The influence of teaching motivations on student engagement in an online learning environment in China

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Given the importance of student engagement for educational success, it is essential to explore how teachers can stimulate student engagement in online learning environment. However, relatively little research drawing from self-determination theory has examined the links between teaching motivations and student engagement. To this end, this study was conducted to survey 414 Chinese college students' perceptions of teaching motivations, their own intrinsic and extrinsic motivations during the learning process, as well as their engagement with online learning. The findings indicated that the survey had satisfactory validity and internal consistency. Structural equation model revealed the interrelationships between autonomy-supportive teaching motivations, controlling teaching motivations, student intrinsic and extrinsic motivations, and student engagement. The results showed that in online learning environments, autonomy-supportive teaching motivations and student intrinsic motivation were positively related to student engagement. Unexpectedly, controlling teaching motivations and student extrinsic motivation had no significant effect on student engagement. Moreover, the mediating effects of student intrinsic motivation including perceived autonomy, competence, and relatedness offered a deeper understanding of the association between autonomy-supportive teaching motivations and student engagement. The main findings and practical implications together are discussed in depth.

Implications for practice or policy:

- Teachers could adopt autonomy-supportive teaching strategies and stimulate students' intrinsic motivation as they have shown to be positive factors for student engagement.
- Developers and educators could enhance student engagement through nurturing inner motivational resources in online learning environment.
- Researchers could verify more factors that influence student engagement and clarify how they could be manipulated in future studies.

Keywords: teaching motivations, student intrinsic motivation, student extrinsic motivation, student engagement, online learning environment

Introduction

More than one billion students were affected by school closures as a result of the Covid-19 pandemic all over the world (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020). Consequently, the urgent transition of school education to online learning and teaching posed challenges for both students and teachers (Chiu, 2021). Given its link to improved persistence, achievement, and retention, student engagement has been correlated with their willingness to participate in online learning activities, (Chen et al., 2010). Student engagement can effectively predict student attrition and is an important indicator for assessing online learning satisfaction and academic achievement (Ronimus et al., 2014).

Student engagement is affected by various factors, such as the support of teachers and peers (Lietaert et al., 2015). Teaching motivations serve as a most important factor because teachers play a vital role in stimulating students' learning motivations (Roorda et al., 2011). Teachers' adoptions of autonomy supportive, and controlling teaching are used to support students' learning (Reeve, 2012). During the online learning process, without direct and immediate teacher help, students cannot initiate and maintain

meaningful communications, and cannot develop conceptual understanding through active engagement with digital resources (Hartnett, 2016). During the learning process in an online environment, if teachers cannot provide sufficient and immediate help, it is difficult for students to start and maintain meaningful interactions and actively engage with digital resources to obtain a sound conceptual understanding (Hartnett, 2016). In view of the observed challenges in online learning, promoting active learning through teaching motivations may be an effective teaching strategy.

One theory of motivation that has played the important role in researching effective teaching motivations is self-determination theory (Chan et al., 2021). Self-determination theory suggests that when teaching design fully meets the psychological needs of students, students will actively engage in learning tasks (Hsu et al., 2019). Therefore, self-determination theory can explain the influence of demand-based teaching motivations on engagement and learning. A lot of research has focused on exploring the intrinsic and extrinsic motivation of students' learning based on self-determination theory (Fischer et al., 2019).

Self-determination theory has mainly been applied to investigate students' face-to-face learning optimisation (Ryan & Deci, 2020), but little online learning research has used this theory (Chen & Jang, 2010). Ryan and Deci (2020), suggested future self-determination theory research should look more closely at how online learning and remote classroom technologies stimulated student engagement and learning. Online learning has been researched in higher education (Hsu et al., 2019), but little is known about how students engage in online learning from a self-determination theory perspective. In addition, there have been few studies on the influence of teaching motivations on student engagement in online learning context. Even fewer studies have explicitly addressed controlling teaching motivations and its relations to learning motivation and engagement (De Meyer et al., 2014). Therefore, this study applied self-determination theory to investigate the factors that influence student engagement in the online learning environment. This study provided empirical evidence to enrich self-determination theory by presenting how teachers can use strategies to satisfy students' needs for better engagement. It also provided suggestions for improving the quality of online learning. The following research questions were crafted to address the aim of this study:

1. Is the adapted instrument to measure teaching motivations, student intrinsic and extrinsic motivation, and student engagement, valid and reliable?
2. What are the relationships between measures of teaching motivations, student intrinsic and extrinsic motivation, and student engagement?
3. To what extent does student intrinsic motivation mediate the relationship between autonomy-supportive teaching motivations and student engagement?

Literature review

Student engagement

Student engagement is defined by the extent of a student's involvement in the learning activity. It includes four highly correlated aspects: behavioural engagement, cognitive engagement, emotional engagement, and agentic engagement (Reeve, 2012). Behavioural engagement refers to the concentration, effort, and persistence that learners present in completing tasks (Christenson et al., 2012; Fredricks et al., 2004). Cognitive engagement is reflected in the use of deep cognitive strategies, self-monitoring, and active self-regulation (Appleton et al., 2006; Fredricks et al., 2004). Emotional engagement is the emotional experience of learners on learning activities (Fredricks et al., 2004), manifested by enjoyment or interest in the task and sense of belonging to the learning community (Sugden et al., 2021). Agentic engagement means the learners' constructive contributions to the teaching process (Reeve, 2012), such as expressing their pursuit of goals and personal preferences.

Self-determination theory

Self-determination theory is a motivational theory about human behaviour (Deci & Ryan, 1985). The emphasis of self-determination theory on using instructional tasks to invoke students' intrinsic motivations as the critical step in facilitating high-quality engagement, differentiates it from other motivation theories that focus on the contributions of students' expectations, beliefs, and goals to their classroom engagement (Reeve, 2012; Reeve & Halusic, 2009). To promote high-quality student engagement, self-determination theory puts forward recommendations on how teachers can use instructional tools to involve, nurture, and

vitalise students' learning motivations in the learning process (Niemiec & Ryan, 2009). Self-determination theory has been widely used and recognised in the fields of education, psychology and management, including basic needs theory, goal contents theory, organismic integration theory, causality orientations theory and cognitive evaluation theory (Deci & Ryan, 1985). Among these, basic needs theory, as an important part of self-determination theory, determines three psychological needs: autonomy, competence, and relatedness (Deci & Ryan, 2000), and explains the relationship between them and high-quality engagement. Goal contents theory introduces goals as another factor affecting motivation in self-determination theory. Intrinsic goals can satisfy individual's basic needs to a greater extent than extrinsic goals, and then enhance learning, performance, and mental health (Vansteenkiste et al., 2006). Organismic integration theory emphasises the role of extrinsic factors on individual motivation. Extrinsic motivation is manifested by four aspects: (1) external regulation, (2) introjected regulation, (3) identified regulation, and (4) integrated regulation (Chiu, 2021; Deci & Ryan, 2000). Causality orientations theory is divided into autonomous guides, controlling guides, and non-personal orientation according to differences in individual motivation orientation (Deci & Ryan, 2000). Cognitive evaluation theory explains how external events impact intrinsic motivation from a controlling an informational aspect (Deci & Ryan, 1985). Controlling external events weaken individual's intrinsic motivation, while informational external events strengthen individual's intrinsic motivation.

Teaching motivations

The involvement of teachers is critical for students' learning engagement and effectiveness in both K-12 and higher education (Shoepe et al., 2020; Van Leeuwen & Janssen, 2019). As important educational constructs, teaching motivations can mobilise and maintain the enthusiasm of learners by meeting their psychological needs or providing external incentives and pressure (Deci & Ryan ,1985; Reeve, 2009). They include autonomy-supportive teaching motivations and controlling teaching motivations, as shown in Table 1. Autonomy-supportive teaching motivations refer to "interpersonal sentiments and behaviours teachers provide during instruction to identify, nurture, and develop students' inner motivational resources" (Reeve, 2009, p. 160), and controlling teaching motivations refer to "interpersonal sentiments and behaviours teachers provide during instruction to pressure students to think, feel, or behave in a specific way" (Reeve, 2009, p. 160).

Table 1
Characteristic and instructional behaviours associated with controlling and with autonomy supportive

Teaching motivations	Characteristic	Instructional behaviours
Autonomy-supportive	• Adopting the learners' perspective • Nurturing inner motivational resources	• Allowing criticism and encouraging independent thinking • Supporting interests, goals and values • Giving the opportunity to choose their own learning tasks • Relying on noncontrolling and informational language
Controlling	• Adopting the teacher's perspective • Relying on outer resources of motivation	• Suppressing criticism or independent opinions • Interfering with rhythm or behavioural plan • Forcing meaningless and uninteresting activities • Relying on pressure-inducing language

Research model and hypotheses

Based on self-determination theory and related literatures, Figure 1 shows the hypothesised model proposed for this study, predicting student engagement being influenced by autonomy-supportive teaching motivations, controlling teaching motivations, and student intrinsic and extrinsic motivation.

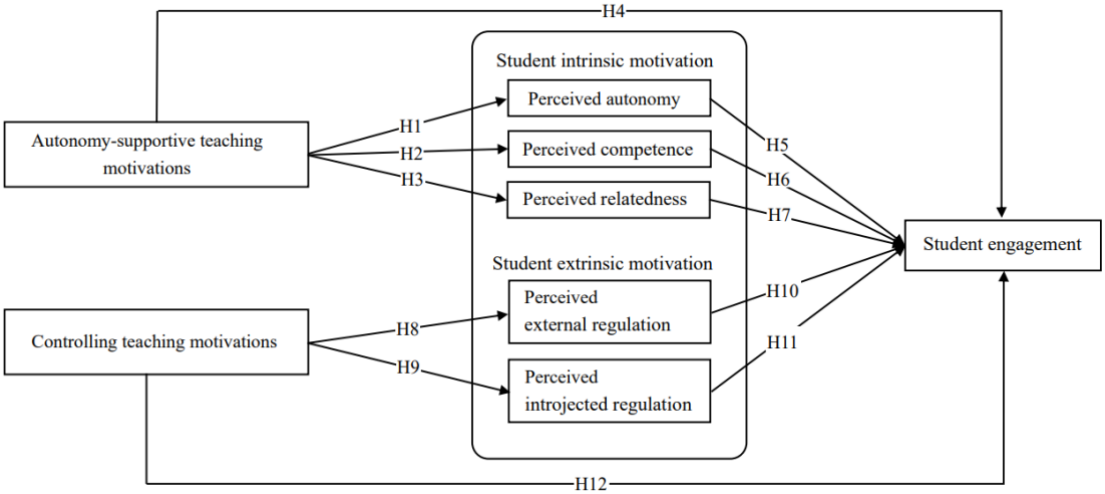


Figure 1. The hypothesised model

Autonomy-supportive teaching motivations

Autonomy-supportive teaching in online learning is centred on learners, motivating their inner motivational resources, and giving learners the right to self-choice, such as allowing learners to study in their own way, enabling them to perceive autonomy. Autonomy-supportive teachers encourage students to think critically and independently, for example, always paying attention to the questions raised by learners in the discussion area, solving learner's problems in a timely way, and giving positive feedback to increase the learner's perception of competence. Focusing on the development of emotional relationships between teachers and students, and students and other students, not only provide learners with knowledge, but also demonstrates care about them, allowing them to positively perceive the relationship and sense of belonging. Black and Deci's (2000) study showed that support for autonomy-supportive teaching motivations had a positive predictive effect on learners' motivation level and learning interest, and a negative effect on their anxiety and attrition rate, especially for learners with weak initial motivation. Vansteenkiste et al. (2012) found that teachers who provided a high degree of autonomy and clear expectations were conducive to the development of learners' inner motivational resources. Williams and Deci's (1996) research confirmed that autonomy-supportive teachers can promote learning autonomy and improve learners' perception of competence and psychological beliefs. Therefore, we hypothesised that:

1. Autonomy-supportive teaching motivations is positively related to the learner's perceived autonomy.
2. Autonomy-supportive teaching motivations is positively related to the learner's perceived competence.
3. Autonomy-supportive teaching motivations is positively related to the learner's perceived relatedness.

In addition, Assor et al.'s (2002) research confirmed a positive association between teacher support for autonomous behaviour and student engagement. Shih's (2008) survey of Taiwanese junior high school students found that learners with stronger perception of teachers' autonomous behaviour showed deeper behavioural engagement and emotional engagement. Therefore, we hypothesise that:

4. Autonomy-supportive teaching motivations is positively related to student engagement.

Student intrinsic motivation

Intrinsic motivation refers to the behaviour that an individual accomplishes without external pressure. In other words, the behaviour itself makes individual feel interesting and pleasant. Basic needs theory in self-determination theory points out that when a learner's three basic needs of autonomy, competence, and relatedness are satisfied, it will motivate their inner motivation resources. Perceived autonomy in this study refers to the way learners study, including study resources and strategies in online learning environment,

which can be self-determined, for example, self-planning and self-assessing. Perceived competence means that learners have the confidence to face the challenges and difficulties, such as learning independently or helping others solve problems. Perceived relatedness refers to the ability to feel the concern and communication from others, such as using discussion boards to interact with others. In the online learning environment, autonomy, self-efficacy, and subjective norms positively influence student engagement, and autonomy's impact is most significant (Riaz & Naeem, 2016). Based on attribution theory, self-determination theory, and self-efficacy theory, Martin and Dowson (2009) concluded that perceived relatedness was conducive to student engagement. They and proposed a 3-tier framework to improve learners' motivation, student engagement, and academic achievement. Using structural equation modelling, Froiland and Oros (2014) found that learners' intrinsic motivation positively impacted student engagement and thus improved their academic performance. This study hypothesised that:

5. Learners' perceived autonomy is positively related to student engagement.
6. Learners' perceived competence is positively related to student engagement.
7. Learners' perceived relatedness is positively related to student engagement.

Controlling teaching motivations

Controlling teachers in an online environment consider themselves to be central in developing learners' external motivation. They mainly use pressuring tactics to make students think, feel, or behave in a teacher-prescribed way, and adopt motivations or penalties such as bonuses or deductions to stimulate external regulation (Reeve, 2009). To stimulate learners' internal regulation, controlling teachers may use methods such as publicising student excellent work of learning in online environment to satisfy their self-esteem and generate a sense of pride. Cognitive evaluation theory in self-determination theory emphasises that controlling external events can weaken student intrinsic motivation and thus enhance their extrinsic motivation (Deci & Ryan, 1985). In addition, through the investigation of secondary school students in the context of physical education, the controlling teaching was closely related to controlled motivation, and frustration needs played a mediating role (Haerens et al., 2015). Rezvani et al. (2017) constructed a structural equation model that confirmed controlling teaching motivations were positively correlated with individual's extrinsic motivation among users of Enterprise Resource Planning systems in Malaysia. In addition, Reeve (2009) proposed that controlling teachers motivate learners to perceive extrinsic motivations, restrain learners' positive results, disturb, and destroy learners' emotional engagement, cognitive engagement, and agentic engagement. Therefore, we hypothesised that:

8. Controlling teaching motivations is positively related to the learner's perceived external regulation.
9. Controlling teaching motivations is positively related to the learner's perceived introjected regulation.
10. Controlling teaching motivations is negatively related to the learner's student engagement.

Student extrinsic motivation

Extrinsic motivation is the behaviour performed to obtain results unrelated to the activity itself. According to organismic integration theory in self-determination theory, identified regulation and integrated regulation are extrinsic motivations with strong autonomy: autonomous motivations. External regulation (i.e., acting to avoid punishment or gain rewards) and introjected regulation (i.e., acting to avoid feeling guilty or to obtain contingent self-worth) are extrinsic motivations with low autonomy: controlled motivations (Ryan & Deci, 2020). To maximise the distinction between extrinsic and intrinsic student motivation, this study measured controlled motivation in place extrinsic motivation. External regulation means that learner's behaviour is controlled by exogenous events, but if the controlling external events (reward or punishment) stop, such behaviour will be difficult to maintain. Introjected regulation refers to learner's behaviour that satisfies internal emergencies. They learn independently to avoid guilt or satisfy their self-esteem. Lu and Yang (2013) in a study of English language learner's motivations, found that extrinsic motivation (e.g., external requirements) was negatively correlated with student engagement. Through an investigation of distance learners, Gao et al. (2015) is confirmed that external regulation and introjected regulation had a negative predictive effect on online student engagement. We hypothesised that:

11. Learners' perceived external regulation is negatively related to student engagement.
12. Learners' perceived introjected regulation is negatively related to student engagement.

Methodology

System overview

Figure 2 shows the learning process of the learners in the self-directed learning cyberspace developed by our team. Students begin by customising the learning task and forming task understanding. A student's task understanding governs their ensuing goal-setting and planning processes, together with student attributes including self-efficacy. Students may start to execute the learning process when a plan has been established. As they perform the specific learning activities in their plans, the learning dashboard monitors content, Q and A, quizzes, and peer assessment. Then students self-assess the effectiveness of their plans and the success of their activities. Students may revise or give up their plan after receiving feedback via the learning dashboard. Once a plan has been finished or discarded, students may self-reflect as they analyse their planning effectiveness and planning processes. Students may modify their task understanding due to reflection.

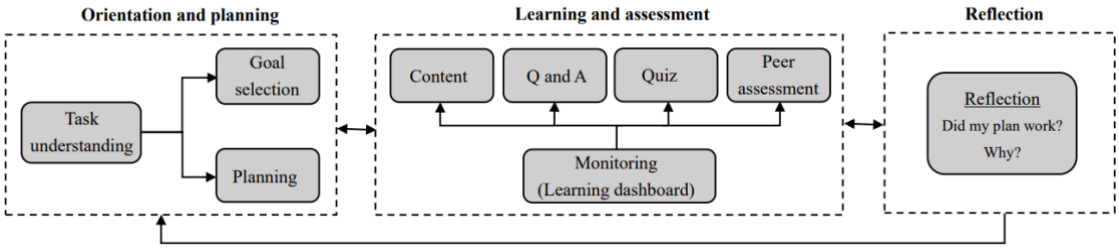
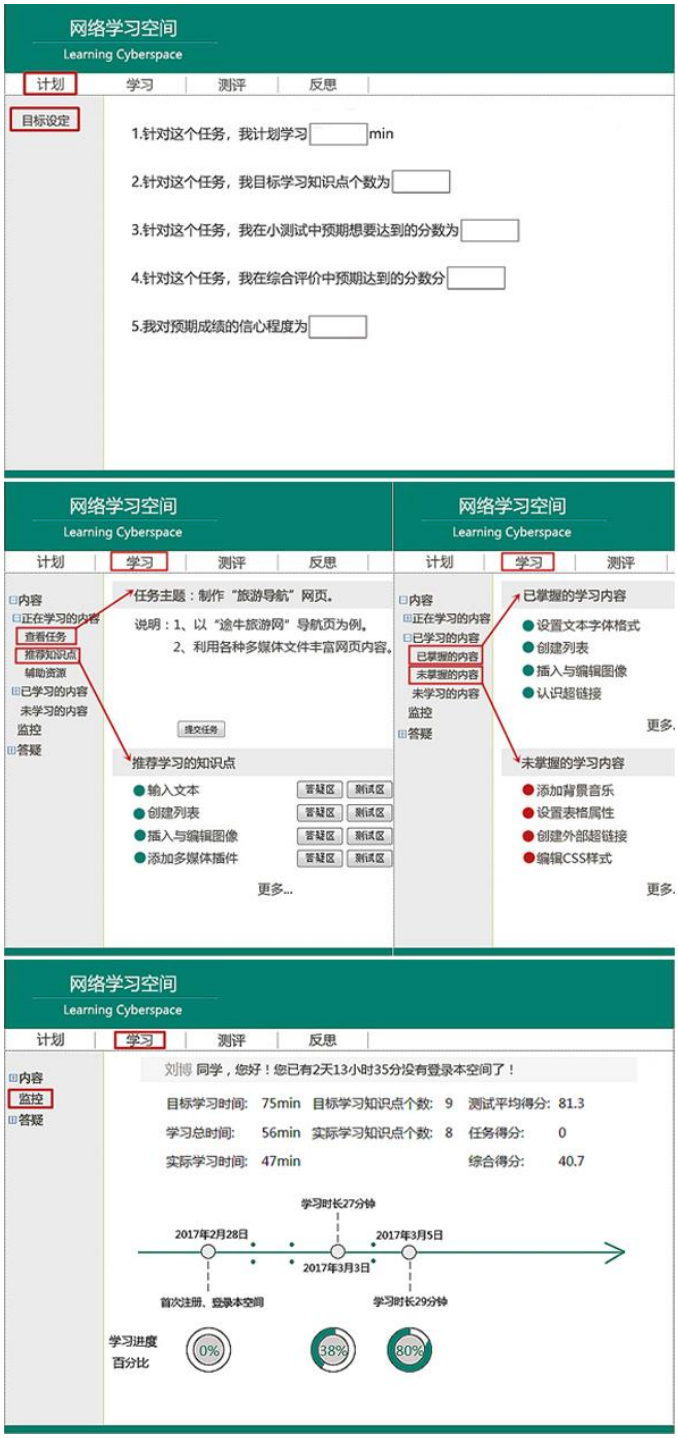


Figure 2. Students' learning system architecture

Zimmerman's (2002) study about learning processes of self-regulated learners showed that in the orientation and planning phase, learners analysed their tasks, set goals, and planned strategies to finish their goals. In this study, tools were provided to learners, to enhance their goal setting, time management, and strategy planning in the online learning environment. This is shown in Figures 3 and 4. Zimmerman and Kitsantas (2007) suggested that self-monitoring generally was a major strategy that learners used during the execution phase. In this phase, learners needed to perform learning strategies, compare performance to their goals, and decide progress. Various online tools were provided for helping students attain their goals effectively. These included recommended knowledge relating to the completion of tasks, and a list of mastered contents or unmastered contents, allowing students to choose the scope according to their own needs. Various information connected with each learner's learning status was provided by the dashboard. In line with Zimmerman and Kitsantas's (2007) idea of self-regulated learning ability including self-evaluation and self-reactions, in the self-assessment stage, a dual-test was included. Learners needed to not only choose the correct answer to the question, but also answer the reason for choosing the answer, to demonstrate their understanding. The learning system provided an evaluation of ability and achievement according to students' performance in completed tasks. During the self-reflection phase, students used the reflection logs to reflect and evaluate how they achieved goals. This enabled them to adjust their learning goals and strategies for the next steps. Students could also check the peer reflection logs to compare their own strategies or shortcomings in the process of completing the task with other students.



1.Self-plan

Manage times
Knowledge points
Expected score
Level of confidence

2.Self-study and self-monitor

Recommended knowledge
Mastered and unmastered contents
Learning dashboard

Figure 3. Online learning environment interfaces for self-plan, and self-study and self-monitor

3.Self-assessment

Dual-test
Overall performance
Peer assessment

4.Self-reflection

My reflection and peer reflection

Figure 4. Online learning environment interfaces for self-assessment and self-reflection

Participants

Based on the self-directed learning cyberspace, the participants of this study were Chinese sophomores and juniors students enrolled in the courses, Web Design and Development and Database Principles. All participants had the necessary computer skills and had not previously used the self-directed learning cyberspace platform. The participants were from various disciplines including educational technology, library science, and information resources management. They each took the courses fully online for 10 weeks. Data were collected by using an online electronic questionnaire (N = 112) and offline paper questionnaire (N = 355) survey. Of the 467 questionnaires distributed, 414 valid questionnaires were returned, giving a response rate of 88.7%. of the valid returned questionnaires, there were 74.4% female students and 25.6% male students. This reflected the overall gender ratio of the courses. The participants ranged in age from 19 to 22 years (M = 20, SD = 0.85). Informed consent was obtained from all participants. Participants were ensured that the responses collected will be used for research and publication only, and that their information would be kept confidential and in compliance with applicable information privacy legislation. All of the participants were voluntary and without reward.

Measurements

The scale utilised in this study was initially drafted by referencing survey questions used in previous studies related to student engagement. The adapted scale consists of 25 items formatted using a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Appendix A contains the questionnaire with its research dimensions and items.

Teaching motivations was divided into two dimensions: autonomy-supportive teaching motivations and controlling teaching motivations. Each dimension consisted of 3 items. These items were adapted from the

questionnaire of Assor et al. (2002), in which the internal consistency coefficient (Cronbach's α) ranged from 0.72 to 0.81. The adaptation was only to phrase the items to fit within the online learning context. For example, when measuring autonomy-supportive teaching motivations, the original item, "Teacher explains why it is important to study certain subjects in school" was modified to "Teacher explains why it is important to study certain subjects in online environment".

Intrinsic motivation was measured by 9 items divided into three dimensions: perceived autonomy, perceived competence, and perceived relatedness. These items were adapted from the Work Motivation Form-Employee scale (Kasser et al., 1992) and the Intrinsic Need Satisfaction scale (Baard et al., 2004). These two scales were created by adapting some items from the Intrinsic Motivation Inventory (Ryan, 1982) which measured three areas of motivation believed to be important (Deci & Ryan, 1985): autonomy, competence, and relatedness. The Work Motivation Form-Employee scale, developed by Kasser et al. (1992), possessed adequate internal consistencies for the total score ($\alpha = 0.79$) as did the Intrinsic Need Satisfaction scale developed by Baard et al. (2004) ($\alpha = 0.87$). Because the scales were designed to measure motivation levels of employees, some of the items had to be modified to measure motivation levels of student. For example, when measuring perceived relatedness, the original item, "I get along with people at work" was modified to "I often feel a lot of distance in our relationship".

Extrinsic motivation was measured by two dimensions: perceived external regulation and perceived introjected regulation. Each dimension consisted of 3 items adapted from the questionnaire of Ryan and Connell (1989), whose participants were elementary school students. The internal consistency coefficient of their questionnaire ranged from 0.62 to 0.89. Only items from their questionnaire suitable for this study object were selected.

The dimension of student engagement included 4 items. These items were adapted from the engagement scale of Sun and Rueda (2012) which had Cronbach alpha values ranging from 0.75 to 0.88. Because their engagement scale was designed to measure engagement levels of graduate and undergraduate students in a distance education setting, only some of the items were selected for this study, which measured student engagement levels in an online learning environment.

Data analysis

The two-step procedure suggested by Anderson and Gerbing (1988) was adopted to analyse the collected data. The measurement model was used to measure convergent and discriminant validity. Next the structural model was examined to investigate the direction and strength of the relationships among the theoretical constructs. The specific operation was as follows.

First, exploratory factor analysis (EFA) of the original scale with 28 items was performed in IBM SPSS 17.0 to clarify the factors. The case numbers in performing EFA should be 5 to 10 times the total number of items during the survey (Stevens, 1996). By this criterion, 140 cases were used to conduct EFA. After removing the items with factor loadings lower than 0.50, 25 items remained in the final scale. Next, confirmatory factor analysis (CFA) was conducted using AMOS 24.0 to verify the construct validity of the autonomy-supportive teaching motivations, controlling teaching motivations, perceived autonomy, perceived competence, perceived relatedness, perceived introjected regulation, perceived external regulation, and student engagement factors. In general, the same cases cannot be used for both EFA and CFA. Therefore, the remaining cases ($N = 274$) in this study were sufficient for structural equation modelling analysis. The values of item loadings and composite reliability were examined for measuring the convergent validity of each construct. To evaluate the validity and reliability of the measurement model, the values of composite reliability and average variance explained were estimated. Pearson's correlation analysis among all the factors was also conducted for discriminant validity. The maximum likelihood method was used to estimate the most appropriate factor model and the fit of the proposed model. Path analysis was executed to examine the direct and indirect relations among autonomy-supportive teaching motivations, perceived autonomy, perceived competence, perceived relatedness, and student engagement in the structural model to assess the fitness of the hypothesised model. Finally, a bootstrap approach to gaining confidence intervals (Preacher & Hayes, 2008) with a resample of 5,000 (95% confidence level) was used to examine the mediation effects of autonomy-supportive teaching motivations and student engagement. The interpretation of the results followed Zhao et al.'s (2010) typology of mediation.

Results

Exploratory factor analysis

Before performing EFA, the Kaiser-Meyer-Olkin value was 0.87, and the Bartlett's test was significant (χ^2 = 2008.40, $p < .001$), showing the suitability of performing EFA. In the process of executing EFA, principal component factoring and Varimax rotation were conducted (Lin et al., 2012). This EFA analysis resulted in the retention of eight factors: autonomy-supportive teaching motivations, controlling teaching motivations, perceived autonomy, perceived competence, perceived relatedness, perceived external regulation, perceived introjected regulation, and student engagement, with a total of, 25 items pursuant to the criterion in determining the number of the factors was eigenvalue above 1(Stevens, 1996).

Table 2 shows the results of EFA including the mean value, standard deviation, factor loading, explained variance, and alpha coefficient. The alpha coefficients of the eight factors were from 0.75 to 0.92, indicating high internal consistency. The factor loadings (pattern coefficients) of all items were from 0.61 to 0.91. The total variance with satisfactory outcomes could explain 77.3%. Taken together, the scale with eight factors had satisfactory internal reliability and validity for performing CFA in this study.

Table 2
Results of EFA

Scale and item	Mean	*SD*	Factor loading	Variance explained (%)	Cronbach's alpha
ASTMS	3.56	1.91		6.0	0.81
ASTMS1			0.74		
ASTMS2			0.76		
ASTMS3			0.70		
CTMS	2.53	2.83		5.7	0.92
CTMS1			0.85		
CTMS2			0.90		
CTMS3			0.85		
PA	3.67	1.70		8.5	0.85
PA1			0.77		
PA2			0.84		
PA3			0.70		
PC	3.60	1.80		27.2	0.82
PC1			0.77		
PC2			0.77		
PC3			0.72		
PR	3.57	1.69		13.7	0.75
PR1			0.78		
PR2			0.66		
PR3			0.68		
ER	2.97	2.53		7.1	0.88
ER1			0.82		
ER2			0.82		
ER3			0.81		
IR	2.68	2.1		4.2	0.80
IR1			0.77		
IR2			0.79		
IR3			0.66		
SE	3.69	2.34		4.9	0.88
SE1			0.87		
SE2			0.91		
SE3			0.78		
SE4			0.61		

Note. ASTMS = autonomy-supportive teaching motivations. CTMS = controlling teaching motivations. PA = perceived autonomy. PC = perceived competence. PR = perceived relatedness. ER = perceived external regulation. IR = perceived introjected regulation. SE = student engagement

Analysis of the measurement model

Indicators' composite reliability, average variance explained, factor loadings, and construct intercorrelations were examined to verify the reliability and validity of the measures (Chin, 1998; Thatcher & Perrewé, 2002). Composite reliability was evaluated for reliability analysis. Table 3 presents composite reliability values, which ranged from 0.80 to 0.91: all higher than of 0.7, meeting the reliability standard (Nunnally & Bernstein, 1994). All constructs' Cronbach's alpha values ranged from 0.79 to 0.91 and exceeded the threshold level of 0.7 for ensuring internal consistency (Fornell & Larcker, 1981). The high composite reliability and Cronbach's alpha values indicated the reliability of the measurement model.

Factor loading and average variance explained were used for measuring validity. Because the loading for all items was sufficiently high on their corresponding constructs (Thatcher & Perrewé, 2002), evidence for convergent validity was provided by the factor loadings from the CFA. All items surpassed 0.67, exceeding the threshold value of 0.50 recommended by Peterson (2000). Table 3 shows the corresponding fit measures.

Table 3
Construct reliability and convergent validity

Construct indicator	Questionnaire items	Factor loading	Cronbach's alpha	Composite reliability	Average variance extracted
Autonomy-supportive teaching motivations	ASTMS1	0.80	0.82	0.83	0.62
	ASTMS2	0.88			
	ASTMS3	0.67			
Controlling teaching motivations	CTMS1	0.86	0.91	0.91	0.78
	CTMS2	0.92			
	CTMS3	0.87			
Perceived autonomy	PA1	0.78	0.83	0.83	0.63
	PA2	0.82			
	PA3	0.77			
Perceived competence	PC1	0.82	0.82	0.82	0.61
	PC2	0.76			
	PC3	0.76			
Perceived relatedness	PR1	0.84	0.79	0.80	0.57
	PR2	0.69			
	PR3	0.73			
Perceived external regulation	ER1	0.87	0.84	0.84	0.64
	ER2	0.76			
	ER3	0.76			
Perceived introjected regulation	IR1	0.74	0.82	0.82	0.61
	IR2	0.89			
	IR3	0.68			
Student engagement	SE1	0.85	0.89	0.90	0.69
	SE2	0.94			
	SE3	0.78			
	SE4	0.73			

Note. ASTMS = autonomy-supportive teaching motivations. CTMS = controlling teaching motivations. PA = perceived autonomy. PC = perceived competence. PR = perceived relatedness. ER = perceived external regulation. IR = perceived introjected regulation. SE = student engagement

Discriminant validity was used to evaluate the extent to which a concept and its indicators differed from another concept and its indicators (Bagozzi et al., 1991). As Fornell and Larcker (1981) suggested, the correlations between items in any two constructs should be lower than the square root of the average variance shared by items within a construct. Table 4 reports the inter-construct correlations and square root of average variance explained. For each construct, all the square root of the AVE values were larger than the correlation coefficients with other constructs, showing the discriminant validity of the survey. Furthermore, the student engagement was significantly correlated with the variables of autonomy-supportive teaching motivations, controlling teaching motivations, perceived autonomy, perceived competence, and perceived relatedness. The correlations between student engagement and autonomy-

supportive teaching motivations, perceived autonomy, perceived competence, and perceived relatedness were positively related (r = 0.65, 0.64, 0.58, 0.67, respectively), while the correlation between student engagement and controlling teaching motivations was negatively related (r = -0.16), suggesting that autonomy-supportive teaching motivations, perceived autonomy, perceived competence, perceived relatedness, and controlling teaching motivations may have played vital roles in driving participant student engagement in online learning. The autonomy-supportive teaching motivations was significantly and positively correlated with the variables of perceived autonomy, perceived competence, and perceived relatedness (r = 0.54, 0.47, 0.61 respectively), which generally indicated that autonomy-supportive teaching motivations may directly related to student's intrinsic motivation. The controlling teaching motivations was significantly correlated with the variables of perceived autonomy, perceived competence, perceived relatedness, perceived external regulation, and perceived introjected regulation. Specifically, the correlations between controlling teaching motivations and perceived autonomy, perceived competence, and perceived relatedness were negative and relatively lower (r = -0.19, -0.22, -0.20 respectively), while the correlations between controlling teaching motivations and perceived external regulation, and perceived introjected regulation were positive and relatively higher (r = 0.42, 0.59 respectively), suggesting that controlling teaching motivations may have affected the developing of both intrinsic and extrinsic student motivations. In summary, all constructs in the measurement model had adequate reliability, convergent validity, and discriminant validity.

Table 4
Correlation of constructs and square root of average variance explained

	ASTMS	CTMS	PA	PC	PR	ER	IR	SE
ASTMS	**(0.79)**							
CTMS	-0.12*	**(0.88)**						
PA	0.54***	-0.19**	**(0.79)**					
PC	0.47***	-0.22**	0.54***	**(0.78)**				
PR	0.61***	-0.20**	0.57***	0.57***	**(0.75)**			
ER	-0.06	0.42***	-0.04	-0.08	-0.01	**(0.80)**		
IR	0.01	0.59***	-0.11	-0.10	-0.12	0.60***	**(0.78)**	
SE	0.65***	-0.16**	0.64***	0.58***	0.67***	-0.03	-0.01	**(0.83)**

Note. *p < .05, **p < .01, ***p < .001. The diagonal values in bold and parentheses represent the square root of the AVE. The non-diagonal values represent the correlations among constructs. ASTMS = autonomy-supportive teaching motivations. CTMS = controlling teaching motivations. PA = perceived autonomy. PC = perceived competence. PR = perceived relatedness. ER = perceived external regulation. IR = perceived introjected regulation. SE = student engagement

Analysis of the structural model

Based on the structural equation modelling, the maximum likelihood was used to verify the fitting effect and hypothesis of the model. The general results of the fitness of the research model are shown in the Table 5. The χ^2/df, goodness of fit index, normed fit index, root mean square error of approximation, comparative fit index, root mean square residual, and Tucker Lewis index were in accordance with previous studies (Kurfalı et al., 2017; Wu & Chen, 2016). Therefore, the values were within proposed range, indicating that the research model had a reasonably good fit.

Table 5
Model fit summary of the research model (CFA)

Fit index	Recommended value	Research model
Chi square/degree of freedom (χ^2/df)	<3.00	1.66
Goodness of fit index	>0.90	0.90
Normed fit index	>0.90	0.90
Root mean square error of approximation	<0.05	0.049
Comparative fit index	>0.90	0.96
Root mean square residual	<0.05	0.035
Tucker Lewis index	>0.90	0.95

Hypotheses testing

Based on the correlation results, a structural equation model approach (Bagozzi et al., 1991) was employed for testing the 12 hypotheses, using AMOS Graphics. In the research model, the path significance of each hypothesised association was examined. Figure 5 shows the standardised path coefficients and path significances. Of all the hypotheses, nine hypothesised associations were significant at $p < .05$, and the three hypotheses linking controlling teaching motivations, perceived external regulation, perceived introjected regulation and student engagement were not significant. Hypotheses 1, 2, and 3, which tested the relationships between autonomy-supportive teaching motivations and perceived autonomy ($\beta = 0.54$, $P < .001$), perceived competence ($\beta = 0.48$, $P < .001$) and perceived relatedness ($\beta = 0.62$, $P < .001$), were supported. Hypothesis 4, which proposed a positive effect of autonomy-supportive teaching motivations and student engagement ($\beta = 0.26$, $P < .001$), was also supported. Hypotheses 8 and 9 examined the relationships between learner's perceived external regulation ($\beta = 0.42$, $P < .001$), perceived introjected regulation ($\beta = 0.57$, $P < .001$), and controlling teaching motivation were supported. However, the relationship between controlling teaching motivation and student engagement (Hypothesis 10) was not supported ($\beta = -.01$, $P = .808 > .05$). Hypotheses 5, 6, and 7, which tested the relationships between online learners' perceived autonomy ($\beta = 0.27$, $P < 0.001$), perceived competence ($\beta = 0.17$, $P = .002 < .01$), perceived relatedness ($\beta = 0.22$, $P < .001$), and their student engagement, were all supported. Hypotheses 11 and 12 which tested perceived external regulation, perceived introjected regulation, and student engagement were unsupported. In addition, variance explained (R^2 value) of student engagement was 0.57, which indicated that supporting the autonomy-supportive teaching motivations, perceived autonomy, perceived competence, and perceived relatedness together explained 57% of the student engagement.

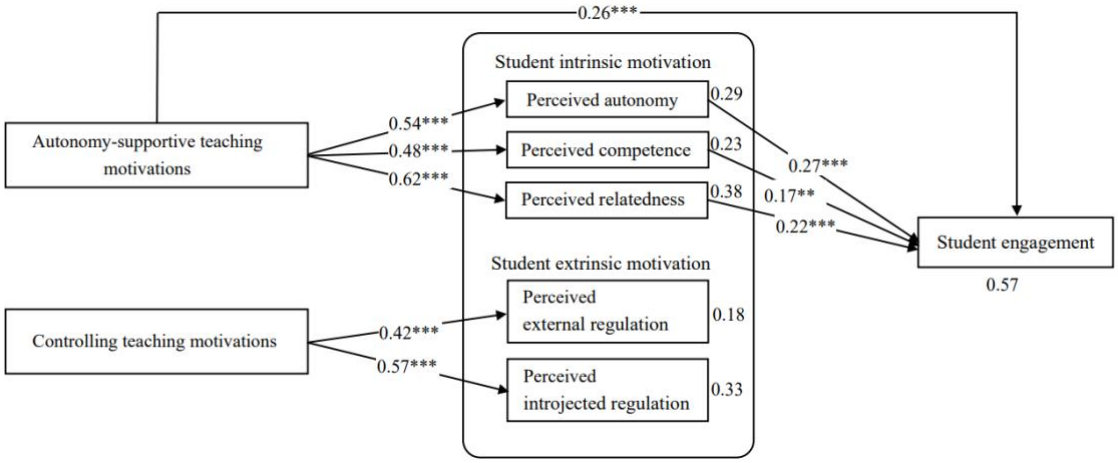


Figure 5. Structural equation model of the hypothesised model
Note. $^{**}p < .01$, $^{***}p < .001$

Mediation effect analysis

The mediating effects of perceived autonomy, perceived competence, and perceived relatedness in intrinsic motivation on autonomy-supportive teaching motivations and student engagement were examined according to Zhao et al.'s (2010) suggestions, using a bootstrapping method (Preacher & Hayes, 2008) in AMOS. The results are shown in Table 6. In the direct model without mediators, the independent variable (autonomy-supportive teaching motivations) significantly affected the dependent variable (student engagement) (path estimate = 0.273, $p < .01$). In terms of the indirect model, autonomy-supportive teaching motivations significantly affected the mediate variable (perceived autonomy, perceived competence, perceived relatedness), and autonomy-supportive teaching motivations significantly affected student engagement with perceived autonomy (estimate = 0.152, $p < .01$), perceived competence (estimate = 0.099, $p < .01$) and perceived relatedness (estimate = 0.184, $p < .05$). Based on Zhao et al.'s (2010) recommendations, perceived autonomy, perceived competence, and perceived relatedness in learners' intrinsic motivation had a complementary mediation effect between the autonomy-supportive teaching motivations and student engagement.

Table 6
Mediation analysis results

Tested relationship	Direct model without mediator	Indirect model	95%CI	Results
ASTMS→PA→SE	0.273**	0.152**	(0.079-0.407)	Complementary (mediation)
ASTMS→PC→SE	0.273**	0.099*	(0.031-0.334)	Complementary (mediation)
ASTMS→PR→SE	0.273**	0.184**	(0.117-0.436)	Complementary (mediation)

Note. *$p < .05$, **$p < .01$. ASTMS = autonomy-supportive teaching motivations. PA = perceived autonomy. PC = perceived competence. PR = perceived relatedness. SE = student engagement

Discussion

The purpose of this study was to examine the relationships among the variables of teaching motivations, learning motivation, and student engagement, and to establish the role of student intrinsic motivation as a mediator for this relationship. The results from EFA and CFA indicated that all the factors of the instrument possessed satisfactory validity and were sufficiently reliable. According to this study, in an online learning environment, autonomy-supportive teaching motivations positively affected students' intrinsic motivation and student engagement. This has also been confirmed in previous studies (Cents-Boonstra et al., 2021; Matos et al., 2018). In contrast, controlling teaching motivations also had positive impacts on extrinsic motivation. Similar to the findings of previous studies (De Meyer et al., 2014; Rezvani et al., 2017), the students who perceived controlling teaching motivations seemed to display more extrinsic and controlled forms of motivations. Intrinsic motivation was associated with student engagement. This was supported by the results in the pre-service teachers' learning motivation and student engagement of Chan et al. (2021). Furthermore, intrinsic motivation played a mediating role between autonomy-supportive teaching motivations and student engagement. The result implied that the learners may give rise to engagement with online learning through improved intrinsic motivation during the online course. This also corresponded with Cents-Boonstra et al.'s (2020) view that autonomy-supportive teachers used more empathy and attention, and more positive feedback, inviting language in the highly engaging lessons for their students, to support perceived autonomy, competence, and relatedness.

However, according to this study, controlling teaching motivations had no significant impact on student engagement. This result was inconsistent with the findings of Reeve (2009). A possible explanation was that under the context of fully online learning, college students learned more freely and autonomously, so their engagement was less affected by the controlling teaching motivations. This finding was also supported by Assor et al. (2002) who showed that controlling teaching motivations could not be consistently effective on student engagement. Furthermore, the utility of controlling teaching motivations needs to be considered with its relevance to a given context (Cents-Boonstra et al., 2021). In addition, there was no association between student extrinsic motivation and student engagement in this study. This finding may have been because students only focused on getting high scores and approval from parents and teachers, and were not interested in learning new things (Saeed & Zyngier, 2012). Therefore, there was still no consensus that controlling teaching motivations and extrinsic motivation were significantly associated with student engagement. In future studies, more effort is needed to elucidate the correlation between these constructs.

Practical implications

This study has important practical implications for promoting engagement of students in online learning environments.

Nurturing students' inner motivational resources
We demonstrated that perceived autonomy, perceived competence, and perceived relatedness had a significantly positive impact on student engagement. Consequently, more attention is needed to identify and capitalise students' inner motivational resources (Perlman & Webster, 2011). Personalised learning support services are essential for teachers to adaptively provide choices based on individual differences among students (Bandura, 2006), and to satisfy students' perceptions of autonomy, including personalisation of services such as interface design. Teachers also need to design challenging tasks for

students, because solving such tasks are conducive to improving students' perception of competence. Moreover, formative evaluation and interactive collaboration areas need to be established in online learning environments. By using peer review, and teacher-student mutual evaluation and interaction, students may reduce online loneliness and anxiety, and enhance their perception of relatedness (Cents-Boonstra et al., 2020).

Provide explanatory rationales areas for tasks or events
It is often difficult for teachers to design interesting teaching activities and meet the basic needs of learners in an online environment. As a result, learners often need to participate in potentially uninteresting activities. Even under these conditions, teachers need to provide a rationale to explain why the activity is truly worth the students' effort. This can support student autonomy (Vansteenkiste et al., 2018). From the perspective of the learner's personal goals, explaining the necessity of accomplishing the task helps students to complete the cognitive transformation from useless to meaningful, and internalises their motivation (Federici & Skaalvik, 2014).

Rely on informational, noncontrolling language
Autonomy-supportive teaching motivations were significantly positively related to student engagement. Hence, we recommend, when completing Q and A, evaluation, or giving other feedback to learners, teachers should encourage students to think independently, providing prompts, instead of telling them the solutions directly (Jang et al., 2010). To save time and energy, teachers could create motivational language templates conducive to student engagement in the online learning environment (Perlman & Webster, 2011), for example: "Your idea is good. You can make it better by ..." or "Your question is very meaningful. I recommend by thinking about it from a different angle you will gain more."

Conclusion

We used self-determination theory to explore the potential relationships among the factors associated with college students' engagement in online environment. As expected, autonomy-supportive teaching motivations and intrinsic motivation were the crucial factors promoting student engagement. We also confirmed that autonomy-supportive teaching motivations affected student engagement through perceived autonomy, perceived competence, and perceived relatedness. The influences of controlling teaching motivation and student extrinsic motivation on student engagement need to be confirmed in future research. This study has enriched the scholarly understanding of the student engagement of college students in the online learning environment. Students' perceptions of teaching motivations and their own intrinsic and extrinsic motivations are essential for further application of online teaching strategies. This study has made the following contributions. First, the provision of a validated instrument for measuring students' perceptions of teaching motivations, student intrinsic and extrinsic motivations, and student engagement in online learning environment. Second, this study extended the previous literature by integrating self-determination theory to explain how teaching motivations affect student engagement in online learning environments. Therefore, the findings have extended the knowledge of the positive relationship between autonomy-supportive teaching motivations and student engagement in online learning environments.

There are some limitations of this study. The first is in relation to convenience sampling. The whole sample was collected at a normal university in northern China, where female students outnumbered males. Therefore, the research results may have limited generalisability to other more diverse cohorts. In addition, data were only gathered from the end of the online course, so changes in online learning environment may not have bend reflected. In the future more longitudinal studies should be performed.

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Appendix A
Survey instrument

Item code	Item text
ASTMS1	Teacher gives me enough time to finish it.
ASTMS2	Teacher explains why it is important to study certain subjects in online environment.
ASTMS3	Teacher is willing to listen to students' complaints regarding her.
CTMS1	Sometimes I want to work on one topic, and teacher forces me to move to another topic.
CTMS2	Teacher is willing to listen only to opinions that fit her opinion.
CTMS3	Teacher forces me to prepare for uninteresting task.
PA1	I am free to express my ideas and opinions in online learning environment.
PA2	My feelings toward online learning environment are taken into consideration.
PA3	When I am in online learning environment, I have to do what I am told.
PC1	Most days I feel a sense of accomplishment from learning in online environment.
PC2	My teachers tell me I am good at using online learning environment.
PC3	I have been able to learn interesting new skills in online learning environment.
PR1	I feel loved and cared about.
PR2	I feel a lot of closeness and intimacy.
PR3	I often feel a lot of distance in our relationship.
ER1	That's what I'm supposed to do.
ER2	To prevent teachers (or others) from criticising/punishing me.
ER3	I receive some form of explicit compensation (e.g., credit, certificate).
IR1	I want the teacher to think I'm a good student.
IR2	I'll feel ashamed of myself if I don't.
IR3	I want the other students to think I'm smart.
SE1	I follow the rules of the online learning environment.
SE2	I complete my task on time.
SE3	I am interested in the work at the online learning environment.
SE4	When I read the course materials, I ask myself questions to make sure I understand what it is about.