

Identifying Learner Problems Framed within MOOC Learning Designs

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Abstract: Detecting learners who face problems in MOOCs usually poses difficulties due to the high instructor-learners ratio, the diversity of the population, and the asynchronous participation mode. Existing solutions mainly draw on self-reported problems in discussion forums and on dashboards displaying learners' activity traces. However, these approaches cannot scale up easily or do not consider the course learning design. This paper presents a conceptual framework aimed at guiding MOOC instructors in the identification of potential learners' problems and indicators of such problems, considering the learning design of the course (e.g., types of activities, difficulty, etc.). An instrumental qualitative case study served for the evaluation and refinement of the framework. The results showed that the framework positively helped instructors to reflect on potential learners' problems they had not considered beforehand, and to associate such problems with a set of indicators related to their learning designs.

Keywords: MOOCs, Instructors, Design Framework, Learner Identification, Co-design

1. Introduction

MOOCs have been prominent in the educational domain and, during the last year, with the coronavirus outbreak, they have experienced a drastic growth in the number of new users and courses provided with respect to the last previous years (Shah, 2020). However, despite this high number of users, support to learners during MOOC enactment has been rather overlooked (Gregori, Zhang, Galván-Fernández, & Fernández-Navarro, 2018), still presenting research challenges such as the provision of timely and useful feedback for those learners experiencing course-related problems (Aldowah, Al-Samarraie, Alzahrani, & Alalwan, 2020). Current practices to identify learners who face problems in MOOCs, as well as to assist them, regularly require that instructors look at posts explicitly reporting these problems in discussion forums (Onah, Sinclair, & Boyatt, 2014). Yet, the high number of posts (Shatnawi, Gaber, & Cocea, 2014), the diversity regarding learners' knowledge (Deboer, Seaton, & Breslow, 2013) and the asynchronous learners-instructor communication, pose doubts about its scalability for instructors.

To that end, the use of Learning Analytics (LA) is explored to automate the identification of learners' problems and the provision of personalized feedback (Gašević, Dawson, Rogers, & Gasevic, 2016). Mainstream MOOC platforms (e.g., Coursera, Open edX, Canvas Network) usually store data regarding participants' behavioural footprints generated at course runtime (Jansen, van Leeuwen, Jansen, & Kester, 2020), such as the interactions with other learners (e.g., number of posts), the interactions with course resources (e.g., PDF downloads, video views), or the student learning outcomes (e.g., quiz scores, attempts). This information can be displayed through dashboards to keep learners aware of their performance, and to assist instructors in the detection of critical learner behaviours (Urrutia, Cobos, Dickens, White, & Davis, 2016). However, current LA strategies used for identifying learners who may need further assistance have not been founded on pedagogical strategies for instruction (Gašević, Dawson, & Siemens, 2015). Concretely, the information displayed in the dashboards does not usually consider the course characteristics or the pedagogical intentions of the instructors. For instance, the work by Dabbebi et al., (2017) revealed that, in the case of a dashboard, not all collected student data were equally meaningful for MOOC instructors, since the learning context determines whether some data is more or less informative than other.

Gašević et al., (2016) argued that LA should be informed by the course context and learning design (LD) to result in useful conclusions and appropriate intervention. One approach to get this

information is to explicitly obtain it from MOOC instructors, by including them in the loop and making them actors of the decision-making process (Rodríguez-Triana, Prieto, Martínez-Monés, Asensio-Pérez, & Dimitriadis, 2018). This same approach can be applied to the design of detection strategies for learners facing problems. This way, instructors would be involved in how to identify learners with problems and how to assist them, based on their expertise. For instance, instructors are the ones aware of the difficulty of the activities, the pedagogical connections between the different course activities, or the relevant indicators that might point out problematic situations.

Given this context, the identification of potential problems that learners might face during the MOOC, as well as the identification of indicators that might help in the detection of learners facing them, are two crucial aspects which should be considered to shape useful feedback interventions. To the best of our knowledge, previous solutions did not consider the LD information to detect learners facing problems and do not guide instructors in such a process. In this paper, we present a study that aims to answer the following research question (RQ): ***How can instructors be supported in the identification of potential learners' problems considering LD parameters at design time?*** To answer the RQ, we proposed a conceptual framework, named FeeD4Mi, to help MOOC instructors in the reflection and identification of problems and indicators pointing to potential learners' difficulties within their LDs. Consequently, two sub-research questions associated to the previous RQ were defined:

- a. *RQ-1: To what extent did FeeD4Mi cover the problems and indicators potentially describing learners' difficulties within MOOC LDs?*
- b. *RQ-2: To what extent did FeeD4Mi facilitate instructors to reflect on additional problems and indicators for MOOC LDs?*

The structure of the paper is as follows. Section 2 introduces the proposed framework. Next, Section 3 describes the design of the study including the context, the participants, and the data sources. Finally, the results are presented (Section 4) and discussed together with ideas for future work (Section 5).

2. Framework Presentation

FeeD4Mi is a five-dimension framework foreseen to be employed during the design phase of the course and expected to facilitate MOOC instructors to: (a) recognize potential problems in MOOCs; (b) define potential behaviours of learners having an expected problem; and (c) choose the adequate support for the identified problems. We defined FeeD4Mi through a research process, based on a literature review (e.g., Aldowah et al., 2020; Botelho et al., 2019; Henderikx, Kreijns, & Kalz, 2018) and on experiences with MOOC instructors (Topali et al., 2019; Topali, Ortega-Arranz, Martínez-Monés, & Villagrà-Sobrino, 2020), regarding the detection of learners facing problems, from which we abstracted the important parameters identified in the provision of feedback practices. The final proposal encompasses five dimensions (see Figure 1) and a sequence of steps, related to each dimension, as described below:

- **Learning Design Analysis.** Learners' problems and feedback practices are context dependent. LDs contain information useful for the design of feedback regarding activities' objectives, tools, resources and expected outcomes (Gašević et al., 2016). We can derive such information from the instructors, who are the ones responsible of the pedagogical strategies applied. That is, the consideration of the instructors' course decisions (e.g., difficulty of the activities), the course components, and the connection among such components (e.g., the answers to Quiz A are given in Video I and Video II).

- **Reflection on Learner Problems.** This step encompasses a reflection on the learners' problems that can occur in a MOOC during the learning process. FeeD4Mi includes a catalogue of problems regarding content-related, peer collaboration, technical, learners' assistance, community building and self-regulation issues.

- **Selection of Problem Indicators.** This step deals with the detection of indicators that point to behaviours associated with the identified problems. These indicators can be classified into self-reported (e.g., private messages referring to the problem) and log data (e.g. number of attempts in assignments, time spent in the course, etc.) indicators.

- **Reflection on Feedback Conditions and on Feedback Aspects.** These two steps involve the creation of rule-based decisions and the design of feedback interventions based on the last two

dimensions of FeeD4Mi (see Figure 1). These dimensions are guided by the factors of feedback quality described by Molloy & Boud (2014). According to such factors, when designing feedback, educators need to define: a) the feedback provider (e.g., instructor, peers, context), b) the time (e.g., on time feedback or delayed on purpose), and c) the feedback type (e.g., hints or direct feedback). FeeD4Mi includes a catalogue of scalable feedback practices.

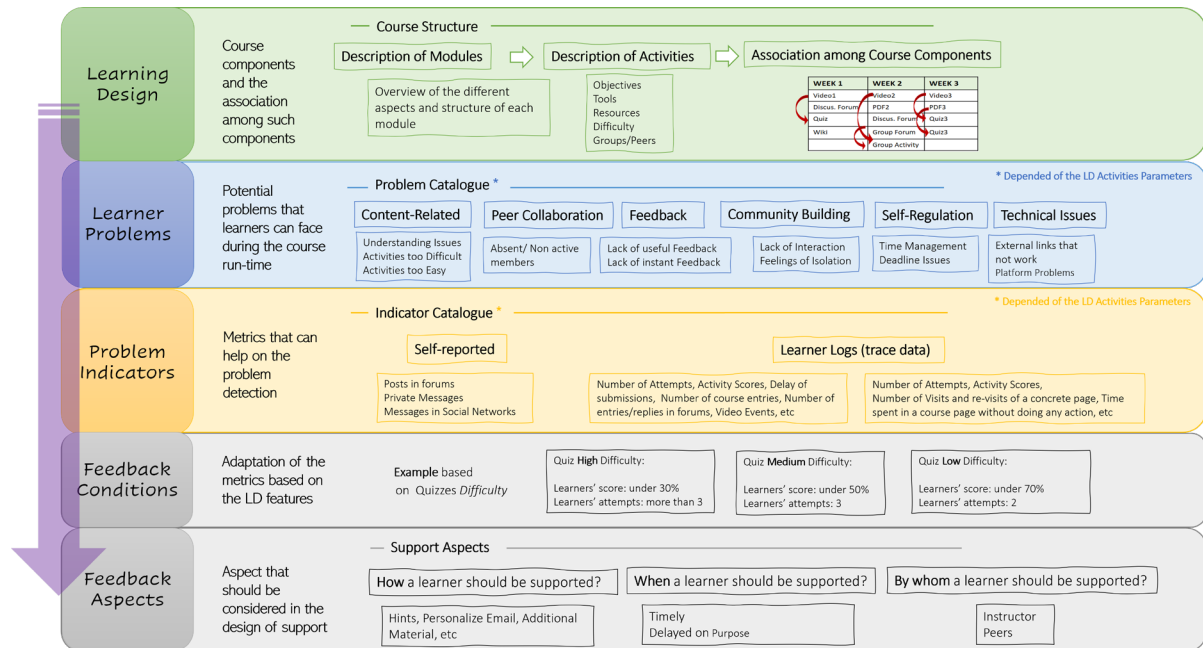


Figure 1. FeeD4Mi Overview Presenting the Five Dimensions and Their Content.

3. Methodology

In this section, we report an evaluation of FeeD4Mi regarding the posed RQs (see Section 1). More concretely, the evaluation was designed as an instrumental qualitative case study (Creswell, 2006), consisting of two co-design sessions (Case#A and Case#B) with three MOOC instructors (two were instructors of the same course) who were preparing their upcoming MOOCs. Case#A was about a MOOC on the subject of EU-Russia Relations and was offered in Estonia. Case#B involved a MOOC about Programming and was offered in Greece. Both included different types of activities. The participants were selected following a purposive sample approach (Fraenkel, Wallen, & Hyun, 2012). That is, participants were selected due to their previous experience as MOOC instructors (on average, 3 MOOCs), and due to their intention to provide a MOOC in the upcoming weeks. During the co-design sessions, we requested participants to perform tasks associated to the first three FeeD4Mi dimensions:

1. **Summarize the course LD:** We asked participants to outline their course, describing the modules, the activities (e.g., quizzes, documents), and their relationships and features (e.g., difficulty, group activities), according to the first dimension of the framework.

2. **Reflect and specify learners' problems:** We asked participants to specify potential problems that learners could face in their courses based on the previous outline. Initially, participants brainstormed about problems without the support of FeeD4Mi. The problems mentioned allowed us to evaluate the "completeness" of the catalogue of problems included in FeeD4Mi (RQ-1). In a second step, we introduced participants to the problems enlisted in such catalogue according to the course LD. This allowed us to test the "discoverability" of the problems suggested by FeeD4Mi (RQ-2).

3. **Reflect and select problem indicators:** We asked participants to connect the mentioned problems with indicators that could help identify such problems (e.g., video metrics). Participants brainstormed on the indicators without the support of FeeD4Mi and we evaluated the "completeness" of the indicators' catalogue (RQ-1). Later, we presented the FeeD4Mi catalogue to help participants to reflect on additional indicators that might result informative, thus testing "discoverability" (RQ-2).

The data sources used in this evaluation were: the participants' artefacts (i.e., participants products created during the co-design experiences) [*Art_CaseX*], which were analysed considering the FeeD4Mi catalogues; the recordings of the sessions [*Rec_CaseX*], from which the time employed was also measured; and the observations made by the leading researcher during such sessions [*Obs_CaseX*].

4. Results

The analysis of the artefacts created by instructors revealed a total number of 9 potential problems that were identified without using FeeD4Mi (see white colour in Table 2). While instructors from Case#A focused more on content-related problems (e.g., difficulty of quizzes, academical writing in assignments), instructor of Case#B focused more on peer interaction problems such as communications in discussion forums and peer assessments. FeeD4Mi already included 5 of those problems (55.56%). Problems related to learners' familiarity with the course platform, learners' different backgrounds, and lack of proper interaction among peers were mentioned by participants and they were not included in FeeD4Mi (see '*' in Table 2). After being exposed to the FeeD4Mi catalogue of problems, participants considered additional issues that might be potentially relevant to their courses. Concretely, 2 potential problems in Case#A (25% additional) and 4 potential problems in Case#B (57.14% additional). For 2 of such problems, participants expressed their concern regarding the difficulty and unawareness of how to deal with such challenges (before being introduced to the FeeD4Mi catalogue of indicators).

In the task *Reflect and select problem indicators*, participants identified 19 different indicators that may provide alerts on the previous problems (see Table 2). The FeeD4Mi catalogue of indicators already considered 14 of them (73.68%). It seems interesting to highlight that all the non-included indicators require content analysis for their interpretation, such as the analysis of the learners' submitted work or the content of forum posts. In the second step of this task using FeeD4Mi, a total number of 6 indicators were pointed out as useful (20.69%). Additionally, as expressed by Case#A instructors, while some indicators may not be meaningful enough alone, their combination with other indicators could reveal potential problems (e.g., the time spent in a quiz together with the number of video watches).

Furthermore, we evaluated also the effort associated to the sequential process related with the use of FeeD4Mi (which was performed during the co-design sessions). To that end, we analysed the data sources to understand the suitability and the difficulties of such process within instructors' regular MOOC practice (see Table 3). The excerpts suggest that the whole process helped participants to further reflect about potential learners' problems and to specify their own LD (see Table 3, *Positive*). Nevertheless, it is worth mentioning that participants also reported emerging negative impressions from such a process. Specifically, the reflection on problem indicators seemed a complex task for them that required extra effort (see Table 3, *Negative*). Additionally, the long duration of the process, on average 1.5 hours, was considered tiring for the instructors, who at the end, wanted to quickly finish the session.

5. Discussion & Conclusions

This study focused on supporting MOOC instructors in the identification of potential learners' problems and indicators, that may provide alerts on such problems, considering the course LD. To this end, we propose a conceptual framework, FeeD4Mi. *RQ-1* aimed at understanding the extent to which FeeD4Mi supports the problems and indicators associated with the LD as described by instructors. Results from the co-design sessions revealed that FeeD4Mi directly supports 55.56% and 73.68% of the problems and indicators, respectively. All non-supported indicators require content analysis of learners' posts and artefacts. This evaluation provided useful insights to complement the current catalogue of problems, although further work is needed to investigate useful indicators for such new potential problems.

RQ-2 deals with the discoverability of FeeD4Mi to help instructors reflect and identify problems and indicators not considered before. Results showed that instructors identified 6 additional problems thanks to the reflection triggered by FeeD4Mi. Specially, the LD and the association of problems with the different components helped to detect tricky course parts that can be challenging for learners. Also, it contributed in improving specific course aspects, such as the type and nature of activities. Moreover, instructors identified 6 additional indicators from the FeeD4Mi catalogue.

The co-design sessions also revealed that using FeeD4Mi was not a trivial task for MOOC instructors. In practice, we observed that the process associated to FeeD4Mi seemed time consuming and complex, especially towards the reflection on indicators. Likely, such complexity was influenced by the fact that the process lasted 1.5 hours. Consequently, it seems interesting to explore whether the time needed, and the complexity of the process can be reduced, and if these results are also transferable to novice MOOC instructors. The evaluation allowed us to collect initial evidence of the FeeD4Mi benefits and insights to refine the process and catalogues. This study presents some limitations as it is based on two co-design sessions involving only three MOOC instructors. As a future work, we plan to perform an evaluation with more instructors to understand the extent to which the results obtained in this study can be generalized for multiple instructors and course topics. This evaluation could also incorporate the remaining dimensions of the framework, aiming at a comprehensive overview of the framework benefits for the creation of instructor-designed feedback strategies in MOOCs.

Table 2. Identified learners' problems and indicators. Grey: Additional aspects emerged from the reflection with FeeD4Mi. *Aspects reported by the participants which were not included in FeeD4Mi

	Problem	Association with the LD	Problems' Indicators	
Case#A: EU-Russia Relations	Misunderstanding of the given task	Discussion forums and quizzes of modules 1-4	Posts in discussion forums Email from the learners A lot of time spent in a page	
	Issues of academic writing and referencing (various levels of knowledge)	Assignments of modules 4-5	*Analyzing submitted work Email from the learners More attempts in a quiz	
	*Communication skills	Discussion Forums	Post Interaction: entries and replies	
	*Students are not familiar with LMS functions	Module 0	Email from the learners *Posts in wrong spaces *Check post-course survey	
	Issues of connectivity and accessibility of various interactive materials	Content page, content videos and videos recap.	Logs of course access Check technical questions Email from the learners	
	*Language issues	Whole Course	Video features (pause, forward)	
	Absent/ non-active members	Whole Course	Check post-course survey	
	Deadline / Time issues	Whole Course	Posts in discussion forums Email from the learners Delays of activity submissions	
	Case#B: Programming	Peer assessment	Projects of modules 1-5	Scores in peer feedback
		*Different backgrounds	Discussion Forums	*Naïve/advanced questions
Low participation forums		Discussion Forums	A lot of visits in the forums	
Lack of instant feedback		Discussion Forums and Emails	Posts in discussion forums Non replies in posts / emails	
Understanding / Content issues		Whole Course	Posts in discussion forums Scores in quizzes	
Activities too difficult		Whole Course	Posts in discussion forums Scores in quizzes under thresholds	
Deadline / Time issues		Projects of modules 1-5	Posts in discussion forums Many posts of the same problem	

Table 3. Excerpts Related with the Co-Design Process.

Categories	Labels	Excerpts of Evidence
Positive	[Rec#CaseA]	"I think it was useful to reflect on the things that we should maybe pay attention to. [...]I think that for future planning, it's also relevant".
	[Rec#CaseB]	"I haven't noted the course design and what we created is really useful".
Negative	[Obs#CaseB]	The identification of indicators is more challenging to proceed than the

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