Criteria for Quality Assurance to Develop MOOC Courses on Climate Change

Abdolrasoul Habibipour[1], Ashok Tripathi[2], Andrei Rybin[3], Olga Timokhina[3], Kanshukan Rajaratnam[4], Oksana Bugaenko[5], Ekaterina Shiman[5], Jari Porras[2], Karl Andersson[1], Anna Ståhlbröst[1], Serestina Viriri[6], Mandlenkosi Gwetu[6]

[1]Luleå University of Technology, Luleå, Sweden

[2] LUT University, Finland

[3] ITMO University, Russia

[4]Stellenbosch University, South Africa

[5]Northern Arctic Federal University, Russia

[6]University of KwaZulu-Natal, South Africa

Abstract

This article is focused on identifying criteria for quality assurance to develop Massive Open Online Courses (MOOCs), with a particular emphasis on developing MOOC on the usage of disruptive information technologies (DITs) as tools to work on climate change mitigation efforts. The research has been done within the context of Living Laboratory in Climate Change (LiLaCC) project, which is an Erasmus+ CapacityBuilding project in the field of Higher Education, with its six university partners in Europe and Africa. In so doing, a literature review on understanding criteria for quality assurance for MOOCs has been conducted. The literature reviews then formed the basis to develop empirical data collection tool, i.e., open-ended questionnaire. The six university partners then reflected on the identified criteria and also identified several other aspects that needs to be taken into account, when it comes to develop MOOCs, with a particular focus on climate change issues. Accordingly, eight overarching themes for quality assurance were identified, namely 1) organization of the lecture, 2) teaching quality, 3) methodology, 4) technical aspects, 5) motivation and culture, 6) delivery of MOOCs, 7) assessment, and 8) dissemination and promotion of MOOCs. Each of the themes includes several factors for quality assurance that can be used by both university researchers as well as practitioners in the field. The article provides a regulatory framework for matters related to teaching, learning, supervision and admissions to the MOOC in climate change.

Keywords: Climate change, Education, MOOC, Quality assurance, Quality manual

1. Introduction

The objective of this article is to identify criteria for quality assurance to develop Massive Open Online Courses (MOOCs), with a particular emphasis on developing MOOC on the usage of disruptive information technologies (DITs) as tools to work on climate change mitigation. It aims to provide a regulatory framework for matters related to teaching, learning, supervision and admissions to the MOOC in climate change. The outcomes of this article can be used as the Quality Manual (QM) to develop MOOCs in higher education. The research has been done within the context of Living Laboratory in Climate Change (LiLaCC) project, which is an Erasmus+ CapacityBuilding project in the field of Higher Education, with its six university partners in Europe and Africa.

The LiLaCC QM is prepared and developed within MOOC level (i.e., course level), so the quality assurance in higher education in the university level is beyond the scope of this manual. In doing so, the research is developed based on available literature (both focusing on MOOC as well as in general level), which is complemented by collecting data from all LiLaCC partners.

The literature review then formed the basis to develop an empirical data collection tool, i.e., an open-ended questionnaire. The six university partners then reflected on the identified criteria and identified several other aspects that need to be taken into account, when it comes to develop MOOCs, with a particular focus on climate change issues. In the following, each of the abovementioned themes and associated criteria are presented and discussed in greater detail.

Accordingly, eight overarching themes for quality assurance were identified, namely 1) organization of the lecture, 2) teaching quality, 3) methodology, 4) technical aspects, 5) motivation and culture, 6) delivery of MOOCs, 7) assessment, and 8) dissemination and promotion of MOOCs (Costello et al., 2018; Mishra, 2007; Owlia & Aspinwall, 1996; Xiao et al., 2019; Yepes-Baldó et al., 2016; Yousef et al., 2014); each theme includes a number of criteria. In the following, each of the abovementioned themes are explained in greater detail.

2. Organization of the content

Organization of the content of MOOC courses may include criteria such as relevance of curriculum to the future jobs of the learners, up-to-date content, containing primary knowledge and skills, supporting collaborative learning among learners, flexibility of knowledge, being cross-disciplinary and usefulness of the courses.

Regarding the relevance of curriculum to the future jobs of the learners, a vision is required to be defined. If we imagine how DITs can affect climate change mitigation efforts in the future, we should state this so that we can measure whether the MOOC works towards that vision. Employment opportunities after MOOC completion as well as pool of industrial partners interested in providing internships and job placements can be considered as important factors that should be taken into account, when it comes to the relevance of the curriculum. The emphasis must be on right skills and competencies for the future jobs.

The MOOC content should be up to date by including newest research results regarding the topic. This can be done e.g., by accreditation of the MOOC by leading experts in DITs for climate change mitigation. The courses should also contain primary knowledge and skills such as basics of sustainability and how DITs can be linked to that. Therefore, prior knowledge in DITs (blockchain, artificial intelligence (AI), internet-of-things (IoT) and machine learning) are advisable, though not mandatory.

In order to support the collaborative learning among learners, team building and group work are essential parts of the MOOC. The MOOC will include both individual and team test tasks, including team working, innovation sessions, as well as personal and team activities. There might also be projects or collaborative learning. Group projects however might be difficult in a MOOC setting but perhaps each student could undertake a project and then write a reflective essay.

Flexibility of knowledge and being cross-disciplinary is an important aspect in relation to the MOOC content. If we are to solve challenging climate change problems, we need cross-disciplinary knowledge. DITs adapted for climate change mitigation solutions, should be considered within the MOOC. Thus, the MOOC content will be crossdisciplinary and versatile. We need to list all knowledge necessary for success on this topic and then either have some as prerequisite knowledge or incorporate it into the MOOC.

In respect to the usefulness of the courses, MOOC participants will have an opportunity not only to expand their knowledge, but also make a career shift from DIT to DIT for climate. This course might be useful for those, interested in career development in international environmental organisations and climate conscious companies. In doing so, lots of practical examples are necessary to be included, as the participants might not be only university students, but non-university citizens as well.

Other criteria that are important to be taken into consideration and are relevant to the MOOC content are:

- Proper description of MOOC goals and objectives
- MOOC weekly/overall student workload
- MOOC designed/actual student workload ratio
- Clear description of learning outcomes
- Consistency of MOOC learning outcomes with the requirements of European Qualification Framework / national qualifications framework, employer needs
- Proper description of the clarity and completeness of MOOC design and contents
- Defining grading system: tools, description, grading criteria and scale
- Description of prerequisites for successful completion of the course
- Proper wording of MOOC relevance and demand for MOOC
- Promo video

3. Teaching quality

Within the MOOC courses, teaching quality is of utmost importance, particularly because there are no traditional and regular interactions between the teachers and the learners. Teaching quality may refer to the teaching competence, theoretical knowledge, practical knowledge, teaching expertise and communication, relevance of the teaching, as well as rhetorical organization of the lectures.

The teaching must be led by competent teachers to ensure confidence in the material presented. Teaching competence model is essential. It shall include both formal criteria (such as educational and research level – for example, whether the teacher has a degree and publications, how many years of teaching experience he/she has, does he/she have any experience in online education), and personal qualities relevant for MOOC teaching (for instance, presentation skills, good command of English language and articulation necessary for performing video lectures).

Regarding the theoretical knowledge, it can be divided into two main components: DITs and, climate change. The main questions to consider are:

- Does the teacher possess relevant knowledge in blockchain, AI, IoT, machine learning?
- Does he/she have any educational background in climate change?

In doing so, academia is good at discerning the teaching quality of theoretical knowledge. Expertise in the subject as well as past teaching experience matter.

When it comes to the practical knowledge, industry experts must be included to ensure that quality of teaching of practical knowledge is excellent. The MOOC shall include practical examples of using DITs for climate change mitigation, and the teacher should be aware of these examples. Practical examples can come from the challenges we collect, as well as from the case studies originating in the challenges and solutions available with the companies.

Teaching expertise, language and communication skills are also important when it comes to teaching quality. The relevance of teaching quality is obvious. We should include teaching and learning experts to ensure that the teaching quality is good. If we have experts in different fields, then we have higher probability of producing relevant content aligning to those fields.

Defining rhetorical strategies most relevant to our MOOC. Rhetorical organization of the MOOC can be explained as:

- Illustration/Exemplification – giving examples of technologies already used (successfully or not) to mitigate climate change.
- Description – basic description of the DITs used.
- Cause & Effect – about relevant climate change problems.
- Compare & Contrast – comparing various DIT tools for relevant climate change problems.

- Process (Analysis) – what are the ways of using particular DITs for particular climate change problem and what mitigation results it might produce.

4. Methodology

Proposed development methodology for MOOC courses must be consistent with the defined objectives. The development of the MOOC should include a wide and diverse set of people, including academics, practitioners and policy makers. The development methodology also depends heavily on the target audience. For example, for citizens we should tie the approach to living labs (Bergvall-Kåreborn et al., 2009; Habibipour, 2020; Ståhlbröst, 2008) while if we target university students we could use design science approach (Hevner et al., 2004; Peffers et al., 2007)

Regarding the overall methodology, definition and explanation of the outcomes, objectives, contents, activities and assessment are of vital importance. Outcomes should be in line with career or educational benefits, getting a new job, starting a business, or completing prerequisites for an academic program. The objectives might be:

- Creation of an intercontinental network between HEIs from Europe and Africa with the aim to improve the quality and access to teaching-learning programs through the implementation of high quality MOOCs that address the development of competencies and knowledge that are required in today's learners.
- Increasing the visibility of the HEI in Scandinavia, Russia and South Africa.
- Improving the relationship between the HEI and the labour situation in the region, increasing the employability of young people and adults.
- Promoting equal access to quality education and long-term prosperity.
- Modernizing the educative offer and the HEI management systems.

Outcomes also depend heavily on the intended audience. For university students we should focus on what to teach so that the students can make a difference in their occupation while for citizens it should focus more on simple behavioural changes.

In respect to the overall MOOC development process, this needs to be mapped carefully. The MOOC platforms usually have a road map of this. Generally, following steps can be followed:

Decide target groups, Define topics, Establish the purpose, Find experts, Find example cases, Experience a MOOC first hand, Select a MOOC provider, Decide on subject matter, Determine governance, Design your MOOC, Pilot test your MOOC, Promote the MOOC, Manage the MOOC, and Maintain the MOOC

Student-centered learning approach should be considered both in personal level and team tasks. Principles to be taken into account are:

- Learner-centered teaching engages students in the hard, messy work of learning.
- Learner-centered teaching includes explicit skill instruction.
- Learner-centered teaching encourages students to reflect on what they are learning and how they are learning it.
- Learner-centered teaching motivates students by giving them some control over learning processes.
- Learner-centered teaching encourages collaboration.

5. Technical aspects

Technical aspect in the MOOC context may refer to the user interface, video content, learning and social tools, technical performance, compatibility of the platform, accessibility of the platform, as well as availability of the platform.

The user interface must be simple but appealing and both web and mobile app approaches for the interface of MOOC courses should be considered. Regarding user interface, several points should be considered, such as:

- How do learners evaluate the MOOC design in terms of user interface design?
- How do learners evaluate the MOOC design in terms of universal instructional design?
- The goal of user interface design is to make the user's interaction as simple and as efficient as possible.

The key attributes that are associated with user interface are:

- Clarity: the information content is conveyed quickly and accurately.
- Discriminability: the displayed information can be distinguished accurately.
- Conciseness: users are not overloaded with extraneous information.
- Consistency: a unique design, conformity with a user's expectations.

- Detectability: the user's attention is directed towards required information.
- Legibility: information is easy to read.
- Comprehensibility: the meaning is clearly understandable, unambiguous, interpretable, and recognizable.

Videos are great for reflective learning. The video content must be produced professionally. It is recommended that the videos be short and concise, and individual recordings do not exceed 5-10 minutes.

Social media tools and platform for student communication is necessary. Social media networks can be used for MOOC promotion and updates. Gamified learning would be positive (badges) and might be linked to social media.

The MOOC compatibility should be as wide as possible. Compatibility with operating systems (Android, Linux, Apple iOS, Microsoft Windows, etc.) and different media (PC, Tablet, Mobile, etc.) should be taken into account. Next to that, accessibility and availability of the chosen platform are other important criteria. The platform shall be accessible at least for participants from project partner countries (Sweden, Finland, Russia and South Africa). The courses should be accessible both online as well as downloadable content. Regarding the availability of the platform, it is preferred to use one of the currently existing platforms. It is important to consider, what will be the

technical requirements for using the platform for the MOOC participant (system requirements, language, etc.).

Regarding the MOOC functionality test, the aim is to verify that its elements are operable on all supported operating systems and browsers as may be specified in the system requirements of the online learning platform, as well as to verify that the types, forms, means and resources that are being used for MOOC learning activities are consistent with the standards established by the online platform of the course.

MOOC unfolds though a learning process which is terminal and operated through a learning management system and methodologies designed to achieve the target learning outcomes, and an assessment system to validate their achievement.

Other technical related aspects are

- MOOC user identification (objectivity of user identification procedure and monitoring of entrance test conditions)
- Availability of MOOC contents and assessment tools to an unlimited number of users to the extent sufficient to achieve the target learning outcomes and their evaluation
- Technical implementation of the procedure for monitoring the conditions for training assessment activities
- Certificate for issuing to learners upon successful completion of MOOC
- Use of licensed materials or third-party materials created by authors other than the authors of MOOC (texts, including chapters, articles or fragments thereof,

published in books, magazines, or internet websites; illustrations, including drawings, charts, schemes and diagrams; photographs, including reproductions of works of graphics, painting, sculpture or architecture, etc.)

6. Motivation and culture

Motivation and culture refers to several criteria such as encouraging the learners, existence of systems of reward, presentation of content in an engaging way, emission of positive messages to learners, non-discrimination on grounds of birth, race, sex, religion, opinion or any other personal or social circumstances, willingness to help, privacy protection, and finally value creation for the learners.

Student-centred teaching would encourage learners. Practical examples that are underpinned by theory encourages learners. The MOOC should be centred on active learning. Existence of systems of reward can be done through e.g., gamification, receiving credits (depending on the university), employment opportunities (e.g., after capstone projects defence), etc.

Presentation of content in an engaging way can be achieved by developing relevant graphic and video materials. Interactive component of the MOOC such as quizzes, online meetings with mentors will be developed. Accordingly, the videos should be short and interactive.

Emission of positive messages to learners is also another important criterion. Climate change as a global problem shall be described within the MOOC, with particular attention to relevant regional climate problems. Thus, participants will become more environmentally conscious. For example, each video could have an “emissions during this video” bar.

Non-discrimination on grounds of birth, race, sex, religion, opinion or any other personal or social circumstances is the next factor that should not be neglected. Doing so, there will be no limits for participating in the MOOC. No prior knowledge or education is required, though the MOOC will be advised to those participants, who have some background knowledge in DITs. The MOOC is no subject to tuition fee. MOOC will be deployed on the platforms with strict and transparent privacy settings.

7. Delivery of MOOCs

Several factors are identified as the main criteria in relation to the delivery of MOOCs. They are included but not limited to the effective presentation, sequencing, timeliness, feedback from the learners, providing opportunities for learners to become more selforganized and finally inclusion.

Effective presentation is necessary and it is of crucial importance to have a style guide for the project that will consistently be followed for all MOOCs. Criteria of the effective MOOC presentation will be agreed on by all partners. Visual materials and styling of the MOOC shall be unified, and in line with Erasmus+ directives.

Regarding sequencing and timeliness, each MOOC module will have exact timetable (i.e. number of hours dedicated for each part, number of exercises and tests). Students shall have option of "self-regulation" of their schedule, though those students who want to participate in Capstone projects and gain certificates, shall be working in line with the overall MOOC timeline. The sequencing might be in different level of modules. It might start with citizen level and end to expert level.

Feedback from the learners is another important criterion to develop MOOCs. Request for certain topics might be collected from the future (potential) learners and researchers can then research and produce the courses. Feedback forms shall also be developed, and MOOC participants will fill them in after the MOOC completion. Feedback issues to be covered:

- Overall MOOC impression and satisfaction,
- Feedback on teaching practices,
- Feedback on teamwork,
- Feedback on MOOC technical implementation,
- Feedback on MOOC results (e.g., employment opportunities it may bring)

Providing opportunities for learners to become more self-organized is necessary but might face some restrictions on how you may proceed from one to module to the next. For example, participants shall organise teams in order to submit Capstone projects at the end of the MOOC. Each team shall choose a team leader and organise its work.

When it comes to the inclusion, MOOC participants with disabilities and from remote areas should be able to take the courses. The design should also be inclusive to incorporate as many participants as possible.

8. Assessment

Several criteria might be relevant to the assessment of MOOCs, when it comes to the quality assurance. Quizzes, electronic assessment techniques, peer-assessment, selfassessment, and fairness of examinations are important aspects related to the MOOC assessment.

A quiz is recognized as an interactive form of learning and checking the learning progress. Using of electronic assessment such as (E-test, short quizzes and surveys) besides defining deadlines for each quiz-test will enhance the quality of the produced MOOCs. The quizzes and tasks can be defined at both individual and group levels. A procedure might be designed in which the quizzes will get graded automatically.

Halfway and at the end of the MOOC, there may be peer assessment exercises. Peerassessment may include (a) automated tutors; (b) peer feedback; (c) auto-scoring of assignments; (d) reflective networks; (e) written comments; (f) oral comments; (g) meta-verbal; (h) emoticons; and (i) self-checks.. Regarding the self-assessment, selfassessment form to be developed. At the beginning and end of the MOOC learners might be asked to complete the form by entering a number between 1 and 10 against each learning objective (e.g., 1 = poor knowledge, 10 = expert) or enter 'N/A' if they feel the learning objective is not relevant to their area of work. However, this approach might be challenging with ordinary citizens, although it will work with the university students.

Examination criteria will be published online and included into graduate competence model. Clear evaluation rubric and if possible automatic grading will be considered for the MOOCs. Assessment tools must be consistent with learning outcomes (i.e., verifiability of target learning outcomes by actual learning outcomes).

The user assessment of the MOOC is designed and provided by the MOOC copyright holders and the online platform operator and it uses feedback from the MOOC learners. This feedback allows to assess MOOC learners' satisfaction with the course and to identify, in a timely manner, where it needs to be updated, corrected and improved in terms of quality, accessibility, use-friendliness and consistency with obligatory reviews requirement, in a deferred change mode.

Learners are free to provide feedback on 5 aspects: MOOC contents; MOOC structure; Teaching quality; Grading and certificate issue; and MOOC technical aspects and ergonomics. MOOC learners can also leave feedback in no particular format by filling out the online assessment form. MOOC learner reviews and feedback on the five aspects listed above will be posted on the course page and kept there for two years.

9. Dissemination and promotion of MOOCs

Dissemination of the course through different platforms as well as through offlibe resources is necessary. Use of opinion leaders such as former students or professors of prestige as endorsers of the course should not be neglected. The courses can be promoted through project website, as well as LinkedIn channels, Facebook, etc.. Scientific publications as well as attending relevant conferences, organizing and attending workshops and other academic events as well as other types of presentations are essential to promote the MOOCs. Depending on the MOOC, one dissemination approach might be to allow learners to download the course materials and use it offline.

10. Conclusion and future research

This paper is developed as a joint effort by all LiLaCC partners, in order to be considered as quality assurance guideline for the MOOCs to be developed within the context of LiLaCC project. Several criteria were identified that need to be taken into account when the MOOC courses are developed. Table 1 shows an overview of the identified criteria for quality assurance within the MOOC level. These criteria are briefly discussed and explained in the body of this article. Taking these aspects into account will result in higher quality in the MOOCs on "Disruptive Information Technologies in Climate Change Mitigation", as well as the four associated modules, namely, artificial intelligence, machine learning, blockchain and Internet of Things in climate change mitigation efforts. This article also opens up directions for future research. One interesting research direction would be to study, how these criteria are correlated and may influence each other. For example, how different assessment approaches are affected by the methodologies that are used to develop MOOC courses. Our hope is that the presented article can be used as a starting point for a more comprehensive quality assurance protocol for MOOC courses in different platforms.

Table 1. Overview of the identified criteria for quality assurance in LiLaCC MOOCs

Organization of the content	**Teaching quality**	**Methodology**	**Technical aspects**	**Motivation and culture**	**Delivery of MOOCs**	**Assessment**	**Dissemination and promotion of MOOCs**
Relevance of curriculum to the future jobs of the learners	Teaching competence	Proposed development methodology consistent with the defined objectives	User interface	Encouraging the learners	Effective presentation	Quizzes	Dissemination of the course through different platforms
Up to date content	Theoretical knowledge	Definition and explanation of the outcomes, objectives, contents, activities and assessment	Video content	Existence of systems of reward	Sequencing, timeliness	Electronic assessment techniques	Dissemination of the course through resources offline
Containing primary knowledge and skills	Practical knowledge	Overall MOOC development process	Learning and social tools	Presentation of content in an engaging way	Feedback from the learners	Peer-Assessment	Use of opinion leaders such as former students or professors of prestige as endorsers of the course
Supporting the collaborative learning among learners	Teaching expertise and communication	Studentcentered learning approach	performance	Emission of positive messages to learners	Providing opportunitie s for learners to become more selforganized	Selfassessment	
Flexibility of knowledge, being crossdisciplinary	Relevance		Compatibilit y of the platform	Non-discriminatio n on grounds of birth, race, sex, religion, opinion or any other personal or social circumstances	Inclusion	Fairness of examinations	
Usefulness	Rhetorical organization of the lecture		Accessibility of the platform	Willingness to help			
			Availability of the platform	Privacy protection			
				Value creation for the learners			

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