Effect of Instruction Intervention on MOOC Forum Discussion: Student Engagement and Interaction Characteristics

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Abstract. This study delves into the effect of instruction intervention on a MOOC forum discussion to ascertain its impact on students' participation and the characteristics of their interactions. Using a mixed-method approach combining social network analysis (SNA) and inductive qualitative analysis, the relationships and underlying interactions within an EFL MOOC discussion were examined. The findings revealed that instruction intervention by teachers effectively augmented students' engagement within the discussion area, fostering both instructor-learner and learner-learner interactions. Additionally, the conventional hub-and-spoke structure, where the instructor serves as the central node in the MOOC forum, was found to be subject to change through instruction intervention. Network analysis of the original post and a comparative assessment of two instances highlighted the direct reply tie definition as the most informative for revealing interaction relationships. It is recommended that teachers and teaching assistants actively and strategically participate in MOOC discussions to facilitate independent learning in the era of intelligent education.

Keywords: instruction intervention · learner interaction · network construction · MOOC forum discussion · social network analysis

1 Introduction

Educational institutions worldwide have increasingly embraced online instruction to cater to students across various educational levels, aligning with the progress of intelligent education. This shift has been facilitated by the widespread use of the Internet and the emergence of new online platforms, where Massive Open Online Courses (MOOCs) stand out as a consequential phenomenon. While interaction with peers and instructors is acknowledged as a potent means of learning support (Smith, 2018), the effectiveness of traditional learner-instructor communication in MOOCs is being questioned due to the large number of students involved and the diversity of their backgrounds, needs, and motivations (Johnson et al., 2020). Research highlights that students often experience feelings of isolation in online education, resulting in high dropout rates, increased boredom, and diminished achievement (Jones & Smith, 2017; Lee et al., 2019). Notably,

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Gillani and Eynon (2019) assert that the discussion forums, fostering semi-synchronous exchanges among thousands of participants worldwide, distinguish MOOCs from earlier forms of online learning. Therefore, examining the dynamics of interactions within these forums promises fresh insights into the pedagogical value and potential of MOOCs.

1.1 Study on MOOC Forum Engagement

Prior research indicates that engagement in MOOC forums involves active participation in course activities (Smith, 2018), and lack of engagement increases the likelihood of discontinuation (Wang et al., 2020). MOOC discussion forums often suffer from low student involvement, with a few dominating the discourse (Jones & Smith, 2017; Xie & Zhang, 2020). To improve MOOC effectiveness, alternative approaches to student engagement are necessary. Suggestions include implementing discussion prompts that foster meaningful interactions and emphasizing self-regulation, teaching presence, and social presence as predictors of engagement and persistence (Reeve, 2012). Maintaining a positive forum atmosphere and encouraging high-quality posts are crucial for MOOC organizers (Wang et al., 2020).

1.2 Study on MOOC Forum Interaction

Previous studies indicate that in MOOCs, learner interactions are often instructor-centric, with limited learner-learner interactions (Xie & Zhang, 2020; Wu et al., 2021). The instructor's role and status can inadvertently create a hub-and-spoke structure where they dominate communication (Gillani & Eynon, 2019). Additionally, learners tend to engage more with peers and form stronger connections within content-related networks in MOOC forums (Gillani & Eynon, 2019; Xie & Zhang, 2020). Therefore, this study focuses on analyzing ties within content-related discussions to understand instructor-learner interactions within the learning community.

1.3 Instruction Intervention in MOOC Forum Discussion

In traditional lectures, instructors use pedagogical interventions based on student behavior observations (Wise & Cui, 2020). However, with larger class sizes and online interactions, it becomes challenging for instructors to observe social cues and intervene effectively (Gillani & Eynon, 2019). Instructor involvement in discussions is considered important for quality online learning (Gillani & Eynon, 2019; Wu et al., 2021), but the specific impact and ways of involvement remain unclear. Some studies suggest a positive association between instructor involvement and student contributions (Gillani & Eynon, 2019; Xie et al., 2020), while others indicate null or negative associations, suggesting potential conversation impediments (Wu et al., 2021). Wise and Cui (2020) emphasize considering both the level of involvement and the manner in which instructors engage in discussions, proposing strategies such as modeling interactive techniques, involving learners as facilitators, and utilizing analytics for monitoring interaction dynamics. Teaching presence encompasses course design, discourse facilitation, and direct instruction (Wise & Cui, 2020; Wu et al., 2021).

1.4 Current Study

Drawing on the existing literature, exploring the dynamics of interactions within MOOC forums holds the potential to provide valuable insights into the pedagogical value and opportunities afforded by MOOCs. Consequently, the primary objective of this study is to examine the effects of instructional interventions on the discussions within a MOOC forum, with a specific focus on investigating potential improvements in student participation and interaction characteristics.

2 Research Design

2.1 Research Questions

Based on the research purpose, two research questions were formulated:

1. To what extent can instructional intervention improve students' participation in the discussion forum?
2. What are the characteristics of instructor-learner interactions and learner-learner interactions resulting from instructional intervention?

2.2 Participants

The present study analyzed the effects of instructional intervention in two instances of an online course on *Internet + College English* (Round 1 and Round 2). The courses were conducted on the Chinese MOOC platform, iCourse (www.icourses.cn), in spring 2020 (Round 1) and autumn 2021 (Round 2) respectively. Round 1 had 3,151 registered students, while Round 2 had 5,202 registered students. In Round 1, students received a carefully designed intervention that incorporated both asynchronous and synchronous online instruction to foster their active participation in the online discussion process (Table 1). In contrast, students in Round 2 did not receive this intervention.

Table 1. Summary statistics for forum participation in Round 1 and Round 2.

Sub-forum	# Parts	# Teachers	# Sub-threads	#Posts	Posts/user
Round 1	380	2	53	601	601/380
Round 2	60	2	2	63	63/61

2.3 Research Instrument

A mixed method of social network analysis (SNA) and inductive qualitative analysis was adopted to analyze the relationships and the underlying interactions they represent in discussions in a EFL MOOC. Ten edgelists were generated to represent learner interactions in the MOOC forum, utilizing Wise and Cui's (2018) five distinct tie definitions for the content-related discussion networks (see Fig. 1).

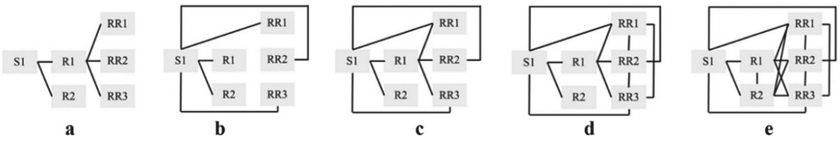

Fig. 1. Wise & Cui's (2018) Ties Extraction Method. Note. (a) Direct Reply; (b) Star; (c) Direct Reply + Star; (d) Limited Copresence; (e) Total Copresence. S = thread starting post; R = reply post; RR = reply to reply post. Solid lines represent ties extracted using this definition.

2.4 Procedure

2.4.1 The Proposed Instruction Intervention Approach on MOOC Forum Discussion

Acknowledging the potential benefits of the instructor's role in online instruction and the significance of well-designed tasks and activities for instructional intervention (Wise & Cui, 2020), this paper proposes a judicious combination of asynchronous and synchronous online instruction to actively involve students in the online discussion process and promote their engagement (see Fig. 2).

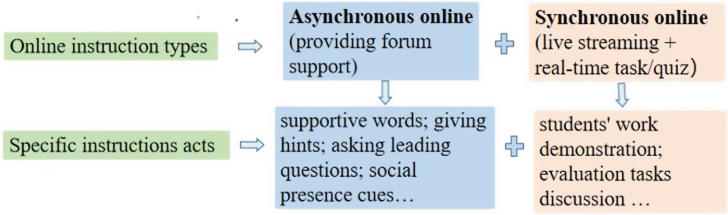

Fig. 2. The proposed intervention in online instructions

Figure 2 depicts actions for asynchronous and synchronous online instruction. In asynchronous instruction, the focus is on providing forum support through feedback that uses encouraging language and provides hints rather than direct answers. Supportive words and social presence cues create a sense of instructor support. Asynchronous discussions guide students in case analysis, evaluation, proposing solutions, and evaluating tasks to improve understanding. Synchronous instruction involves pre-class guidance through live streaming media (e.g., Zoom) and real-time quizzes (e.g., Kahoot!). This creates a virtual classroom for real-time interaction. Instruction intervention includes tasks, oral and written discussions, peer evaluation, and real-time quizzes. This design benefits student engagement and learning performance while enabling teachers to track progress and adjust instruction effectively (Chen et al., 2021a, 2021b, Alonso, et al., 2005).

2.5 Data Collection and Analyses

The teaching materials utilized in this study were extracted from an open online course called "Internet + College English" offered on the iCourse platform in China (https://www.icourse163.org/). The course comprised five modules encompassing technology-enhanced listening, speaking, reading, writing, and translating skills. Spanning a duration of twelve weeks, the course specifically focused on leveraging technology to enhance language learning. For the purpose of this study, Module Two, which centered around "technology-enhanced speaking skill drilling," was selected. Within this module, one specific discussion topic was chosen for analysis: "What will China be like in 30 years? Write a mind-map on the topic and share your answer here. Let's share, discuss, and learn together." A total of 55 threads containing 657 discussion posts were collected from 440 learners enrolled in the MOOC.

2.5.1 Thread Classification

Out of the 657 posts that were analyzed, all of them were found to be relevant to the discussion topic. To identify non-content-related posts, we employed a binary classification method based on the approach proposed by Wise et al. (2017). Content-related starting posts encompassed activities such as seeking or providing help, sharing course-related information or resources, asking or responding to subject-related questions, expressing or commenting on subject-related ideas, or sharing external resources. On the other hand, non-content-related posts did not meet these criteria. Following Wise and Cui's framework (2018), the post types were further categorized as thread-starting, reply, and reply-to-reply. After excluding one repeated post and nine non-content-related posts, the corpus comprised 647 content-related posts from 435 users out of 8,349 MOOC learners. In Round 1, there were 53 thread-starting posts, 295 reply posts, and 397 reply-to-reply posts (see Table 2). In Round 2, there were two thread-starting posts, 61 reply posts, and two reply-to-reply posts (see Table 2).

Table 2. Data information of the present study.

Discussion Topics		Content-related Posts		
	Forum	Thread-starting	Reply	Reply-to-reply
Sharing: My mind map on the topic *What will China be like in 30 years?*	Round 1	53	295	397
	Round 2	2	61	2

2.5.2 Network Construction and Network Properties

Ten nodelists were generated to represent the network of MOOC forum participants, based on ten edgelists connecting 440 learners' IDs with 664 content-related posts. These nodelists and edgelists were imported into Gephi 0.9.2 for Windows to construct undirected weighted networks. The Rotate layout algorithm was used for visualization. For

each of the five networks corresponding to the five tie definitions, the number of edges, average node degree, average edge weight, and graph density were computed(Wise et al., 2018).

3 Result and Discussion

3.1 Analysis of Student Engagement in Online Discussion Forums

Student engagement in online discussion forums was analyzed based on the number of participants and the frequency of their participation. Table 3 shows that, for the same original post, in Round 1, both the teacher and the students participated more compared to Round 2. In Round 1, the total number of participants was 382, including 2 teachers, while in Round 2, there were 61 participants, including 2 teachers (see Table 3).

Table 3. Students engagement in terms of the number of participants in the two instances.

Rank	Round 1(N = 382)	Round 2(No = 61)
1	T1 (285)	T1(60)
2	S1 (56)	S2 (2)
3	S2 (41)	S6 (2)
4	S5 (33)	S1 (1)
5	T2 (24)	S3 (1)
6	S3 (20)	S4 (1)
7	S4 (19)	S5 (1)
8	S6 (16)	S7 (1)
9	S13 (13)	S8 (1)
10	S15 (12)	T2 (1)

Among the top 10 lists (ranked by degree) in the Round 1 and Round 2 networks, there were sixteen distinct learners. Apart from T1 and T2, who appeared on the high-degree lists for both networks, the remaining 16 learners exhibited high degrees in either one network or the other, but not in both. Although they were labeled as S1, S2, and so on in both instances, it is important to note that they represent different individuals (see Table 3). This signifies that the top players in the two networks were distinct individuals.

When examining the frequency of participation, the data indicated that in Round 1, the two instructors participated significantly more frequently compared to Round 2. T1 ranked Number 1 with a degree of 285 (see Table 3) in Round 1, and T1 also ranked Number 1 with a degree of 60 (see Table 3) in Round 2. Regarding the high-frequency participants, in Round 1, there were eight students who ranked among the top frequency participants. All of them had degrees higher than 10 (see Table 3), with S1 having a degree of 56, S2 with a degree of 41, and S5 with a degree of 33 (see Table 3). However, in Round 2, the top two participants had a degree of only 2, while the rest of the participants all had a degree of 1.

3.2 Analysis of the Community in Round 1

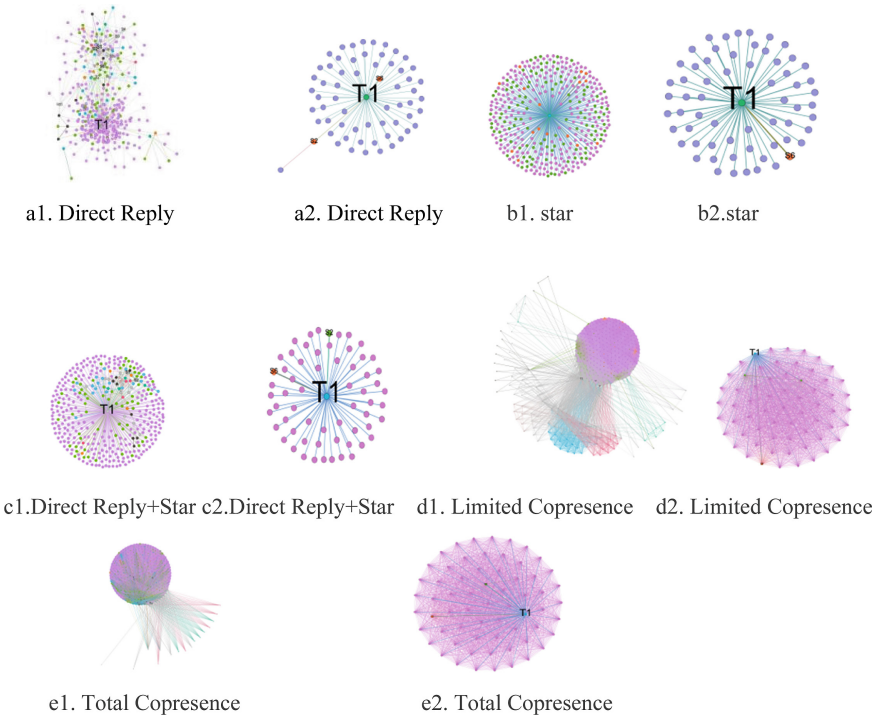

Fig. 3. Visualized graphs of the network

Table 4. Network measure of five networks.

Tie Definition	Round1 (N = 382)				Round 2 (N = 61)			
	#of edges	Avg node degree(SD)	Avg edge weight(SD)	Graph density	#of edges	Avg node degree(SD)	Avg edge weight(SD)	Graph density
DR	522	2.945 (15.14)	1.08 (0.286)	0.007	62	2 (7.683)	1.016 (0.127)	0.032
S	382	3.52 (34.353)	1.764 (0.514)	0.005	62	4 (15.62)	2.032 (0.254)	0.032
DR + S	633	4.971 (34.579)	1.504 (0.554)	0.009	63	4 (15.493)	2 (0.311)	0.032
LC	40231	217.274 (119.686)	1.034 (0.254)	0.55	1953	66.095 (15.743)	1.066 (0.368)	1
TC	67456	357.133 (78.69)	1.014 (0.154)	0.922	1953	66 (15.493)	1.065 (0.358)	1

The analysis of the five types of social network analysis (SNA) ties corresponds to content-related discussion posts derived from a main post, which can be considered a

micro-level analysis within SNA. In Round 1, this main post generated over 50 subthreads, more than 500 discussions, and engaged over 380 students in the discussion (see Table 4). This indicates a substantial level of participation from both the number of participants and the extent of students' involvement, showcasing their active engagement.

Instructor T1 actively participated in the interactive discussion, providing guidance for forum discussions through synchronous meetings held prior to class. With numerous participants and high frequency of participation, there were both original posts and subthread posts. The characteristics of the five types of ties observed in such a large-scale and high-frequency discussion involving multiple participants and posts are described as follows: Direct Reply (DR) serves as a model that objectively illustrates the hierarchical connections among original posts, replies, and replies to replies.

Regarding the Direct Reply tie, the figure clearly illustrates that the overall forum posts revolve around the original post by T1 (see Fig. 3 a1). Subsequently, with an abundance of replies and content, additional top posts have emerged, most of which have received comments from T1. Consequently, many students have followed the instructor's lead and actively participated in replying to the top posts, thereby fostering interaction among students themselves. Notably, the degree of interaction for participants such as ST1 and ST2 (see Table 5) reached 56 and 41, respectively.

Table 5. Subthread with high interaction degree

Subthread(ST)	(T1/T2) Instructor degree	Reply	Participation(%)
ST1	+	56	14.7%
ST2	+	41	10.8%
ST5	+	33	8.7%
ST3	+	20	5.2%

Star: The number of students engaging in interactions with teachers is substantial (refer to Fig. 3 b1), and their distribution is uniformly spread around the teachers, forming a sphere consisting of equidistant points centered on the teachers. This observation indicates that, within this discourse, students predominantly interact with teachers. Moreover, students in closer proximity to T1 exhibit a higher frequency of interactions with teachers, whereas students located further away from T1 demonstrate comparatively fewer interactions with teachers.

Limited Copresence & Total Copresence: Owing to the significant number of participants within the same post, as defined by copresence ties, the graph exhibits a high level of density (refer to Fig. 3 d1, e1). However, this density does not appear to hold substantial relevance for analyzing the network centered around a single original post. Our focus in this research revolves primarily around examining the dynamics of teacher-student and student-student interactions under this particular post. Consequently, these two modes of interaction do not seem to offer distinct advantages in our study.

In this paper, the author contends that when analyzing the aforementioned interactions under a main post, the most effective approach is to employ Direct Reply ties

to illustrate the patterns of interaction. This perspective diverges from Wise & Cui's claim (2018), who argue that DR + Star can adequately depict the nature of interaction. Nonetheless, the data presented in this paper demonstrate that, in comparison to DR + Star, employing the DR tie alone enables a clearer representation of high-frequency participants, their frequency of interaction, the distinctive community characteristics that arise from interactions among these high-frequency participants, as well as the formation of different communities fostered by various high-frequency participants.

3.3 Analysis of the Community in Round 2

The data revealed a hub-and-spoke structure with limited learner-learner interactions, where the instructor served as the central node (see Fig. 3 a2–e2). Despite a diverse student population and no online pre-class guidance provided by the instructors, the main post generated two sub-posts, over 60 discussions, and the participation of more than 60 students, primarily from the larger society rather than the author's university.

The analysis of the Fig. 3 (a2-e2) demonstrated a consistent hub-and-spoke structure, with minimal variation. The tie maps showed limited interaction among participants, with only two direct replies observed. The similarity among the five tie maps indicated that using different types of ties had little significance in analyzing a discussion network with limited interaction. Previous studies also highlighted the instructor-centric nature of learner interactions in MOOCs, resembling the hub-and-spoke structure observed here (Smith et al., 2019; Johnson, 2020, Brooks et al., 2021)). In Round 2, a similar hub-and-spoke structure was confirmed, further emphasizing the influential role of instructors due to their position and status in the course.

In the upcoming research phase, the author plans to conduct a qualitative analysis of the teacher's intervention in the forum. This analysis will explore strategies such as questioning, guidance, and encouragement employed by teachers to promote student participation in online discussion forums.

3.4 Instructors in the Two Communities

3.4.1 Network Structure

Social network analysis revealed differences in interactions surrounding instructors (T1 & T2) between Rounds 1 and 2 (see Table 6). In Round 1, there were six times more nodes and eight times more edges compared to Round 2, indicating a larger and more interconnected community formed around instructor T1. The degree of T1 in Round 1 was over four times higher than in Round 2, suggesting direct interactions with a greater number of learners. Both communities showed a significant proportion of learners solely connected to the instructor. However, Round 1 had higher interconnections among learners compared to Round 2, as indicated by a higher average node degree. Additionally, Round 1 had a slightly higher average edge weight, implying more repeated interactions with the same individuals.

Table 6. Network structures of the two instances (ties based on direct reply).

	Round 1	Round 2
# of nodes	383	60
# of edges	522	62
Graph density	0.007	0.032
Avg node degree (SD)	2.945 (15.14)	2 (7.683)
Avg edge weight (SD)	1.08 (0.286)	1.016 (0.127)
Instructor degree	285	60

3.4.2 Communication Techniques

In Round 1, qualitative analysis identified distinct communication techniques employed by instructors T1 and T2. T1 used words of encouragement, offered hints, asked leading questions, and incorporated social presence cues. They motivated learners with phrases like "Good job!" and "Great! I love your idea of '10G' ~ Great ~" to inspire learners, utilizing hints to guide independent problem-solving. T1 also employed greetings, addressed learners by name, and echoed their words to encourage expression of ideas.

Similarly, in Round 1, T2 frequently provided positive feedback and utilized social presence cues. For example, they praised clear outlines with comments like "Good job! Your outline is quite clear ~".

To summarize, in Round 1, both instructors made more posts, responded more frequently, and employed distinct communication techniques including supportive words, hints, questions, and social presence cues. In contrast, in Round 2, T1 posted less frequently and used fewer social presence cues. These differences in instructor participation may contribute to the disparities observed in the network structures formed during interactions.

4 Conclusion and Implication

The research findings highlight several key points. Firstly, instructional interventions effectively enhance student participation, promoting both instructor-learner and learner-learner interactions. Secondly, instructional intervention can alter the predominant hub-and-spoke structure in MOOC forums, allowing learners to form their own learning communities. Thirdly, network analysis demonstrates that defining direct reply ties offers the clearest depiction of interaction relationships.

This study contributes to the literature by: (1) Revealing characteristics of instructor-learner and learner-learner interactions in Chinese MOOC discussions. (2) Identifying the correlation between instructional interventions and student engagement. (3) Providing insights for instructors on fostering interactive learning communities in MOOC forums. Teachers and teaching assistants are recommended to participate in targeted

and planned ways to support students' independent learning in the era of intelligent education.

Jung and Lee (2018) emphasized the importance of instructors establishing clear rules for participation and expected outcomes in MOOCs. This involves defining learning goals, discussion topics, assessment criteria, and learning expectations. Wang (2022) suggests that providing clarity on how students should participate in learning activities and what is required to fulfill the learning tasks enhances engagement.

In terms of blended instruction, teachers should assume guiding roles and maintain active involvement in the learning process. They can offer training and support to students in utilizing technology, address obstacles that arise during blended learning, and ensure students stay on the right path towards achieving their learning goals more effectively (Tang et al., 2022).

5 Future Research Directions

The present study serves as a pilot investigation on the impact of instructional interventions, featuring asynchronous and synchronous online instruction, to engage students and enhance interaction. However, it is regrettable that the effects of this intervention on learning outcomes were not available at the time. Future research is recommended to compare the teaching effects of such interventions in distance learning settings. It is important to note that this study primarily aimed to provide objective behavioral validation of the Online Social Engagement (OSE) through students' behaviors rather than solely relying on self-reported data. It does not attempt to measure or claim to measure all learning that occurs in an online course.

Another limitation of the present study is the lack of analysis on individual small learning communities within the data. Consequently, the actual impact of instructional interventions on student engagement was not fully observed in this study.

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