

Teaching assistants' interventions in online courses: a comparative study of two massive open online courses

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ABSTRACT

The purpose of this paper is to explore the characteristics of teaching assistants' interventions in Massive Open Online Courses (MOOCs). The study of interaction patterns in MOOCs can inform the design and development of mechanisms for more effective learning. We performed an analysis of teaching assistants' interactions in two different MOOCs in different subject matters (technology and humanities). The study revealed notable differences in the characteristics of teaching assistants' interventions within the two courses, in terms of language used, length of messages, response time and length of discourse. The findings of this study provide us with useful insights on current human interventions in MOOC forums, driving our effort in designing future modules to support the large number of students of these courses, with the ultimate objective to improve the learning experience for each individual student of future MOOCs.

CCS CONCEPTS

• **Education** → E-learning, Learning analytics

KEYWORDS

Learning analytics, Massive Open Online Courses, discussion forum, teaching assistant intervention

1 INTRODUCTION

Massive open online courses (MOOCs) increasingly play an important role in online learning. Today, a variety of courses can be found online, in which many different instructional approaches are applied. Discussion forums in MOOCs provide opportunities for interactions among learners and tutors. In a discussion forum, learners can interact with their peers and the instructional staff, and discuss the course's content, ask questions and provide

answers to questions of other learners. Prior work has shown that active participation in discussion forums helps learners improve their learning performance [4, 9, 13]. Part of this improvement is due to the intervention of instructors in learners' discussions. Their role is to guide learners within the course's platform, pose interesting questions, guide them in answering their questions, and generally support and encourage them, supporting their learning experience.

With the objective to support a more engaging and effective learning experience, there has been a lot of research on instructor interventions within forum discussions [16]. It is clearly understood that the presence of instructors and teaching assistants in discussion forums is an important factor in the evolution of the learners' participation and outcome. Moreover, the level of instructor intervention may influence discussions and participation of learners in unexpected ways [11]. In their research, Mazzolini and Maddison [10] studied the effect of instructor intervention on student participation in online discussion forums. The findings of their study showed that higher frequency of instructor posting resulted to shorter dialogues and less frequent learner postings, i.e. somehow negative effect, in terms of student participation.

Another study by Balaji and Chakrabarti [2] revealed that facilitating discourse has a strong positive effect on students' interactions in discussion forums. The findings of this study also indicate that the instructor's role in online discussions is essential for maintaining the interest and motivation of learners, as well as active participation and engagement with the course material.

Compared to online discussion forums, MOOCs, bear distinct characteristics, like their open and non-formal nature, that may shape motivation, engagement, and creation of a community. So, MOOC forums need to be further studied. In MOOC forums, there is a distinction in the roles of the *instructors*, the *forum moderators* and *teaching assistants*. Instructors are members of the teaching staff who design and deliver course material, create adequate assessments and decide upon the course planning and pedagogies. The forum moderators are responsible for supervising all activities in the forum, structuring the discussion, intervening in cases of improper messages (e.g. posting solutions for the course assignments). Because of the large number of messages in a MOOC forum, quite often additional help is required, so that messages are responded promptly and learners' basic educational needs are supported adequately. This role is undertaken by the *teaching assistants (TAs)*, who sometimes can be ex-students or students that early enough excelled in the course.

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The role of teaching assistants in MOOCs can be crucial, so it is worth investigating it, and more so in conjunction with courses of different subject matters, in order to understand whether subject matter plays some role in the TA's patterns of intervention. In our study, we focus on studying the role of teaching assistants in two MOOCs of different subject matters. We base our research on data from the discussion forums of two courses, one related to technology (Introduction to Programming) and the other one to humanities (World History of Religion). The courses were delivered in 2017 and attended by over 5,000 students each, delivered through mathesis.cup.gr, a prominent Greek MOOCs platform, based on OpenEdX technology. (See [12] for a recent study, focusing on the learners of the same two courses). Both courses were supported by very active TAs, who were in fact students of the two course that volunteered to play this role. The TAs of the two courses were highly-graded learners, with high levels of engagement within the course, playing a role that is also found in formal learning as peer learning by senior students in the traditional proctor model. It should be noted that both of these courses were delivered for the first time, so the TAs were also attending the course for the first time.

The ultimate objective of our research is to provide effective support to students of MOOCs through the course forum by devising adequate algorithms. In order to achieve such an objective, we strive to investigate the characteristics of TAs' interventions, and observe any differences in the interventions in the discussion forums of the two courses. We believe that this study will give us important insights on how teaching assistants behave within courses discussion forums and provide us with ideas on designing automatic responses for MOOCs in the future. In particular, we performed a qualitative analysis of a sample of teaching assistants' messages in the two courses. We chose a random set of 200 posts per course, in which teaching assistants had intervened. The samples respected the TAs percentage of contribution to the respective forums. We adapted a hybrid coding scheme based on Chandrasekaran's taxonomy [8], which was used to label teaching assistants' messages. Two coders performed the labeling of the messages in the coding scheme categories. Then, we compared the classified messages in the two courses and discussed the observed differences.

2 RELATED WORK

Instructor and teaching assistant intervention within MOOC discussion forums has been a topic of interest in many studies. In their study, Tomkin and Charlevoix [14] investigate the impact instructors and other instructional staff have on student learning outcome and participation rates within the discussion forum of a Physics course. By dividing enrolled students in two groups, using an A/B test, one without and the other with instructional interaction, they tried to identify differences in students' learning outcomes. The results showed that there was no significant difference between the two groups in terms of completion rates, but they did have differences on forum badge completion. In a similar work An et al. [1], divided students in three groups with

different facilitation approaches to identify differences on students' participation rates in the frame of an online course. In the first group, instructors were responding to students' messages directly and students had to reply to at least two other student posts. In the second, the instructors did the same but the students were not constrained to answer to other peer posts, while in the third group, students could only communicate with other peers and not with instructors. Results showed that in group 2, interaction of students with other peers rarely occurred because students chose to communicate more with the instructors. In groups 1 and 3, students tended to communicate more with other peers, when the instructor intervention was minimal.

In the related field of forum posts classification, that is necessary for building automated interventions, Wise et al. [15] built a predictive model in order to categorize and identify threads, based on whether or not they relate to the course's content. The results revealed some useful evidence where content-related threads contained some distinct linguistic features over the unrelated threads and the classifier accuracy was quite satisfying (>0.77).

In their work, Chandrasekaran et al. [7] studied the problem of instructor intervention in discussion forums and built a binary classifier in order to predict whether an instructor should intervene in a discussion thread or should not. The results of this study showed that such a decision problem is quite difficult to solve, and the classifier's accuracy differs in courses with different subject matter. In another work, Chandrasekaran et al. [8] studied ways for automatic guidance of instructors in MOOC discussion forums. They proposed a new taxonomy of contributions of instructors. They applied natural language processing techniques in order to analyze discussion forum texts and categorize them, and then used conditional random fields (CRF), a supervised machine learning technique, to create a predictive model. They proposed a dashboard that used this model, and made suggestions to instructors for interventions on urgent threads.

These studies provide interesting examples on how the design of instructional staff intervention can alter learners' participation in the discussion forum.

3 ANALYSIS OF TEACHING ASSISTANTS' CONTRIBUTION

3.1 Context of the study

For our study, we used data from two MOOCs offered in 2017 on the mathesis.cup.gr platform. The first course, 'Introduction to Python' (IP), was an introductory course to computer programming through Python. The second course, 'World History: Man versus Divine' (WH), aimed to introduce learners to the history of Asian religions during the Second Circle of World History. The duration of the two courses was 6 and 9 weeks, respectively. The instructional design of both courses consisted of video lectures, assignments and weekly tests, supported by a structured forum. Our study was based on anonymized discussion forum data. Participation in the forum was optional, although

students were encouraged to use it and contribute by posting questions and comments related to the course. In each course, some participants emerged as particularly active in the forum and were available to support their fellow students, while they demonstrated good understanding of the subject matter. These were soon contacted by the course instructors; they were assigned the role of *teaching assistants (TAs)* and were also asked to contribute in subsequent editions of the courses. The number of students that were assigned the TA role, was three for the IP course and four for the WH course. The TA's role was to follow the forum discussions regularly, and help other learners with their questions and issues raised on a voluntary basis.

In our previous study [12], we have studied the same two courses by focusing on learners. The analysis of the learners' demographics has shown some important differences between the two courses. In the IP course, the educational level for the majority of them was *Higher Education* and their age ranged between 25 to 45 years. On the other hand, in the WH course, the majority of learners did not state their educational level, perhaps an indication of lower educational level, and their age was mostly above 45 years.

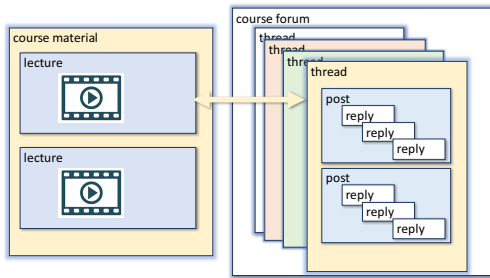


Figure 1: Forum structure: *threads, posts and replies*

3.2 Analysis of data

The discussion forums of the courses under study unfold in three levels, *threads* that are related to a specific topic or period of learning (e.g. thread for week 1), *posts* that are messages posted in the context of a thread, and *replies* to posts (Figure 1).

The contribution of the Teaching Assistants in the forums of the two courses is summarized in Table 1. As we can see, there are similarities as well as notable differences in the patterns of TAs' participation in the two courses. Starting with the percentage of posts with TA participation, our analysis indicated that teaching assistants of the WH course had higher engagement than the teaching assistants of the IP course. In fact, TAs of WH participated in 53.8% of all posts, against 38.5% for the programming course. In terms of activity, as measured by the number of messages posted, the two courses have similar characteristics; the three TAs of the IP course posted an average of 38.6 messages per course-week, while the four TAs of the history course posted 37.8 messages per course-week, i.e. in both courses the TAs on average posted almost 8 messages per working day. In terms of length, the messages were lengthier for the history course (average length 58 words) compared to those of the Python programming course (average length 42.6 words).

This suggests that TAs in the history course were more analytic than those of the programming course. By comparing the average response times, it was found that the WH course TAs were significantly more responsive (4 hours, against 13.3 hours of the IP course, t -test $p < 0.1$).

	IP Course	WH Course
Percentage (%) of posts with TAs' participation	38.5	53.8
Avg number of replies posted per TA, per week	38.6	37.8
Avg number of words per reply	42.6	58.0
Avg response time (hours) to a message	13.3	4.0

Table 1: TAs' contribution in the discussion forums

Next, we study the characteristics of the posts in which teaching assistants intervened, see Table 2.

	IP Course	WH Course
Avg (SD) length [†] of posts with TA participation	5.3 (s=6.8)	7.2 (s=5.0)
Avg (SD) length of posts with no TA participation	5.0 (s=2.9)	4.1 (s=2.1)
Avg (SD) number of TA's replies per post	1.3 (s=0.8)	2.8 (s=1.4)

[†]total number of replies for a post

Table 2: Posting activity measures of TAs in both courses

The mean length of posts with TA participation was not found significantly different for the two courses ($p=0.4$) despite the large difference of the sample mean values, due to the high dispersion of the post lengths. On the other hand, the mean length of the posts in which TAs did not participate, was found to be significantly different for the two courses ($p=0.01$). So, posts of the IP course where TAs did not participate, tend to be slightly longer than those of the WH course. Moreover, the average number of replies TAs contributed per post was significantly higher, 2.8 for the history course and 1.3 for the programming course, (t -test $p < 0.01$). This may be explained by the fact that in the programming course, which is technology-related, learners usually post problems to which teaching assistants can give exact replies, usually in a single message. In the history course, students raised issues related to more abstract concepts, for which the TAs' replies invoked lengthier dialogues with the learners.

4 ANALYSIS OF TA INTERVENTIONS

In this section, we proceed further with our study by analyzing the content of teaching assistants' interventions, in the two courses. It is common in a MOOC study, to use mostly quantitative data

from traces students leave with their behavior [5, 6]. Content analysis, however provides a better understanding of forum interactions. However, it is a tedious process since it involves very large volumes of data. So, in this study, we attempt to analyze a sample of teaching assistants' interventions.

4.1 Coding scheme

In the study that follows, the unit of analysis is the message. The objective was to classify by hand-coding a random sample from each courses' TA messages. By manually diving deeper in the TAs messages' content, we aim at comparing their patterns of intervention across the two courses.

First we randomly choose 200 posts in which TAs had intervened and used a coding scheme, presented in Figure 2, adapted from the 'Instructor Interventions' taxonomy proposed by Chandrasekaran, et al. [8]. We do not include the peer interventions because we wish to focus only on the TA interventions in student conversation.

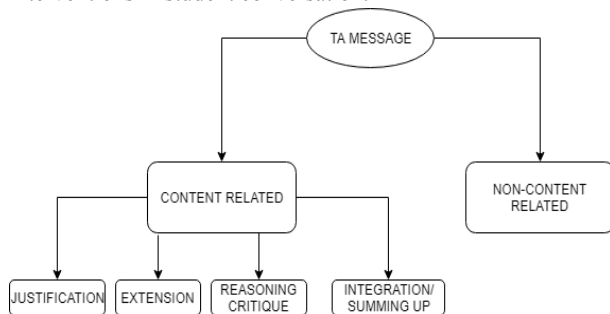


Figure 2: Coding scheme used for categorizing TAs' messages

As we can see from Figure 2, the coding scheme comprises two levels of message categorization. At the first level, the message is examined for its general content. In terms of its relation to the content of the course, it is labeled as 'Content related', or 'Non-content related'. A 'Content related' message relates to lectures, the assignments or weekly tests and problems by posing exploratory questions that may have risen after studying the course's material.

At the second level, if the message is related to the content of the course, then it must be specifically assigned to one of the following categories.

1. *Justification request*: A message that contains analytical explanations of a theory or suggests a solution to a problem. The TA provides evidence and explains in detail the solution of a problem a learner faces.
2. *Extension*: A message that comes after the solution of a problem discussed previously and the TA contributes alternative solutions and explains the pros and cons of each one of them to the learner.
3. *Reasoning Critique*: A message where the TA poses her own statement on a problem. The TA makes criticism on an issue and by referring to own experience may propose a solution.

4. *Integration/Summing up*: A message where the TA states plainly the solution of a problem without being too detailed. Normally such a message implies that the current conversation should end with this statement.

4.2 Coding of the transcripts

The coding task was performed by two coders. The principal investigator discussed the coding scheme with the coders, who then coded all TA messages from the randomly selected posts. The coders were encouraged to refine the protocol as they coded. Their results were evaluated for interrater reliability using Cohen's kappa (k). Cohen's kappa is a chance-corrected measure of interrater reliability. In calculating Cohen's kappa, reliability is reported after accounting for the possibility of chance agreement between coders [3]. In our five-category coding scheme the results showed a kappa coefficient 0.90. This interrater reliability is considered high, so it demonstrates a reliable coding, based on the fact that a consensus was achieved, on which to base our analysis.

5 RESULTS

The results of the coding are presented in this section. In Figure 3, the coding results at the first level of categorization across the two courses are shown.

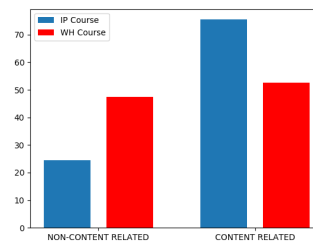


Figure 3: First level of categorization of the two courses messages

We observe that for the IP course almost 75% of the messages were content related, while the WH course messages were more evenly distributed in between content and non-content. In the IP course, most posts related to problems learners faced with some Python code. The TAs intervened in such posts and made an effort to provide solutions by giving coding examples or by guiding the learners' thinking process. On the contrary, the conversations that were not content-related referred either to problems learners faced with the MOOC platform, or to installation problems of the Python environment or even to assignment deadlines. On the other hand, in the WH course, almost half of the interventions were coded as 'Non-content related'. The TAs of this course had the tendency to act more socially and intervene to conversations that were even irrelevant to the content. There were conversations where users were introducing themselves or engaged in social chat; and in many such cases TAs participated without offering any topic-related support to learners. To further analyze the TAs behavior, in Figure 4 we present the results from the second level categorization of topic-related messages.

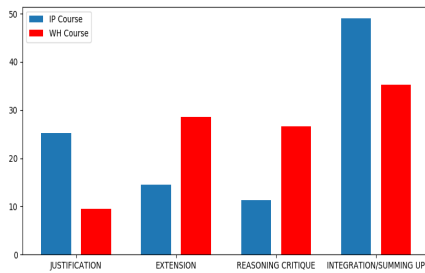


Figure 4: Second level of categorization of the two courses messages

Figure 4 shows the distribution of the ‘Content related’ messages to the different classes. There are noticeable differences between the two courses.

In the IP course, almost half of the TAs’ interventions are classified as contributing towards *integration or summing up of a problem*. For the posts examined, most of messages (49.1%) were direct answers to learners’ questions about some Python code issues. Such messages usually included a short explanation of the solution followed by the correct code. After such intervention, usually the conversation came to an end or continued with just a thankful message from the student.

The second message class, in terms of size, was that of ‘Justification’ interventions (25.4%). In such interventions, TAs tend to answer theoretical questions of learners. These questions related to the use of Python libraries, methods of Python classes, functionality of Python interpreter and other subject related questions about the programming language that needed clarifications. These messages were quite lengthy, containing a lot of programming terminology and sometimes examples of code that learners could run in order to understand better the corresponding concepts. The last two categories that were less common in the data sample were those of ‘Extension messages’ (15.9%) and the ‘Reasoning Critique’ (9.6%) interventions. The only occasions that did ‘Extension’ interventions occur were in conversations in which the students were discussing the performance of different solutions to a problem. In these conversations, the TA intervention just added some more information to the learners’ discussion and did not, in principle, solved any specific problem. The TAs just proposed another correct solution and the conversation would continue after that. The last category, ‘Reasoning Critique’, occurred even less frequently. In these cases, the TAs intervened in discussions where they proposed a solution as the correct one, by referring to their own experience as programmers.

In the WP course, on the other hand, there are some notable differences. We can see that in this course too, the ‘Integration of a problem’ is the most common kind of TA intervention (37.4%). This is quite expected as a result, because TA’s role is to help learners overcome their issues and propose solutions to them. So ‘Integration of a problem’ has been the most common type of intervention in both discussion forums. There have been differences however in the other three categories. The second

most frequent type of intervention that occurred within the forum was that of ‘Extension messages’ (28.3%). In many conversations learners were discussing historical facts and religion-specific issues that were presented through the video lectures. In these conversations, the TA’s intervention just added more information and historical resources to the conversation in order to extend the learners’ knowledge on the discussed theme. Examples were: links to historical websites, references to historical books or details that were not observed by learners in the video lecture. In a similar percentage (26.1%) the ‘Reasoning Critique’ intervention occurred. Many conversations contained an exchange of opinions between learners in different historical facts and acts of historical figures. These conversations also were inspired by the content of the video lectures. TAs took the opportunity to intervene and express their own opinion and critiques not only on the historical facts, but also on other learners’ opinions. Such interventions resulted in long dialogues and in some cases in controversies between learners and TA.

The messages that occurred less often were those categorized as ‘Justification’ interventions (8.2%). These interventions contained conversations on cases when video lectures extracts were not clearly comprehended by learners. TAs took the chance to intervene and in an analytical way clarify points made and answer theory-related questions.

Another notable difference that is observed in the TA interventions is the type of conversations that TAs developed with learners and their attitude observed through their messages. TAs in the IP course were more direct in their messages with a more formal style, while in the WH course the answers were quite extended and informal (see also reply lengths in Table 1). Such observations imply also differences between the two courses’ TAs.

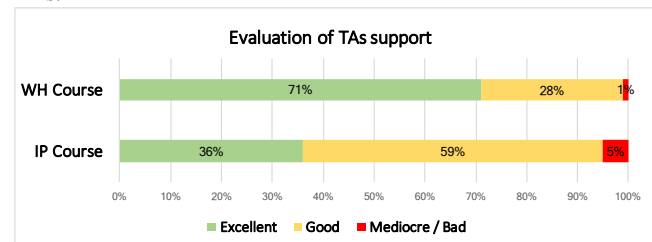


Figure 5: Users’ evaluations of TAs support in both courses

The questionnaires that were filled in by participants at the end of the courses, revealed that TA interventions were perceived positively by the users in both courses (see Figure 5). The fact that the majority (71%) in WH described it as ‘Excellent’ may imply that the more informal approach of TAs in discussions results to better user experience in the forum.

6 DISCUSSION

It has been shown that there are some differences in TA’s interventions in the discussion forum of these two different subject courses. The factors that may have contributed to these

differences are as follows. One factor is the nature of the course's subject matter. The computer science course belongs to exact sciences so in most times the conversations that occurred related with problems learners faced with the tools of the course and ways of using them. This may explain the fact that '*Justification*' and '*Integration*' interventions occurred mostly in the IP course. On the other hand, in a humanities course, most questions relied to historical facts and interpretations. This may explain the quite frequent '*Extension*' and '*Reasoning Critique*' interventions within the forum. Historical facts are presented through the course and usually the learners strived to explore in much more detail facts that relate to them or make their own statements about them. As for the frequently occurred category, '*Integration/Summing up*', as already discussed, it may be expected to be the most frequent kind of intervention, because this depicts the general role of TA within the discussion forum, as to provide learners suggestions on their problems and conclude such discussions where the suggestions are to be further explored by learners. A final point to be made, relates to the demographics and motivation of students of the two courses, the IP students were more skills focused and did not strive to develop social interactions, while the WH ones were of a different age group, and different attitude towards the subject matter and motivation for participation in the course, that was reflected in the learners' interactions.

7 CONCLUSION

In this paper, we adopted both, a quantitative as well as a qualitative approach, i.e. used mixed methods, in order to explore the differences between the instructional staff interventions in the discussion forum of two courses of different subject matters. More specifically, we focused on teaching assistants, who volunteered to support fellow students in the two courses. We measured the interventions, and then we studied the discussion forums and we classified a sample of messages using a relevant coding scheme.

The results revealed some quite notable differences between the characteristics of the two courses' TA interventions, in terms of language used, length of messages, response times, length of discourse. It seems that the nature of the subject matter played a significant role in the type of interactions that occurred within the discussion forums, and moreover in the type of TA interventions that occurred within them. Another factor that seemed to contribute to the observed differences may be the educational level of the participants and generally their demographics. This factor is also related to the subject matter of the course, as different demographics are attracted by different course topics.

In conclusion, through this study we obtained some interesting insights on the differences in TA interventions in two courses of different subject matters. In future research, we wish to explore further such differences by extending the data set and by expanding the analysis in other subjects (Physics, Philosophy etc.). Further understanding of human TAs behavior patterns within current MOOCs is expected to drive the design of automated interventions in MOOCs in the future.

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