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Understanding students' engagement in MOOCs: An integration of self-determination theory and theory of relationship quality

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Abstract

Although Massive Open Online Courses (MOOCs) attract millions of people to enroll in their courses, the completion rate for most courses is very low. A majority of MOOCs students are not fully engaged in MOOCs, thus leading them to quit in the early stage of the courses. Therefore, it is important to investigate students' engagement in MOOCs. Drawing on self-determination theory and the theory of relationship quality, this study proposes a model that conceptualizes the MOOCs engagement as consisting of psychological engagement and behavioral engagement and explores the antecedents of students' engagement in MOOCs. The research model is tested using data collected from 374 students of Chinese University MOOC. The results show that fulfillment of three basic psychological needs for autonomy, competence and relatedness have significant positive effects on intrinsic motivation, increasing students' psychological engagement in MOOCs. Relationship quality significantly predicts students' psychological engagement, and psychological engagement promotes behavioral engagement in MOOCs. Implications for research and practice as well as limitations of this study are discussed finally.

Introduction

In recent years, Massive Open Online Courses (MOOCs) have gained rapid development with the advantages of numerous quality educational resources, openness and low cost (Alraimi, Zo, & Ciganek, 2015; Zhou, 2016). Despite the sudden rise of MOOCs, there are still many problems to be resolved. One of the most important issues is the high dropout rate of MOOCs learners (Freitas, Morgan, & Gibson, 2015; Onah, Sinclair, Boyatt, & Foss, 2014; Watson, Watson, Yu, Alamri, & Mueller, 2017). Although millions of people enroll in MOOCs, the dropout rate of most courses can up to 90% (Hew & Cheung, 2014; Jordan, 2014). Many scholars have speculated on and verified the reasons for the high dropout rate. They pointed out that there is a certain correlation between MOOCs learners' engagement and the dropout behavior, and proposed that students

Practitioner Notes

What is already known about this topic

- MOOCs are becoming more and more popular around the world, but the dropout rate of MOOCs is still very high.
- Student engagement is very important to reduce the dropout rate of MOOCs.
- There are multiple kinds of engagement patterns and it is a huge challenge to stimulate students to actively engage in MOOCs.
- Intrinsic motivation significantly affects student engagement in MOOCs.

What this paper adds

- Student engagement in MOOCs contains psychological and behavioral engagement, and students' psychological engagement promotes their behavioral engagement.
- Relationship quality which consists of trust and commitment is an important predictor of students' psychological engagement in MOOCs.
- This study also examines the relationship between the antecedents of intrinsic motivation and students' psychological engagement in MOOCs.

Implications for practice and/or policy

- Cultivating students' trust and commitment (such as providing a channel for students to know about others and arranging group tasks) should be taken into account when MOOC platforms want to increase students' engagement intention.
- Meeting students' needs for autonomy, competence and relatedness (such as providing multiple versions of one course, setting different levels of challenge activities or task, and guiding everyone to interact with and respect each other) can increase their intrinsic motivation, leading to their active engagement in courses.

with higher level of engagement are less likely to drop out (Freitas *et al.*, 2015; Goldberg *et al.*, 2015; Xiong *et al.*, 2015).

Previous studies about engagement in MOOCs focused on the engagement patterns (Ferguson & Clow, 2015; Khalil & Ebner, 2017; Phan, McNeil, & Robin, 2016) and the impact of engagement on performance or completion (de Barba, Kennedy, & Ainley, 2016; Freitas *et al.*, 2015; Goldberg *et al.*, 2015; Onah *et al.*, 2014). Scholars have mentioned that student engagement contains multiple components, but most studies consider the "engagement" as a multidimensional uniform variable, or focus on one dimension of engagement (such as behavioral engagement) (Appleton, Christenson, Kim, & Reschly, 2006; Cho & Cho, 2014; Fredricks, 2011; Li, Zhang, Bonk, & Guo, 2015; Liu, Calvo, Pardo, & Martin, 2015; Reeve, Jang, Carrell, Jeon, & Barch, 2004). However, a small amount of literature indicates that there is a certain interrelationship between different dimensions of engagement (Cheung, Shen, Lee, & Chan, 2015; Fang, Zhao, Wen, & Wang, 2017). Thus, it is necessary to explore the relationship between different types of MOOCs engagement and their influencing factors. Besides, although some studies have explored the antecedents of student engagement in self-regulated learning, the underlying mechanism of MOOCs student engagement is different from traditional online learning engagement because MOOCs have the obvious social interaction feature (Onah *et al.*, 2014; Zhang, Yin, Luo, & Yan, 2017). Given that understanding the antecedents of multiple dimensions of MOOCs engagement would help both academics and practitioners gain insights into how to cultivate and maintain learners' engagement, and thus reducing the dropout rate of MOOCs, it is meaningful to identify the influencing

factors of MOOCs student engagement. This study therefore sets up to empirically explore the factors which lead to the engagement in MOOCs.

In particular, this study identifies influencing factors by first analyzing the characteristics of MOOCs. Self-organization and social interaction are two salient features of MOOCs learning. First, on MOOC platforms, the absence of teachers' direct supervision determines that students must arrange their learning activities by themselves and entirely self-regulate their learning process (Hood, Littlejohn, & Milligan, 2015; Pellas, 2014; Phan *et al.*, 2016; Sun & Rueda, 2012). Second, unlike other online educational platforms, MOOCs emphasize the interaction between students. MOOC platforms set discussion forums as a part of the courses. Students are expected to ask questions about course content and exchange ideas via a discussion forum (Hew & Cheung, 2014; Onah *et al.*, 2014).

Considering the specific context of MOOCs, this study explores the antecedents of engagement in MOOCs from the perspectives of self-determination theory (SDT) and the theory of relationship quality. As students are less directly encouraged and supervised by instructors, they need to have a higher level of self-motivation to engage in MOOCs. SDT is a well-established macro-theory of motivation that emphasizes the importance of humans' inner resources for behavioral self-regulation (Deci, Koestner, & Ryan, 1999). The theory of relationship quality is widely used to reflect sustainable relationship exchange (Morgan & Hunt, 1994; Rauyruen & Miller, 2007; Sheu, 2015). A relationship between students and other participants as well as MOOCs platform is established during their interaction process. Strong relationship with other learners and MOOCs platform stimulates students' learning (Diep, Cocquyt, Zhu, & Vanwing, 2016). Therefore, the relationship quality is also crucial to the engagement in MOOCs whose significance has been implied but lacks further research.

Theoretical background

Student engagement in MOOCs

Engagement is defined as "the behavioral intensity and emotional quality of a person's active involvement during a task" (Reeve *et al.*, 2004, p. 147). Student engagement can be seen as a combination of behavioral and psychological facets (Finn, 1989; Glanville & Wildhagen, 2007; Horstmanshof & Zimitat, 2007). Behavioral engagement mainly involves students' participation in class activities and academic-relevant activities, which is considered to be essential to prevent dropout (Fredricks, Blumenfeld, & Paris, 2004). Psychological engagement can be seen as a result of interaction in emotion and cognition, and it stresses students' affective reactions toward class and the psychological investment in learning (Glanville & Wildhagen, 2007; Marks, 2000; Ramey *et al.*, 2015).

Based on previous conceptualization of engagement, student engagement in MOOCs here represents the psychological state that students are emotionally and cognitively active in their courses and the behavioral effort students expend in MOOCs learning to master the knowledge and perform well (Fredricks *et al.*, 2004; Ray, Kim, & Morris, 2014; Reeve *et al.*, 2004; Sun & Rueda, 2012). It includes both psychological and behavioral components. Psychological engagement in MOOCs mainly reflects more internal states, such as feelings of enthusiasm and energy toward the courses, sense of significance and valuing their courses. Behavioral engagement in MOOCs specifically encompasses more observable activities which include not only video watched, but also extra activities that contribute to broadening and deepening students' understanding of course knowledge, such as quizzes answered, assignment submitted and comments posted in a discussion forum.

Self-determination theory

SDT is one of the most empirically supported motivation theories which has been widely adopted in many areas, such as workplace (Baard, Deci, & Ryan, 2004), commercial service (Lin, Tsai, & Chiu, 2009) and educational service (Jeno, Grytnes, & Vandvik, 2017; Zhou, 2016). Central to this theory are intrinsic and extrinsic motivation and the concept of basic psychological needs that provides the basis for motivation (Gagné & Deci, 2005; Sørebø, Halvari, Gulli, & Kristiansen, 2009).

Intrinsic motivation refers to "the doing of an activity for its inherent satisfactions rather than for some separable consequence" (Ryan & Deci, 2000, p. 56), while extrinsic motivation is "a construct that pertains whenever an activity is done in order to attain some separable outcome" (Ryan & Deci, 2000, p. 60). Many researches have revealed that intrinsic motivation is more influential for self-organized behaviors than extrinsic motivation. For example, individuals are usually strongly driven by intrinsic motivation to participate and share knowledge with others in online communities (Hau & Kim, 2011; Lou, Fang, Lim, & Peng, 2013). A comparative experiment showed that students are more motivated to perform well by intrinsic goal (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). As can be seen from previous studies, the major determinant of individuals' self-organized behavior is intrinsic motivation. Therefore, this study focuses on the role of intrinsic motivation.

SDT proposes that the adoption of intrinsic motivation depends on the satisfaction of three universal psychological needs: the needs for autonomy, competence and relatedness (Ryan & Deci, 2000). Autonomy refers to the desire to self-initiate and self-organize one's own behavior, which entails that an individual can freely chose his actions and feel initiative even when his actions are affected by outside sources. Competence implies that people tend to feel effective in their interactions with social contexts and have the desire to show one's capacities. Relatedness refers to the desire to feel connected to others and want to perceive the acceptance and support of others (Deci & Ryan, 2002; Roca & Gagné, 2008; Sørebø *et al.*, 2009).

In the context of MOOCs, students' intrinsic motivation enhances their participation in online discussion and other course activities (Xiong *et al.*, 2015; Yang, 2014). As for the psychological needs, the satisfaction of students' basic psychological needs for autonomy, competence and relatedness through teachers' support can foster students' self-regulation for learning and improve their academic performance (Niemiec & Ryan, 2009; Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008). In online learning environments, the three psychological needs have the apparent connections with features of online learning. The flexible and open learning context provides students with autonomy; the technological skill development or knowledge expansion correspond to competence; computer-mediated social interactions may meet students' need for relatedness (Chen & Jang, 2010; Durksen, Chu, Ahmad, Radil, & Daniels, 2016). Hence, it is appropriate to adopt SDT to address students' engagement problems in MOOCs.

Relationship quality

Students are required to interact with others when they attend courses in MOOCs. The more interactions undertaken by student–student or student–instructor, the greater the intensity of the relationship between students or student-community. The theory of relationship quality highlights the development and maintenance of successful relationship during relational exchange process (Chiu, Hsu, & Wang, 2006; Morgan & Hunt, 1994). It is frequently applied to online community contexts to give an explanation for collaborative behavior or knowledge sharing (Chang & Chuang, 2011; Hashim & Tan, 2015; Ma & Yuen, 2011), of which the nature is similar to the characteristics of students' engagement in MOOCs.

The core components of relationship quality are trust and commitment (Morgan & Hunt, 1994). Trust refers to the positive beliefs and expectations of individuals that consider other people as a reliable and upright person who will follow the existing rules (Chiu *et al.*, 2006; Morgan & Hunt, 1994). Commitment, arising from regular and frequent interaction, represents one's feeling that one has an important and beneficial relationship with another party and has a desire to maintain the relationship (Morgan & Hunt, 1994). When people realize that they share similar goals or values with others, commitment is assumed to increase.

Trust and commitment have been found to be necessary in online environments. Trust is recognized as a significant facilitator of positive online behaviors (Chang & Chuang, 2011; Hashim & Tan, 2015; Shen, Lee, & Cheung, 2014). Lack of trust may bring about students' abandon of online learning (Hamidi & Chavoshi, 2018). When there is a high level of trust among people, more open and relaxed relationship atmosphere is created, thus promoting their interaction and the willingness of engagement in online community activities (Hashim & Tan, 2015). Online students with strong sense of community which includes trust are more likely to feel gratification with the online learning (Rovai, 2002). As pointed out by De Meo, Messina, Rosaci, and Sarne (2017), trust relationship is identified as an additional motivation for students to engage in online learning activities. MOOC learners' behavior is directly driven by trust (Costello, Brunton, Brown, & Daly, 2018). Establishing trust among online learning students is essential for the success of an online learning platform (Wang, 2014). Commitment is also important to develop online volitional behaviors. Commitment stimulates online community members' continuous participation by increasing their feelings of association with others (Hashim & Tan, 2015). With commitment comes the intention of people to do positive online acts. Maintaining committed relationship with an online community strengthens members' collective intention to endeavor to sustain engagement in community's activities and contribute in the community (Shen *et al.*, 2014). Learners who are conscious of online relationship commitment have higher intention to share their expertise and knowledge on an online learning platform (Ma & Yuen, 2011).

Based on previous studies, it can be argued that students' learning can benefit from relationship quality. However, relationship quality in MOOCs has still been an understudied component. In this study, we specify trust and commitment as the two dimensions of relationship quality and examine the role of relationship quality in students' engagement in MOOCs.

Research model and hypotheses

Drawing on SDT and the theory of relationship quality, we proposed a model for students' engagement in MOOCs. The research model is illustrated in Figure 1.

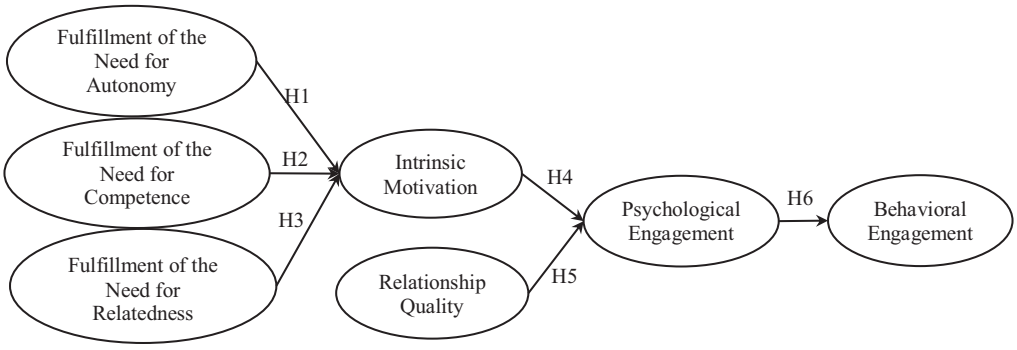

Figure 1: Research model

The need for autonomy and intrinsic motivation

The need for autonomy among students reflects a desire to self-manage ones' actions in their learning and to be the origin of their own learning patterns (Deci & Ryan, 2002). The flexibility of MOOCs support student rights to freely choose courses. This condition meets the need for autonomy and then stimulates students' intrinsic enjoyment of learning. Roca and Gagné (2008) demonstrated that an autonomy-supportive context is able to enhance perceived playfulness which represents intrinsic motivation. An increase in students' perception of autonomy enhances their interest for lessons (Chen & Jang, 2010; Durksen *et al.*, 2016; Tsai *et al.*, 2008). Therefore, we hypothesize that:

H1: Fulfillment of the need for autonomy has a positive impact on students' intrinsic motivation in MOOCs learning.

The need for competence and intrinsic motivation

The need for competence represents individuals' needing to feel effective and successful when they perform an activity, which impels people to seek challenges that are most suitable for their capacities (Deci & Ryan, 2002). In MOOC settings, students can expand their knowledge and show their capability by completing course tasks and answering quizzes. When their need for competence is satisfied, their confidence in learning is enhanced and they conceive of MOOC courses as optimal activities for their capacities, and thus they tend to be more intrinsically motivated to study (Yang, 2014). Therefore, we hypothesize that:

H2: Fulfillment of the need for competence has a positive impact on students' intrinsic motivation in MOOCs learning.

The need for relatedness and intrinsic motivation

The need for relatedness refers to an individual's needing to feel connected to and supported by others (Deci & Ryan, 2002). When people are valued and respected by those to whom they feel connected, they are more intrinsically motivated to perform an activity (Deci & Ryan, 2000). Students who perceive that their teacher genuinely likes and cares for them are more likely to enhance their interest about learning (Niemiec & Ryan, 2009). In MOOC settings, students feel more connection and mutual respect with a wider range of peer learners, and this can dispel loneliness and neglected feelings that may occur in individual learning, thus increasing students' enjoyment of MOOCs learning. The feeling of relatedness contributes to the enhancement of individuals' motivation (Roca & Gagné, 2008). Therefore, we hypothesize that:

H3: Fulfillment of the need for relatedness has a positive impact on students' intrinsic motivation in MOOCs learning.

Intrinsic motivation and psychological engagement

An individual with a high level of intrinsic motivation pursues an activity for the pure inherent satisfaction and enjoyment prompted by the emotional state that doing the thing is interesting (Alraimi *et al.*, 2015; Ryan & Deci, 2000). When students are more intrinsically motivated to learn in MOOCs, their feelings for the courses will be more positive because they consider learning in MOOCs as an action that is enjoyable and meaningful. Thus, they are full of enthusiasm and vitality to participate in the courses. Increasing student interest can enhance their positive emotion and cognition about engagement in online learning (Sun & Rueda, 2012). It is reasonable to assume that students who are intrinsically motivated tend to engender more positive feelings and perceptions toward MOOCs learning. Therefore, we hypothesize that:

H4: Students' intrinsic motivation has a positive impact on their psychological engagement in MOOCs.

Relationship quality and psychological engagement

Relationship quality, consisting of trust and commitment, here describes a relationship state with others and MOOC platforms. The higher the level of trust between students and the stronger the degree of commitment to MOOCs, the greater the quality of the relationship. If students perceive that other learners are friendly and trustworthy, the learning atmosphere among students will be more relaxed which allows them to engage openly without fearing of making mistakes (Hashim & Tan, 2015), thus leading to more positive feelings and perceptions about their courses. Students who have a good sense of trust are more likely to show greater enthusiasm for their online learning programs, which leads to frequently participate in community activities (Rovai, 2002). When students think that the relationship with MOOCs is necessary and beneficial, they expect to maintain this relationship. The more they commit themselves to the relationship with MOOCs, the more they will feel valuable and enthusiastic about the courses in MOOCs and be willing to engage in MOOCs. The positive relationship with a learning program is a significant predictor of adult learners' online participation (Diep *et al.*, 2016). Thus, we assume that a higher level of relationship quality enhances students' positive feelings with the courses and the willingness to devote their energy into MOOCs. Therefore, we hypothesize that:

H5: Relationship quality has a positive impact on students' psychological engagement in MOOCs.

Psychological engagement and behavioral engagement

Psychological engagement in MOOCs represents students' internal feeling and cognitive state of the course, while behavioral engagement mainly reflects the student participation in course-based activities which encompass basic learning behaviors (such as video watched) and higher level behaviors (such as making extra effort to deepen what they have learned) (Reeve *et al.*, 2004; Stumpf, Tymon, & van Dam, 2013; Sun & Rueda, 2012). Different types of engagement are dynamically related rather than being isolated from each other (Fredricks *et al.*, 2004). Some studies have suggested that psychological engagement induces individual behavioral engagement in a mobile application (Fang *et al.*, 2017), or online games (Cheung *et al.*, 2015). It is reasonable to assume that students' positive psychological state about the course contributes to students' active involvement during the MOOCs learning. That is, if a student perceives that the course is valuable and attends it psychologically by a degree of enthusiasm, s/he will actively participate in the course and make an effort to perform better, such as increasing the frequency and intensity of watching the course videos, reading the course materials and performing other relevant course activities (eg, completing assignments, discussing with others by posting in forums). Therefore, we hypothesize that:

H6: Students' psychological engagement has a positive impact on their behavioral engagement in MOOCs.

Method

Research setting

Chinese University MOOC (http://www.icourse163.org/), one of the most authoritative MOOC platforms in China, was chosen as a target platform in this study to examine students' engagement. This platform joins 146 well-known universities and institutions to provide thousands of

quality courses which cover a wide range of disciplines, including computer science, bioscience, economics, psychology and pedagogy. The courses in Chinese University MOOC consist of the courseware (course videos and relevant materials), quizzes, assignments, discussions and examinations. It is the largest MOOC platform in China with more than 13 million people attending classes. Therefore, Chinese University MOOC is suitable to be used in this investigation.

Measurement

The measures of the constructs in this study were adapted from extant literature (see Appendix A). Some terms were slightly modified to fit our research context. Since seven-point Likert scales provide more choices which make it easier to use and can accurately measure a respondent's true evaluation (Finstad, 2010; Joshi, Kale, Chandel, & Pal, 2015), seven-point Likert scales were utilized for all items, ranging from "strongly disagree" to "strongly agree." Seven-point Likert scales were used for all items, ranging from "strongly disagree" to "strongly agree." The scales for fulfillment of needs for autonomy, competence and relatedness were borrowed from Ke and Zhang (2010). The scale for intrinsic motivation was adapted from Ray *et al.* (2014). We used the scale for relationship quality developed by Chiu *et al.* (2006) that correspond to its two dimensions (eg, trust and commitment). Finally, the scales for psychological engagement and behavioral engagement were derived from the study of Stumpf *et al.* (2013).

Data collection

An online survey was conducted in this study to collect data. This survey was released as a final assignment of the course "The Basic Knowledge of Information Management" that was taught by us in Chinese University MOOC in 2014. The course aimed to introduce information management theories and methods. Its major contents included information distribution, information retrieval, information services and information systems.

It was completely voluntary to answer the questionnaire, and we informed students about the purpose of this questionnaire. In order to encourage more students to respond to our survey, we told students that completing this survey could get extra credit. This survey contained two parts: the demographics and MOOCs usage information of respondents, and the scales of seven constructs in the research. After excluding the unqualified responses in this survey, we obtained 374 valid responses. Among these respondents, male accounted for 53.2% and female accounted for 46.8%. Most of them (44.7%) aged 19–22 followed by the respondents over the age of 28 (31.0%). For education background, more than 90% of the respondents got a bachelor degree or higher. In terms of internet usage experience, 43.9% of the respondents had more than 8 years of internet usage experience. 46.3% of them login to Chinese university MOOC platform 3–5 times per week. The specific demographics of the respondents are shown in Table 1.

As online survey was used to collect data, the response rate is difficult to be calculated. In order to solve this problem, we checked the demographic difference between the first third and the last third of respondents (Kim, Mukhopadhyay, & Kraut, 2016). According to the results, there are no significant differences between the two sub-groups in demographics except for login frequency. We further compared the variable means for these two sub-groups and found that there was no significant difference between these two sub-groups except for trust. These results suggest that response bias is not a critical concern for this study.

Data analysis

The partial least squares (PLS) method was used in this study to test the research model. PLS is capable to estimate the measurement model and the structural model at the same time.

Table 1: Demographics

Variables	*Category*	*Frequency*	*Percentage*
Gender	Male	199	53.2
	Female	175	46.8
Age	Under 18	4	1.1
	19–22	167	44.7
	23–25	68	18.2
	26–28	19	5.1
	Above 28	116	31.0
Education	Below bachelor	33	8.8
	Bachelor	260	69.5
	Master or above	81	21.7
Internet experience	Under 2 years	20	5.3
	3–4 years	66	17.6
	5–6 years	66	17.6
	7–8 years	58	15.5
	Above 8 years	164	43.9
Login frequency in Chinese university MOOC (per week)	More than 5 times	66	17.6
	3–5 times	173	46.3
	2–3 times	61	16.3
	Less than once	74	19.8

Compared to the covariance-based structural equation modeling (CB-SEM), PLS is more suitable for this study as it has little requirements for sample size, and has no restriction on normal distribution (Chin & Newsted, 1997). And PLS can model second-order constructs which is the case of our study, such as our construct of relationship quality. For all the reasons above, PLS is appropriate for this study. Thus, SmartPLS was used as the analytic tool to conduct data analysis. In the following section, measurement model and structural model will be examined and reported, respectively.

Measurement model

Reliability and validity of the constructs were assessed in the measurement model. The assessment of each construct's reliability included Cronbach's α, Composite Reliability (CR) and average variance extracted (AVE). The criteria of reliability were proposed that the values for Cronbach's α, CR should higher than 0.7, and the critical value for AVE is 0.5 (Fornell & Larcker, 1981). As shown in Table 2, the minimum values of AVE, CR and Cronbach's α were 0.770, 0.920 and 0.870, respectively, all above the recommended threshold, indicating that all constructs were reliable.

The validity analysis, including convergent validity and discriminant validity, were evaluated using confirmatory factor analysis. Convergent validity was tested by checking factors loading of each construct. The factor loading of each indicator of a construct is higher than 0.7, showing the good convergent validity (see Appendix B). And each item loading is greater than all of its cross-loadings, satisfying the requirement of discriminant validity. The discriminant validity also can be tested by comparing the correlation coefficient between the latent variables and the square roots of AVE. The square root of AVE of each construct should be higher than the correlation of the specific construct with all the other constructs in the model. From the results of Table 3, all square roots of AVE values exceed the correlations, suggesting that the measurement model has good discriminant validity.

Table 2: Reliability

	AVE	*CR*	*Cronbach's α*
BENG	0.805	0.925	0.878
PENG	0.770	0.930	0.900
IXM	0.880	0.956	0.931
TRS	0.794	0.920	0.870
CMT	0.848	0.943	0.910
FNA	0.865	0.951	0.922
FNC	0.845	0.942	0.908
FNR	0.887	0.959	0.936

Note: BENG = Behavioral engagement, PENG = Psychological engagement, IXM = Intrinsic motivation, TRS = Trust, CMT = Commitment, FNA = Fulfillment of the need for autonomy, FNC = Fulfillment of the need for competence, FNR = Fulfillment of the need for relatedness.

Table 3: Correlation matrix with the square root of the AVE in the diagonal

	BENG	*PENG*	*IXM*	*TRS*	*CMT*	*FNA*	*FNC*	*FNR*
BENG	**0.897**							
PENG	0.721	**0.877**						
IXM	0.496	0.585	**0.938**					
TRS	0.431	0.469	0.430	**0.891**				
CMT	0.511	0.606	0.520	0.594	**0.921**			
FNA	0.445	0.472	0.446	0.370	0.460	**0.930**		
FNC	0.558	0.628	0.481	0.542	0.654	0.480	**0.919**	
FNR	0.467	0.524	0.397	0.633	0.610	0.371	0.632	**0.942**

Note: Bold numbers on the diagonal denote the square roots of AVEs.

For the formative construct, it was evaluated by examining the weights of each sub-construct. Relationship quality is a second-order formative construct including two first-order constructs, namely trust and commitment. As shown in Table 4, the weights were statistically significant for first-order constructs, suggesting that all the items make an important contribution to relationship quality.

Structural model

The PLS results of the structural model are presented in Figure 2. According to the results, fulfillment of the need for autonomy has a significant positive effect on intrinsic motivation ($\beta = 0.268$, $t = 4.313$, $p < 0.01$), supporting H1. Fulfillment of the need for competence exerts an important effect on intrinsic motivation ($\beta = 0.273$, $t = 4.297$, $p < 0.01$), validating H2. Fulfillment of the need for relatedness is found to be significant to intrinsic motivation ($\beta = 0.125$, $t = 2.174$, $p < 0.05$), so H3 is supported. Intrinsic motivation has a positive impact on psychological engagement ($\beta = 0.378$, $t = 6.607$, $p < 0.01$), thus leading support to H4. Relationship quality is positively associated with psychological engagement ($\beta = 0.388$, $t = 7.625$, $p < 0.01$), supporting H5. Psychological engagement is found to be positively related to behavioral engagement ($\beta = 0.714$, $t = 17.550$, $p < 0.01$), supporting H6. Overall, fulfillment of needs for autonomy, competence and relatedness together explain 30.1% of the variance in intrinsic motivation. Intrinsic motivation and relationship quality account for 45.2% of the variance in psychological engagement. 50.9% of the variance in students' behavioral engagement in MOOCs is explained by psychological engagement.

Table 4: Formative second-order constructs

2nd order construct	*1st order construct*	*Weight*	*T-value*
Relationship quality	Trust	0.513	36.165
	Commitment	0.506	33.273

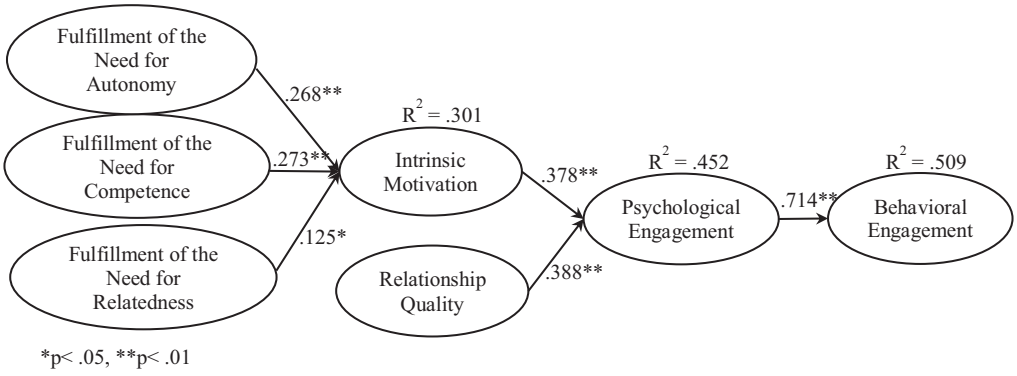

Figure 2: Results of structural model

Discussion

This study applies SDT and the theory of relationship quality to understand students' engagement. The results show several interesting findings.

First, we found that fulfillment of needs for autonomy, competence and relatedness are important facilitators of students' intrinsic motivation and hence of their engagement in MOOCs. When students can arrange MOOCs learning in their own way, feel competent in MOOCs learning, and have the sense of being connected to others, their basic psychological needs are satisfied, thus increasing their motivation and contributing to their engagement in MOOCs. These findings verify the applicability of SDT in MOOCs environment and echo with previous studies which showing the three basic needs are associated with intrinsic motivation and also lead to positive learning outcomes in synchronous hybrid learning environments (Butz & Stupnisky, 2017; Chen & Jang, 2010).

Second, intrinsic motivation and relationship quality both significantly predict students' psychological engagement in the course. When students think that learning in MOOCs is pleasant, they have more positive feelings and perceptions toward MOOCs, and they are energized by their courses. This finding is consistent with previous literature which suggests that promoting students' intrinsic motivation is a good way to enhance their retention (Xiong *et al.*, 2015). Besides, students showing more trust in others and commitment to MOOCs are more enthusiastic with their courses and tend to be more proactive in participation in the courses.

Third, psychological engagement is positively associated with behavioral engagement, indicating that students with the positive psychological state of participation in MOOC courses are more likely to spend more time and effort to persistently engage in MOOCs. In other words, in order to encourage students to remain proactive engagement in MOOCs learning, one important measure is to stimulate their positive psychological reactions. This result is in line with prior research which reveals the important effect of psychological engagement on behavioral engagement in the context of online games (Cheung *et al.*, 2015).

Theoretical implications

In investigating the factors that affect students' engagement in MOOCs, this study can extend previous research in several ways. First, student engagement in MOOCs has been conceptually considered as being composed of psychological and behavioral engagement, and the potential relationship between the two different types of engagement are further empirically explored which is largely ignored by prior research on MOOCs. This study shows that students' psychological engagement significantly promotes their behavioral engagement. Therefore, arousing the psychological engagement in MOOCs can be a good approach to facilitate students' sustained behavioral engagement. It stimulates future studies to further examine the relationship between different engagement types.

Second, this study highlights the antecedent factors of intrinsic motivation in MOOCs learning (namely the needs for autonomy, competence and relatedness), which fill a gap in the extant literature that neglects the antecedents of motivation in student engagement in MOOCs. This study explores the role of intrinsic motivation according to the self-organization feature of MOOCs learning. Then we identify the antecedent factors of intrinsic motivation based on SDT. We suggest that fulfillment of the basic psychological needs for autonomy, competence and relatedness can enhance students' intrinsic motivation, giving rise to positive psychological status of learning and optimally motivated learning behavior in MOOCs. The result of this paper contributes to a better understanding of the application of SDT in the context of MOOCs. It implies that future study on students' engagement in MOOCs should further take the formation and development of motivation into account especially the innate psychological needs.

Third, proposing relationship quality as a key factor promoting student engagement is a novel contribution of this study, giving a new insight into student engagement in MOOCs. One of the important features of MOOCs learning process is social interaction. Some prior studies treat social interaction among learners as an important factor of the success of online learning, while other important factors related to student interaction, such as relationship quality are neglected. This study fills the gap in the existing literature by adding relationship quality into student engagement in MOOCs. The result demonstrates the significant impact of relationship quality on students' engagement in MOOCs. It indicates that cultivating students' trust and commitment can induce student psychological engagement and hence of their active behavioral engagement. This finding gives an implication to future researchers that factors related to social interaction which are widely examined in virtual contexts but scarcely adopted in MOOC settings can further be used to explain students' behavior in MOOCs.

Practical implications

Understanding what affects students' engagement can help to improve the design of courses and reduce the dropout rate of MOOCs. Our study advises MOOC providers to focus on evoking students' psychological engagement which can enhance their proactive behavioral engagement. It is feasible for MOOC providers to improve students' psychological engagement by strengthening their intrinsic motivation and relationship quality. The specific methods are shown below.

First, fulfillment of needs for autonomy, competence and relatedness enhance students' intrinsic motivation, leading to the positive feeling toward the courses and their active engagement in MOOCs. MOOCs can offer a more flexible and autonomy learning environment to students, for example, MOOCs can provide multiple versions of one course (eg, a brief version and a detailed version), thus, students can choose different version of the course according to their time schedule and educational degree. Besides, MOOC providers can better meet students' need for

competence by setting task difficulty and different levels of challenge activities. These measures allow students to attend the task or challenge activity that they think is the most suitable for their abilities. In addition, MOOC platforms can improve student-interface interaction to encourage student to interact with others, and guide everyone to respect each other. By doing that, students' need for relatedness would be satisfied. Overall, in order to increase students' intrinsic motivation to engage in the courses, MOOCs should try to meet these needs for autonomy, competence and relatedness.

Second, relationship quality is crucial for students' engagement. MOOCs can increase students' relationship quality by cultivating their trust and commitment. MOOCs can provide a channel for students to have a rough idea of other learners' educational backgrounds, learning experience in MOOCs and so on, thus helping to build initial trust among students. And MOOC platforms should take measures to ensure a harmonious discussion and learning atmosphere to deepen and maintain mutual trust between students. Besides, enhancing their commitment can be accomplished by setting up common learning goals at class levels and arranging group tasks which require students to work together.

Limitations and future research

Although the findings are useful, the present study has some limitations that should be noted. First, the selection of our survey subjects is limited to Chinese. Thus, it is necessary to implement cross-cultural investigations on this research topic which can give better explanations of learners' engagement from a global perspective. Second, this study focuses on intrinsic motivation and the antecedent factors of intrinsic motivation, while there have other patterns of motivation in consideration of the broad range of student motives for MOOC sign up, such as social motivation (Xiong *et al.*, 2015). Therefore, other motivations can be further explored in future studies. Third, this study only examined the effect of fulfillment of three basic psychological needs, intrinsic motivation and relationship quality on student engagement, while there exist other important determinants of student engagement. Future studies are supposed to explore other factors related to self-organization and social interaction, such as collaborativism and constructivism. Besides, trust has been found to contribute to the collaborativism in online learning (Jameson, Ferrell, Kelly, Walker, & Ryan, 2006). Thus, it is also interesting to further investigate the relationship between relationship quality and collaborativism/constructivism in MOOC student engagement. Fourth, this study only adopted the self-report instrument without collecting the actual behavior data. It may not capture the actual MOOC engagement behaviors. Therefore, future studies can expand the research by tracking student behaviors in MOOCs and investigating the differences between subjective and actual behaviors.

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Statements on open data, ethics and conflict of interest

a. The data used in this study can be accessed by contacting the corresponding author.
b. There are no ethical issues related to the selection and treatment of subjects associated with this paper.
c. The authors have no conflict of interest.

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APPENDIX A

Table S1. Measures of the constructs

Constructs	*Items*	*Source*
Fulfillment of the need for autonomy	FNA1: I feel like I can make a lot of inputs to deciding how I learn the course. FNA2: I feel like I can pretty much be myself when learning in MOOC system. FNA3: There are many opportunities for me to decide for myself what and how I learn in MOOC system.	Ke and Zhang (2010)
Fulfillment of the need for competence	FNC1: In MOOC system, I get many chances to show my capability. FNC2: When learning in MOOC system, I often feel very capable. FNC3: I feel very competent when I am learning in MOOC system.	Ke and Zhang (2010)
Fulfillment of the need for relatedness	FNR1: People in MOOC system are pretty friendly towards me. FNR2: I really like the people learning in MOOC system. FNR3: I get along with people in MOOC system.	Ke and Zhang (2010)
Intrinsic motivation	IXM1: I find participating in MOOC system to be enjoyable. IXM2: The actual process of participating in MOOC system is pleasant. IXM3: I have fun participating in MOOC system.	Ray *et al.* (2014)
Relationship quality—Trust	TRS1: Members in the MOOC system are truthful in dealing with one another. TRS2: Members in the MOOC system will not take advantage of others even when the opportunity arises. TRS3: Members in the MOOC system will always keep the promises they make to one another.	Chiu *et al.* (2006)
Relationship quality—Commitment	CMT1: I feel a sense of belonging towards the MOOC system. CMT2: I am proud to be a member of the MOOC system. CMT3: I have the feeling of emotional attachment to the MOOC system.	Chiu *et al.* (2006)
Psychological Engagement	PENG1: I am enthusiastic about my course. PENG2: My course really interests me. PENG3: The course that I learn is very satisfying to me. PENG4: My course is personally fulfilling.	Stumpf *et al.* (2013)
Behavioral engagement	BENG1: I often take extra initiative to get things done. BENG2: I actively seek opportunities to contribute. BENG3: I often put more effort into my study than is required to help the learning succeed.	Stumpf *et al.* (2013)

APPENDIX B

Table S2. Cross-loadings

	BENG	*PENG*	*IXM*	*TRS*	*CMT*	*FNA*	*FNC*	*FNR*
BENG1	**0.867**	0.643	0.385	0.393	0.478	0.370	0.539	0.421
BENG2	**0.931**	0.688	0.482	0.395	0.473	0.427	0.530	0.410
BENG3	**0.893**	0.607	0.467	0.371	0.425	0.398	0.431	0.428
PENG1	0.687	**0.877**	0.476	0.381	0.505	0.359	0.527	0.457
PENG2	0.665	**0.901**	0.560	0.411	0.516	0.451	0.492	0.445
PENG3	0.620	**0.893**	0.517	0.380	0.492	0.458	0.482	0.412
PENG4	0.522	**0.839**	0.511	0.403	0.539	0.453	0.530	0.402
IXM1	0.467	0.555	**0.938**	0.405	0.500	0.408	0.430	0.352
IXM2	0.509	0.569	**0.958**	0.427	0.498	0.437	0.476	0.415
IXM3	0.416	0.519	**0.917**	0.376	0.464	0.408	0.446	0.348
TRS1	0.462	0.448	0.404	**0.875**	0.543	0.405	0.478	0.603
TRS2	0.282	0.328	0.342	**0.879**	0.491	0.278	0.436	0.472
TRS3	0.402	0.473	0.402	**0.918**	0.553	0.304	0.531	0.613
CMT1	0.451	0.547	0.437	0.593	**0.909**	0.369	0.640	0.592
CMT2	0.482	0.560	0.514	0.514	**0.922**	0.474	0.566	0.567
CMT3	0.480	0.565	0.487	0.531	**0.930**	0.429	0.598	0.526
FNA1	0.387	0.431	0.394	0.329	0.414	**0.930**	0.429	0.320
FNA2	0.419	0.452	0.431	0.355	0.463	**0.947**	0.458	0.357
FNA3	0.434	0.433	0.418	0.346	0.405	**0.912**	0.451	0.358
FNC1	0.444	0.508	0.398	0.497	0.606	0.460	**0.869**	0.626
FNC2	0.526	0.588	0.459	0.518	0.596	0.415	**0.938**	0.544
FNC3	0.563	0.627	0.465	0.481	0.605	0.452	**0.948**	0.583
FNR1	0.439	0.479	0.352	0.616	0.538	0.320	0.601	**0.939**
FNR2	0.451	0.507	0.387	0.584	0.598	0.394	0.581	**0.930**
FNR3	0.429	0.494	0.382	0.590	0.585	0.332	0.605	**0.955**

Note: Bold numbers denote the item loadings on the respective constructs.