



Examining the necessary condition for engagement in an online learning environment based on learning analytics approach: The role of the instructor



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ABSTRACT

This study analyzes the impact of an instructor on the students' engagement using learning analytics approach by tracking one university's log data of teaching and learning activities in a web-based learning platform. Based on the tracking data and theoretical analysis, this study builds a teaching and learning interaction activity model to show how the instructor's course preparation and assistance activities affect different dimensions of student engagement activities and the relationship between these activities. The results reveal that an instructor's course preparation is significantly positively related to the students' viewing activities, while instructor's guidance and assistance has a significant impact on the students' completing learning tasks. The study also indicates that the students' viewing activities have a direct positive influence on their completing learning tasks activities. Students' completing learning tasks exert direct positive influence on their interaction for learning, while their viewing activities have an indirect impact on their interaction activities.

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1. Introduction

1.1. Research background

Information technology applied in higher education has gradually influenced teaching and learning strategies, methods, activities, as well as the way students are engaging with their study (Beer, Clark, & Jones, 2010; Coates, 2007; Lane, 2009). The degree to which students have been actively engaged in their academic work deeply affects the level of their learning outcomes, cognitive development and educational quality (Hu & Kuh, 2002; Kuh, 2003; Smith, Sheppard, Johnson, & Johnson, 2005). How students engage with the online courses and how the role of the instructor impacts students' engagement are issues that are attracting increasing attention in the online learning environment. Discussing these engagement issues can help examine the students' online learning activities, and evaluate the quality of online teaching and learning, so as to help the instructors design appropriate online courses, as well as implement necessary support strategies to improve the quality of online learning (Richardson & Newby, 2006; Robinson & Hullinger, 2008).

Currently, more and more studies of online education have begun to focus on student engagement. Previous works refer to various aspects of engagement, such as the relationship of self regulation and student

engagement (Sun & Rueda, 2012), the impact of technology on student engagement (Chen, Lambert, & Guidry, 2010; Nelson Laird & Kuh, 2005), student cognitive engagement (Richardson & Newby, 2006), and student engagement characteristics (Coates, 2007). Most of the above studies have revealed that the instructors seemed to have great effect on students learning experience, and it is the instructor's responsibility to sustain and facilitate student engagement in online education (Robinson & Hullinger, 2008; Smith, Sheppard, Johnson & Johnson, 2005). Although those studies have indicated the importance of the instructor in the online learning environment, most of them focused on the students' aspects to examine the student engagement topic. Yet, very little research has directly looked at the impact of the instructor on student engagement. Furthermore, some studies have focused on the instructor' role on student engagement, but most of them are primarily based on a questionnaire or a survey (Bangert, 2008; Garrison & Cleveland-Innes, 2005; Shea, Li, & Pickett, 2006). There are few studies using big data collection to analyze student engagement in the online environment (Beer, Clark & Jones, 2010; Morris, Finnegan, & Wu, 2005; Phillips et al., 2010). Some researchers have used tracking data of student activities in the learning management system (LMS) to investigate student's learning, they primarily emphasized the "student" as the analysis unit, ignoring the instructor's role and the relationship between students and instructors. Therefore, this study will try to focus on three aspects to investigate student engagement: 1) examining the instructor's role on student engagement; 2) using learning analytics approach to investigate student engagement; and 3) employing "course" as the analysis unit to add the instructors' activities tracking data to examine

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the impact of the instructors on students and the relationship between the instructors and students.

Recently, the learning analytics field based on big data analysis has captured more and more attention of researchers. In the first International Conference on Learning Analytics and Knowledge, learning analytics is defined as “the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs” (Long & Siemens, 2011). In the information technology environment, a large amount of data about online teaching and learning activities is available, yet effective use of these data to improve teaching and learning has not been optimized. Large data sets exist in a university and online learning environments. However, on the one hand, these data are not easy to acquire; on the other hand, in higher education, the utilization of these data is limited and inefficient (Beer, Clark & Jones, 2010; Dawson, Heathcote, & Poole, 2010), and there are some delays in analyzing those data and providing immediate feedback (Long & Siemens, 2011). Most organizations still focus on the data level, and have not changed the data to meaningful information through analysis process (Elias, 2011).

1.2. The main purpose of the study

Compared with studies using questionnaire or survey approaches to investigate student engagement in the online environment, learning analytics can capture direct data of online activities, providing more authentic, objective, and timely evidence (Lockyer, Heathcote, & Dawson, 2013; Phillips et al., 2010). This study focuses on the tracking data in an online learning environment on a college level. It aims to examine how the role of instructor affects students' engagement in the online learning environment, in order to provide suggestions for the more effective use of information technology development in higher education.

2. Related work

2.1. Engagement in the online learning environment

Student engagement typically refers to time and effort students devote to their academic experiences (Jennings & Angelo, 2006; Kuh, 2003). When investigating student engagement in the online learning environment, it is necessary to determine the indicators or measurement of engagement. The earlier, influential and best known research about engagement measurements is the “Seven Principles for Good Practice in Undergraduate Education” (Chickering & Gamson, 1987). Based on the principles, the National Survey of Student Engagement (NSSE, 2003) was designed to assess the dimensions of college-level student engagement.

Coates (2007) used iterative analytical process to develop four clusters about engagement patterns in online and general learning practices based on the data obtained by the Student Engagement Questionnaire (SEQ) (Coates, 2006) in several Australian universities. Among the SEQ, seven scales are designed to measure online engagement of campus-based students, such as concerning the students' use of online learning systems to do academic work with their peers, and interaction with others in online discussion.

Currently, there is a significant body of research focusing on the factors that influence student engagement in college-level online learning environment. For example, Chen, Lambert and Guidry (2010) found that there exists a positive relationship between the internet and web-based learning technologies and student engagement and learning outcomes through multiple regression analysis of survey data gathered from the 2008 administration of NSSE. Sun and Rueda (2012) demonstrated that situational interest and self-regulation are significantly related with the behavioral, emotional and cognitive engagement. Similarly, Richardson and Newby (2006) specifically examined the impact of students' prior

on-line experience, students' different program area focus, gender, age and employment status on the cognitive engagement such as students' motivations and strategies in online learning courses.

2.2. Instructor's role in the online learning environment

In a web-based learning environment, the instructor's role needs to be reconsidered. Instead of just imparting knowledge, the instructors need to provide more guidance and assistance to learners, consider how to integrate online resources to organize learning content, create a high quality online learning environment, and emphasize course process management to stimulate students' learning motivation and enhance learning effect (Coppola, Hiltz, & Rotter, 2001; Marks, Sibley, & Arbaugh, 2005). The concept of teaching presence is regarded as the key concept for examining the instructor's role in much online learning researches. Teaching presence is one of the important elements in the Community of Inquiry (CoI) framework proposed by Garrison, Anderson, and Archer (2000). They demonstrated that cognitive, social and teaching presence are three elements integrated in an online community for sustainability of a community of inquiry in higher education. They regarded the design of the educational experience and facilitation as the two general functions of teaching presence. Shea, Li and Pickett (2006) clustered teaching presence items into two categories described as Instructional Design and Organization and Directed Facilitation, which focus on preparation before the class and assistance during and after the class.

Further researches have investigated the impact of teaching presence on student learning in the online learning environment based on the concepts of CoI framework. For example, Garrison and Cleveland-Innes (2005) indicated that teaching presence, such as design and teaching approach, is crucial for the adoption of a deep approach to student learning. A study by Shea, Li and Pickett (2006) also identified that active teaching presence has a positive impact on students' sense of learning community through a survey-based study conducted in a large asynchronous learning environment in which 1067 students from 32 colleges participated. When the instructors provide effective instructional design and organization, and active guidance, students displayed higher levels of learning community. Moreover, Bangert (2008) examined the influence of social and teaching presence on the level of online learners' critical inquiry, and found that the social presence combined with teaching presence can facilitate deep levels of critical inquiry. Most of those researches emphasize the impact of one or some dimensions of teaching presence or social presence on students learning, few of them have considered the whole picture of the relationship among teaching, social and cognitive presence (Garrison, Cleveland-Innes, & Fung, 2010). This study will attempt to address the issue by exploring whole picture of the impact of the instructor on student engagement.

More importantly, the above studies examine student engagement and the role of instructor through the insight from students' experience and their feedback by using a survey or questionnaire method, therefore they lack more objective evidence which can demonstrate more accurate information about interactions among instructor and students (Carini, Kuh, & Klein, 2006; Lockyer, Heathcote & Dawson, 2013; Phillips et al., 2010).

2.3. Learning analytics used in the studies on student engagement

Long and Siemens (2011) proposed that the most critical factor influencing future higher education is big data and its related analysis. Big data analysis can help the higher education institution managers and educators to improve decision-making process, optimize the allocation of resources, monitor students' difficulties in time and offer support, as well as change higher education academic mode and teaching pedagogies and methods. In other words, the purpose of the learning analytics based on large data is not just evaluation. The more important objective is to adjust the content, strategies and activities of the learning

process, and provide feedback and intervention immediately in order to promote the quality of teaching and learning.

With regard to the studies about using learning analytics to examine student engagement in an online learning environment, [Phillips et al. \(2010\)](#) investigated how students engage with a lecture-recording supported learning system in three different units of two universities. By utilizing usage logs of the system, ten different usage behaviors are developed according to students' hit frequencies in the lecture-capture system. Besides analyzing usage logs of learners' activities in online environments, based on eight of the above conceptual usage behavior patterns, they continued to have semi-structured interview with six students to supplement their initial stages of research. In their study, the interviewee students' course final grades are included in the research, and the relationship between students' learning behavior patterns and the learning outcomes is created.

According to student access tracking logs of three undergraduate courses, [Morris, Finnegan and Wu \(2005\)](#) examined student engagement behavior and its relationship with students' persistence and achievement in online courses. By analyzing the frequency and duration of participation, such as number of content pages viewed and discussion posts read, and seconds spent viewing content pages and reading discussions, etc., the researchers indicated that active engagement is a significant factor in successful online learning. Besides comparing LMS usage information and grade performance, [Beer, Clark and Jones \(2010\)](#) also considered instructors' participation in the discussion forums, and found that if the instructors participate more in the discussion forums, students had higher engagement. The research considered the impact of the instructor on student engagement. However, it only mentioned students' different level of engagement depending on whether the instructors participate in discussion forums or not. Instructor's specific activities in the forums were not examined.

Other recent research has specifically considered students social networks by obtaining data from the instructors and students' activities in online discussion forums ([Cambridge & Perez-Lopez, 2012](#); [Dawson, Bakharia, & Heathcote, 2010](#); [Rahman & Dron, 2012](#); [Wise, Zhao, & Hausknecht, 2013](#)).

Most of the related studies have considered some dimensions of student activities, such as viewing content pages and participating discussion board, especially students–instructor interaction activities in the discussion forum. Further investigations are needed into more aspects of student activities and instructor impact in the online learning environment. Our study will examine more overall and specific dimensions and aspects of the instructor's and students' activities, and investigate more details about the relationship among those activities.

As for the analysis unit of researches using tracking data to examine teaching and learning, most of previous studies have employed “student” as the unit in one course to analyze the correlation between student activities and their academic achievement. For example, [Macfadyen and Dawson \(2010\)](#) employed 118 students as the sample, capturing their LMS tracking data in one online undergraduate course to study which variables could accurately predict student achievement. In research conducted by [Smith, Lange, and Huston \(2012\)](#), 539 students were chosen as the sample in one online freshman-level course. The researchers tried to identify if the key variables of students' activities could be effectively used to predict students' course outcome. Some studies have expanded their research focus to more courses, but still used the student as the analysis unit. [Morris, Finnegan and Wu \(2005\)](#) used 354 students enrolled in three courses to assess the relationship between student online participation behavior and their achievement. [Falakmasir and Habibi \(2010\)](#) ranked online learning activities of 824 students in 11 courses based on their impact on students' final grades. While the research discussed above uses “student” as the analysis unit, instructor's activity tracking data records cannot be employed as the variables to examine the relationship between the instructors and students. [Dawson, McWilliam, and Tan \(2008\)](#) considered instructors' engagement in the context of whole institution level and faculty

management level. In the whole institution level, instructors' number of interaction recorded by the LMS per full-time equivalent student in different department or teaching unit was compared. The whole institution level analysis can demonstrate the trends of instructor behavior and LMS adoption across the university. Analysis at the faculty level provided the senior management differences usage trends of instructors' interaction with students across schools in one teaching unit. The research has considered the impact of the instructor's role on student, however, it has not examined the specific instructor activities, and which activities influence students at what level or degree.

In order to address those above issues, this study will try to employ “course” as the analysis unit to use both students and instructors' behavioral attributes recorded in the LMS as variables to analyze more specifically and deeply about the impact of instructor on student engagement in the online learning environment.

3. Research context and methods

3.1. Research context

This study selected a university in south-east China which has implemented a LMS called Tsinghua Educational Online (THEOL), which has been used in nearly four hundred universities and colleges in China. The most important reason for choosing this university is its higher usage of the THEOL. The university has more than thirty thousand undergraduate students and more than four thousand faculty. The courses created in the platform have risen constantly since 2009.

THEOL provides comprehensive functions and tools to support students learning and the instructors teaching, mainly including modules related to course content learning; course administration tools providing course information such as course introduction, syllabus, course notification; interaction tools that permit students asking questions and communicating with their instructors and peers; assessment tools that assist the instructors to get feedback about students' learning process and effect as well as help students have self-evaluation. The description of THEOL tools is shown in [Table 1](#).

3.2. Data collection

This study selected all the courses from September, 2012 to May, 2013 on THEOL in the university, as samples. The data was obtained from the platform's web log. The courses cover almost all the disciplines ranging from Science, Engineering, and Economics to History, Language, Education, Arts, etc. Courses which have not been registered by students and have zero visit record were deleted from the samples. The final total samples for this study are 900 courses.

This study used the number of related operations of the instructors and students in all sample courses on the online system, as the measurement indicators of online teaching and learning activities. Those data has been transformed to standardize data to make further analysis. Regarding the measurement, the majority of previous researches have focused on frequency variables of students, such as number of content pages, courseware or other related material and resource viewed ([Falakmasir & Habibi, 2010](#); [Morris, Finnegan & Wu, 2005](#)), number of discussion

Table 1
Description of THEOL tools.

Supporting tools	Description
Administration tools	Course introduction, instructor introduction, syllabus, course notification
Course content	Lesson plan, multimedia courseware, electronic books
Interaction tools	Discussion forum, frequently asked question (FAQ) area, email
Assessment tools	Course assignment, test, questionnaire

messages read, posted and responded (Falakmasir & Habibi, 2010; Macfadyen & Dawson, 2010), number of email messages sent, number of assessments completed (Macfadyen & Dawson, 2010), number of times students log into a course (Campbell, Finnegan, & Collins, 2006; Smith, Lange & Huston, 2012), and number of assignments uploaded (Falakmasir & Habibi, 2010). Besides those measures, this study employs other variables of students and some frequency variables of instructor. In sum, this study used 16 variables, including:

- 1) the number of instructors entering the course,
- 2) the number of instructors posting course notification,
- 3) the number of instructors uploading learning materials,
- 4) the number of instructors identifying and presenting FAQs of the course,
- 5) the number of instructors administering course questionnaires,
- 6) the number of instructors administering assignments;
- 7) the number of students entering the course,
- 8) the number of students viewing course notification,
- 9) the number of students viewing learning materials,
- 10) the number of students completing course questionnaires,
- 11) the number of students making reflection notes,
- 12) the number of students completing and uploading assignments,
- 13) the number of students posting topics,
- 14) the number of students responding to discussion posts,
- 15) the number of students replied by the instructors and other students in the discussion forum; and
- 16) the number of students asking questions.

Within those variables, identifying and presenting FAQs refers to the instructor discovering students' frequently asked question during learning the course or summarizing typical questions students usually post in the discussion forum, addressing those problems and questions, and presenting them to students. Administering questionnaire refers to the instructor posting course questionnaire in order to understand students' learning attitude or opinions, gain feedback of students' learning process in time, in order to adjust teaching pace and methods. Students making reflection notes refer to students' records of the key points of the course content and their reflection at anytime in the learning process.

3.3. Data analysis

Guided by engagement activities, teaching presence and online interaction researches and theories, this study acquires five latent factors through those 16 variables, including preparation activities by instructor, guidance and assistance activities by instructor, viewing activities by students, completing learning task activities by students, and interaction for learning. A Structural Equation Modeling (SEM) has been established to analyze group interactive activities among college instructors and students in an online learning environment to explore instructor's impact on student engagement.

By using the data derived from the university's online learning platform, this study tests the model, and then examines the instructor'

activities, students' activities and interaction activities among the instructor and students, as well as the relationship between those activities. SEM has the potential to analyze relationships between manifest variables (directly measured or observed, indicator) and latent variables (the underlying theoretical construct).

4. Latent variables identified

This study collected data of 16 indicators of instructors' and students' online activities, in which six of them focus on the instructor's role on students' learning; ten of them are close to students' learning activities.

As illustrated in the role of instructor literature, teaching presence includes instructional design, organization, facilitating discourse and direct instruction components (Anderson, Rourke, Garrison, & Archer, 2001). Shea, Li and Pickett (2006) clustered teaching presence items into two categories that interpreted as Instructional Design and Organization and Directed Facilitation. Among the six indicators of instructor's role on students' learning, three of them refer to setting up clear course goals and requirement, building curriculum materials and providing course instruction, similar to the description of Instructional Design and Organization component (Shea, Li and Pickett, 2006). According to that, those three indicators are clustered into one factor called "preparation activities by instructor", which focuses on designing and planning course content and learning activities. The other three indicators are related to keeping students on track, and diagnosing students' misperceptions, similar to the description of Direct Facilitation component (Shea, Li and Pickett, 2006). Therefore, those three indicators are clustered into one factor called "guidance and assistance activities by instructor", which emphasizes assistive role of the instructors in offering instructional support to students.

In the student engagement literature, most benchmarks or indicators that measure students' engagement emphasizes students' preparation for the study, making reflection on what they have learned, and interaction with their instructors and peers. Robinson and Hullinger (2008) modified four benchmarks of NSSE to evaluate student engagement level in the online learning environment. Among them, "level of academic challenge" primarily measures the academic effort students are spending on reading, writing, preparing for their study, and working on their assignments. "Student-faculty interaction" and "active and collaborative learning" refer to students having discussion with their academic faculty about reading, class notes, grades or assignment, and career plans, receiving prompt feedback from faculty, as well as working with other students. In terms of the ten indicators about student activities in our study, six of them are close to the level of academic challenge, in which three of them refer to activities students view and understand learning materials, thus clustered into one factor called "viewing activities by students"; the other three are related to students completing learning tasks and making learning reflection activities, and categorized to one factor called "completing learning tasks activities by students". The remaining four indicators are close to the benchmarks of student-faculty interaction as well as active and collaborative learning in Robinson and Hullinger (2008), which could be clustered into one factor called "interaction for learning".

Table 2
Correspondence of latent variables and manifest variables.

Teaching and learning activity factors (latent variables)	Indicators (manifest variables)
Preparation activities by instructor	The number of instructors entering the course, posting course notification, and uploading learning materials
Viewing activities by students	The number of students entering the course, viewing course notification, and viewing learning materials
Guidance and assistance activities by instructor	The number of instructors identifying and presenting FAQs of the course, administering course questionnaire, and administering assignments
Completing learning tasks activities by students	The number of students completing course questionnaires, making reflection notes, completing and uploading assignments
Interaction for learning	The number of students posting topics, responding to discussion posts, replied by instructors and other students in the discussion forum; students asking questions

To summarize the above analysis, this study constructed five factors (latent variables) about instructor's activities and students' engagement activities in the online learning environment. Two types of instructor's activities include course preparation, and guidance and assistance activities; three dimensions of students' engagement activities involve viewing and completing learning tasks, as well as interaction for learning. Among three factors regarding students, viewing and completing learning tasks stress individual aspect, while interaction activity is group collaborative knowledge construction dimension. The correspondence between these latent variables and manifest variables are shown in Table 2.

5. Research questions and hypotheses

In the online learning environment, instructors, learners and environment are the key factors that influence the learning process and effect. Among them, the instructor is the core factor, directly affecting the behavior of the students and interaction between the instructors and learners (Clark, 1993). As stated in the critical analysis of the extant literature above, instructor's teaching presence, such as design and teaching approach, plays a vital role in the adoption of a deep approach to students' learning. When the instructors provide effective instructional design, organization, and active guidance, students display higher levels of learning community, and deep levels of critical inquiry (Bangert, 2008; Garrison & Cleveland-Innes, 2005; Shea, Li, & Pickett, 2006).

The instructors should design appropriate learning activities to stimulate learners' higher level cognitive activities (Dunlap, Sobel, & Sands, 2007; Jensen, 1998). Only when the instructors have designed high quality of teaching materials and activities, and provided learners with immediate feedback and support, can learner–content and instructor–student interaction be effective.

Based on the above literature, the instructors have a positive impact on students' learning. In this study, we have obtained two types of instructor activities and three dimensions of student engagement. In order to examine how different types of instructor activities affect student engagement, six research hypotheses are proposed below:

Hypothesis 1 (H1). Instructor's course preparation positively affects students' viewing activities;

Hypothesis 2 (H2). Instructor's teaching guidance and assistance positively affects students' completing learning tasks activities;

Hypothesis 3 (H3). Instructor's course preparation positively affects students' completing learning tasks activities;

Hypothesis 4 (H4). Instructor's teaching guidance and assistance positively affects students' viewing activities;

Hypothesis 5 (H5). Instructor's course preparation positively affects students' interaction for learning;

Hypothesis 6 (H6). Instructor's teaching guidance and assistance positively affects students' interaction for learning;

Moreover, for the purpose of investigating the relationships among the three dimensions of student engagement, we have another five hypotheses:

Hypothesis 7 (H7). Students' viewing activities positively affects their completing learning task activities;

Hypothesis 8 (H8). Students' viewing activities positively affects their interaction for learning activities;

Hypothesis 9 (H9). Students' interaction for learning positively affects their viewing activities;

Hypothesis 10 (H10). Students' completing learning tasks activities positively affects their interaction for learning;

Hypothesis 11 (H11). Students' interaction for learning positively affects their completing learning task activities.

The hypothesis model is shown in Fig. 1.

6. Main findings: constructing teaching and learning interaction activities model

Through the above description of latent variables and manifest variables, this study employed structural equation model analysis software AMOS 17.0 to have exploratory specification search which can explore the relationships between pairwise variables in the hypothesis model to find the appropriate SEM model. When doing exploratory specification search, AMOS automatically compares each path in the model, forms a number of identifiable path combination hypothesis model, and makes model fitting test using the sample data. After making the exploratory specification search, the best-fit model and the results (standardized estimates) returned by AMOS is demonstrated Fig. 2.

Five hypotheses remained (H1, H2, H5, H7, H10), and all of them are positively significant at the level of 0.001. However, for Hypothesis 5, that instructor's course preparation has a negative impact on students' interaction for learning is unreasonable according to the above

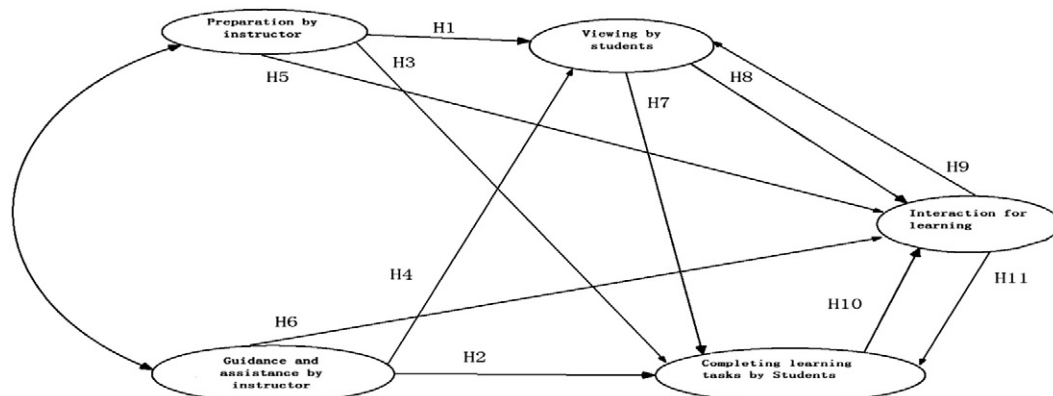


Fig. 1. Research hypothesis model.

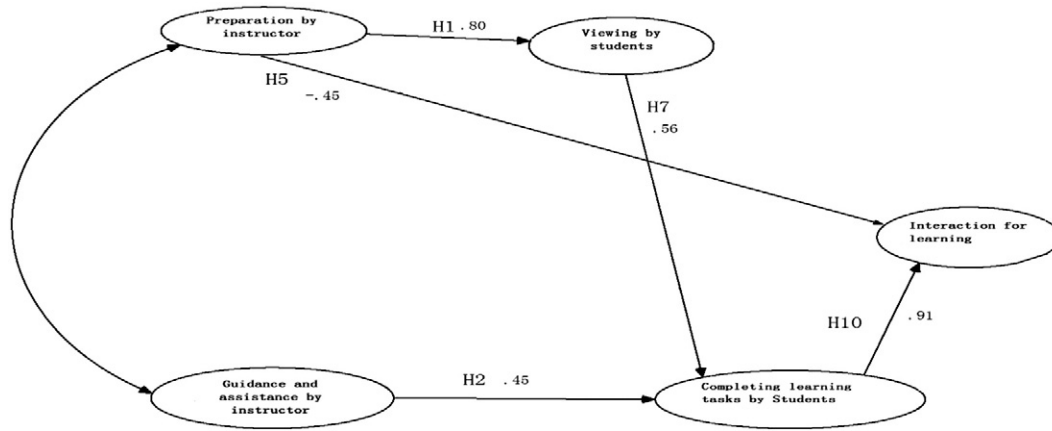


Fig. 2. Model after exploratory specification search.

literature about the instructor's role. Thus, we further modified the model, deleting H5. The modified model and the results are shown in Fig. 3.

To assess how the hypothesized modified model fits the measured data, this study used several important goodness-of-fit measures. In this test, $\chi^2 = 671.072$, $df = 89$, $p < .01$. The χ^2 is not too small, because of the large samples (900). Other goodness-of-fit measures, goodness of fit index [GFI] = .914; normed fit index [NFI] = .919; comparative fit index [CFI] = .929; root mean square error of approximation [RMSEA] = .085; root mean residual [RMR] = .043.

Those values indicated a good fit between the model and the observed data. The hypotheses results are demonstrated in Table 3.

In this study, the four hypotheses are positively significant at the level of 0.001, thus the results indicate support for all the four hypotheses (H1, H2, H7, H10).

For Hypothesis 1, instructor's course preparation is significantly positively related to students' viewing activities ($\beta = 0.80$). The more

instructors prepare the courses, the more students have viewed related learning content. Specifically, for the three measured indicators that impact instructor's course preparation activities, the most important influence indicator is the number of instructors entering the course (0.85), the second one is posting of the course notification (0.76), and the third is uploading learning materials (0.51). This result indicates that designing and preparing course materials is a critical activity of instructor's course preparation. For the three measured indicators that impact students' viewing activities, the most important influence indicator is the number of students entering the course (0.88). The second one is viewing course notification (0.79), and then viewing learning materials (0.68). The results demonstrate that an instructor entering an online learning platform is the basis of the preparation for the course, and then directly influences students' viewing course materials.

For Hypothesis 2, instructor's guidance and assistance has a positively significant impact on students' completing learning task activities ($\beta = 0.40$). The more instructors provide guidance and assistance to

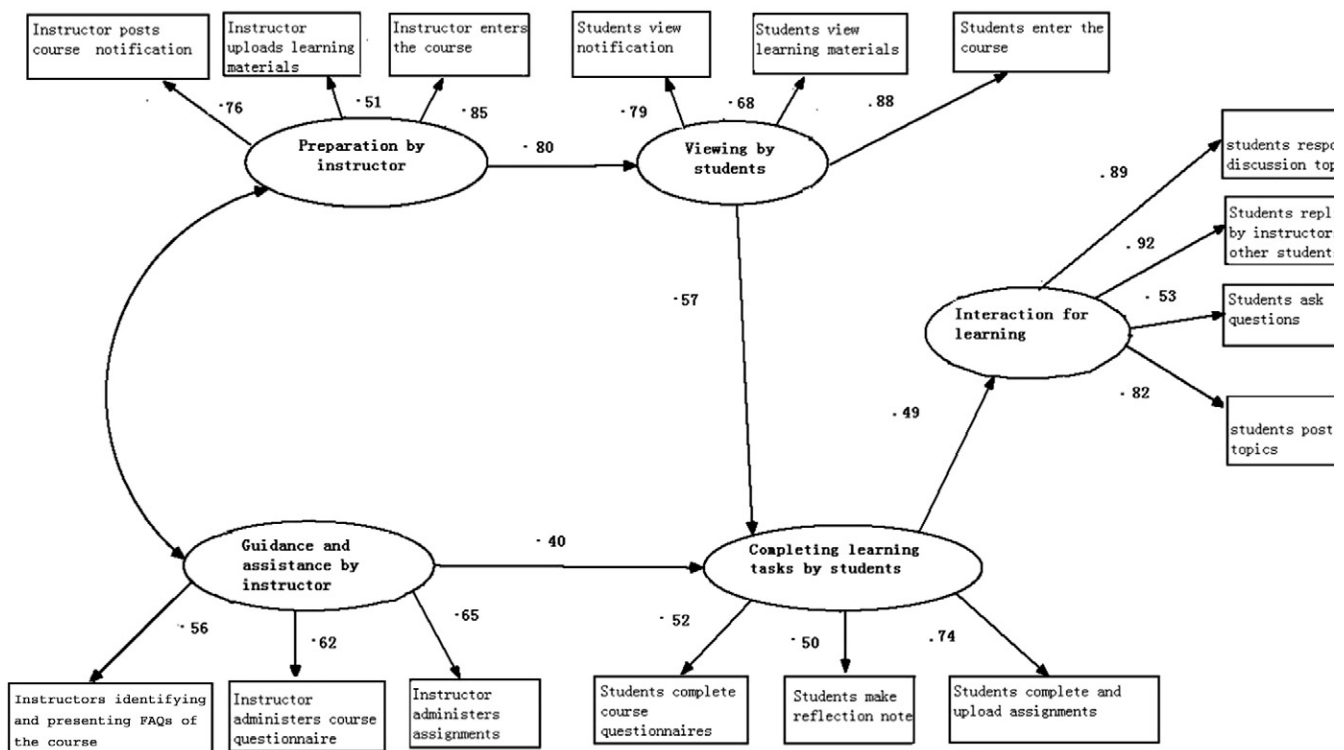


Fig. 3. Teaching and learning interaction activity model.

Table 3
Research hypotheses results.

Research hypotheses	Standardized estimates β	Results
H1: Instructor's course preparation \rightarrow students' viewing activities	.80***	Support
H2: Instructor's guidance and assistance \rightarrow students' completing learning tasks	.40***	Support
H7: Students' viewing \rightarrow students' completing learning tasks	.57***	Support
H10: Students' completing learning tasks \rightarrow interaction for learning	.49***	Support

*** Indicates $p < 0.001$.

students, the more students could complete their tasks. Thus, if the instructor would like to improve students' completing more learning tasks, they need to offer more assistance to students. Specifically, administering assignments plays the most critical role in the instructor's guidance and assistance activities (0.65), while completing and uploading assignments (0.74) dominates students' completing learning tasks, making reflective notes (0.50) and completing course questionnaire (0.52) are also vital learning activities.

Comparatively, the influence of instructor's course preparation on students' viewing ($\beta = 0.80$) is stronger than that of instructor's guidance and assistance on students' completing learning tasks ($\beta = 0.40$). This result demonstrates that the instructor's preparation activities can more easily enhance students' viewing activities; while the impact of instructor's assistance activities on students' completing learning tasks is weaker.

For Hypothesis 7, students' viewing activities directly exerts a positive influence on their completing learning task activities. This hypothesis is supported indicating that the more students view learning materials and content related to the online course, the more they have completed learning tasks ($\beta = 0.57$).

The supported Hypothesis 10 demonstrates that the students' completing learning tasks exert direct positive influence on students' interaction for learning ($\beta = 0.49$). For the specific indicators that influence interaction for learning activities, students' activities in the discussion forum, such as actively posting topics, responding to others' questions and replied by instructors and peers, are the most important influence indicators.

7. Discussion

7.1. The impact of instructor's role on students learning activities

This study makes a comprehensive investigation and examines more dimensions of the instructor's and students' activities, as well as more specific relationships among those activities compared with the previous studies.

The findings of this study reveal that instructor's course preparation activities positively affect students' viewing activities (H1), while instructor's guidance and assistance activities have significant impact on students' completing learning tasks (H2). With respect to the instructor's guidance and assistance activities, the critically influential indicator is the instructor administering assignment; administering course questionnaire and identifying and presenting FAQs students are facing in the course also dominate the guidance activities. It seems that the nature of the learning task assigned to students is a key factor that determines the level of student engagement; receiving suggestions and feedback from the instructor is also vital for students' involvement in course learning. The findings are consistent with the previous researches that the quantity of assignment and students' level of learning approach depends on whether the task and materials can lead to students' higher level of learning and instructors' prompt assistance (Garrison & Cleveland-Innes, 2005; IUCPR, 2003; Ramsden, 1992).

The results of this study also show that the impact of instructor's preparation on students' viewing (0.80) is greater than that of instructor's guidance and assistance on students' completing learning tasks (0.40), indicating that instructor administering assignments and

course questionnaires, and presenting FAQs are not yet fully guaranteed that students' completing learning tasks activities occur. Thus, instructors should understand students' characteristics and real learning needs, further improve instructional design on teaching assistance and guidance, in order to enhance students' active learning reflection, and help students to improve their cognitive process from lower level to higher level (Anderson & Krathwohl, 2001).

Moreover, the students' completing learning tasks have direct positive impact on their interaction for learning activities ($\beta = 0.49$). Although students' viewing activities have no direct impact on their interaction activities, the viewing activity has an indirect influence on the interaction activity ($\beta = 0.28$), demonstrating that both of them can impact interaction for learning. Therefore besides emphasizing guidance and assistance, the instructors still cannot ignore course preparation and design of the learning content. And in order to promote interaction activities, such as posting on the discussion forum, asking questions to instructors, students should make deep and sufficient interaction with learning content including completing the questionnaire, making learning note and reflection, etc. Furthermore, it might be concluded that effective student engagement cannot simply only depend on instructors sending course materials, but instructors' assistance and prompt feedback would be required to help students make learning reflection and actively participate in course discussion (Garrison & Cleveland-Innes, 2005).

Overall, the findings of the study reveal the importance of instructor's role on student engagement in the online learning environment. The role of instructor is not only limited to elaborately designing curriculum materials and preparing for the course, but also extends to focusing on using a variety of methods and tools to design and plan effective learning activities to enhance students' learning, and providing process guidance and assistance, so that students have greater participation in interaction activities, and more positively engage in their academic work. In other words, the results demonstrate that in order to improve students' engagement in learning activities, the instructors should pay a high degree of attention to design appropriate materials and activities which can enhance instructor–students interaction (Robinson & Hullinger, 2008), as well as monitor students' learning processes, discover students' learning difficulties immediately and provide timely feedback.

7.2. Compared with Community of Inquiry (COI) literature

In the study of Garrison, Cleveland-Innes and Fung (2010), they have investigated the relationship of teaching presence, cognitive presence and social presence using the SEM method. Based on the survey data, they proposed that teaching presence plays a central role in establishing and facilitating cognitive and social presence; while social presence could be seen as a mediating variable between teaching and cognitive presence. In our study, instructor's role directly influences two dimensions of students' engagement activities (viewing and completing learning tasks), while indirectly affects students' interaction for learning through the viewing and completing learning tasks. Cognitive presence emphasizes critical thinking and four phases of inquiry process, including triggering event or communication, exploration in search for information and knowledge, integration ideas, resolution of the issue or problem (Garrison, Anderson & Archer, 2000). Comparing with the data about

cognitive presence they obtained from survey, in our study, data about students' viewing and completing learning task captured from log data using learning analytics represent more objective of the students' activities. As for the social presence, emotional expression, open communication and group cohesion are three categories in this presence. The social presence emphasizes emotions, respectful attitudes, and a sense of group commitment in a supportive context for educational process (Garrison, Anderson & Archer, 2000). Similarly, data acquired by Garrison et al. are still based on more subjective information; in our study, interaction for learning focuses on the more authentic "activity". Thus, using learning analytics approach, the researchers could obtain more objective, direct and authentic data which reflects the measurable relationship among the instructor and learner behaviors; while using the survey or questionnaire the researchers could get more subjective information that may examine the cognitive and emotional issues in the man-mind.

Moreover, comparing the cognitive presence and the students' activities in our study, whether those activities reflect inquiry process should depend on the specific activities. For example, for the activity of students' completing assignments, our study used the number of operations of this activity; whether students' completing assignment activity could be included in the cognitive presence depends on the nature of the assignments and how the students completing the assignments. Further research should be carried out to investigate more specific aspects about the viewing, completing learning tasks activities and interaction for learning activities, and the relationships among instructor's and students' activities.

8. Conclusion and further research

This study builds a robust, empirically generated teaching and learning interaction activity model that shows clearly how the instructor's course preparation and assistance activities affect different dimensions of student engagement activities. Through examining interaction between instructor, student and learning content, it also shows the relationship among these engagement activities as the necessary condition to improve student learning in one university's online learning environment.

Compared with the body of researches that examine student engagement in the online environment (Coates, 2007; Richardson & Newby, 2006; Robinson & Hullinger, 2008; Sun & Rueda, 2012), this study investigates instructor's impact on student engagement more directly and comprehensively. Moreover, instead of using traditional survey or questionnaire data collection methods, this study uses a learning analytics approach to gain greater insight from a large amount of data automatically obtained by an online learning system. Compared with the studies using learning analytics approach to examine student engagement in the online environment (Beer, Clark & Jones, 2010; Phillips et al., 2010; Rahman & Dron, 2012), this study examines instructors' activities in a more nuanced way, and considers more aspects and dimensions of the instructors' and students' activities in the online learning environment.

A main limitation of this research is that there are 16 specific indicators used to represent five types of teaching and learning activities; that is probably different from the activities defined by other engagement topic researches. Further researches should analyze additional indicators to explore instructor's impact on student engagement. Moreover, this study adopts the whole data in one university, more studies need to be conducted to examine other situations and have comparison between different universities. Furthermore, this study has examined the necessary level of engagement, future researches need to explore the specificity of student activities to investigate student engagement. Finally this study has been confined to the university sector, yet there is a reason to apply the model to the online

learning environment that is being developed with increasing complexity in elementary and secondary education.

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