Technical Quality of a Mobile SPOC

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Abstract—Computer based Learning Environments are mainly shaped by emerging environments such as Massive Open Online Courses (MOOCs), SPOCS (Small Private Online Courses) and Mobile learning. This variety challenges the quality of the content delivered in these various environments. In Moroccan higher education, SPOCS is a trending topic widely used in its context of blended learning. The present work focuses on an SPOC delivered as a hybrid mobile app and on factors that define its technical quality. The objective is to propose a set of technical quality factors which are defined following a study of literature, focusing on frameworks, labels, practices that are used to assess the quality of e-learning environments, MOOCs, SPOCs and mobile applications. ISO standards for the quality software and the guidelines for the most dominant Mobile Operating Systems (Android/IOS/Windows phone) are also considered when defining these criteria. The proposed criteria can be twofold used: 1) to assess the technical quality of an existing mobile SPOC; 2) constitutes guidelines to increase the technical quality of a new mobile SPOC

Keywords—Quality assessment, Technical criteria, SPOC, Mobile App, ISO Standards.

1 Introduction

Small Private Online Courses (SPOCs) are a trending phenomenon in online learning thanks mainly to the fact that they aim at offering a tailor-made course intended for a small group of learners. Recently, SPOCs like MOOCs (Massive Online Open Courses) have revolutionized universities by supporting blended learning and flipped classroom learning. In the era of mobile technologies, developing mobile accessibility to SPOCs represents a real challenge to fulfilling the learning needs of mobile learners. Mobile technologies can enrich educational opportunities for learners and offer the possibility of extending the scope and the value of SPOCs by improving access to learning materials due mainly to some features such as flexibility to learn anywhere and anytime, interactivity, portability, popularization and personalization [1] and thus allow promoting collaborative learning and informal learning by maximizing learner interactions and dialogues [2].

In order to develop mobile dimension within an SPOC, it is extremely important to consider quality requirements and success factors that ensure a successful experience for learners before investment on development of such a new environment.

The quality of e-learning systems is an emergent subject. In recent years, valuable studies and sophisticated approaches are available to deal with global guidelines, benchmarks and quality standard models for: mobile learning [3; 4], online education, e-learning [5, 6] and open education including MOOCs and Open Educative Resources (OERs) [7, 8 and 9]. As the authors are interested in SPOCs delivered as a mobile app, a few works on developing a common framework for evaluating the quality of SPOCs or mobile apps exists.

Even concept quality is complex and any discussion about it is challenging, the authors aim, by the present work, to contribute to exploring the quality characteristics that ensure success of such emergent environment namely SPOC mobile app.

2 Objective

The quality of e-learning, MOOCs and mobile apps concern many dimensions: Pedagogical, Technical, Sociocultural and Economic dimension. The pedagogical dimension has been widely treated in proposals frameworks quality. But when proposing an SPOC as a mobile app, be it native or hybrid mobile app, technical dimension and user experience are extremely important. The objective of this work is to propose a list of criteria as an instrument for approaching the technical quality in an SPOC which is delivered as a mobile app. To this end, the authors explore the previous studies and summarize the most based proposal quality frameworks for e-learning, MOOCs, SPOCs and mobile apps. The issue of this article ought to prove to be useful to assess the technical quality of an existing SPOC mobile app and to staff concerned with the design and development of an SPOC mobile.

3 Methodology

The present work narrows the focus down as regards literature review pertaining mainly to the previous studies relevant to the quality of e-learning, MOOCs/SPOCS and mobile apps. The authors determine to explore frameworks with the view to benchmarking approaches used for assessing the quality of online courses and mobile learning. The literature study is concerned also with standards for the quality software and the guidelines for designing and developing mobile apps. For the Technical requirements, the authors are mainly inspired by the ISO/ IEC 25023: 2016 for software quality and by the guidelines for designing mobile apps for the most popular mobile operating systems (Android/IOS/Windows phone).

Both quantitative and qualitative analyses were performed to identify the most cited quality factors relevant to all dimensions of an SPOC mobile app. Then, the authors focused on the technical quality factors of a mobile app and apply Pareto law to identify the most relevant factors of technical quality of SPOC. Finally, the authors proposed a list of technical criteria that can be twofold: 1) to assess the technical quality of an existing SPOC mobile app 2) or to constitute a set of guidelines applicable to SPOC designers in order to develop its mobile version.

4 Results

4.1 Works on quality e-learning

To address the question of the quality of e-learning, various innovative and participative processes initiatives and programs have been developed from the community of organizations, universities, associations and institutions through the world. Nowadays, valuable assurance quality Models, Benchmarks and standards for assessing quality in e-learning are available with the aim to ensure the quality and success factors of online courses [8]. In table 1, the authors summarize some frameworks and tools used to assess the quality in e-learning.

Table 1. Some Frameworks/Labels/Systems quality used to assess quality in e-learning

Quality Model	Framework
E-xcellence1: EADTU (the European Association of Distance Teaching Universities) Netherlands	6 sections: (1) Strategic management; (2) Curriculum design; (3) Course design; (4) Course delivery; (5) Staff support; (6) Student support
ACODE2 (the Australasian Council of Open, Distance and e-Learning)	8 benchmarks: (1) Institution-wide policy and governance for technology enhanced learning; (2) Planning for institution-wide quality improvement of technology enhanced learning; (3) Information technology systems, services and support for technology enhanced learning; (4) The application of technology enhanced learning services; (5) Staff professional development for the effective use of technology enhanced learning; (6) Staff support for the use of technology enhanced learning; (7) Student training for the effective use of technology enhanced learning; (8) Student support for the use of technology enhanced learning.
AVU3 The African Virtual University	7 criteria: (1) Institutional Policies and Mission; (2) Program Design and Development; (3) Course design and Development; (4) Learning Infrastructure and Resources; (5) Learner Support and Progression; (6) Learner Assessment and Evaluation; (7) Community Capacity Building Development and Engagement.
ROI4 Rubric for Online Instruction	6 dimensions: (1) Learner Support and Resources; (2) Online Organization and Design; (3) Instructional Design and Delivery; (4) Assessment and Evaluation of Student Learning; (5) Innovative Teaching with Technology; (6) Faculty Use of Student Feedback.
ECBCheck5	6 dimensions (1) Information About and Organization of the programme; (2) Target group Orientation; (3) Quality of the Content; (4) Programme/ Course Design; (5) Media Design; (6) Technology
Quality matters (QM)6	8 General Standards and 43 Specific Review Standards: (GS1) Course Overview and Introduction; (GS2) Learning Objectives;

[1] http://e-xcellencelabel.eadtu.eu/
2 www.acode.edu.au
3 http://www.avu.org/avuweb/en/
4 https://www.csuchico.edu/eoi/
5 http://www.ecb-check.net/
6 http://www.qualitymatters.org/

	(GS3) Assessment and Measurement; (GS4)Instructional Materials; (GS5) Course Activities and Learner Interaction; (GS6) Course Technology.

4.2 Works on quality MOOCs

Works relevant to the quality in MOOCs are an emergent area and various frameworks that deal with quality assessment are proposed in literature. It can be noted that the quality concept is complex (Quality assurance; Quality evaluation, Quality improvement, Quality enhancement...); frameworks used to assess MOOCs/SPOCs quality concern in general institutional level, Course level, Student level, Assessment level and Social learning level. Various Tools and practices are used to assess or approach quality (frameworks, Labels, Benchmarks, Dimensions, Factors, Criteria, Questionnaires, Checklist, Indicators, Metrics, Items...)

In the foremost frameworks proposed to assess MOOCs/SPOCs quality, the technical criteria were not meticulously expressed. The authors found, for example, the general term 'Technology', 'Course technology" 'media design'...Table 2 summarized main frameworks and practices used to assess quality in MOOCs with emphasizing relevant technical criteria to be considered in our tool

Table 2. Frameworks used to assess the quality in MOOCs

Reference/Year	Proposed/used Framework	Technical criteria
[10] (2016)	3 dimensions: (1) Learning objectives (Potential dimension) (2) Learning realization (Process dimension) (3)Learning achievements (Result dimension)	(2) Learning realization (Process dimension) not explicit
[11] (2015)	Quality Matters (QM) Eight standards/43 criterias (1) Course overview and introduction (2) Learning objectives (3) Assessment and measurement (4) Instructional materials (5) Learner interaction and engagement (6) Course technology (7) Learner support (8) Accessibility	(GS6) Course Technology Technologies required in the course are readily obtainable. The course technologies are current. Links are provided to privacy policies for all external tools required in the course. (GS8) Accessibility and Usability. Course navigation Ease of use. Accessibility Course design Readability.
[12] (2014)	2 Dimensions / 6 Categories/74 items (1) Pedagogical criteria 1.1 Instructional design (Lecture/ Organization 1.2 Assessment (e-assessment/peer-to-peer assessment (2) Technical Criteria 1.1 User interface 1.2 Video content 1.3 Learning and social tools	(2) Technical Criteria 1.1 User interface 1.2 Video content 1.3 Learning and social tools 1.4 Learning analytics

	1.4 Learning analytics	
[13] (2014) [14] (2017)	OPENUPED7: 6 sections: (1) Strategic management; (2) Curriculum design; (3) Course design; (4) Course delivery; (5) Staff support; (6) Student support 8 features: (1) Openness to learners; OL; (2) Digital openness; DO; (3) Learner-centered approach; LC; (4) Independent learning; IL; (5) Media-supported interaction; MI; (6) Recognition options; RO; (7) Quality focus; QF; (8) spectrum of diversity SD.	(3) Course design: Technical design User interface (4) Course delivery 4.1 Technical infrastructure 4.1.1 System design and architecture 4.1.2 Technical infrastructure management (5) Staff support 5.1 Technical aspects 5.1.1 Technical support 5.1.2 Technical training (6). Student support 6.3. Technical support 6.3.1. Online services availability 6.3.2. Professional management of technical support 6.3.3. Online technical support system availability
[15] (2015)	COURSE SCAN questionnaire 10 Dimensions/62 items: (1) first Merill's instructional principles focused on learning activities: (1) Problem-centered; (2) Activation; (3) Demonstration; (4) Application; (5) Integration Augmented by five further principles focused on learning resources and learning supports: (6) Collective knowledge; (7) Collaboration; (8) Differentiation; (9) Authentic resources; (10) Feedback	Instructional principles
[16] (2014)	10 dimensions (Improvement quality) (1).Interaction, (2) Collaboration; (3) Motivation; (4) Network of Opportunities/ Future directions; (5) Pedagogy; (6) Content; (7) Assessment; (8) Usability; (9) Technology; (10) Support for Learners.	(8) Usability; (9) Technology
[6] (2014)	10 quality Benchmarks (1) Institutional support (vision, planning, & infrastructure), (2) Course development, (3) Teaching and learning (instruction), (4). Course structure, (5) Student support, (6) Faculty support, (7) Technology, (8) Evaluation, (9) Student assessment, (10) Examination security.	(7) Technology
[17] (2014)	7 categories/ 71 indicators (1) Core requirements; (2) Structure participant; (3) Requirements; (4) Assignments; (5) Media design; (6) Communication; (7) Resources.	(5) media design; (6) communication
[18] (2017)	10 Indicators high quality (1) Accessibility; (2) Flexibility; (3)	(1) Accessibility; (2) Flexibility; (3) Interactivity; (4) personalization; (7) Use of media (10)

[7] http://www.openuped.eu/quality-label

	Interactivity; (4) Personalization; (5) Transparency; (6) Open and shared content; (7) Use of media; (8) Pedagogical enhancement; (9) Reflection; (10) Social learning.	Social learning.
[19] (2013)	7C framework design assurance quality (1) Conceptualize; (2) Capture; (3) Communicate; (4) Collaborate; (5) Consider; (6) Combine; (7) Consolidate.	The 7Cs of Learning Design framework aims to provide teachers with the guidance and support they need to make more pedagogically informed design decisions.

4.3 Standards on quality software

The authors are inspired by the standard ISO/IEC 25023:2016 in the present work. This standard has been defined by International Organization for Standardization (ISO) and IEC (the International Electrotechnical Commission) in software engineering area and concerns quality of a product/software. Because the quality model is generic, it is possible to apply it to any software product by tailoring to a specific purpose. Table 3 reports the most known Standards which deal with quality and guidelines for mobile operating systems:

Table 3. Standards on quality software

Standards	
ISO 9000/ISO 8402	***Quality definition***
ISO/IEC 25023:2016 Systems and software Quality Requirements and Evaluation (SQuaRE)	Measurement of system and software product quality: provides measures including associated measurement functions for the quality characteristics in the product quality model:(Functionality, Performance, Compatibility Usability Reliability, Security, Maintainability, Portability)
ISO/ IEC 9126-1	A quality model that comprises six characteristics and 27 sub-characteristics of software product quality. Functionality, Usability, Maintainability, Reliability, Portability. Efficiency.
Flat design	Guidelines for IOS mobile app design
Material Design	Guidelines Android/Windows phone mobile app

4.4 Works on quality mobile apps

Works relevant to mobile apps quality reflect the diversity of frameworks used to describe or to assess the quality of a mobile app. In Table 4, are reported the main criteria or dimensions quality of a mobile application/software from the relevant articles reviewed.

Table 4. Criteria quality of a mobile application / software from the relevant reviewed articles

Reference/Year	**Proposed/used Framework**
[3] (2016)	5 dimensions: Functionality, Accessibility, Interactivity, Ease of use, Interface Design
[20] (2015)	5 dimensions: Functionality, Usability, Dependability, Performance, Availability
[21] (2016)	13 dimensions: Functionality, Interface Design, Usability, Performance, Availa-

	bility, Quick Response, Flexibility, Scalability, Maintainability, Reliability, Connectivity, Security, User interface
[4] (2016)	8 dimensions: Functionality, Usability, Performance, Security, Communication, Portability, Support. Pedagogical
[22] (2015)	4 criteria/9 characteristics/39 requirements: (Technical/Pedagogical/Economic/Socio-Cultural) : Functionality ,Security, Performance, Pedagogical, Usability, Support, Service Level, Communication, Portability
[23] (2013)	9 dimensions: Functionality, Usability, Performance, Security, Communication, Portability, Service level, Support, pedagogical
[24] (2013)	4 criteria and 9 characteristics and 44 requirements: (Technical/Pedagogical/Economic/Socio-Cultural) : Functionality, Security, Performance, Pedagogical, Usability, Support, Service Level, Communication, Portability.
[25] (2017)	5 dimensions: pedagogy, Technical Usability, Connectivity, Contextuality, content
ISO/ IEC 9126	6 dimensions: Functionality, Usability, Maintainability, Reliability, Portability. Efficiency
ISO/ IEC 25023: 2016	9 dimensions: Functionality, Usability, Performance, Maintainability, Reliability, Security, Portability. Efficiency, Compatibility

Figure 1 shows criteria quality for mobile application/software as they were cited in articles reviewed classified by frequency of their occurrence.

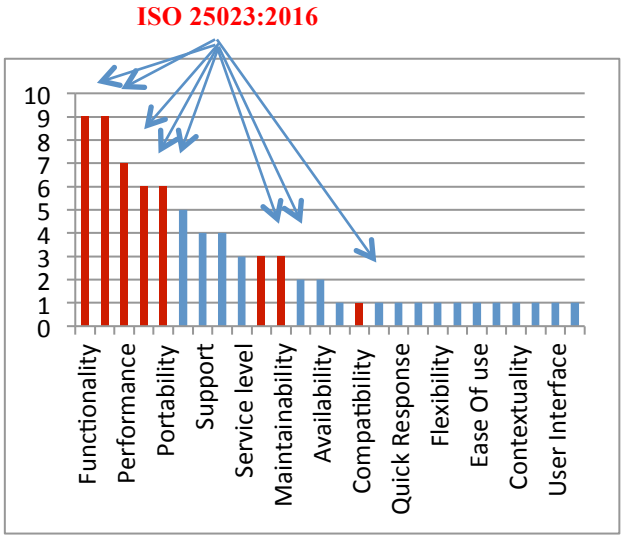

Fig. 1. Criteria quality for mobile application/software

5 Discussion

As the present work deals with technical criteria, the authors disregard the following criteria in the subsequent analysis:

- Pedagogy (e.g. pedagogical strategy, motivation, learner, multimedia, and assessment) from [4, 22, 23, 24 and 25]
- Support and service level from [22, 23 and 24] which are considered as economic criteria
- Support from [4] considered as socioeconomic criterion
- Contextuality from [25] which means authenticity and learning in different contexts
- Content from [25] (e.g., curricular fit, scope, validity, sequence, and language)
- Communication from [4, 22, 23 and 24] considered as socio-cultural criterion
- For the criterion Usability, as it is a qualitative criterion and includes both technical and nontechnical aspects, the authors retain it in the present analysis and they consider several technical requirements which could affect usability such as the design of user interface, navigation…
- In [23, 24] Usability is considered as a pedagogical criterion but when considering its meaning in the relevant works, the authors found that user interface is the most considered when evaluating this criterion.
- The authors also considered that the criterion Interface Design from [3] is similar to the criterion User interface from [21].
- To identify the most important technical criteria relevant to the articles reviewed. The authors proposed to plot the diagram corresponding to the variant ABC of the Pareto law (see Figure 2) to highlight the most important criteria that affect the quality of a mobile application. The authors transfer generic concepts phenomenon and causes when using Pareto law in our case, the phenomenon considered is the quality of a SPOC mobile app and the causes correspond to the criteria.

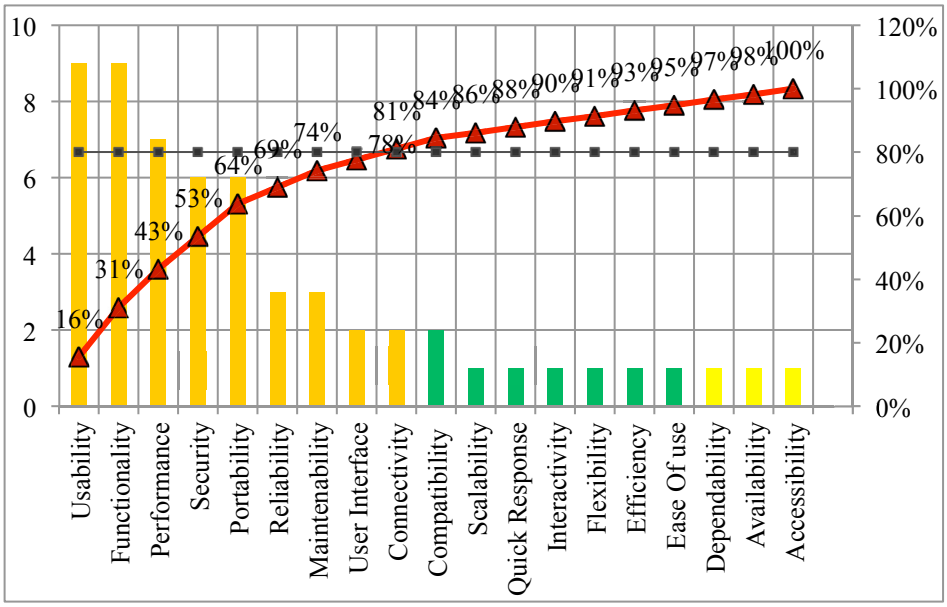

Fig. 2. Pareto diagram for more relevant Technical criteria quality for mobile app

The Pareto diagram emphasizes the importance of focusing on the criteria from class A. As mentioned above, User Interface is the major technical criteria to consider in Usability criteria. It is also found that criteria from ISO/IEC 25023:2016 standards are mainly represented in the result found in the present work. Finally, to assess an SPOC mobile app quality, the authors propose the framework namely: User Interface, Functionality, Performance, Security, Portability, Reliability, Maintainability and Connectivity.

6 Proposed Technical Criteria

Each criteria of proposed framework is categorized into sub-criteria or Items to be checked so as to potentially approach the technical quality when designing an SPOC delivered as a mobile app (Table 5)

Table 5. Proposed Technical Criteria and sub-criteria

Technical Criteria	Sub-criteria/Items
User Interface	-Visual design (typography, Colors, Animations) -Layout and organization (Homogenous (Lisibility (Negative blank, Information Hierarchy…) ,Orientation (portrait/landscape),) -Navigation (Accessible (tab bars, Top navigation, Hamburger Menu…), Intuitive (gesture and moving device) design (Orientation: Horizontal/vertical; Haut/bas), Input mode: More touch than click) -Accessibility (Personalization (Fonts, Colors, Size), Alternative resources, Load files , Offline access) -Contents (Video (Quality, duration, Format, Allow various speed), Image (Resolution, size, Format), Labels (Image, Icones, Typography), Audio (Format, duration), Links (Label), Text (Typography, color), Icons (Design, label), Additional Resources (format, utility, emplacement))
Functionnality	-Include Messaging strategy (push notifications, in-app notifications, Course Announcements) -Include various communication types (Student-student , student-teacher, Real-time chat, synchronous or asynchronous (forum, email)) -Include Social Tools (Technical Support (installation, configuration, upgrade, error correction) -Include Analytics (track users, collect outcomes data) -Consideration of Physical constraints (Battery management,Memory , anagement, Storage management mechanism, Connectivity management (wifi, 2G, 3G, 4G, offline mode…)) -Searching functionality -Capability to identify technological requirements -Provide easy-to-find links to support services
Security	-Authentification -Autorisation -Include input validation -Uses tools and setting for safeguarding sensitive data -Uses tools for files protection -Ensure the integrity of data -Ensure privacy and confidentiality of the data stored -Session attack protection
Performance	-Response time (of First Screen , UI transition, Loading time)

	-Availability (anytime, anywhere) -Battery consumption -Memory consumption -SPOC mobile app size
Reliability	-Stability after: -abnormal Close -battery life -Disconnection -User fault -Backup when low battery -Recovery after log-out/ disconnection
Maintainability	-Easy to debug -Easy to modify -Easy to Upgrade
Portability	-Easy to setup -System adaptation (IOS, Android, …) -Device adaptation (Smartphone, Tablet,..) -Different browsers Support
Connectivity	-Accommodates a wide range of connectivity: wifi, 3G, offline -Allow Sharing content

7 Conclusion and future works

The present study aims at proposing a list of criteria that address as much as possible all the relevant technical aspects when designing SPOCs mobile. The proposed criteria must support educators designing an SPOC delivered as a mobile app. In order to complete and validate the proposed criteria and to understand the strength and weakness of its relevant categories and items, the authors intend to experiment it to design an SPOC as a mobile app as a course delivered in blended learning. This list must also carry out forthcoming new technical ideas. The authors consider the criteria list as a first starting point, which has to be improved or adapted in their on-going works.

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