Supporting instructors in the design of actionable feedback for MOOCs

Paraskevi Topali
GSIC-EMIC Research Group
Universidad de Valladolid
Valladolid, Spain
evi.topali@gsic.uva.es

Alejandro Ortega-Arranz
GSIC-EMIC Research Group
Universidad de Valladolid
Valladolid, Spain
alex@gsic.uva.es

Irene-Angelica Chounta
Colaps Research Group
University of Duisburg-Essen
Duisburg, Germany
irene-angelica.chounta@uni-due.de

Juan I. Asensio-Pérez
GSIC-EMIC Research Group
Universidad de Valladolid
Valladolid, Spain
juaase@tel.uva.es

Alejandra Martínez-Monés
GSIC-EMIC Research Group
Universidad de Valladolid
Valladolid, Spain
amartine@infor.uva.es

Sara L. Villagrá-Sobrino
GSIC-EMIC Research Group
Universidad de Valladolid
Valladolid, Spain
sarena@pdg.uva.es

***Abstract*—The provision of feedback in Massive Open Online Courses (MOOCs) is a non-trivial task for instructors. Current Learning Analytics (LA) solutions provide opportunities for scaling up such feedback strategies. Yet, most of these solutions lack course contextualization and guidance for MOOC instructors. This paper presents a conceptual framework and a web-based tool aimed at supporting instructors in the design and enactment of feedback strategies within MOOC learning designs. Both the framework and the tool are based on a structured process and include a set of catalogues facilitating the reflection and (re)design of these strategies. Additionally, this paper reports an evaluation of the framework catalogues and the usefulness of the framework process in an online workshop (N=11). As part of this ongoing work, we also explored the experience of participants with the tool. The results are positive, highlighting the usefulness of the framework catalogues, especially for non-experienced MOOC instructors. We envision that the initial evidence gathered can contribute to research on conceptual and technological tools supporting feedback design, and to promote the synergy among LA and human-centered approaches in MOOC settings.**

Keywords—MOOCs, Feedback Design, MOOC Instructors, FeeD4Mi, FeeD4MiTool

I. INTRODUCTION

Despite the acknowledged impact of feedback on learning and engagement [1], Massive Open Online Courses (MOOCs) represent a learning context where delivering timely and personalized feedback regards an ongoing challenge [2], [3]. Specifically, the wide instructor-learners ratio renders difficult the manual provision of interventions that satisfy the learners' needs [4]. To address this problem, the field of Learning Analytics (LA) offers opportunities for automatically retrieving and interpreting information about learners' progress and thus, scaling up interventions. LA in MOOCs frequently involve techniques related to machine learning, visualizations, natural language processing, social network analysis, etc. [5]. These techniques can support instructors' awareness of learners' progress. However, the information provided is not always actionable, because LA solutions often lack contextualization within the course design. That is, LA may not consider the instructional decisions about the course (e.g., activities, expected learning outcomes, etc.) that can have a relevant impact in the identification of learners needing feedback and in the provision of such adequate feedback. For instance, knowing that the answers to a quiz can be found in a certain video could help trigger an intervention for those students who failed the quiz and had not watched the video.

Previous research highlighted the need for interpretation of LA together with the course learning design [6], [7], to support contextualized interventions. Approaches that promote teachers' agency in the design process of interventions have shown their potential to facilitate contextualized LA interventions [8]. Instructors are the ones who know best, for instance, the difficulty of each activity, the background needed for understanding the contents or the course learning steps where failing is most likely. Prior technological solutions [9]–[11] let instructors to control and select the parameters they consider informative for identifying critical cohorts of learners. However, and despite their promising results, existing proposals do not consider their implications for MOOC instructors (e.g., cognitive workload) [12], since they do not guide them in the process of designing feedback strategies. MOOC instructors could be guided and supported in this process by tools that help them identify the many aspects that are required by the design of effective feedback interventions (e.g., potential learners' problems, indicators to identify them, feedback interventions) [13].

To face the aforementioned challenges, we propose FeeD4Mi, a framework that aims to guide MOOC instructors in reflecting on learners' problems and preparing feedback interventions, and its supporting tool (namely FeeD4MiTool), that enables instructors to create and enact automatic and semi-automatic feedback interventions. This paper presents the results of a workshop conducted to evaluate the FeeD4Mi and to explore participants' experience with the FeeD4MiTool. Thus, the overarching research question (RQ) guiding this study is: "***How can FeeD4Mi support MOOC instructors in the design of feedback interventions that take into account the learning design of the course?***".

The structure of the paper is as follows. Section 2 provides an overview on the existing LA tools which give instructors an active role in the design of feedback aspects. Section 3 presents FeeD4Mi and FeeD4MiTool. Next, Section 4 illustrates the methodology of the study. Finally, Section 5 and Section 6 discuss the obtained results, and draw the lines of the future work, respectively.

II. RELATED WORK

Previous research explored the use of LA tools, such as dashboards, visualizations, and recommender systems to support the provision of automatic or semi-automatic feedback. For example, Klusener et al. [14], proposed a set of visualizations depicting learners' progress aiming at informing

instructors about reasons for potential dropouts, and thus, helping to shape adequate interventions. Teusner et al. [15] suggested the use of a recommender system to provide automated support to learners struggling with programming assignments. Wang et al. [16] discussed the creation of automatically generated feedback for correcting assignments. While these solutions support the scaling of feedback interventions in massive contexts, they do not consider contextual course aspects, such as the learning goals, the feedback aims or the learning topics per module.

There exist some other studies aiming at supporting instructors in the design of contextualized feedback strategies, but which were not originally intended for MOOC purposes. These studies describe LA tools for course instructors to personalize and fine-tune features for the detection of specific learner cohorts. For example, Ali et al. [9] presented LOCO, a LA tool presenting students' performance where instructors were able to select the most informative LA features to understand the learners' progress and to discover problems and weaknesses. Similarly, Liu et al. [10] and Pardo et al. [11] presented the Student Relationship Engagement and OnTask systems, respectively, that permitted educators to select the metrics of their preference and provide personalized feedback through email messages to students.

Nevertheless, these proposals do not guide instructors throughout the process of designing feedback (e.g., which indicators could be applied according to the envisioned problem). The design of feedback interventions should be associated with decisions related to the timing, the content, and the type of support. MOOC instructors may lack understanding of the information provided by LA tools or ignore feedback related aspects, especially if they do not have previous experience in MOOC settings. Thus, the provision of guidance on how to design feedback for large scale may be a more supportive approach.

Attending the previous limitation, in this paper we propose FeeD4Mi to help MOOC instructors in the design of feedback strategies following a human-centered approach. Additionally, we present a web-based tool (FeeD4MiTool) which incorporates the main features of FeeD4Mi to enable instructors to create computer-interpretable feedback interventions within learning designs.

III. FEED4MI

FeeD4Mi is a conceptual framework created with the purpose of driving MOOC instructors to: (a) consider potential learners' problems that can arise during the course, within the elements of the course design, (b) associate such problems with indicators that could identify students experiencing such problems, and (c) define feedback interventions based on the identified problems. The framework is constructed following a Design-Based Research (DBR) methodology [17]. DBR is organized in several design phases, and it is applied in an iterative way to refine the developed solutions progressively under a close collaboration with the stakeholders. Likewise, we built FeeD4Mi based on MOOC-related literature and on interviews with MOOC instructors. FeeD4Mi is further refined following a human-centered iterative procedure through a set of co-design events with MOOC instructors [18].

FeeD4Mi consists of five dimensions (see Figure 1), namely Learning Design, Learner Problems, Problem Indicators, Feedback Condition Synthesis and Feedback Aspects. These five dimensions are organized as a sequential process, aiming at facilitating instructors in the design of feedback strategies. Therefore, through this process, instructors start from a reflection on the pedagogical aspects of their course (Learning Design dimension), and on possible behaviours of learners that face a problem (Learner Problem and Problem Indicators dimensions) to come up with feedback interventions adapted to the different behaviours identified (Feedback Conditions Synthesis and Feedback Aspects). Additionally, FeeD4Mi includes a catalogue of potential learners' problems, indicators and feedback interventions that can help MOOC instructors (especially non-experienced instructors) in the design of feedback strategies.

To make the feedback designs automatically actionable in online environments, we have implemented the FeeD4Mi framework (including the process and catalogues) into a technological solution: FeeD4MiTool. FeeD4MiTool is a tool that represents and imports learning designs to which feedback strategies can be attached by following the aforementioned process. Additionally, FeeD4MiTool also enables the automatic enactment of the designed feedback strategies during course run-time (e.g., identify learners with potential problems, provide the configured feedback interventions). Figure 2 presents two screenshots of the tool, including (a) the dimension where relations among learning design components are configured; and (b) the dimension where the problems and indicators are configured.

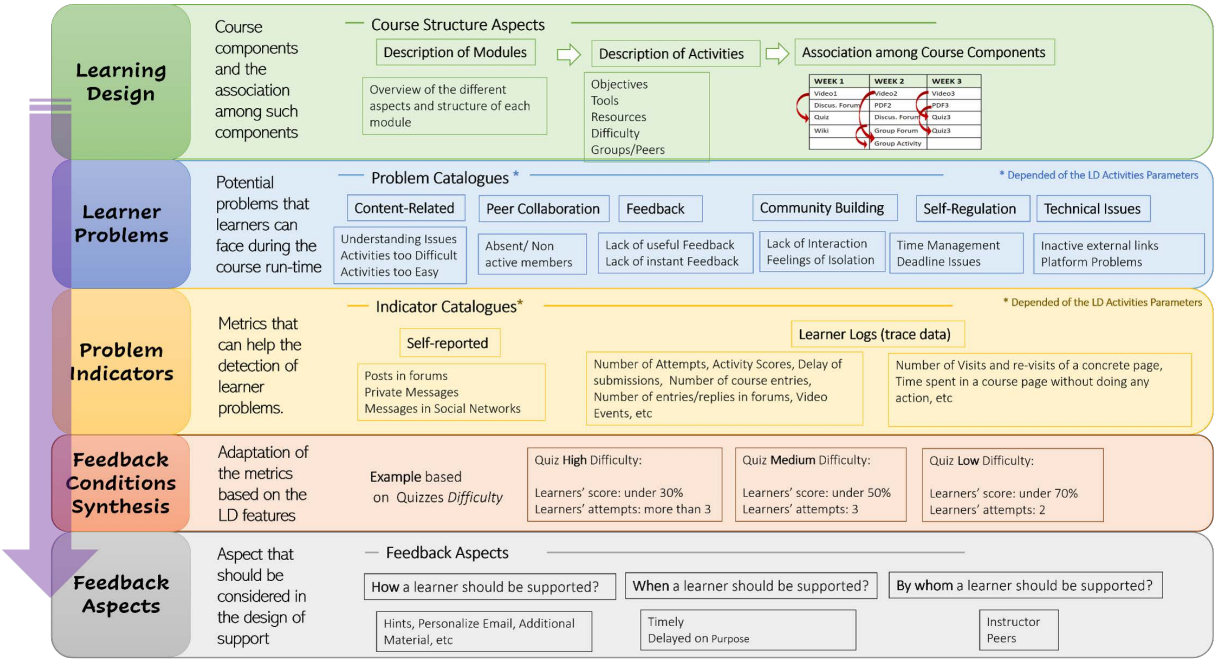

Fig. 1. FeeD4Mi overview representing the framework dimensions and the associated catalogues

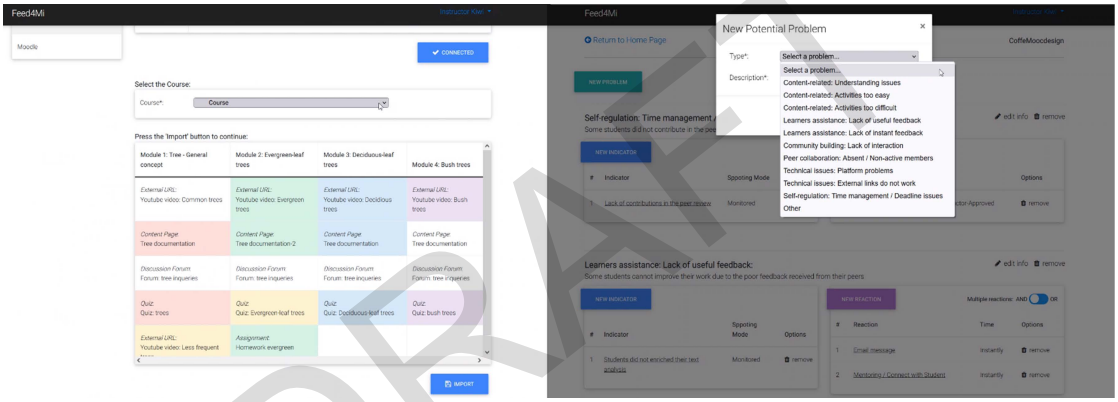

Fig. 2. Screenshots of FeeD4MiTool.

IV. Methodology

The goal of this paper is to examine how FeeD4Mi can support MOOC instructors in the design of feedback practices. To help answer the posed RQ, we have identified two sub-questions:

- RQ1: To what extent the envisioned student problems, the associated indicators and the expected reactions designed by the participants are supported by the FeeD4Mi catalogues? (**Catalogue Completeness**)
- RQ2: How the FeeD4Mi process suits the participants' design practice? (**Process Usefulness**)

Apart from evaluating the framework, we additionally explored FeeD4MiTool by gathering the perceptions of participants regarding their experience with the tool.

A. Study Context & Participants

To involve the end users actively in the design process of feedback interventions, we organized a 3-hour workshop. In our case, we conducted an open-enrolment workshop about feedback in MOOCs carried out in a MOOC-related international conference that was fully online. The participants of the evaluation were selected following a convenience sample approach. Convenience sampling refers to the use of target individuals that are available for the evaluation [19]. Yet, all participants were likely to have interest in MOOCs as the expected users of FeeD4Mi/FeeD4MiTool. A total number of 11 participants located in 9 different countries gave their informed consent to participate in this study. Figure 3 shows a detailed graphic of participants' previous experience as MOOC instructors, students, and researchers.

B. Data Collection and Analysis

During the workshop, participants were randomly assigned to groups of 3 or 4 people which also included one facilitator who guided participants through the different phases of the workshop. Each group was provided with a real MOOC design to collaboratively reflect on potential learners' problems, their indicators, and to design feedback interventions. The data analysis followed a mixed-method design [20]. We collected qualitative and quantitative data, and the results of the analysis were triangulated to understand the perceptions and experiences of participants with the tool. This process is presented in Figure 4. The workshop was divided in three sequential happenings:

- Happening 1 (H1) "*Participants create their feedback designs without the use of FeeD4Mi*": Each group received a different MOOC design outline in a MuralApp canvas. Based on the course information (i.e., course context, type of activities, relationship among the activities, course duration etc.), participants created feedback strategies by following the FeeD4Mi process (i.e., detecting potential learner problems, associating them with indicators, deciding feedback interventions). In this happening, participants were not provided with the FeeD4Mi catalogues to avoid biasing them in the design of their feedback strategies. This information helped to understand to what extent the feedback design decisions of participants are supported by the catalogues of FeeD4Mi.
- Happening 2 (H2) "*Participants create their feedback designs with the use of FeeD4Mi*": After a short live demo of FeeD4MiTool, groups were provided with a guide for starters. Using this guide, we asked the groups to computationally configure some of the feedback strategies designed before by using FeeD4MiTool. Participants were encouraged by the facilitators to check the different catalogues of the tool and to consider them when (re)designing their strategies. During this happening, participants were given the chance to explore and familiarize with the FeeD4Mi process, catalogues, and tool.
- Happening 3 (H3) "*Participants respond the questionnaire regarding their experience with FeeD4Mi and FeeD4MiTool*": Participants were provided with an online questionnaire to collect their perceptions and experience with FeeD4Mi including its process, catalogues, and technological development. The questionnaire included 4 Likert-scale questions with associated textboxes to further explain the given scores (see Table 1), the Net Promoter Score (NPS) item [21], and two open-ended questions about what they liked the most and the least about the tool.

The iterative methodology that is being followed to develop FeeD4Mi (i.e., DBR) will help us to refine and enhance the proposed framework and tool according to the results and insights obtained in this formative evaluation. FeeD4Mi evaluation happened through the FeeD4MiTool which incorporated the aspects of the framework. Thus, we additionally gathered the perceptions of participants regarding their experience with the tool.

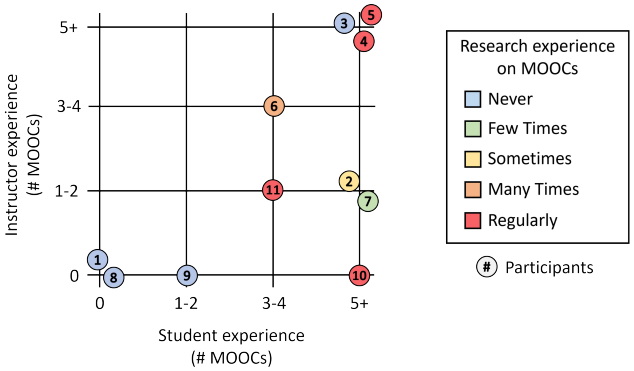

Fig. 3. Participants' previous experience on MOOCs.

V. Results

This section describes the results of the evaluation following the same structure of the research design (see Figure 1). All the results are supported with the corresponding excerpts of evidence using the following tag: *[happening:data source:participant].*

A. Catalogue Completeness

During H1, participants came up with 44 potential learner problems that may lead to a feedback intervention. We compared these problems with the ones included in the FeeD4Mi catalogue of learners' problems. In summary, FeeD4Mi included 14 out of 44 problems named by participants (31.82%), mainly related to content understanding, peer collaboration and feedback issues. Six (6) problems could be supported by the framework with a more detailed description of the catalogue aspects. From these 6 problems, one regarded content-related issues, and the rest of them addressed peer and group collaboration aspects. Specifically, while FeeD4Mi includes a general category on peer collaboration problems, this category needs a better description to add concrete issues such as those mentioned by participants: "the unequal contribution on group assignments" [H1: Art] or the "fair evaluation of peer assignments" [H1: Art]. Finally, the framework did not include 16 reported problems, many of which were related with the learning and instructional design of the course (N=10). For example, participants reported issues regarding "the design of only mandatory assignments which may decrease the course interest". The rest of the aspects mentioned (N=9) were not considered as problems, since they regarded either general comments about the course-design (N=5) or indicator ideas (N=3). Probably these proposals were due to participants misconceptions, fact that a facilitator observed, i.e., "I noticed some misinterpretations or misconceptions between participants' statements, [..]" [H1: Obs].

Regarding the indicators, participants reported 43 indicators as alerts of the previous learners' problems, out of which 29 are covered by FeeD4Mi (67.44%). Examples of such indicators regard learners' scores in assignments, learners' post interaction (for example, entries and replies in forums) or learners' clickstream activity. Ten (10) indicators (23.26%) were not included in FeeD4Mi. Among these indicators we found proposals about "number of learners at a concrete point of MOOC set by instructor", and "number of off-topic words in forum posts" [H1: Art]. From the rest of the indicators (N=4), 2 were not precise enough, and 2 were not measurable (e.g., "students care too much about the results of peer assessment" [H1: Art]).

Participants proposed 21 feedback actions to overcome learners' potential problems. FeeD4Mi confirm 13 of such solutions (61.90%), such as improving peer assessment via "rubrics on how to access", offering good practices and clear explanations related with course actions, e.g., "provide examples of good reflections" [H1: Art] and applying gamification via leaderboards and badges. Participants reported 8 additional interventions, not supported by FeeD4Mi. Five (5) of them were related with the group formation and peer evaluations, such as "some learning analytics-based feedback about peers", "evaluation of peer members" [H1: Art]. Other proposals regarded "breaking tasks in smaller steps" and "Instructors to start Threads where learners can interact with group members" [H1: Art].

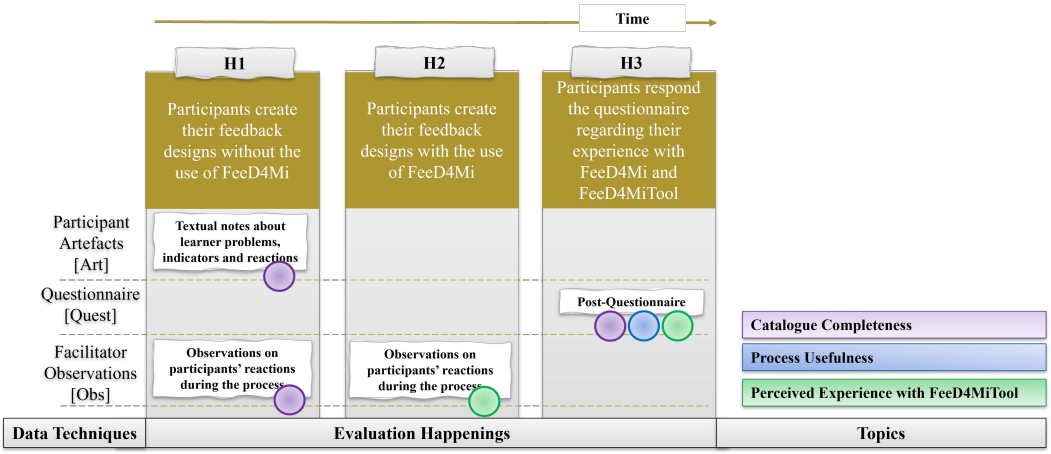

Fig. 4. Evaluation happenings, data gathering techniques and explored topics employed in this study.

The answers at the [ST1] item of the questionnaire (Table 1) permitted us to complement our insights about FeeD4Mi catalogues. Most of the participants expressed positive impressions about the collection of aspects that FeeD4Mi offers. For instance, "I think the combination of qualitative/quantitative indicators for problems is useful" [H3: Quest: Part#1], "The use of a predefined feedback aspects opens up some new way to increase the engagement of learners in the MOOCs" [H3: Quest: Part#6]. Two of the participants with high experience as MOOC instructors (5+ Courses) acknowledged the interest of the proposal, highlighting their awareness of the catalogue ideas presented. Characteristically, "It has a good repository of options, and these are well-known" [H3: Quest: Part#7], "It is a very nice implementation of ideas I already met before" [H3: Quest: Part#9]. Additionally, participants self-reported that FeeD4Mi helped them to reflect on further aspects "The different options regarding the rules allowed me to identify conditions I never thought about before" [H3: Quest: Part#10], and its contribution could be promising for the design of feedback interventions "The use of a predefined feedback aspects opens up some new way to increase the engagement of learners in the MOOCs" [H3: Quest: Part#6].

Finally, to investigate the extent to which participants' MOOC previous experience relates to their perceptions of the FeeD4Mi catalogues, we calculated the Spearman's order-rank coefficient. Spearman's correlation was selected due to the ordinal and non-numerical possible answers regarding the previous experience of participants (e.g., 1-2 courses, 3-4 courses). Results (see Table 2) show a significant negative strong correlation (ρ=-0.896, p-value<0.001) between the catalogue usefulness and the previous experience as MOOC instructor. That is, although, in general the catalogue suggestions were considered as useful for most participants (Med = 4 out of 5, IQR = 1.5), the more experienced the participant is, the less useful the FeeD4Mi catalogue is. Considering our small sample size, this correlation had an indicative character.

B. *Process Usefulness*

[ST2] and [ST3] helped us to shed light on how participants perceived the FeeD4Mi process. Results revealed the participants' broad agreement on the usefulness of guiding them through the process of designing feedback strategies with FeeD4Mi (Med = 4 out of 5, IQR = 0.5). Self-reported comments highlighted:

- The helpful structure of the process: "It's a simple but well-designed process since every step depends on the previous one" [H3: Quest: Part#10]
- Its value on designing interventions: "The process of identifying indicators for the problem at hand and then selecting proper reactions seems promising for providing more authentic feedback" [H3: Quest: Part#4].
- The participants' positive experience: "It forces you to reflect on the feedback process" [H3: Quest: Part#8].

Additionally, results on the correlation analysis between the usefulness of the process ([ST2], [ST3]) and the previous experience of the participants (see Table 2) did not reveal significant correlations. Therefore, we can infer that the general agreement on the usefulness of the process was confirmed for both experienced and non-experienced participants.

C. *Experience with FeeD4MiTool*

The observations and the comments provided at [ST4] illuminated participants experience with FeeD4MiTool which, in general, was perceived as helpful for the design of feedback interventions, e.g., "this tool is effective in MOOC practice" [H3: Quest: Part#11], and for teacher practices, e.g., "It will be an efficient way to summarize my actions as a teacher" [H3: Quest: Part#10]. Facilitators' observations highlighted participants' interest with the tool and the straight-forward process, i.e., "they were interested in how the tool works and it was easy for them to find their work around" [H2: Obs].

FeeD4MiTool potential adoption was measured through the NPS [21], an item often use to measure user loyalty. The NPS is calculated as the percentage of promoters (participants selecting 9 or 10 in the likelihood-to-recommend item) minus the percentage of Detractors (participants selecting 0 to 6). The NPS obtained in this evaluation is -18. This score shows the potential of the tool (1 Promoter, 7 Neutrals, 3 Detractors) but it needs some usability changes before being adopted, as stated by participants in the questionnaire [21]. In this regard, few participants expressed their concerns such as "I personally

think the reaction selection should have a bit of adaptivity based on the indicators" [H3: Quest: Part#4], or "While the platform is very user friendly, the number of different attributes might be a bit overwhelming" [H3: Quest: Part#4].

Moreover, we asked participants to report what they liked the most and the least during their experience with the FeeD4Mi and FeeD4MiTool. FeeD4Mi was considered as "facilitating scaffolding of learning in MOOCs" [H3: Quest: Part#9] with participants to mention its possibilities for feedback design (N=3) and the structured process (N=3) among the most beneficial aspects. Specifically, "[I liked the most that] it is possible to build from earlier identified problems and categories, but also to elaborate on them" [H3: Quest: Part#1], "I like the possibility to send specific feedback using the if/then rules" [H3: Quest: Part#2]. Other positive aspects regarded the FeeD4MiTool which "is built intuitively, has nice interface and it is easy to use" [H3: Quest: Part#5] and "the flexibility of feedback and interventions" [H3: Quest: Part#4] it offers. On the other hand, several participants reported the various aspects FeeD4MiTool lack: (i) of hints in concrete steps of the process, e.g., "lack of hints of how using the system" [H3: Quest: Part#6], (ii) flexibility e.g., "I think there should be an adaptive connection between the module type, potential problems and proper solution" [H3: Quest: Part#4].

TABLE I. H3 QUESTIONNAIRE ITEMS RELATED TO PARTICIPANTS EXPERIENCE WITH FEED4MITOOL AND FEED4MI (N=11).

Label	Questionnaire Statement	Median	IQR
[ST1]	FeeD4Mi suggested me feedback aspects (problems, indicators, reactions) that I did not consider before and which could be useful in my feedback design	4	1.5
[ST2]	The process followed (i.e., identification of LD components, identification of problems, identification of indicators and thresholds, selection of reactions) was helpful to design relevant feedback strategies	4	0.5
[ST3]	The process followed was relevant/logical for the design of feedback interventions	4	0
[ST4]	I would be interested in using FeeD4MiTool for feedback in my courses	4.5	1.25

TABLE II. SPEARMAN CORRELATION COEFFICIENT REGARDING PARTICIPANTS' PREVIOUS EXPERIENCE AND PARTICIPANTS' PERCEPTIONS ABOUT FEED4MI (N=11). *SIGNIFICANT AT P<0.001.

Previous Experience	[ST1]	[ST2]	[ST3]	[ST4]
MOOC Instructor	-0.896*	-0.345	0.030	-0.133
MOOC Student	-0.530	-0.088	-0.041	0.252
MOOC Researcher	-0.349	0.352	-0.192	0.172

VI. DISCUSSION AND CONLUSIONS

Acknowledging the challenge of the provision of effective feedback in MOOC settings [2], [3], the current paper explores how MOOC instructors can be supported in the design of feedback interventions considering course design aspects. To that end, we introduced FeeD4Mi and FeeD4MiTool, a conceptual and a technological tool to guide instructions in the design and delivery of feedback in MOOCs. In this paper we report the second iteration of FeeD4Mi and FeeD4MiTool which were evaluated with MOOC-related stakeholders through a remote workshop addressing the RQ "How can FeeD4Mi support MOOC instructors in the design of feedback interventions that take into account the learning design of the course?". Our results are encouraging, indicating the benefits of the FeeD4Mi catalogues (RQ1) and the FeeD4Mi process (RQ2).

Concretely, attending the catalogue completeness, the results revealed that FeeD4Mi fully covers 31.82% of the problems, 67.44% of the indicators and 61.90% of the feedback reactions as stated by the participants. This evidence suggests that FeeD4Mi can represent most of the feedback strategies designed, especially the indicators and feedback reactions. Although the learners' problem category got a relatively low percentage of support, we observed that many participants' answers referred to concretions of other general problems supported by FeeD4Mi. Additionally, the self-reported comments complemented our insights about the FeeD4Mi catalogue, which agreed its potential value for the feedback design ([ST1] med = 4/5, IQR= 1.5). Based on such comments, FeeD4Mi seemed to facilitate participants' reflection on learners' challenges, on metrics to detect such challenges and on reactions that they had not considered before. The strong negative correlation between participants' MOOC previous experience and their perceptions revealed that the more experienced the participants are, the less informative the catalogues are.

On the other hand, participants revealed aspects not included in FeeD4Mi. Many participants pointed out learners' problems that were associated with learning design decisions, such as the type of assignments (e.g., compulsory or optional), or the alignment of the course objectives. Non-supported indicators were related to critical points of the course such as the level of engagement in a specific activity or the examination of the number of learners at concrete course moments. Although these proposals were not observed in previous co-design sessions of FeeD4Mi, in the next iteration we will examine the inclusion of such indicators and its connection with the reported learner problems. Finally, most of the new reactions reported by participants were related to group or peer formation. While FeeD4Mi is considering problems related to group/peer collaboration, this evaluation helped us to spot the need for better definition of the options offered by our framework to address such problems and enhances it with further ideas. Attending the proposals that were either broad enough or not matching with problems and indicators, FeeD4Mi could be useful for cases where inductors cannot specify aspects of their course and reflect on concrete problems, indicators, and support reactions.

With respect to the FeeD4Mi process, [ST2] and [ST3] served to examine the usefulness of such process for the design of feedback strategies. The qualitative evidence gathered and participants' high rate ([ST2] Med = 4/5, IQR= 0.5; [ST3] Med = 4/5, IQR = 0) revealed the positive perception about the relevance and usefulness of the FeeD4Mi process. Additionally, the existence of non-significant correlation between participants' previous MOOC experience and the usefulness of the process indicates that FeeD4Mi was perceived as useful for both experienced and non-experienced users. Also, the FeeD4Mi process was among the main aspects the participants liked, a fact that was highlighted by the evidence gathered on the open-ended question "What did you like most from the FeeD4Mi?"

Furthermore, we evaluated participants' experience with the FeeD4MiTool tool which incorporated all the catalogues and the framework structured process. The general perceptions were positive and regarded the support it offers to MOOC instructors and the pleasant interface. However, the negative Net Promoter Score (-18) and the various comments in the final questionnaire pointed out several limitations associated with the lack of descriptions and hints in the tool that could ease its use, and the lack of flexibility, especially on the indicator selection page.

Finally, this study presents a set of limitations that need to be considered. The first limitation regards the participants' selection criteria (convenience sampling) depending on the availability of the participants during the settings of a conference. Despite the strong connection of the conference with MOOC topics, in the future we plan to evaluate the updated FeeD4Mi version following a purposive sample approach [18], that is, selecting participants based on their knowledge and previous experience about the topic (i.e., feedback design in MOOCs). Additionally, we acknowledge that due to the small sample size providing answers to the workshop questionnaire (N=11), we cannot generalize these results. Therefore, considering the study findings and the limitations mentioned above, we plan to carry out a new evaluation of FeeD4Mi, as a new iteration of the DBR methodology, in which we will apply the improvements observed. We envision that the initial evidence gathered can contribute to research on conceptual and technological tools supporting feedback design, and to promote the synergy among LA and human-centered approaches in MOOC settings.

ACKNOWLEDGMENT

This study has been partially funded by the Spanish State Research Agency and the European Regional Development Fund (TIN2017-85179-C3-2-R, PID2020-112584RB-C32) and the European Social Fund and Regional Council of Education of Castile and Leon (E-47-2018-0108488).

REFERENCES

[1] A. Espasa and J. Meneses, "Analysing feedback processes in an online teaching and learning environment: An exploratory study," *High. Educ.*, vol. 59, no. 3, pp. 277–292, 2010.

[2] H. Aldowah, H. Al-Samarraie, A. I. Alzahrani, and N. Alalwan, "Factors affecting student dropout in MOOCs: a cause and effect decision-making model," *J. Comput. High. Educ.*, vol. 32, no. 2, pp. 429–454, 2020.

[3] E. B. Gregori, J. Zhang, C. Galván-Fernández, and F. Fernández-Navarro, "Learner support in MOOCs: Identifying variables linked to completion," *Comput. Educ.*, vol. 122, pp. 153–168, 2018.

[4] S. Shatnawi, M. M. Gaber, and M. Cocea, "Automatic content related feedback for MOOCs based on course domain ontology," in *International Conference on Intelligent Data Engineering and Automated Learning*, 2014, pp. 27–35.

[5] M. Khalil and M. Ebner, "When learning analytics meets MOOCs - A review on iMooX case studies," in *Communications in Computer and Information Science*, 2016.

[6] M. Dollinger and J. M. Lodge, "Co-Creation strategies for learning analytics," in *ACM Intern. Conference Proceeding Series*, 2018, pp. 97–101.

[7] D. Gašević, S. Dawson, T. Rogers, and D. Gasevic, "Learning analytics should not promote one size fits all: The effects of instructional conditions in predicting academic success," *Internet High. Educ.*, vol. 28, pp. 68–84, 2016.

[8] M. J. Rodríguez-Triana, L. P. Prieto, A. Martínez-Monés, J. I. Asensio-Pérez, and Y. Dimitriadis, "The teacher in the loop: Customizing multimodal learning analytics for blended learning," *Proc. 8th Intern. Conference on Learning Analytics and Knowledge*, 2018, pp. 417–426.

[9] L. Ali, M. Hatala, D. Gašević, and J. Jovanović, "A qualitative evaluation of evolution of a learning analytics tool," *Comput. Educ.*, vol. 58, no. 1, pp. 470–489, 2012.

[10] D. Y. T. Liu, K. Bartimote-Aufflick, A. Pardo, and A. J. Bridgeman, "Data-driven personalization of student learning support in higher education," in *Learning Analytics: Fundaments, Applications, and Trends*, vol. 94, A. Peña-Ayala, Ed. Springer, Cham, 2017, pp. 143–169.

[11] A. Pardo, K. Bartimote-Aufflick, S. Buckingham Shum, S. Dawson, J. Gao, D. Gašević, S. Leichtweis, D. Liu, R. Martinez-Maldonaldo, N. Mirriahi, A. C. M. Moskal, J. Schulte, G. Siemens, and L. Vigentini, "OnTask: Delivering Data-Informed, Personalized Learning Support Actions," *J. Learn. Anal.*, vol. 5, no. 3, pp. 235–249, 2018.

[12] I. A. Chounta and N. Avouris, "Towards the real-time evaluation of collaborative activities: Integration of an automatic rater of collaboration quality in the classroom from the teacher's perspective," *Educ. Inf. Technol.*, vol. 21, no. 4, pp. 815–835, 2016.

[13] J. Hattie and H. Timperley, "The power of feedback," *Review of Educational Research*, vol. 77, no. 1. pp. 81–112, 2007.

[14] M. Klusener and A. Fortenbacher, "Predicting students' success based on forum activities in MOOCs," in *Proceedings of the 8th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications*, 2015, pp. 925–928.

[15] R. Teusner, T. Hille, and T. Staubitz, "Effects of Automated Interventions in Programming Assignments : Evidence from a Field Experiment," in *Proceedings of the Fifth Annual ACM Conference on Learning at Scale*, 2018, pp. 1–10.

[16] K. Wang, B. Lin, B. Rettig, P. Pardi, and R. Singh, "Data-driven feedback generator for online programing courses," in *Proceedings of the Fourth ACM Conference on Learning @ Scale*, 2017, pp. 257–260.

[17] T. Amiel and T. C. Reeves, "Design-Based Research and Educational Technology : Rethinking Technology and the Research Agenda," *Educ. Technol. Soc.*, vol. 11, no. 4, pp. 29–40, 2008.

[18] P. Topali, Ortega-Arranz, A., Martínez-Monés, A., Villagrá-Sobrino, S., Asensio-Pérez, J.I.& Dimitriadis, Y." Supporting MOOC Instructors in the Identification of Learner Problems Framed within the Learning Design" in *Proceedings of 29th International Conference on Computers in Education,* 2021, pp. 297-302

[19] J. R. Fraenkel, N. E. Wallen, and H. H. Hyun, *How to Design and Evaluate Research in Education, 8th Edition (2012)*. Brooklyn Park, MN, U.S.A.: McGraw-Hill Education, 2012.

[20] J. W. Creswell, *Research design: qualitative, quantitative and mixed approaches*. Thousands Oaks, CA, U.S.A: SAGE Publications Inc, 2013.

[21] F. F. Reichheld, "The One Number You Need to Grow," *Harvard Business Review*, vol. 81, no. 12. pp. 46–54, 2003.