Building Quality into MOOCs: An Evaluation Framework for Women-in-STEM Mentoring Programs

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WIP: Building Quality into MOOCs: An Evaluation Framework for Women-in-STEM Mentoring Programs

Abstract

This Work in Progress (WIP) paper addresses women's underrepresentation in STEM higher education and academic leadership, which remains a key challenge. Among the several strategies and actions implemented and evaluated, mentoring programs have emerged as an effective strategy to foster women's persistence, leadership, self-efficacy, and sense of belonging in these fields. Within this context, the (blinded for review) program at a Latin American university integrates Massive Open Online Courses (MOOCs) as a core component of its mentoring model, aiming to provide accessible, high-quality learning resources that complement mentoring relationships and community-building efforts. This practice-based paper presents the development and expert validation of a quality evaluation framework for MOOCs integrated into a mentoring program for academic women in STEM. The framework combines the principles of the 7Cs Learning Design Framework with the Quality Matters rubric. Then, it is complemented by the PDCA quality cycle, applying an engineering-based approach to evaluate instructional design, interactivity, accessibility, and alignment with mentoring objectives. In addition, participants' perceptions were gathered through structured surveys to examine how effectively course design and learning activities supported the mentoring goals and addressed learners' needs. Preliminary findings indicate that practice demonstrates how structured quality assurance processes can strengthen digital mentoring ecosystems for women in STEM. Finally, the paper discusses implications for sustainability, scalability, and transferability to other institutions seeking to integrate MOOCs into mentoring and professional development programs that advance gender equity in STEM.

Keywords: Women in STEM, Mentoring, MOOCs, Quality Assurance, Gender Equity

Introduction

In recent years, the demand for new online learning modalities has grown exponentially, driven by technological advances and the global shift toward flexible education. Among these modalities, Massive Open Online Courses (MOOCs) have become a key tool for democratizing access to higher education, offering scalable, self-paced learning opportunities that transcend geographical and temporal constraints [1] [2]. However, while MOOCs have significantly expanded educational access, ensuring their pedagogical and technical quality remains a persistent challenge. Persistent issues in design, engagement, and retention highlight the need for more robust quality assurance frameworks [2].

In this context, this study focuses on an online course developed within a mentoring program for women in STEM, designed to foster professional development, leadership, and collaboration skills among women in academic roles. The course also aims to strengthen their participation in

an inclusive learning community. To ensure its quality and long-term impact, this research proposes an engineering-based quality assurance framework that integrates three complementary models: the 7Cs Learning Design Framework [3] [4], the Quality Matters (CPE) Rubric [5] [6], and the PDCA (Plan–Do–Check–Act) continuous improvement cycle [7] [8] [9]. This triadic approach combines pedagogical coherence, technical rigor, and iterative enhancement, providing a structured methodology that aligns course design and implementation with learner needs, institutional goals, and the principles of equity and inclusion in STEM education.
In alignment with the conference theme, this study advances human-centered engineering education by presenting STEM mentoring MOOCs as digital environments that promote equitable participation, sustainable development, and ethical leadership among women in STEM. Through an engineering-based quality assurance process, it integrates human-centered design, continuous improvement, and digital transformation to enhance online mentoring as a driver of inclusive innovation. To operationalize this contribution and guide the evaluation process, this Work in Progress is structured around the following research questions:

RQ1. How effectively does the integrated framework combining the 7Cs Learning Design Framework, the Quality Matters (CPE) rubric, and the PDCA cycle support the evaluation of pedagogical and technical quality in a mentoring MOOC for women in STEM?

RQ2. How do the different quality dimensions defined by the integrated framework perform in the context of a mentoring MOOC for academic women in STEM?

Theoretical framework

Ensuring the quality of MOOCs requires an integrated approach that connects pedagogical, technical, and managerial perspectives. As illustrated in Figure 1, the proposed conceptual framework combines three complementary models: the 7Cs Learning Design Framework, the Quality Matters (QM) Rubric, and the PDCA (Plan–Do–Check–Act) Cycle, to guide a systematic evaluation and continuous improvement process for MOOCs in STEM mentoring programs.

The integration of these models reflects a multilayered view of quality: the 7Cs framework provides the pedagogical foundation for coherent and learner-centered course design [3]; the QM rubric ensures compliance with recognized standards of accessibility, usability, and instructional quality [5] [6]; and the PDCA cycle, drawn from engineering and management, operationalizes a culture of evidence-based, iterative improvement [7] [8].

Together, these layers establish an engineering-driven model for quality assurance, in which design, evaluation, and feedback operate as interdependent components to enhance both the learning experience and institutional sustainability of MOOCs.

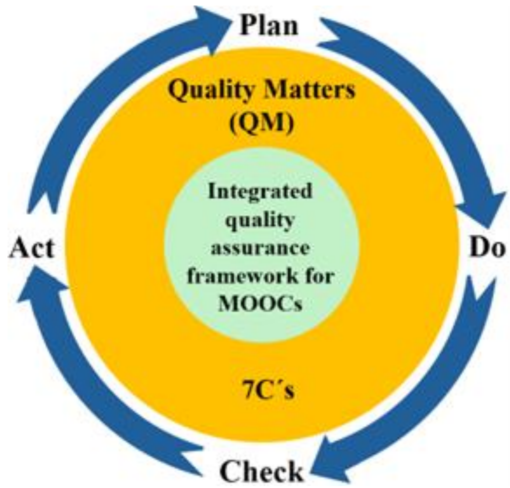

Figure 1. Engineering-based integrated model for MOOC quality assurance and continuous improvement, combining the 7Cs Framework and the Quality Matters Rubric, and then applying the PDCA Cycle

The literature highlights that the quality of MOOCs depends on the integration of pedagogical coherence, usability, accessibility, and interactivity [2] [10] [11]. Following this integrated perspective, each component of the framework contributes a distinct yet complementary dimension to the evaluation of MOOC quality.

The 7Cs Learning Design Framework proposed by Conole [3] establishes seven interconnected dimensions that ensure pedagogical coherence in online learning environments. The 7Cs stand for: conceptualize, capture, communicate, collaborate, consider, combine, and consolidate. Briefly, *Conceptualize* articulates the course vision, target learners, and pedagogical approaches; *Capture* refers to the identification and curation of open educational resources and other materials; *Communicate* addresses the mechanisms that foster learner–tutor and peer interaction; *Collaborate* emphasizes group-based learning and co-construction of knowledge; *Consider* involves reflection, assessment, and evidence of learning; *Combine* synthesizes the previous elements into a coherent course structure; and *Consolidate* closes the cycle through implementation and iterative refinement of the design [3], [4]. These seven dimensions guide the instructional design process toward an engaging and learner-centered experience, ensuring pedagogical alignment and coherence across the course structure.

Building on this pedagogical foundation, the Quality Matters (QM) Continuing and Professional Education (CPE) Rubric introduces a structured, measurable set of eight general standards designed to ensure technical, structural, and accessibility quality in online courses [2] [5] [6]. These standards are:

1. Course Overview and Introduction (COI), which explains the course design and structure to learners at the outset;

2. Learning Objectives (LO), which establishes measurable competencies describing what learners will achieve;
3. Assessment and Measurement (AM), which ensures that assessment strategies evaluate learner progress toward the stated objectives;
4. Instructional Materials (IM), which verifies that resources are current, purposeful, and aligned with learning objectives;
5. Course Activities and Learner Interaction (CAI), which promotes active engagement and meaningful interaction among learners and instructors;
6. Course Technology (CT), which ensures that the tools used support learning objectives and enable active learning;
7. Learner Support (LS), which provides clear access to technical, academic, and accessibility services essential for learner success;
8. Accessibility and Usability (AU), which ensures that course navigation, content, and multimedia are accessible to all learners, including those with disabilities [5], [6].

The QM rubric ensures that each course component meets recognized international benchmarks for online education, promoting clarity, inclusivity, and alignment between instructional intent and learner experience. Finally, the PDCA Cycle (Plan–Do–Check–Act) provides the methodological basis for continuous quality improvement [7] [8]. Originating from engineering and quality management, this model introduces an iterative process that translates evaluation results into evidence-based action. Each step of the process indicates an action, that is,

- *Plan* defines objectives and expected outcomes,
- *Do* implements course strategies and instructional design,
- *Check* analyzes data and learner feedback, and
- *Act* introduces informed modifications for ongoing enhancement [9].

Combining the 7Cs with Quality Matters and, sequentially, with the PDCA model establishes a comprehensive engineering-based framework that ensures MOOCs are pedagogically sound, technically robust, and continuously improved to promote high-quality learning experiences in STEM mentoring programs.

Methodology

This exploratory–descriptive study employs a mixed-method approach to develop and test an integrated framework for evaluating and improving the quality of online courses. Although broadly applicable, the framework was tested in the mentoring MOOC for women in STEM at a private university in South America. The methodological process followed the logic of the continuous improvement cycle PDCA (Plan-Do-Check-Act), in which each stage corresponded to a specific methodological component.

- *Plan (Validation and adaptation of the evaluation criteria)*. The first stage consisted of translating and adapting the CPE version of the QM rubric into Spanish. A group of three experts reviewed each item for linguistic accuracy and contextual relevance using a 5-point scale and qualitative comments. The feedback informed adjustments in terminology and phrasing, resulting in a validated rubric adapted to the higher-education context.
- *Do (Integration of evaluation models and construction of the instrument)*. In the second stage, the validated QM rubric was systematically compared with the 7Cs Framework to align the pedagogical and technical dimensions (Figure 2). Each of the 7C components was mapped onto the eight QM standards, generating a correlation matrix that revealed areas of conceptual overlap in learning objectives, materials, activities, communication, and accessibility. Based on this mapping, weighted relevance values were assigned to each QM standard, producing the integrated evaluation matrix used in this study.
- *Check (Application of the instrument and data analysis).* The third stage involved applying the integrated matrix to the mentoring MOOC. A group of 14 participants evaluated the course's design, interactivity, accessibility, and alignment on a 1–5 Likert scale.
- *Act (Improvement planning, future work).* The final stage of the PDCA cycle has not occurred yet, but it will guide future refinements of the MOOC based on the findings.

QM Matrix

	COI	**LO**	**AM**	**IM**	**CAI**	**CT**	**LS**	**AU**
7Cs	Item 1 … Item n	Item 1 … Item n	Item 1 … Item n	Item 1 … Item n	Item 1 … Item n	Item 1 … Item n	Item 1 … Item n	Item 1 … Item n
Conceptualize	3	4	3	2	2	1	1	2
Capture	2	3	2	4	2	3	2	4
Communicate	4	3	2	2	3	2	3	4
Collaborate	2	2	2	2	4	3	2	2
Consider	2	4	4	3	3	2	1	2
Combine	2	3	3	4	3	3	1	2
Consolidate	2	3	4	2	2	2	1	2
Weights	**0.120**	**0.155**	**0.141**	**0.127**	**0.148**	**0.113**	**0.700**	**0.127**

Figure 2. Mapping of the 7Cs dimensions to Quality Matters and the resulting weight distribution for the PDCA cycle.

This process ensured that the framework remained contextually grounded yet scalable, enabling its adaptation to other online learning environments.

Study context, participants, and researcher role

The study was conducted within a mentoring MOOC developed as part of the (blinded for review) program at a private university in South America. The course is designed to support academic women in STEM through structured learning activities, peer interaction, and mentoring-oriented content focused on professional development, leadership, and community building.

Participants in this exploratory phase included 14 academic women in STEM who completed the MOOC and voluntarily participated in the course evaluation process. The sample reflects the target population of the mentoring program and provides formative feedback on instructional design, accessibility, and alignment with mentoring objectives.

The researchers acted as educational researchers and evaluators, responsible for designing the integrated evaluation framework, adapting the Quality Matters rubric to the local context, and analyzing participant feedback. To mitigate potential bias arising from insider evaluation, the study emphasizes the use of structured instruments, predefined evaluation criteria, and transparent reporting of methods and results.

Ethical considerations

This study followed institutional and ethical guidelines for educational research involving human participants. Participation in the evaluation was voluntary, and all responses were collected anonymously through structured surveys. Participants were informed of the study's purpose and the use of their data for research and quality improvement. The research protocol was submitted to and approved by the Institutional Ethics Committee of the host university. At the time of submission of this Work in Progress paper, the formal ethics approval resolution is pending, and documentation will be provided upon request.

Preliminary findings

The evaluation yielded a weighted quality index of 0.845, indicating a high overall level of course quality based on the integrated 7Cs + Quality Matters (QM) framework. As shown in Figure 3, the highest normalized scores were obtained in Instructional Materials (IM=0.901) and Learning Objectives (LO=0.883), reflecting strong coherence between course design, content, and intended learning outcomes.

Category	Weight	Raw Mean	Normalized Mean	Weight × Normalized Mean
COI	0.120	4.158	0.832	0.100
LO	0.155	4.416	0.883	0.137
AM	0.141	4.120	0.824	0.116
IM	0.127	4.507	0.901	0.114
CAI	0.141	4.104	0.821	0.116
CT	0.113	4.413	0.883	0.099
LS	0.077	3.635	0.727	0.056
AU	0.127	4.230	0.846	0.107
Total	**1.000**			

Figure 3. Evaluation results based on the integrated 7Cs and the Quality Matters (QM) Frameworks.

The values displayed in Figure 3 correspond to the normalized weighted scores obtained for each Quality Matters (QM) standard, expressed on a 0–1 scale, where 1 represents the maximum achievable quality level. Each score reflects the average rating (1–5 Likert scale) provided by the 14 participants for the items associated with that standard, multiplied by the relevance weight assigned to the standard through the 7Cs–QM mapping (see Figure 2), and then normalized by the maximum possible weighted value. Scores above 0.85 indicate that the standard meets or exceeds the QM threshold of acceptable quality for certification-level course design; values between 0.75 and 0.85 are interpreted as areas with adequate performance but clear opportunities for improvement; and values below 0.75 identify priority dimensions for the *Act* phase of the PDCA cycle. This interpretive scale allows the reader to situate each result within a common reference frame and to identify which components of the MOOC should be prioritized in subsequent improvement cycles.

Moderate results were observed in Course Activities and Learner Interaction (CAI=0.821) and Accessibility and Usability (AU=0.846), suggesting effective but improvable mechanisms for engagement and inclusion. The lowest score corresponded to the standard Learner Support (LS=0.727), pointing to the need for enhanced guidance and feedback channels. Overall, these preliminary results indicate that the pedagogical and technical design of the mentoring MOOC may be robust. Moreover, they identify specific dimensions that will guide future PDCA-based continuous improvement actions

Conclusions and future steps

As a Work in Progress, this study presents several limitations that should be acknowledged. First, the evaluation was conducted with a relatively small sample (n = 14), reflecting the exploratory nature of the study and limiting the generalizability of the findings. Second, the framework was applied within a single mentoring MOOC in a single institutional context, and the results should therefore be interpreted as context-specific. Finally, while the study operationalizes the Plan, Do, and Check phases of the PDCA cycle, the Act phase has not yet been implemented at the time of this submission and is intentionally positioned as a focus of future work.

Despite these limitations, this study applied an integrated framework combining the 7Cs Learning Design Framework, the Quality Matters (QM) rubric, and the PDCA cycle to evaluate the quality of a MOOC developed within the context of a mentoring program for women in STEM. Preliminary results revealed high overall quality and strong alignment in key dimensions, including Learning Objectives, Instructional Materials, and Course Technology.

The integration of the 7Cs framework and the QM rubric provided a coherent structure for evaluating pedagogical and technical dimensions, while the PDCA cycle offered a systematic approach to continuous improvement. Building on these findings, the next stage of this research will focus on operationalizing the PDCA cycle by implementing improvement actions based on identified gaps, and on translating evaluation results into targeted modifications to course design, assessment strategies, and learner support.

Regarding the applicability of these preliminary findings, the proposed framework can be adopted by other institutions with realistic resource constraints. At a minimum, replication requires: (i) a small team of two to three instructional design or quality-assurance experts able to adapt the QM rubric to the local language and institutional context; (ii) access to an open-license translation of the QM CPE rubric and the 7Cs framework, both of which can be reproduced without proprietary software; (iii) a basic digital learning platform (e.g., Moodle, Open edX, or an LMS already in use) capable of hosting the MOOC and collecting learner feedback through structured surveys; and (iv) a cohort of at least 10–15 learners willing to provide evaluative responses on a Likert scale. With these resources, institutions can implement the *Plan–Do–Check* phases reported in this study. More mature implementations, capable of sustaining the full *Plan–Do–Check–Act* cycle across multiple iterations, also benefit from institutional support for ethics review, dedicated time for the evaluation team, and access to basic analytics tools. These conditions make the framework particularly suitable for universities with emerging online-learning ecosystems and for mentoring programs seeking a structured, evidence-based approach to quality assurance without requiring large-scale investments.

Future work will extend the application of this integrated model to additional MOOCs and mentoring contexts to further examine its scalability and replicability. Overall, this study reinforces a human-centered approach to engineering education by strengthening digital learning environments that promote sustainable innovation, ethical leadership, and equitable participation in STEM. Grounded in quality assurance and continuous improvement, the proposed framework contributes to a more inclusive and effective mentoring ecosystem for women in engineering.

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