Education Tech Research Dev (2022) 70:263–288
https://doi.org/10.1007/s11423-022-10081-4

DEVELOPMENT ARTICLE

Learner-centric MOOC model: a pedagogical design model towards active learner participation and higher completion rates

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Accepted: 9 January 2022 / Published online: 25 January 2022

Abstract
MOOCs support the global need of learning resources with large impact through online access and no geographical boundaries. However, pedagogical design limitations in MOOCs are known to result in passive role of the learner, lack of learner connect and engagement, limited interactivity with course content and peers, all of which result in low completion rates. In this paper, we present the goals of a learner-centric MOOC (LCM) model aimed towards addressing some of the critical pedagogical challenges of MOOCs and exhibit the use of the model through its primary implementation phase. The LCM model collates and translates all integral pedagogical elements of a MOOC into a learner-centric dimension to promote active learner participation and enhanced engagement with learning content and peers through fostered interactions. To demonstrate the primary use and effectiveness of the model, it has been adopted in the design and conduct of 15 different MOOCs, which were offered through two different MOOC providers. Initial empirical evidence has been presented for the effectiveness of the model towards improved learner participation through several measures, including completion rates, engagement of participants with LCM elements and perception of learners on the usefulness of the model and its adoption. The average completion rate for 15 LCMs was found to be 36.35 ± 25.61, 95% CI: 10.74–61.96%, which is significantly higher than the completion rates reported in literature. The average persistent rates, defined as the rate of completion for active learners, was 59.38% for LCMs. The model elements were also found to be effective in engaging learners in formative assessment activities and meaningful peer discussions on the forum. The learners' perception on the adoption of the LCM model voiced several pedagogical benefits of the model which were categorized into themes. These included enhanced learner motivation and engagement with content, enhanced interactivity and peer learning, formative assessment and feedback, and catering to diversity. These themes directly aligned with desired pedagogical outcomes of the model to address some of the existing limitations of MOOCs.

Keywords MOOCs · Challenges in MOOCs · Learner-centric MOOC model · Pedagogical design · Learner engagement · Completion rate

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Introduction

Though teaching and learning in an online environment is different from classroom education, the outcome is expected to be the same i.e. good learning. The definition of good learning states that it is collaborative and social, not competitive and isolated (Chickering & Gamson, 1987). However, in a technology-driven learning environment, good learning should: (1) encourage reflection, (2) enable dialogues, (3) foster collaboration, (4) apply theory learnt to practice, (5) create a community of peers, (6) enable creativity, and (7) motivate the learners (Conole, 2013). The integration of these factors becomes crucial during the design of online learning content.

MOOCs support the global need of learning resources with large impact through online access and no geographical boundaries (Baturay, 2015). However, maintaining high retention rates in MOOCs has often been a challenge (Reich & Ruipérez-Valiente, 2019). This challenge points towards poor learner motivation, which may decline with time due to personal reasons or due to known limitations in the design of MOOCs (Khalil & Ebner, 2014; Yousef et al., 2014). Literature denotes that the pedagogical design of MOOCs is currently insufficient to cater the diversity of geographically dispersed learners with varied motivations, educational backgrounds and learning requirements (Hew, 2018; Sunar et al., 2015). As reported in a recent field study on behavioral science interventions in online education, adequately supporting diverse students requires more than a light-touch intervention (Kizilcec et al., 2020). The design limitations are attributed to inefficient pedagogical considerations and adoption of teaching–learning strategies which mimic the classroom lecture format (Ubell, 2017). The report further states that these pedagogical strategies ignore the established theories of how people learn and plausible integration of innovative developments of technology in online learning. This results in a passive role of the learner, lack of learner connect and engagement, limited interactivity of learners with course content and feeling of isolation and boredom for participants, all of which in turn result in low completion rates (Jordan, 2015).

Numerous MOOC design guidelines and frameworks in literature enumerate important learning support elements to address the existing pedagogical challenges (Conole, 2013; Gayoung et al., 2016; Hew, 2018; Pilli & Admiraal, 2017). However, MOOCs' low completion rate has barely improved, despite years of investment in course development and learning research (Reich & Ruipérez-Valiente, 2019). The MOOC instructors had also pointed out the amount of effort required to design a MOOC addressing the expectations of the learners (Evans & Myrick, 2015). Thus there is a need to come up with a prescriptive MOOC model with refined pedagogy illustrating the details of the MOOC design, its goals as well as experimental evidence, beyond proof of concept, for its implementation and effectiveness. Here, we present the learner-centric MOOC (LCM) model to address some of the existing MOOC challenges of learner engagement and improve the learning quality of MOOCs. This study is aimed at presenting the primary use of the model towards building improved learner participation, learner action and interaction with the content to achieve meaningful learning. It also lends guidance towards design challenges, such as encouragement of collaboration, participant engagement and video content development, which are often faced by MOOC instructors (Sari et al., 2020). In the primary implementation phase, the model was adopted in 15 different MOOCs which were offered through two MOOC providers, namely National Programme on Technology Enhanced Learning (NPTEL) and IITBombayX. Through evaluations on the components of the LCM model adopted in these MOOCs, initial empirical evidence has also been provided on the effectiveness of the model towards increased learner participation and engagement.

Background

In a learner-centric instructional approach, learners are considered as co-creators of knowledge (Huang, 2002) who influence the content, activities and pace of learning (Froyd & Simpson, 2008). It has been known that well implemented learner-centric instructions, in a classroom setting, can lead to increased motivation to learn, greater retention of knowledge and deeper understanding of content (Collins & O'Brien, 2003).

In the context of online learning, before the advent of MOOCs, studies have shown that active learning strategies promoted learner achievement, enhanced motivation and resulted in deeper learning (Austin & Mescia, 2004; Phillips, 2005). Some of these active learning strategies used in online learning content include quizzes with immediate feedback, group projects, video lectures with questions, reflective writing, readings etc. (Austin & Mescia, 2004). The activities engage the learners and help them create their own learning experience, where the role of an educator transitions from an expert transmitting information to a facilitator guiding the students. However, such a learner-centric online environment needs to be fostered by instructors through deliberate planning. Several MOOC studies reflect on strategic and design guidelines regarding the adoption of learner-centric approaches, while only a few MOOCs employ these strategies, that too, as discrete entities. Some of these existing pedagogical strategies in MOOCs have been described in the next section.

Pedagogical strategies and frameworks in MOOCs

Experts in the field have proposed and implemented several pedagogical strategies and frameworks in the design of MOOCs. We have clustered this MOOC literature into two categories as: (1) pedagogical strategies drawn from existing MOOC experiences and (2) proposed frameworks and models for MOOC design.

Pedagogical strategies drawn from existing MOOC experiences

While designing or evaluating the pedagogical approaches of MOOCs, the perspective of a learner is equally critical as that of an instructor. Various MOOC design principles have been proposed from learners' perspective, including learner empowerment as active learner, clear orientations, collaborative learning, peer assistance and feedback, and use of technology to enhance learning (Guàrdia et al., 2013). Another survey-based empirical study, targeting learners and professors with MOOC experience, identified 74 indicators which were distributed over six categories (Yousef et al., 2014). The two key categories identified for effective MOOCs, included learning analytics for providing feedback to learners, performance reports, self-reflection; and assessment which emphasized on different types of assessment integrated within tasks to provide feedback to learners.

A literature review, investigating significant factors leading to high attrition rates in MOOCs, suggested enhancement in student–student and student-instructor interaction, peer-assessment and development of online skills as possible methods to improve MOOC retention (Khalil & Ebner, 2014). Findings from 56 MOOC publications were synthesized to formulate 13 course design suggestions in order to enhance students' engagement, improve academic achievement and lower the attrition rates of MOOC (Pilli & Admiraal, 2017). Many of the suggested learner-centric design strategies such as encouraging students to participate, personalized feedback, peer and self-assessment, facilitating learner-centered communities, have also been emphasized in earlier MOOC design literature.

A number of pedagogical strategies in MOOCs have also been proposed through case studies comparing a set of MOOCs. One such case study reported five design strategies, implemented in three highly-rated MOOCs from different disciplines (Hew, 2016). These strategies include (1) problem-centric learning with clear expositions, (2) instructor accessibility and passion, (3) active learning, (4) peer interaction, and (5) using varied helpful course resources and bite-sized videos covering one or two main concepts. In a follow-up study, top 10 highly-rated MOOCs were evaluated to reveal the effective design strategies for MOOCs (Hew, 2018). The most frequently mentioned engagement factors remained the same as stated in the earlier report, while the two most commonly reported student disaffections were attributed to forum- and peer-related issues. Though all of these pedagogical design strategies mentioned in this section enumerate the important elements of the learner-centric approach, they fail to suggest a design procedure on how to absorb these strategies towards active learner participation. Few of the suggested frameworks and models for MOOC design have been reported in the next section.

Proposed frameworks and models for MOOC design

For effective MOOC design, a learning design framework proposed 7Cs of conceptualize, capture, communicate, collaborate, consider, combine and consolidate at four different levels of design (Conole, 2013). Though the research suggested course features to design a MOOC with enhanced learner experience and ensuring quality, the report did not prominently elaborate on the precise steps as a procedure to adopt the framework. Grover and colleagues also presented a framework for design and evaluation of MOOCs, with a focus on the distributed nature of intelligence where learning activities are distributed across people, environment and situations (Grover et al., 2013). Though the framework defined the interconnected dimensions of MOOCs that work synergistically for individual or group learning, a clear set of guidelines or actions for MOOC creation as well as the results on the effectiveness of the framework were not distinctly included.

Another MOOC model was proposed, integrating the existing learning characteristics of xMOOCs and cMOOCs with adaptive learning and knowledge management (Fidalgo-Blanco et al., 2015). Though the model presented learning strategies, aligned with technological framework, for diverse MOOC users, it did not focus on learner engagement challenges of MOOCs. The study presented the effectiveness of the framework on one MOOC with completion rate as 28.2% and high satisfaction levels of participants in learning.

Another MOOC design model was developed to improve the practice of MOOC development in Korea by specifying easy-to-use course development procedures and guiding strategies (Gayoung et al., 2016). The model entailed 9 specific steps for systemic design of MOOCs; however, the existing pedagogical challenges in MOOCs, such as lack of learner interactivity, learner connect and engagement, were not addressed. Additionally, the results on the effectiveness of the model were evaluated for one MOOC lecture which was designed using the model.

From the literature review, we observed that most of these existing pedagogical MOOC models lack two critical aspects: instructional guidance for translating pedagogical aspects of MOOCs into an interactive LCM, and implementation of the model, beyond proof of concept, on larger number of MOOCs. In this paper, we present a MOOC design model, termed as LCM model, which differentiates from the existing models in two key facets (1) it is a prescriptive design model which collates all critical pedagogical elements of a MOOC in a learner-centric approach towards addressing some existing MOOC challenges of active learner participation and engagement and (2) it has already been adopted in the design and conduct of 15 different MOOCs to show the primary use of the model and its effectiveness towards increasing learner participation. The initial empirical evidence has been provided to exhibit the effectiveness of the model through several measures, including completion rates, engagement of participants with LCM elements and perception of learners on the usefulness of the model and its adoption.

The LCM model

The LCM design model provides guidelines to organise appropriate pedagogical elements for achieving instructional goals required to address the existing challenges of low active participation of learners and engagement. From the available theoretical and empirical evidence on MOOCs challenges and the existing pedagogy and frameworks in MOOCs, four critical parts of instructional design and channels of learner engagement were identified. To cater to these channels of learning engagement in MOOCs i.e. videos, formative assessments and feedback, discussion forums and learning resources, four key structural elements were packaged into an LCM model (Murthy et al., 2018). The structure and function of these elements in the LCM model transpired as a result of informed design requirements which in turn surfaced from existing pedagogical challenges in MOOCs.

The LCM model (Fig. 1) is a prescriptive model for creating LCMs to address the challenge of learner engagement by designing multiple interaction opportunities for learners. These enhanced interaction opportunities motivate the learners to actively participate with peers and engage with the content. Our model falls under the broad umbrella

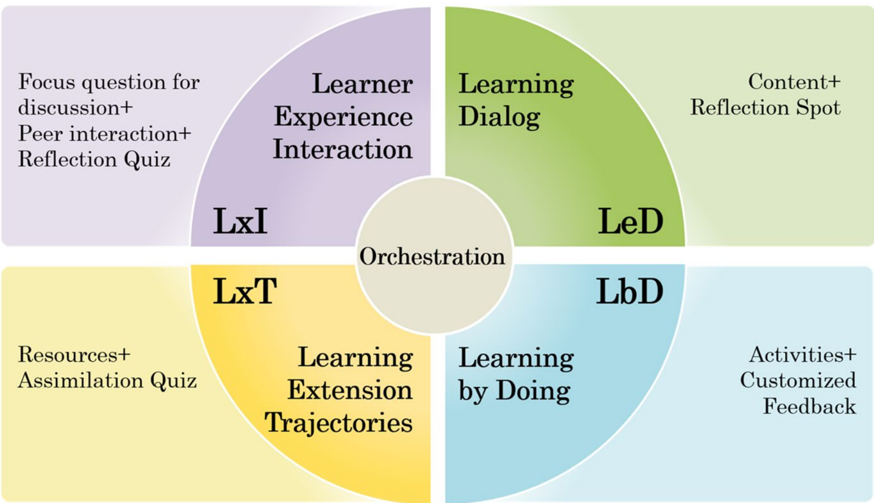

Fig. 1 The learner-centric MOOC (LCM) model

of learner-centric approach; however, each element of the model has its own theoretical underpinning derived from literature which led to well-informed design decisions. In this section, we will describe the purpose of each element, its functions, structure and dynamics of working.

Core structural elements and their purpose

The LCM model presents actionable guidelines for content design and activity formats for all critical pedagogical features of MOOCs. The model elements attempt to address some of the existing pedagogical challenges of MOOCs by making some informed design decisions (Table 1). The design of the elements ensures that the associated dynamic interactions amongst learners, instructor and content are maintained. Examples of these structural elements, implemented in our MOOCs, have been provided in the supplementary data.

Learning dialog (LeD)

Videos are an integral part of instructional design in MOOCs which provides learning flexibility to participants, and ease of content delivery to instructors for varied topics. However, keeping learners engaged with the video content becomes a challenge especially as the length of the videos increases. Based on video engagement analysis, it was shown that irrespective of the video length, the median engagement time for MOOC videos is at most 6 min (Guo et al., 2014). Claims have been made that short videos (~6–10 min) complement the optimal attention span of students, and help sustain learner engagement to lecture content (Hew, 2018). Studies also report that short videos intertwined with quizzes emulate one-on-one tutoring which fit into a manageable period of time that learners can dedicate to MOOCs and maintain attention (Glance et al., 2013). There exists empirical data which shows that addition of interactive elements to the videos potentially enhances the engagement and attention span of learners (Cummins et al., 2015; Geri et al., 2017). However, not many MOOCs have been practicing this mode of interactive learning via videos.

The LCM model proposes interactive MOOC video termed as LeD, which is a short video (~5–10 min) aimed at promoting meaningful learning of the concept through learner interaction. The creation of short videos involves the principle of chunking (Miller, 1956), which goes beyond numbers in this setting. Figure 2A illustrates the structure and dynamics of LeD, which comprise two key goals of (1) providing conceptual knowledge to learners through short videos and (2) providing interactivity through explicit spots called reflection spots (RS). Reflection spots are in-video activities for learners to express prior conceptions, reflect, articulate their reasoning and receive feedback from the instructor. At the RS, the instructor poses a question such as an automated multiple choice question or provides a brief activity to be performed. The learner is expected to pause the video and respond to the question or activity before resuming the video. Thus, learners express their thinking and articulate their reasoning while interacting with LeDs. After the RS activity, the instructor continues with the video addressing the common expected responses for the RS, and summarizes the correct answer with feedback. The instructor then continues with the rest of the video content, which may contain additional RSs. The Supplementary Fig. I shows an example of an RS, which requires the learners to reflect on their prior knowledge on routers, before moving on to a related concept.

Table 1 The LCM model elements mapping to the existing pedagogical challenges in MOOCs

	Pedagogical challenges in traditional MOOCs	LCM model elements addressing these challenges
Videos	• One-way transmission of knowledge • Long video lectures • Monotonous • Low engagement of learners	Learning Dialog: Short (5–10 min) and interactive conceptual video with reflection spots to offer interactivity and engagement with content
Formative Assessment	• Lack of non-graded practice exercises for every concept • Lack of appropriate feedback to enable participants improve their learning	Learning by Doing: Frequent formative assessment activities with constructive and customized feedback that guides learners to improve their learning
Learning Resources	• Poor engagement of diverse learners on an online learning platform	Learning Extension Trajectories: Group of varied learning resources to advance learning along diverse paths followed by an assimilation quiz to incentivize learning
Discussion Forum	• Low learner participation in forums • Scattered and unfocused discussions	Learner Experience Interaction: Focused peer discussions using a focus question followed by a reflection quiz activity to incentivize learner participation on the forum

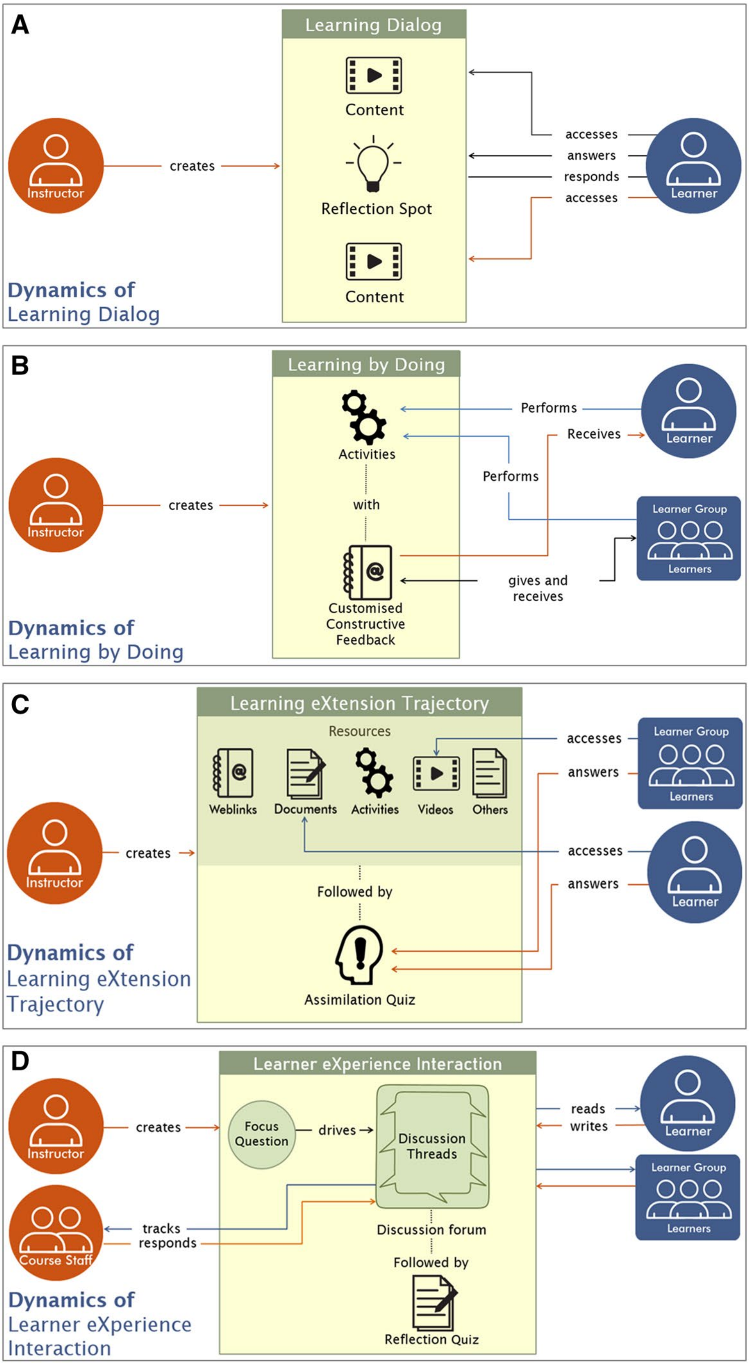

Fig. 2 **A** Structure and dynamics of learning dialog (LeD). **B** Structure and dynamics of learning by doing (LbD). **C** Structure and dynamics of learning extension trajectories (LxT). **D** Structure and dynamics of learner experience interaction (LxI)

Learning by doing (LbD)

Learning activities become significant in online learning with challenges of transactional distance (Shearer et al., 2014), which questions the pedagogical interaction between the teacher and learner. Literature recommending MOOC design principles often suggest use of varied learning activities for deep and critical learning (Guàrdia et al., 2013; Salmon, 2013). A recent study exhibited the benefits of learning by doing with immediate feedback, versus passive use of informational assets, in enhancing student learning outcomes (Koedinger et al., 2015). The importance of feedback on quizzes, to help learners understand the topic of study and improve their learning outcome, has also been reported in MOOC studies (Yousef et al., 2014). This practice of providing frequent formative assessment activities with immediate feedback has been adopted in some of the highly rated MOOCs (Hew, 2016). However, it is not typically observed in most of the MOOCs.

The LCM model integrates ungraded formative learning by doing (LbD) activities, with feedback, which typically follow immediately after every LeD. Figure 2B illustrates the structure and dynamics of LbD, where the learner performs these ungraded activities and receives immediate feedback on their work. The LbD activities intend to serve two major goals: (a) provide multiple opportunities for concept attainment, retrieval practice and integration of knowledge and (b) provide immediate constructive and customized feedback to clarify learners' misconceptions. Constructive feedback provides an explanation of why a particular option is correct as well as explains the rationale behind each of the incorrect options. The feedback is also customized as it is modified based on the option chosen so that it suitably addresses the learner's understanding. The feedback can be designed by the instructor and provided via an automated system response, or through self-assessment or peer-review process using descriptive rubrics. The Supplementary Fig. II shows a screenshot of an example for an LbD activity along with the constructive and customized feedback provided for it.

Learning extension trajectories (LxT)

Course resources that cater to participants' learning needs or preferences have been identified as one of the key factors that engage learners online (Hew, 2018). Though MOOC instructors provide supplementary course resources to learners, diversity of learners is often not taken into account (Kalz & Specht, 2013). This diversity extends to varying learner goals, prior knowledge and learning preferences. Use of varied, but relevant learning resources and activities, is one way to support different learning preferences (Bangert, 2004; Hew, 2016). Some of the highly rated MOOCs provided resources in different formats depending on the needs of the learners, including videos, readings, course specialisms, optional challenges etc. (Hew, 2018). Though it is critical for an instructor to realise the learner needs for varied resources, it is equally important to ensure that the learners benefit from these resources.

Some of the key goals of learning extension trajectories (LxTs) integrated into the LCM model include: (1) catering to varied learning goals and diverse levels of learning, (2) enabling the learner to increase the depth and breadth of their existing knowledge and (3) ensuring learners' engagement with the resources and assimilation of key concepts. Figure 2C illustrates the structure and dynamics of LxT, which comprise a group of diverse learning resources and an assimilation quiz (AQ) associated with each resource to incentivize learners' engagement with the content. The learners are provided with 2–3 distinct learning resources (book chapters, videos, specialised course links, research papers) each week to choose and learn. The resources do not necessarily align with the LeD content for the week; however, they may extend into different trajectories based on the learner cohorts and specific identified goals. These identified goals may include ensuring prerequisites, advancing the depth of knowledge, or supporting learners' inherent motivation to learn a new concept. AQ is a short graded activity, which closes the loop for LxTs, ensuring that learners access the resources and assimilate the key concept from the given resource. The AQs, which are not intended to be too complex, have a minor grade associated with them. Though learners are provided with varied learning resources for the week, they are expected to go through any one of the LxT resources, and attempt the associated AQ. This provides the learner with the autonomy to make decisions and choose their own learning path. The supplementary Fig. III shows two different LxT resources, provided in a MOOC, on technology tools to support the pedagogical strategies discussed in the course.

Learner experience interaction (LxI)

Learner–learner interactions are known to be one of the vital components of successful online learning experience (Frey & Alman, 2003). Discussion forums provide unique opportunities for diverse learner interactions through sharing of opinions and collaborative problem solving. However, discussion forums in MOOCs often face challenges of low learner participation, confined to a minority of learners, and unfocused discussions (Mak et al., 2010; Schweizer, 2013). Active engagement strategies such as tutor-supported forums or peer support forums to encourage forum participation show mixed results with low levels of peer-to-peer discussions (Onah et al., 2014). Recent literature suggested a co-learning approach, providing structured resources and creating issue-focused forums to elicit more conversational discussions (Laurillard, 2016).

The LCM model integrates learner experience interaction which effectively exploits the idea of focused discussions and further provides structured opportunities for peer interactions. Additionally, the learners' participation on the forum is incentivized using a graded reflection quiz (RQ) based on the forum interactions. The key goals of an LxI are to (1) provide an environment for focused discussions where peer learning is engaging and productive and (2) ensure learner participation and peer interaction on the forum. An LxI (Fig. 2D) entails a focus question with the instructed peer activity for learners, discussion forum interactions which are moderated by the course team and a short graded RQ to incentive learners' participation on the forum. The goal of the focus question is to elicit diverse learner views, experiences or learner-created artefacts around the core theme. Focus question comprises explicit activities that guide learners' discussion on a given topic, and hence avoids the common problem of scattered discussion threads. The instructed peer activity requires the learners to interact with each other by viewing and responding to others' posts, thus encouraging participation and leveraging peer learning. Following forum discussions, learners reflect on their interactions and answer the RQ based on their discussions. The focus question in the LxI prevents scattered discussion, and the RQ closes the loop of LxI ensuring learner participation and peer interaction on the forum. The Supplementary Fig. IV shows a screenshot of an LxI with a focus question and clear instructions for peer interaction to foster productive learning discussion.

Orchestration

Effective orchestration of an online course can be defined as a synergy of managing the content creation and conduct of teaching–learning activities along with technology-associated operationalization tasks. Orchestrating an LCM demands attention not only during the creation of content and activities, but notably during the offering of the course for dynamic adaptation of activities in the learning context. This becomes critical in an online setting, where learners may encounter the feeling of isolation (Khalil & Ebner, 2014).

As illustrated in Fig. 3, the main aspects of effective orchestration in an LCM model involve (1) effective management and team coordination for conduct of various activities, (2) capturing learner behavior data through learner actions and learner performance data through scores to generate learning analytics, (3) focusing on interactions with learners to understand their needs and challenges, and augment the course content, (4) adapting or revising the learning resources or course plan based on learners' needs or progress to maintain learner connect and (5) building a sense of community amongst the participants.

Management protocols should be set in place to coordinate the course activities with different teams (instructors, teaching assistants, video recording/editing team, designers, administrative team) to be able to offer the content in a learner-centric manner. Utilizing the course analytics to be aware of the learning situation becomes critical. Learner engagement is captured through learner actions (video watching, completion of practice exercises or quizzes, discussion forum participation etc.) and learner performance (scores in assignments/projects) to enable dynamic adaption of the course content or format. Prompt responses to learners on discussion forums keep the learner engagement high and focused. Weekly or biweekly scheduled virtual interactions provide cognitive support to learners by enabling them to express their understanding on the content, clearing their queries or misconceptions. Understanding the cognitive needs of learners, through virtual interactions or discussion forums, to adapt the course content is an example of dynamic orchestration integrated in LCMs. Interactions with learners through personalized emails regarding their progress in the course, pending assignments or extended deadlines also illustrate dynamic orchestration which provides affective support, and enhances learner connect with MOOCs.

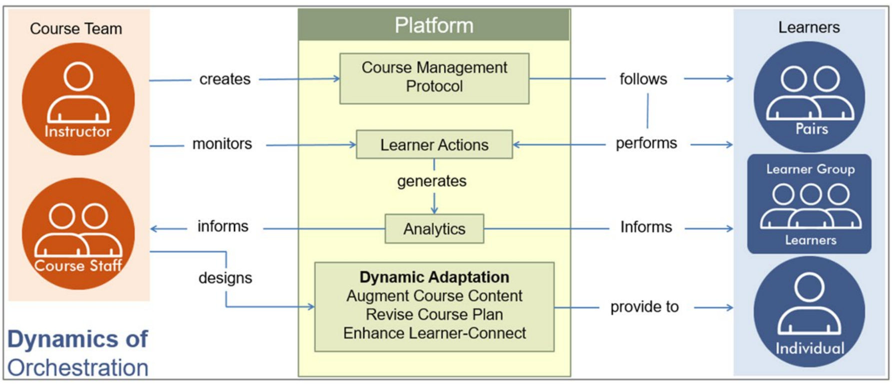

Fig. 3 Structure and dynamics of orchestration in the LCM model

For a MOOC to follow the LCM model entirely, all criteria listed in Table 2 should be applied to its respective structural aspects or elements (i.e. videos, formative assessment activities, learning resources, discussion forums and orchestration). However, it is possible that certain MOOCs may incorporate criteria from the LCM model only for some of the elements.

Implementation of the LCM model

The LCM model has already been adopted in the design and conduct of 15 different MOOCs. Many of these MOOCs have been offered multiple times on two different platforms (NPTEL and IITBombayX) from 2016 through 2020. So far, we have applied the

Table 2 Key criteria for a MOOC to follow the LCM model

	For a MOOC to follow the LCM design, it should:
Videos	**1: Enhance videos into Learning Dialogs** **1A)** Have short (5–10 min) conceptual videos (termed as Learning Dialogs) to promote meaningful learning of individual concepts **1B)** Include in-video activities (termed as Reflection Spots) to enhance engagement and attention span of learners **1C)** Incorporate Reflection spots which provide opportunities for learners to express prior conceptions, reflect, articulate their reasoning and receive feedback from the instructor
Formative Assessment	**2: Incorporate Learning by Doing activities frequently as formative assessments** **2A)** Include formative assessment (termed as Learning by Doing activities) following each Learning Dialog video **2B)** Include assessment activities which provide opportunity to learners for concept attainment, retrieval practice and integration of knowledge **2C)** Provide immediate constructive and customized feedback using automated response/self-assessment/peer-review
Learning Resources	**3: Address diverse learner needs through Learning Extension Trajectories** **3A)** Include a group of varied resources (termed as Learning Extension Trajectories) to address varying learning goals, preferences and prior knowledge **3B)** Provide the autonomy to learners to choose their own resources to advance learning along diverse paths **3C)** Ensure learners benefit from these resources by incentivizing learner engagement with these resources through short graded activities such as Assimilation Quiz
Discussion Forum	**4: Leverage peer learning in discussion forums through Learner Experience Interactions** **4A)** Provide focused questions/activities on the forum to avoid scattered discussion **4B)** Provide guided peer activities to enable learners to elicit their views and experiences, and leverage peer learning **4C)** Ensure interactions (termed as Learner Experience Interactions) and peer learning by incentivizing learner participation through short graded activities such as Reflection Quiz
Orchestration	**5: Offer prompt support to learners and dynamically adapt instructions** **5A)** Maintain constant interactions with learners through asynchronous or synchronous sessions to provide affective support and understand their needs and challenges **5B)** Adapt or revise learning resources as required to address learner challenges **5C)** Offer prompt responses to queries to maintain learner engagement, and promote peer interactions to build a sense of community amongst the participants

LCM model to a variety of skill development MOOCs, teacher professional development MOOCs and disciplinary MOOCs. An example of each type of MOOC has been shown in Table 3. The total number of participant enrolments for these MOOCs has been 83,394. In terms of the model implementation, most of these courses implemented the LCM model in its entirety, while few of them incorporated LCM criteria for selected design elements in their initial offerings.

Research questions

The study evaluated the effectiveness of the LCM model based on several measures, including completion rates, engagement of participants with LCM elements and perception of learners. The following research questions were investigated in this study:

1. How effective were LCMs in the existing MOOC metrics of participants' completion rates?
2. How effective were the LbD and LxI elements of the LCM model in engaging learners in formative assessment activities and active discussion forum participation, respectively?
3. What were learners' perception on the usefulness of the model, and their rationale for the adoption of LCM model in other MOOCs?

Data sources and data analysis

The data source of this research came from MOOCs, which were designed adopting the LCM model (Table 4). The effectiveness of the LCM pedagogy was analyzed through a mixed-methods research using quantitative and qualitative analyses. To address research question 1, all LCMs were used for completion rate and persistence rate analysis, whereas four selective MOOCs were used for engagement studies and participant perception studies. Completion rates for the LCMs were measured as the percentage of participants who passed the course considering the overall enrolments for the course. The reported completion rates generally range between 5 and 15% of registrants (Fidalgo-Blanco et al., 2015; Jordan, 2015; Perna et al., 2014). For comparative analysis, the average completion rate of LCMs (sample mean) was compared with the higher end of reported completion rates i.e. 15% using one sample t-test. The null hypothesis assumed that the difference between the sample mean and the comparison value (15%) is equal to zero, where p value of .05 or above was considered statistically significant. While completion rates are calculated on

Table 3 Types of MOOCs which adopted the LCM model, and the total number of participant enrolments from 2016 through 2020

Domains of Learner-centric MOOCs (N = 15)	Number of participants enrolled per year
• Teacher professional development MOOCs	2016: 17,190
e.g. Pedagogy for effective integration of ICT for school teachers	2017: 25,838
• Skill-development MOOCs	2018: 16,970
e.g. Basic 3D animation using Blender	2019: 11,488
• Disciplinary MOOCs	2020: 11,908
e.g. Demystifying networks	Total: 83,394

Table 4 Learner-centric MOOCs investigated for each research question, and the associated data on total number of enrolments, active learners and their rates of completion

Research question (RQ)	MOOCs investigated to answer the corresponding RQ	Total number of enrolments (N) Number of active learners (N*)
RQ1	15 Learner-centric MOOCs	N = 83, 394 N* = 42,974 Average Completion Rate (CR): 36.35% Average Persistence Rate (PR): 59.38% *One sample t-test for Completion rates* Median: 24.67% Confidence Interval: 95% Std Deviation: 25.61 Theoretical mean: 15 t (observed value) = 3.22 t (critical value) = 1.76 DF = 14 P value (one-tailed) = .003 alpha = .05
RQ2	**MOOC1** (M1): Educational technology for engineering teachers (2016: 1 offering at IITBombayX) **MOOC2** (M2): Pedagogy for effective integration of ICT for school teachers (2017–2018: 3 offerings at IITBombayX) **MOOC3** (M3): Designing learner-centric MOOC (2018–2019: 3 offerings at NPTEL) **MOOC4** (M4): Designing learner-centric e-learning in STEM disciplines (2019: 1 offering at NPTEL)	**M1** N = 5111, N* = 3447 CR: 24.67%, PR: 36.58% **M2** N = 14,170, N* = 4494 CR: 14.41%, PR: 45.46% **M3** N = 5051, N* = 884 CR: 17.5%, PR: 46.35% **M4** N = 622, N* = 178 CR: 7.71%, PR: 26.96%
RQ3	**MOOC2** (M2) **MOOC4** (M4)	

the basis of total enrolment, persistent rates are defined as the percentage of the active learners who passed the course (Shah et al., 2018). By active learners, we refer to those participants, who attempted at least one of the course activities (graded assignments for IITBombayX and practice or graded activities for NPTEL) after their enrolments into these MOOCs.

Research question 2 and 3 were addressed by investigating four MOOCs, which have been offered 8 times in total from 2016 through 2019 (Table 4). Two of our chosen MOOCs of study were offered on IITBombayX (M1 and M2) from 2016 to 2018, whereas the other two were offered on NPTEL (M3 and M4) from 2018 to 2019. In this study, the engagement of learners refers to the extent of active participation that learners have demonstrated in the LbD activity or discussion forums. We examined the engagement of learners towards LbD activities in two MOOCs '*Designing learner-centric MOOC* (*M3*)' and '*Designing learner-centric e-learning in STEM disciplines* (*M4*)'. To measure the engagement of learners with LbD activities, maximum participation that occurred in a week for an individual graded activity was compared to the maximum participation observed for an ungraded activity (LbD) of the same week. Engagement of learners in LxIs was analyzed through a mixed-methods research conducted for two different LCMs: '*Educational technology for engineering teachers* (*M1*)' and '*Pedagogy for effective integration of ICT for* *school teachers* (*M2*)'. Further details for data analysis in LxI participation can be found in earlier reports (Banerjee et al., 2018; Warriem et al., 2016).

Learner perceptions on the usefulness of the LCM elements were evaluated for two offerings of the MOOC '*Pedagogy for effective integration of ICT for school teachers*'. Details of this analysis can be found in an earlier work (Shah et al., 2018). '*Designing learner-centric e-learning for STEM disciplines*' was another MOOC where learner perception on the LCM model was studied. As a part of the post-course survey, the participants were asked "*Do you feel that this learner-centric model should be adopted in other MOOCs and why*?" The question was examined on a 5-point Likert scale followed by an open-ended answer to the same. The question enabled the participants to reflect on their experience with the LCM model and its teaching–learning format, and express their reasoning. The quantitative data was analyzed by performing frequency analysis from the Likert scale data to yield percentages. The qualitative data obtained from the responses of the participants provided descriptions for their choices. Inductive thematic analysis (Braun & Clarke, 2006) was performed to first get familiarized with the participants' responses, followed by generation of initial codes across the entire data set. Further, related codes were collated into categories and themes. The themes were then reviewed against the raw data for consistency, and further by examining their details with clear descriptions for each of them. Content analysis (Wilkinson, 2000) was performed to extract the frequency distributions for each of the themes.

Results

Data retrieved from multiple MOOCs was analysed both quantitatively and qualitatively to enable the evaluation of different measures of capacity for the LCM model.

Completion rates for learner-centric MOOCs

Completion rates indicate the percentage of participants who completed the course from the total number of participants who enrolled on the platform. Since most of the MOOCs have been offered multiple times, Table 4 shows the average completion rates for multiple offerings of these courses. The total number of participant enrolments in 15 MOOCs was 83,394. The completion rates ranged from 4.37 to 90.85% with the median of 24.67%. The mean of completion rates for all LCMs (Table 4) was found to be 36.35 ± 25.61, 95% CI: 10.74–61.96%, which was significantly higher (p value = .003) than the upper end of the range (5–15%) reported in literature.

In MOOCs, there exists a known funnel of participation, which occurs from the time of course awareness till the completion of the course (Clow, 2013). Learners do enroll for MOOCs for multiple reasons, but their lack of initial commitment leads to filtering of learners in the later stages. Thus, persistence rates provide us an awareness of course completion by learners who showed some level of commitment by attempting at least one activity of the course. The average completion rate for the active enrolments i.e. the average persistent rates for all 15 MOOCs was found to be 59.38%.

Engagement of participants with LCM elements

LbD activities

Learner engagement with LbD activities have been analyzed for two different MOOCs (Table 5). Every week of these MOOCs entailed 4–5 ungraded LbD quizzes for practice along with 3 graded quizzes. Post-course analytics was performed to examine weekly engagement of participants in LbD activities in two offerings (O1 and O2) of MOOC3 (M3) and 1 offering of MOOC4 (M4). Table 5 compares maximum participation that occurred in a week for an individual graded activity versus maximum participation observed for an ungraded activity (LbD) of the same week. It was observed that 50% of the time, for 6 weeks (starred values in Table 5) out of 12 weeks, learner participation for the week has either been equal or more for an LbD activity than observed for a graded activity. The ratios for ungraded versus graded quizzes ranged from .64 to 1.36, which showed that for every 100 participants at least 64 participants always attempted for LbDs. The average of these ratios was found to be .95, which suggests that the average participation of learners for ungraded activities is almost equal to graded activities. Since LbD activities are non-graded practice exercises, such participation rate reflects high motivation for participants to complete these activities. The motivation is likely to emerge from effective learning achieved through LbD activities and the immediate constructive feedback provided to learners as soon as they submit their answers. This was also suggested by some of the learner comments, regarding the LbD activities, extracted from the exit survey form of MOOC4. Two examples of such learner comments have been cited here.

> "*With LbDs, I can understand why my answer is wrong and I get feedback for that. If I am wrong I can go back to my video, learn and then again do my LbD once again. I have enough time to do them and any number of times.*"
> "*LbD helps me in understanding the topic by providing practice so that I can judge my understanding level of that particular topic, and how I can improve as a learner.*"

Focused discussion forums (LxI)

One of the studies examined the role of LxI in leveraging peer-learning through focus questions, driving the discussion thread, followed by reflection quiz to incentivize participation (Banerjee et al., 2018). Quantitative and qualitative analyses were performed in the MOOC '*Pedagogy for effective integration of ICT for school teachers*' for examining the peer-connect and engagement of participants in the discussion forum. Participants were observed to be engaged in the discussions even after the course duration. There were a total of 29,355 posts generated over a period of 8 weeks by 1691 participants. Qualitative analysis showed that 73.2% of these discussions were beyond superficial comments, none of which deviated from the focus questions. Focused discussions on the discussion forum indicated enhanced engagement and peer-learning using the LxI pedagogy. Similar engagement results were observed in an earlier report in the MOOC '*Educational technology for engineering teachers*' (Warriem et al., 2016). Results showed that 47% of the active learners (n* = 3447) participated in the discussion forum generating 5023 discussion threads and 9861 comments.

Table 5 Weekly engagement of learners in ungraded vs. graded activities in two offerings (O1 and O2) of MOOC3 (M3) and 1 offering of MOOC4 (M4)

Week	Participants who performed graded versus ungraded (LbD) activities each week								
	MOOC4 (Graded)	MOOC4 (LbD)	Ratio_M4 (LbD/Graded)	MOOC3_O1 (Graded)	MOOC3_O1 (LbD)	Ratio_M3_O1 (LbD/Graded)	MOOC3_O2 (Graded)	MOOC3_O2 (LbD)	Ratio_M3_O2 (LbD/Graded)
1	118	161*	**1.36**	266	171	**.64**	452	323	**.71**
2	96	101*	**1.05**	187	192*	**1.02**	271	296*	**1.09**
3	75	75*	**1**	164	160	**.98**	250	254*	**1.01**
4	66	55	**.83**	160	134	**.84**	205	188	**.92**

Starred values in the table indicate equal or higher learner participation in an LbD activity for the week than observed for a graded activity

Perception of learners on the LCM model

Usefulness of the LCM elements

Effectiveness of the LCM elements was evaluated in two offerings of the MOOC '*Pedagogy for effective integration of ICT for school teachers*' (Shah et al., 2018). The quantitative analysis of the end-of-course questionnaire on usefulness of the LCM elements in the MOOC showed that 92% participants (n = 523) found LeDs useful, 95% found LbDs useful, 77% found LxIs useful and 88% found LxTs useful. The average usefulness of the LCM elements was found to be 89.5%, with positive perception of participants towards the LCM elements. The qualitative analysis (n = 508) showed that 22% of the participants, who completed the course, explicitly mentioned LCM elements as a factor to persevere in the MOOC with comments such as "*Interesting LeDs, LbDs and well planned quizzes kept me going for the entire course. Overall, I found this course useful and engaging*." Additionally, 27% of the participants mentioned active learning strategies employed in the course as their reason to preserve with their intention to implement these strategies in their own classrooms. In an earlier MOOC '*Educational technology for engineering teachers*,' similar results were observed from an end of course survey (n = 688), where LeDs, LbDs and focused discussion forums (LxI) emerged as top three reasons for participants to persevere in the course (Warriem et al., 2016).

Learner rationalization for the adoption of the LCM model

As a part of the post-course survey of the MOOC '*Designing e-learning in STEM disciplines*,' the participants were asked "*Do you feel that this learner-centric model should be adopted in other MOOCs and why*?" The question was asked on a 5-point Likert scale followed by an open-ended answer to the same. 98% of the participants (n = 52) who participated in the post-course survey agreed that the LCM model should be adopted in MOOCs. The participants came up with various explanations in support of the model. The nature of these explanations was extracted through thematic and content analysis. Thematic analysis of these reasons revealed eight core themes which have been enlisted in Table 6 along with examples of learner quotes for each of these themes. The reasons that emerged as themes in this analysis aligned with pedagogical goals of the LCM elements and design recommendations in literature to address the existing MOOC challenges.

The content analysis provided the frequency distribution of these themes, where enhanced motivation and learner engagement (21%), and experiencing a learner-centric environment (19%) emerged as the top two reasons for adoption of the LCM approach (Fig. 4). Many times, individual participants mentioned multiple reasons for integrating the LCM model in other MOOCs. One of the patterns that emerged was that participants (e.g. participant 4, 18, 31) who expressed enhanced interactivity as one of the positive reasons of the LCM approach, also mentioned formative assessment and feedback, enhanced learner motivation and engagement, or learner-centric environment. This is expected from learners in these MOOCs, who simultaneously experienced enhanced interactivity with peers and content, through focused forum discussions, in-video activities and multiple formative assessments with immediate and constructive feedback. The learners could identify the learner-centric pedagogical approach, which further enhanced their motivation and engagement in the course.

Table 6 Illustrative examples of learner quotes for the core themes that were identified from learners' rationale on adopting the LCM model in other MOOCs

Sr. No.	Themes of reasoning	Examples of learner quotes
1	Enhanced learner motivation and engagement	"High motivation through active participation" "Effective teaching–learning strategies to improve engagement"
2	Learner-centric environment	"LC model brings learner to the center of teaching–learning process" "Allows one to choose their own learning path"
3	Enhanced interactivity and peer learning	"Encourages interactivity and sharing of ideas" "Peer learning through sharing of experiences"
4	Effective learning	"Helps in deep conceptual learning"
5	Formative assessment and feedback	"Encourages timely and meaningful feedback which aids learning" "Good mix of practice assessment questions"
6	LCM elements and course design	"Content is well-structured" "Chunking into short duration videos, reflection spots, LbD, LxT are effective"
7	Catering to diversity and resources	"Caters to diversity in MOOCs more effectively"
8	Positive comments and outlier responses	"Yes, all MOOCs should adopt it for providing maximum benefits to learners"

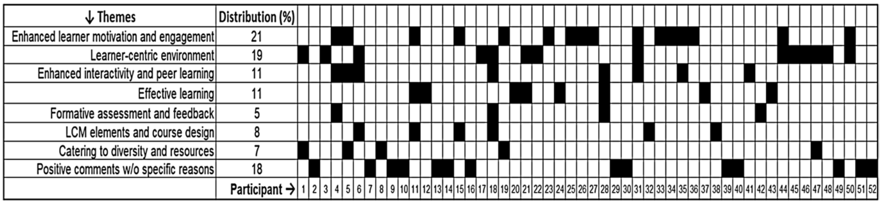

Fig. 4 Distribution of the core themes that emerged from content analysis of participants' responses to adopt the LCM model

Discussion

The literature survey has demonstrated that there is a growing number of researchers embarking in the effective design of MOOCs in order to improve learner engagement, and hence overcome the challenge of high attrition rate in MOOCs. The research is mainly motivated by the fact that MOOCs' learning has the potential to serve thousands of diverse learners with effective learning outcomes. In this paper, we argued the rationale for focusing on a learner-centric pedagogy in MOOCs and proposed the LCM model, described its goals and exhibited the primary use and effectiveness of the model in terms of improved learner participation. The pedagogy of the model makes learners go beyond passively executing prescribed procedures, and become active learners.

The LCM model is a comprehensive but straightforward pedagogical design model to stimulate learner interactions with the content and peers through four key structural elements. These elements include LeD that promotes concept attainment through learner interaction via reflection spots, LbD which is a formative assessment activity with immediate constructive feedback, LxT which advances learning along diverse paths and LxI which cultivates learning through focused discussions. These four core elements of the model share a dynamic of orchestration, with some flexible correlation space between elements.

The LCM model has been implemented in 15 different MOOCs, which have been designed by the authors. Empirical evidence has been provided on the effectiveness of the model, which was examined through several measures. As our first research question, we investigated the success of our MOOCs in terms of completion rates from the total number of individuals who enrolled for each course. The mean of completion rates for all LCMs from the total number of participant enrolments (n = 83,394) was found to be 36.35 ± 25.61, which is significantly higher (p value = .003) than even the upper end of the completion rates (5–15%) stated in literature (Fidalgo-Blanco et al., 2015; Perna et al., 2014). In addition, the average completion rates for active learners (n* = 42,974), called the persistence rate, was found to be 59.38%. Such high completion rates for MOOCs, which were participated by thousands of learners, likely indicate successful engagement of learners with the content and their enhanced motivation to complete the course.

The LCM model emphasizes on learner participation in knowledge development activities as a central element to learning. As our second research question, we examined the effectiveness of the LbD and LxI elements in engaging learners in formative assessment activities and active forum participation. The LbD exercises at the end of each new concept is an attempt to enhance learning through practice and immediate constructive feedback. Since the activities were ungraded, there was no incentive for learners to complete these activities. However, we observed that 50% of the time, learner participation for the week has either been equal or more for an LbD activity than observed for a graded activity. In fact, the ratios for ungraded versus graded quizzes ranged from .64 to 1.36, which showed that for every 100 participants at least 64 participants always attempted for LbDs. The likely explanation, as supported by some of the learner comments, for attempting these LbDs is an opportunity to immediately practice and apply the learnt concept with immediate feedback on their work, all of which is known to aid in learning (Yousef et al., 2014).

In contrast to the challenges of low learner participation in forums and unfocused discussions on the forum (Mak et al., 2010; Schweizer, 2013), we observed that LxI pedagogy in LCMs enabled sustained engagement and enhanced peer connect (Banerjee et al., 2018). These interactions were focused and went beyond superficial comments. The learners were observed to be engaged in discussions even after the course duration, leading towards an evolving community of practice. Realizing the significance of social context in the learning process, one of the intended goals of the LCM model is the creation of such communities of practice, which is led and sustained by participants.

Since the learner perspective seems to be underrepresented in current MOOC research (Kalz & Specht, 2013), in our third research question, we emphasized on learner perception as a focal measure for effectiveness of the model. The average usefulness of LCM elements for 2 course offerings (n = 523) of a MOOC was found to be 89.5% (Shah et al., 2018). The qualitative analysis (n = 508) of participants' feedback indicated that the positive perception of participation towards the LCM elements was related to factors such as the course structure, learner-centric activities and active learning strategies employed during the course. To investigate this further, a post-course survey in the MOOC '*Designing e-learning in STEM disciplines*,' enquired learners about the adoption of the LCM model in other MOOCs. 98% of the participants (n = 52) in the post course survey agreed that the LCM model should be adopted in other MOOCs as well. The reasons that emerged as themes in this analysis also aligned with some pedagogical recommendations in MOOC literature to address some of the existing limitations of MOOCs. These included use of learner-centered approach, valued peer learning, promoting critical thinking towards effective learning (Guàrdia et al., 2013); regular formative assessment with feedback and catering to diversity (Hew, 2018); enhanced interactivity of learners (Khalil & Ebner, 2014); and encouraging learner participation and engagement (Pilli & Admiraal, 2017).

The LCM model attempts to capture some of the key aspects of learner engagement (Deng et al., 2020), including (a) emotional engagement with the content by fostering learner interaction through the use of active learning strategies and providing immediate constructive feedback to learners, (b) cognitive engagement through learning resources designed at varied cognitive levels, (c) social engagement by facilitating peer connect through focused interactions, and (d) behavioral engagement through dynamic orchestration of the course path and offering diverse resources, based on learners' queries, requests and performances. Though we exhibit active participation of learners in our MOOCs, individual evidences for different aspects of these engagements were not presented in this study.

One limitation of the model is that it does not address the aspect of assessment directly. However, we recommend multiple formative assessment strategies inside the LCM model which include: (a) follow concept videos with non-graded practice activities, designed at different cognitive levels, for concept attainment, immediate practice and application of integrated concepts; (b) follow learning resources and discussion forum interactions with a variety of graded activities to ensure that participants assess these resources and participate on the discussion forum, respectively; and (c) all graded and non-graded activities should provide constructive and customized feedback to learners in order to enhance their learning. A limitation of this study is selected sampling of MOOCs for engagement and perception analysis. However, there were multiple MOOC offerings based on the LCM model during 2016 through 2019. The sampled MOOCs were representative, identified from each year and two different platforms (NPTEL and IITBombayX). Following the primary implementation of the LCM model, research on evaluating the impact of the model pedagogy in addressing some of the existing MOOC challenges is still in its initial phases. Additionally, the model validity, reliability, usefulness and usability analyses with a large number of instructional designers will be investigated and presented in the next study before its secondary field implementation by diverse MOOC instructors. Though further analysis is ongoing with the design model, this study attempts to exhibit the primary use of the model, its key goals and practical solutions towards addressing pedagogical challenges of low learner engagement and participation in MOOCs.

In terms of generalizability, the adoption of LCM model elements is not only restricted to MOOCs, but also allows extrapolation of learner-centric strategies from online learning to classroom learning. A recent study exemplified the contextualization of the LCM model in an effective blend of flipped-classroom strategy with traditional classroom learning in an undergraduate engineering physics course (Kannan & Gouripeddi, 2019). The findings showed positive perception of learning, engagement and usefulness towards this blended technique when integrated with LCM-based structured learning activities. These results support a recent report (Napier et al., 2020) that showed that participants can transfer skills learned from MOOCs in their local school settings. In future work, we plan to expand the implementation of the model as well as our analysis to include other key facets of learner engagement in different contexts and populations. Moreover, in light of a large-scale field study (Kizilcec et al., 2020), which discussed the context-based effects of behavioural science interventions in MOOCs, it will be interesting to examine the impact of the LCM model in different contexts, and examine the pedagogy refinements that may be required to support groups in diverse settings.

Conclusion

The study herein demonstrates a pedagogical design model which replicates the learner-centric approach in MOOC environment through interactive learning dialogs (LeDs), formative assessments (LbDs) with constructive feedback, varied learning resources catering diverse learners (LxTs) and focused peer learning (LxIs). The LCM model has been adopted in the design and conduct of 15 different MOOCs, which witnessed 83,394 participant enrolments. The goal of the LCM model is to address some of the critical pedagogical challenges in MOOCs such as poor learner connect, low participation and engagement levels and the inability to cater to diverse learner needs, all of which result in low average completion rates for MOOCs. In comparison, the average completion rate (36.35%) for 15 LCMs was found to be significantly higher than the average completion rates observed in literature. The LCM pedagogy was also found to be effective in engaging participants in 'no-incentive' learning activities and meaningful peer discussions which sustained even after the culmination of the course. The learner perceptions on the adoption of the LCM model voiced several benefits which align with the desired pedagogical outcomes of the model such as enhanced learner motivation and engagement with content, enhanced interactivity and peer learning, formative assessment and feedback, and catering to diversity. Reflecting on our results on completion rates, engagement of participants with LCM elements and perception of learners on the model, the pedagogical design of the LCM model was found to play a critical role in the success of our MOOCs. The LCM model collates and translates all the integral pedagogical elements of a MOOC into a learner-centric dimension to promote active learner participation and enhanced engagement with learning content and peers through fostered interactions. Further, the validity and reliability of the model will also be investigated through its adoption in the design of several discipline-based MOOCs to explore the impact of the LCM pedagogy in different contexts.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11423-022-10081-4.

Acknowledgements We would like to thank Next Education Research Lab for their financial support in the project. We would also like to thank Mr. Lucian Ngeze for his work during the design and execution of some of these learner-centric MOOCs. We are also thankful to Mr. Amit Shukla and Mr. Nitin Ayer for their help in retrieval of data from the MOOC platforms. We appreciate the administrative teams of IITBombayX and NPTEL for their support during the conduct of these courses. Finally, we thank all our MOOC participants who filled in the post-course survey forms which were valuable for the conduct and analysis of these studies.

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