support for progress in the learning path	4
	10.3. Learning Support	10.3. Support for progress of MOOC learning	9
Total			142

Note: Dimensions were retrieved from Ichimura & Suzuki (2017)

According to the analysis results classifying the statements of the guidelines, the 10 dimensions covered the quality criteria addressed in the overall guidelines. The results of the analysis supported the interactivity of dimensions, constructing a learning environment that incorporates the “Learner Background and Intention,” “Pedagogy,” “Communication,” “Assessment,” “Technology,” “Support,” and “Learning Analytics” dimensions. Considering the characteristics of open-access learning in MOOCs, interrelated design criteria across the dimensions were suggested.

Synthesis of Studies for the Generation of Design Strategies

The findings of the previous studies were synthesized and integrated in the model as the statements, suggesting strategic methods for design decisions under each subcategory. The results identified additional subcategories that were included in the related dimensions (Table 1). “Module learning objectives” and “activity” were added to the “Pedagogy” dimension. In the “Assessment” dimension, items of “peer assessment” formulated a cluster. In the “Technology” dimension, “access method” and “operation and maintenance” were included. Some subcategories listed in Ichimura and Suzuki (2017) were combined after the analysis. In total, 142 design strategies were generated in the 10 dimensions. The subcategories and the numbers of the total items were described in Table 1. The “Pedagogy” dimension contains the largest number of strategies at 38 items. Table 2 provides examples of the design strategies itemized in the model.

Table 2

Excerpts from the 10 Dimensions Model: “Pedagogy” Dimension

Dimension	Subcategories	Design Strategies
5. Pedagogy	5.5. Activities: Learners’ demonstration of what they have learned and their practice	5.5.1. Foster instructor–student, student–student (see “Communication” dimension), and content–student interaction (Commonwealth of Learning, 2016). Have learners reflect on the learning resources and their learning activity experiences to promote content–student interaction (Jung et al., 2019). 5.5.2. Start with less complex problems and increase the difficulty level after the previous problems are mastered (Margaryan et al., 2015; Jung et al., 2019). 5.5.3. Ask questions stimulating multiple cognitive levels in problems/quizzes. See Table Bloom’s Taxonomy Cognitive Process Dimension and Assessment 5.5.4. Make problems/quizzes ill-structured (i.e., multiple correct answers), divergent from one another, and related to real-world problems (Margaryan et al., 2015). 5.5.5. Present examples of problem solutions representing a range of quality from excellent to poor examples (Margaryan et al., 2015). 5.5.6. Pose real-world problems possibly relevant to the participants’ workplaces (Stracke et al., 2018; Margaryan et al., 2015; Jung et al., 2019).

In addition to the design strategies itemized in the model, the synthesis of the study project summarized and generated the design resources, associated with learning objectives, such as mapped learning and assessment activities (Ichimura et al., 2020a). Table 3 summarizes the learning activity choices located according to the hierarchical order of Revised Bloom’s Taxonomy (Anderson & Krathwohl, 2001). The result of the synthesis produced the 10 dimensions model in which design strategies and resources are ready for use.

Discussion

In the reviewed quality guidelines, clarity was emphasized across the dimensions and design stages, from definition to presentation, as for diverse MOOC learners with diverse online learning experiences, it is crucial to maintain explicit presentation. Although the basic MOOC process involves self-study, the guidelines encourage interaction and collaboration among learners, using mobile apps and social media. To cater to a large population of participants, technology and learners’ community are expected to function as learning support, which also supports the concept of a community of learning.

Table 3

Revised Bloom's Taxonomy/Digital Taxonomy/MOOC Activities

Cognitive Process	Revised Bloom's Taxonomy (Anderson and Krathwohl, 2001)	Bloom's Digital Taxonomy	MOOC Learning Activities
Creating	Generating (hypothesizing) Planning (designing) Producing (constructing)	Programming (1), filming (1), podcasting (1), mixing/ remixing (1), directing and producing (1), publishing (1), blogging (3)	Lab activities (2) (4), objective creation (2), creating and sharing works (2), planning a research paper (2), hypothesizing alternative ways (2)
Evaluating	Checking (coordinating, detecting, monitoring, testing) Critiquing (judging)	*Grading (3), *blog commenting and reflecting (1), *posting (blog, discussions) (1), *moderating (1), testing (1)	Lab activities (2) (4), *peer-graded assignments (2), *responding to classmates' discussion (2)
Analyzing	Differentiating (discriminating, distinguishing, focusing, selecting) Organizing (finding, uniting, integrating, outlining, parsing, structuring) Attributing (deconstructing)	Mind mapping (3), surveying (3), mashing (integrating data sources into single resource) (1), linking (1), validating (1)	Lab activities (2) (4)
Applying	Executing (carrying out) Implementing (using)	Calculating (3), charting (3), editing (1), uploading (1), running and operating (applications/hardware) (1), playing (educational games) (1)	Quizzes (2), *Wiki (2), *web searching and reporting related to the work (2), using procedures (2)
Understanding	Interpreting (clarifying, paraphrasing, representing, translating) Exemplifying (illustrating, instantiating) Classifying (categorizing, subsuming) Summarizing (abstracting, generalizing) Inferring (concluding, extrapolating, interpolating, predicting) Comparing (contrasting, mapping, matching) Explaining (constructing models)	Categorizing (digital classification) (1), journaling (1), *Tweeting (1), categorizing (1) *commenting and annotating (1), subscribing (1), tagging (3)	Quizzes (2), *forum posting (2), paraphrasing (2), listing examples (2), cause-effect questions (2), note sharing (1)
Remembering	Recognizing (identifying) Recalling (retrieving)	*Highlighting (1) (3), *bookmarking (1), searching (1)	Recall quizzes (2)

(1) Churches, A. (2008), (2) Ichimura, et al. (2020 b), (3) Sneed, O. (2016), (4) Schneider, E. (2013)

Note: * indicates social/interactive activities option

Comparison of the number of statements in the reviewed literature indicates that the "Learning Analytics" dimension might be an area to be explored. Instructors' interpersonal feedback is not feasible in MOOCs; therefore, automated personalization and adoptive courses are promising. Some empirical research has reported adaptive personalized learning paths with the use of an embedded algorithm (Cirulli et al., 2016). The important foundation, though, is the design of a well-analyzed network of learning sequences linking premise knowledge and the process of target skills acquisition (Cirulli et al., 2016). Analytics data use for evaluation of the course has also been addressed (Stracke et al., 2018). In the cycle of design, evaluation and improvement is the phase that is considered to show evidence-based improvement when using learning analytics data (Grover et al., 2013) in the 10 dimensions model.

The reviewed guidelines needed interpretation for practical use, since some of the items were too general or just listed
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the terms from learning theory, instructional theory, or epistemology. Three of the guidelines stated the quality criteria in the descriptive form of the required conditions, and only MOOC (Stracke et al., 2018) included the statements in the imperative verb form, organized by the process and phase. In contrast, the 10 dimensions model lists concrete strategies and methods that are organized by design elements. It prescribes methods that achieve the desired conditions (Reigeluth, 1983) and is organized by the design elements rather than the order of processes, allowing designers to refer to strategies by considering the interrelations and alignment of the dimensions. These methods were obtained after consultation with the ID principles, such as Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001), Merrill's Component Display Theory (Merrill, 1983), and the first principle of instruction (Merrill, 2002), which were interpreted for characteristics of MOOCs. Other related theories and principles were also referred to in the process of composing the model.

The 10 dimensions model is intended for use by novice instructional designers who design MOOCs at their institutions, and it can be used as a primary toolkit for MOOC development (Ichimura, 2022). The model suggests strategies for the stage from when designers join the team. Table 3 shows an example of the design resources, comprising the list of learning activities that designers can choose and optimizing the alignment of learning objectives, learning and assessment activities for learners' diverse needs and levels (Ichimura, 2022). Course designers can implement the activities in the standard MOOC platforms and additional common online tools, which can be performed by learners in massive classes either individually or collaboratively.

The 10 dimensions model was simply completed as a model with a set of strategies, so the evaluation process has not yet been conducted. A formative assessment of the 10 dimensions model remains a direction of future work to test its usefulness. ID practitioners and MOOC designers will inform the evaluation of the model's practical use. In addition, further work must analyze and suggest more ID models and tools that can be useful for MOOC design. The current model is intended for use in the design stage for novice designers. However, for higher-level decision-making in MOOC development, additional strategies are needed, such as analysis and evaluation stages (Reigeluth, 2020). In the case of different settings and designers with more responsibilities, a different version would be needed.

Conclusion

This study analyzed the quality guidelines and synthesized the findings of the study project to propose the 10 dimensions model, which is enriched with the additional design strategies. The framework of the model, built on the 10 design elements, was confirmed with the guidelines. The results of the synthesis proposed the methods for the use of ID theories and tools arranged particularly for MOOCs. The strategies dedicated to MOOC design are distinguished from other forms of online learning. Thus, the primary focus of the model is on designers' usage to aid their decision making. The design suggestions were drawn from the prescriptive analysis of the empirical studies. The results of the existing course analysis and the learners' voices suggested practical strategies that improve design difficulties of MOOCs and fill the gaps between the objectives and the current conditions.

In addition to the practical design suggestions fulfilling the subcategories in the dimensions, additional resources are provided to help designers. Grounded on ID theories, the theoretical wordings and the conceptual quality criteria were included as concrete statements, informing practical approaches. The model prescribes a course design that supports the process of achieving the objectives.

The proposed model has an adjustable, revisable, yet still grounded model that assists designers. The model considered the massiveness and openness that characterize MOOC design. In future MOOCs, those characteristics will be differently defined, and the features of the MOOC learning environment will be expanded by potential design choices that reflect new trends and technologies (Schneider, 2013). The design framework of MOOCs should be inclusive of possible future design choices and new technological implementation. Additional research will reinforce the model and enable more ID theories to be interpreted for MOOC design in the forms of practical strategies.

Note: This paper is based on a presentation at Proceedings of the 19th International Conference for Media in Education (Ichimura et al., 2021), to which the additional findings of the study project were added. Now the dissertation is completed and available as Ichimura (2022), submitted by the first author under the direction of co-authors.

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