

Discussion Types and User Behavior in MOOCs

Short Paper

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Abstract

One of the most significant challenges of Massive Open Online Courses (MOOCs) is the low user engagement rate. Despite its importance, few studies have explored this issue. In this paper, we study user behavior in MOOCs through the lens of community design and investigate the role of distinct types of user interactions on engagement and performance. The results of our study demonstrate that both on-topic and off-topic discussions can enhance user engagement and learning outcomes. However, the impact of each discussion type varies based on specific user characteristics. The findings of our paper have significant implications for the providers and designers of MOOC platforms.

Keywords: Online platforms, massive open online courses, user behavior, student performance

Introduction

Massive Open Online Courses (MOOCs) are often considered to disrupt educational systems (Nambisan et al. 2017). In 2021, 220 million users attended MOOCs, while MOOC providers offered approximately 19,000 courses (ClassCentral 2021). Despite their prominence, MOOCs face low engagement and retention rates (Adamopoulos 2013, Reich and Ruipérez-Valiente 2019). Surprisingly, despite the significance of this problem, prior research has not provided adequate possible solutions to online education platforms to alleviate this issue (Huang et al. 2021). Yet, one of the distinguishing characteristics of MOOCs is that — due to their online nature— learners usually attend such courses independently, with limited social interactions with other learners or instructors. Scholars and practitioners believe that one of the reasons for the low user engagement in MOOCs is a weak sense of community or group identity (Khalil and Ebner 2014, Thompson 2017). While studies in traditional education demonstrate the positive impact of group identity on students' success, fewer studies investigate how group identity can be constructed in an online environment and how it impacts user behavior (Ren et al. 2007). In this paper, we try to bridge this gap by exploring the user engagement issue through the lens of community design.

One of the essential factors in creating a shared identity for group members is facilitating interactions (Thomas et al. 2016). In the context of online communities, individuals may interact with each other by having two types of discussions: on-topic and off-topic. By participating in on-topic discussions, group members can transfer information and cooperate following the group's primary goal, enhancing the group existence perception and self-categorization as a group member (Ren et al. 2012). Off-topic discussions allow members to socialize and know each other more, improving closeness among group members and a

sense of belonging (Cameron 2004). Nevertheless, according to the typical design of MOOCs, students are limited to on-topic discussions in course question-and-answer (Q&A) forums (Tong 2022). Despite the usage of Q&A (on-topic) discussion forums in almost all MOOCs, the problem of low engagement is still persistent. This study tries to understand if user engagement can be improved by facilitating off-topic discussions. However, it is not obvious if adding off-topic discussions will benefit or hinder engagement in MOOCs. In particular, some scholars argue that having off-topic discussions, which are not often related to the primary goal of a community, can dissatisfy some users and detract them from the platform, decreasing their engagement and increasing attrition (Methot et al. 2021). Yet, off-topic discussions might activate a sense of belonging among the students (Cameron 2004). Hence, it remains an interesting empirical question.

To study the impact of off-topic and on-topic discussions, we conducted a randomized field experiment altering the design of a popular MOOC offered and administered by a leading US business school on the edX platform and attended by nearly 3,000 students. The results suggest that facilitating both on-topic and off-topic discussions improve student engagement and learning outcomes. However, the positive impact of off-topic discussions is not the same for all learners. Low-performing users benefit more from off-topic discussions, while on-topic discussions improve the engagement and performance of high performers. Moreover, compared to males, females benefit more from off-topic discussions, but there is not a significant difference between the behavior of males and females due to on-topic discussions. Our work contributes to the literature on online user behavior, especially the emerging literature on student behavior in MOOCs. Our study is the first to show the heterogeneous impact of different discussion types on online user behavior. This research also has significant practical implications relating to the optimal design of MOOCs and the importance of social identity in online communities.

Theory & Background

Social identity refers to individuals' self-concept that derives from their membership in a specific group, along with values and emotional aspects attached to that membership (Tajfel and Turner 1978). The literature in social psychology shows that individuals' self-categorization as group members can lead to self-esteem and self-worth (Hogg 1993). The social bonds and emotional attachment among group members can create positive feelings, such as happiness and joy (Bergami and Bagozzi 2000, Kuppens et al. 2013, McGowan et al. 2017). The social and emotional benefits of group membership can be increased by creating an environment in which individuals can feel a higher level of social identity (McGowan et al. 2017). Studies across various disciplines, including organizational behavior, political science, and education, have consistently examined the role of social identity on individuals' behavior in a group. These studies show that enhancing the feeling of social identity increases individuals' motivation for group work, group commitment, group productivity, etc., enhancing their activity in a group (e.g., Ellemers et al. 1997, 2004, Worchel et al. 1998). Studies have also shown the importance of social identity and a sense of group belonging in users' contribution to communities in online settings (e.g., Ren et al. 2012). However, there is less evidence of the role of social identity in individuals' behavior when they are pursuing a task individually with a personal goal rather than a group goal, such as in learning (Bliuc et al. 2011, Won et al. 2018).

A limited number of studies in education show a positive relationship between social identity and individuals' self-regulation, self-efficacy, and motivation (e.g., Freeman et al. 2007, Oyserman 2007, Pittman and Richmond 2008, Zumbrunn et al. 2014). However, those studies are based on surveys, and their results are exploratory and correlational. In contrast, we explore the causal relationship between social identity and users' motivation in a task with an individual goal rather than a group one. By accessing detailed data related to user behavior over time, we can observe how the mechanisms that can increase social identity impact users' engagement and performance. Furthermore, to our knowledge, most of the prior education studies are limited to the offline setting, and their results might not be generalizable to the online setting (Ren et al. 2012). In offline settings, like a physical classroom, it is easier for learners to form social relationships; thus, there is a stronger social identity. The physical presence of peers, group activities, and interpersonal relations among students can create strong social bonds, impacting students' motivation and engagement. But in an online setting, like MOOCs, the context is more individualistic, and users usually do not see and know each other, decreasing opportunities for social bonding. So, users can be indifferent to having an online social identity. This study bridges this gap by exploring the effectiveness of social identity in an online setting.

One of the necessary factors in forming a shared social identity for members is facilitating group interactions (Thomas et al. 2016). Group interactions can improve the efficacy of group work and commitment to the group by enhancing social identification with group members (Thomas et al. 2016). Group members can generally have two types of interactions: on-topic and off-topic. On-topic discussions can create an environment in which users realize the salience of a group by discussing issues related to the group's primary goal. Off-topic discussions can create a friendlier environment, enhancing closeness among members and improving the sense of belonging to the group (Ren et al. 2007). Studies in traditional (synchronous face-to-face) education show the importance of both types of interactions (e.g., Grant 1988, Liu et al. 2007, Rahman et al. 2011). Students can usually have course-related discussions and solve their course-related issues through study groups. These types of (on-topic) interactions can create an environment in which users realize the salience of a group by discussing issues related to the primary goal of a group (Sassenberg 2002). Studies in the conventional classroom show a positive relationship between having course-related discussions and students' learning and engagement (Rahman et al. 2011, Smith et al. 2009). Based on the above arguments, course-related discussions (on-topic) would help students to feel that they are part of a group, improving their engagement and performance in the course. Furthermore, these types of discussions help students to solve their course-related problems and perform better in the course. Thus, we hypothesize that:

Hypothesis1: On-topic discussions improve users' engagement with the course and their performance in MOOCs.

Moreover, to better engage in the learning process, students also need to feel connected with each other, and this feeling usually depends on the quality of interpersonal relationships (Grant 1988, Rovai 2002). Connectedness can be created in an environment where students can build friendly relationships and trust others. The typical way to make that feeling in the physical classroom is by facilitating non-course group discussions and activities, which help students know each other more and facilitate communication (Liu et al. 2007, Rovai 2001). Prior studies have shown that non-course interactions positively correlate with students' engagement, collaborative learning, and performance (Broh 2002, Hurst et al. 2013). Although off-topic discussions can enhance the sense of belonging (Sassenberg 2002), there are also potential disadvantages to off-topic discussions (Ren et al. 2007). Off-topic discussions can disorganize the environment of online communities, in which users become confused about the primary goal of the communities and decrease their engagement. Perhaps because of these concerns currently, most MOOC providers only focus on course-related questions and answer forums (Tong 2022). Despite the practical importance, the question of whether MOOC providers should facilitate off-topic discussion remains unanswered in the literature. Based on the above arguments, it is possible that off-topic discussions enhance users' engagement with online courses by creating a sense of community and a friendlier environment. However, off-topic discussions also have the potential to disorganize the environment of the online learning community and negatively impact users' behavior. Hence, we hypothesize that:

Hypothesis2(a): Off-topic discussions enhance users' engagement with the course and their performance in MOOCs.

Hypothesis2(b): Off-topic discussions hurt users' engagement with the course and their performance in MOOCs.

Experiment

We conducted a randomized field experiment in 2019 on a MOOC offered and administered by a leading business school on the edX platform. The course is a 12-week master-level operation analytics course and is structured as two sections, weeks 1-5, followed by a midterm exam in week 6, and weeks 7-11, followed by a final exam in week 12. Each week, the course consists of lecture videos, readings, and practice problems. Approximately 3,500 learners across the globe signed up for the course, and 2,258 of them actively continued the course till the end; 32% of them were female. The users could audit the course for free or pay a registration fee to receive a certificate upon successfully completing the course (78% of users registered to receive a certificate). As part of all MOOCs on this platform, all learners can ask and answer questions in the corresponding course forum.

On-topic discussions were discussions related to issues about the course materials and content, and they occurred in the Q&A forums of the course. All users had access to the Q&A forum from the beginning of the course since this is part of the basic structure of the MOOC, and the forums are considered an important channel for students to address their questions about the course. Off-topic discussions were general discussions not directly related to course materials. To assess the impact of off-topic discussions, we created a unique environment where users can interact about topics other than the course. Specifically, after the midterm, we created a new subforum called "Social Hangout." This subforum was a place for students to discuss non-course related topics and created a repository of additional information for the learners that was not vital to their learning process. To limit any potential contamination and measure the impact of off-topic discussions more robustly, we restricted the access to the "Social Hangout" subforum just to the learners in the off-topic group, i.e., learners in the on-topic and control groups did not have access to the social hangout subforum, as described below.

The experiment was conducted in the second half of the course, after the midterm examination. We randomly assigned users to one of the three groups¹: on-topic discussion, off-topic discussion, and a control group. Individuals in the on-topic group received an email encouraging them to participate in the Q&A forums. The users in the off-topic group received an email that motivated them to participate in the new off-topic discussion forum. The control group received no specific encouragement but had access to the Q&A forum. To measure the treatment effects, we tracked users' behavior, including forum activity, engagement, scores, etc., before and after the intervention. In this study, we specifically focus on variables necessary for the users' success in this course: their engagement with the course content and their performance (Goli et al. 2021). We measure engagement as the time spent on video lectures after the treatment and the performance as the final exam score. We also control for users' demographics and prior performance on the midterm exam. Table 1 defines the variables used in the study, and Table 2 shows the descriptive statistics of the variables.

Variable Name	Variable Definition
User Characteristics	
Age	Participants' age
Gender	Participants' gender (Male or Female)
Enrollment Track	Participants' enrollment status (Certificate or Audit)
Language	Participants' primary language (English or not English)
Education	Participants' education level
Final	Final score (scale 0-1)
Midterm	Final score (scale 0-1)
Engagement	Video hours
Off-topic Assignment	An indicator for off-topic initial treatment assignment
On-topic Assignment	An indicator for on-topic initial treatment assignment
Off-topic Activities	Number of off-topic interactions (e.g., posts, answers, comments)
On-topic Activities	Number of on-topic interactions (e.g., posts, answers, comments)
Table 1. Variable Definition	

Variable	Min	Mean	Max	SD
Age	19	33	66	8.3
Midterm	0	0.66	1	0.31

¹ We ensured the randomness by comparing the user characteristics of the three groups and there are not any significant differences among them. Due to space limitation, we could not provide the details of the test.

Final	0	0.58	1	0.28
Engagement (Video hours)	0.12	8.14	35.69	5.51
Off-topic Activities	0	0.41	13	1.3
On-topic Activities	0	0.78	38	3.11
Table2. Descriptive Statistics of Variables				

Empirical Analysis and Results

Since we are interested in assessing the impact of forum activities on users' behavior, we cannot simply use the initial random assignments as the independent variables. Even though users were randomly assigned to the treatment groups, this can be considered an "intention to treat" since users can choose whether to become active in the forums. This participation is likely based on their special characteristics, making the sample biased (Angrist et al., 1996). For instance, learners who are already more active in the forums may be more engaged with the course. This issue could lead to potential endogeneity and bias in the estimates. To remedy this issue, it is recommended to use the initial random assignment as an instrument variable (IV)² for estimating the treatment causal effect (Bijwaard and Ridder 2005).

We use the two equations of (1) and (2) for that purpose. Specifically, we use the two-stage least squares estimator as the video hours, and the final scores are continuous variables. Equation (1) shows the first stage, demonstrating that the exogenous assignment causes variations in each treatment. Equation (2) is the second stage that models the dependent variables (e.g., engagement and performance) as a function of the predicted treatments from equation (2), control variables, and the possible interactions among treatments and the controls. In equation (1), $T_i = (\text{On-topic Assignment}_i, \text{Off-topic Assignment}_i)$ is the vector of the initial randomly assigned treatment for user i . And $A_i = (\text{On-topic Activities}_i, \text{Off-topic Activities}_i)$ represents the vector for the user discussion activities. X_i represents the user-level control variables (i.e., age, gender, etc.), y_i demonstrates the dependent variable (e.g., engagement, performance), \hat{A}_i is the predicted value of users forum activities from equation (1). u_i and ε_i are user-specific random errors.

$$A_i = \alpha_0 + \alpha_1 T_i + \alpha_3 X_i + u_i \quad (1)$$

$$y_i = \beta_0 + \beta_1 \hat{A}_i + \beta_2 X_i + \beta_3 \hat{A}_i * X_i + \varepsilon_i \quad (2)$$

Main Effect

We first examine the main effect of the two types of treatments on learners' behavior. As the engagement model in Table 3 shows, both off-topic and on-topic discussions can significantly increase users' engagement. Having an off-topic discussion increases the engagement with course videos by 0.452 hours ($\beta = 0.452, p < 0.01$)³, while having an on-topic discussion can enhance the engagement by 0.387 hours ($\beta = 0.387, p < 0.05$). Moreover, the performance results show that both treatments can significantly increase the users' learning outcomes. Specifically, having an off-topic discussion, on average, increases the final score by 1.2 percentage points ($\beta = 0.012, p < 0.01$). While having on-topic discussions increases the score by 1.4 percentage points ($\beta = 0.014, p < 0.05$). The results can be explained based on group identity theory (Tajfel and Turner 2004). Both on-topic and off-topic discussions can create a shared identity among learners. On-topic discussions can enhance the perception of group existence and facilitate members' self-categorization process. Using on-topic discussions, members realize they are part of a group and can help each other succeed in the learning journey. Off-topic discussions create a friendlier environment in which

² We checked the validity of IV by considering both relevance and exclusion restriction assumptions. However, because of space limitation, we could not include the details of that in the paper.

³ p-values in parentheses; ^ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

the learners have an opportunity to become more familiar with each other and socially bond with each other. That environment can develop a sense of belonging, increasing learners' engagement and commitment to the course. Generally, the results indicate that, unlike previous studies that predicted the negative effect of off-topic discussions (e.g., Kohonen-Aho and Tiilikainen 2017, Methot et al. 2021), these types of discussions can positively impact user behavior in an online learning setting. Off-topic discussions can satisfy the affective aspect of shared social identity, enhancing user engagement and performance. These types of discussions may construct a friendlier environment in which the users have an opportunity to become more familiar with each other and socially bond with each other. These results imply that in addition to learning opportunities, online learning platforms need to facilitate the social environment of online courses.

	Engagement	Performance
Off-topic Activities	0.452** (0.003)	0.012** (0.007)
On-topic Activities	0.387* (0.049)	0.014* (0.040)
Constant	1.717** (0.001)	0.042** (0.009)
User Characteristics	YES	YES
Adj. R2	0.51	0.80
N	2,258	2,258

Table 3. Main Effects

Post-Hoc Analysis: Heterogeneous Effects

In addition to the main effect, we are also interested in the moderating effect of users' prior performance in the course, which is measured based on midterm score and gender. Table 4 demonstrates the results. As the 'Midterm Interaction' model indicates, having an on-topic discussion does not significantly impact the behavior of users with lower midterm scores. However, for students with higher midterm scores, an on-topic discussion significantly increases both user engagement (On-topic Activities \times Midterm, $\beta = 1.057, p < 0.05$) and performance (On-topic Activities \times Midterm, $\beta = 0.031, p < 0.01$). Furthermore, the results indicate that the effect of having an off-topic discussion is stronger for users with lower midterm scores than for higher scores (engagement: Off-topic Activities \times Midterm, $\beta = -1.012, p < 0.05$; performance: Off-topic Activities \times Midterm, $\beta = -0.027, p < 0.1$).

This behavior can be observed potentially because users with higher midterm scores are usually motivated enough to continue the course and are less sensitive to social identity and group belonging as external motivation (Lei 2010, Ryan and Deci 2000). Thus, the marginal benefit of social interaction decreases for those users, and having off-topic discussions does not significantly impact their behavior. However, users with lower midterm scores are more likely to lose their motivation to continue the course (Borrella et al. 2019, Lu et al. 2021). In such cases, engaging in on-topic discussions (Q&A) may not be motivating enough because of prior weak performance (Harackiewicz et al. 2002, Swinnerton et al. 2017). Nevertheless, off-topic discussions create an opportunity for them to interact with others and feel as belonging to the group, increasing their motivation.

	Midterm Interaction		Gender Interaction		
	Engagement	Performance		Engagement	Performance
Off-topic Activities	1.173*** (0.001)	0.031** (0.008)	Off-topic Activities	0.170 (0.393)	0.006 (0.280)
Off-topic Activities \times Midterm	-1.012* (0.022)	-0.027^ (0.062)	Off-topic Activities \times Gender (Female)	0.827** (0.008)	0.016^ (0.072)

On-topic Activities	-0.271 (0.264)	-0.008 (0.446)	On-topic Activities	0.224 (0.273)	0.009 (0.191)
On-topic Activities × Midterm	1.057* (0.032)	0.034* (0.014)	On-topic Activities × Gender (Female)	0.792 (0.170)	0.023 (0.243)
Constant	2.176** (0.000)	0.058*** (0.001)	Constant	1.811** (0.001)	0.044** (0.008)
User Characteristics	YES	YES	User Characteristics	YES	YES
Adj. R2	0.51	0.80	Adj. R2	0.48	0.79
N	2,258	2,258	N	2,258	2,258
Table 4. Heterogeneous Effects					

p-values in parentheses; ^ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Moreover, the results show that females benefit from off-topic discussions more than males. As the 'Gender Interaction' models suggest, off-topic discussion significantly increases the engagement of females (Off-topic Activities × Gender, $\beta = 0.827, p < 0.01$). The performance models show the same for users' learning outcomes (Off-topic Activities × Gender, $\beta = 0.016, p < 0.1$). We also see that there is not any differential impact on the on-topic discussions. According to prior literature, this behavior may be due to the difference in the structure of peer interactions between males and females (Rose and Rudolph 2006). Specifically, according to studies in social psychology, compared to men, women are more connection-oriented and are more interested in interpersonal relations (Huang et al. 2018). Organizational theorists also show that women value cooperation and social connections more than men, who show more outcome-based behavior (Mason 1995). Motivational studies support this difference by showing that men are more promotion-focused and interested in demonstrating their competitiveness. At the same time, prior research suggests women are more interested in interpersonal relationships and communion motives (Costa Jr et al. 2001, Feingold 1994). Thus, off-topic discussions, which facilitate interpersonal relations, may positively impact females' behavior more than males'. These results demonstrate the importance of considering user characteristics in designing and managing MOOCs. Since different people can have different learning styles, priorities, goals, cognitive abilities, etc., it is crucial for managers to consider that in providing satisfactory services.

Conclusion & Discussion

This study examines the low user engagement issue from a community design perspective and shows the importance of social interactions in online education. By running a field experiment on a MOOC and facilitating two types of interactions, we demonstrate that both on-topic and off-topic discussions can enhance users' engagement and learning outcomes. However, the significance of the impacts can be different based on users' characteristics. We specifically show that low-performing users benefit more from off-topic discussions, and on-topic discussions improve high performers' engagement and learning outcomes. Moreover, we demonstrate that while on-topic discussions enhance the engagement and performance of both males and females, females benefit more from off-topic discussions. This paper extends the current literature on user behavior in designing and improving IT artifacts. Using a novel approach, we show the importance of considering the dynamics of human behavior in developing platforms, in general, and MOOCs, in particular. This study contributes to the literature on MOOC as a digital innovation that has captured less attention in the literature on information systems (Gupta and Bostrom 2009). It shows the importance of creating an appropriate learning environment for the success of online education. The results of this study have significant practical and managerial implications. We emphasize the importance of appropriate platform design in user engagement and the success of the platforms. Our results guide MOOCs designers and managers on improving users' engagement by facilitating both on-topic and off-topic interactions. We also underscore the importance of considering user characteristics in designing and managing MOOCs. Since different people can have different learning styles, priorities, goals, cognitive abilities, etc., managers should consider providing satisfactory services. In the future, we will examine the moderating effects of user characteristics more comprehensively by analyzing users' age and

education level. Moreover, in the future, we will analyze user interaction behavior in forums to shed light on the underlying mechanisms related to a shared identity.

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