Association between psychological need satisfaction and online self-regulated learning

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Abstract

The role that psychological need satisfaction and self-regulated learning play in academic online learning has been extensively researched. However, the impact of the three psychological needs, perceived autonomy, competence, and relatedness, on online self-regulated learning remains unclear. This investigated the association between the satisfaction of psychological needs and the six dimensions of online self-regulated learning. This cross-sectional study adopted a quantitative approach. In all, 315 students from four higher education institutions participated in the present study. Students were asked to complete the online questionnaire of psychological need satisfaction and an online self-regulated learning questionnaire. Structural equation modeling was performed to examine the structural relationships between the two. Our study showed that perceived autonomy predicted goal setting, environment structuring, time management, and self-evaluation but did not predict help-seeking and task strategies. Perceived competence did not predict environment structuring. Perceived relatedness predicted environment structuring, help-seeking, and self-evaluation. This study appears to be the first to examine the predictions of need satisfaction to increase students' capability in regulating their learning.

Keywords Perceive autonomy · Competence · Relatedness · Self-regulation · Online learning

Introduction

Over the course of the present century, a dramatic increase has been seen in the study of students' performance during online learning. Students' levels of motivation and the ways in which they regulate their learning may significantly influence students' success in academic performance, including in online learning. Self-determination theory (SDT) holds that students' academic performance is determined by their motivation (Deci & Ryan, 2008; Ryan & Deci, 2020). Those with good motivation will succeed in an academic

(Hidayatullah & Csíkos, 2023; Józsa et al., 2022; Welesilassie & Nikolov, 2022), including in the online learning context. At the same time, motivation in academic performance has been found to be the result of psychological needs consisting of perceived autonomy, competence, and relatedness (Akbari et al., 2015; Ryan & Deci, 2020). Satisfaction of these three psychological needs will bring students greater psychological well-being, motivation, and performance (Jeno et al., 2019; Luo et al., 2021). Accordingly, online learning that provides for these three psychological needs can motivate students, affect their involvement, and increase their achievement.

Adopting a different perspective, self-regulation learning theory (Zimmerman, 1990) suggests that self-regulated learning is a key factor in students' academic performance (in either online or offline learning). Self-regulated learning is a monitoring process involving goal orientation, environment structuring, time management, task strategies, help-seeking, and self-evaluation (Pintrich, 2000). Dignath and Veenman (2021) argued that self-regulated learners plan, monitor, and control their learning to achieve their goals by enacting metacognitive strategies that support these activities. Self-regulated learning has been observed in several

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empirical studies to play a critical role in promoting academic performance. For example, Rivers et al. (2022) noted that goal setting, planning, and help-seeking positively predict students' achievements. Their achievements were also determined by skills such as setting personal goals, planning a schedule, and help-seeking behavior in online learning. Similarly, Zhang et al. (2023) found that having the ability to self-regulate online learning, such as composing a suitable schedule and study environment, seeking necessary help, and receiving performance feedback from others; can significantly predict an individual competency in online learning. Thus, self-regulated learning skills play a critical role in academic success in online learning.

While the role that satisfaction of psychological needs (Seiver & Troja, 2014; Wei & Chou, 2020) and self-regulated learning (Cho & Heron, 2015; Vilkova, 2022) has been extensively studied in the context of academic online learning, the relationship between the two has received little attention rarely been studied. Several studies have addressed the relationship between SDT and self-regulated learning. For example, Bai and Gu (2022) showed that perceived autonomy significantly influences online self-regulated learning. Nonetheless, this study did not determine whether another aspect of psychological needs (perceived competence and perceived relatedness) predicts self-regulated learning. Xia et al. (2023) reported that the satisfaction of psychological needs acts as a predictor and mediator for self-regulated learning. However, these findings remain unclear as since the dimensions of self-regulated learning were not explored. It is rare to find empirical evidence for the association between perceived autonomy, competence, relatedness, and online self-regulated learning, in particular in self-regulated learning, which, as suggested by Pintrich (2000), consisted of six dimensions (goal setting, environment structuring, task strategies, time management, help-seeking, and self-evaluation). We assumed that where students' psychological needs are more satisfied, they have increased motivation (Ryan & Deci, 2000, 2020) to perform self-regulation in online learning. To fill this existing, this study contributes to understanding the relationship between the two constructs in the context of online learning.

Theoretical framework

Psychological need satisfaction in online learning

What we know about psychological needs is largely based upon the theoretical framework of SDT, which holds that intrinsic and extrinsic human motivation comes from human psychological needs. Intrinsic motivation refers to the need to acquire skills or abilities and the enjoyment of learning. Extrinsic motivation leads to the achievement of goals outside of the learning process (G. Józsa et al., 2022). According to SDT, people are intrinsically motivated when they are satisfied with their psychological needs for autonomy, competence, and relatedness (Ryan & Deci, 2020). By contrast, those who experience the need for autonomy, competence, and relatedness run a greater risk of maladaptive behavior (Schuitema et al., 2016; Standage et al., 2005). That is, the satisfaction of psychological needs matters for academic learning.

Perceived autonomy refers to the individual sense of initiative and ownership of one's own activity (Ryan & Deci, 2020). When students perceive more autonomy in their classes, they will better organize and regulate their personal goals (Schuitema et al., 2016), including task, management, evaluation of their studies, and independently solving their problems. People with perceived competence believe that they know what they are doing, can complete their tasks, and possess the knowledge and necessary skills to succeed (Xia et al., 2022). Then, perceived relatedness refers to the individual perception of connecting with others in a social context (Akbari et al., 2015; Deci et al., 1991). It is experienced through feeling connected within supportive or close relationships (Durksen et al., 2016). These are basic human needs and have a critical role in shaping individual performance, motivation, and achievement. Individual performance, motivation, and development in social life can be maximized if the environment provides individuals with their psychological needs for autonomy, competence, and relatedness (Deci et al., 1991).

Most students and educators are familiar with the integration of digital technology in the classroom (Danesi, 2016). Higher education institutions have become more familiar with integrating digital technology in support of academic learning, such as blended learning pedagogy, which mixes face-to-face instruction with online learning (Waterhouse et al., 2022). Numerous studies have shown that academic achievement is closely associated with the satisfaction of psychological needs. Luo et al. (2021) reported that students' achievement of intrinsic motivation in online learning is associated with these three basic needs. In addition, the achievement of extrinsic motivation is only associated with perceived competence and relatedness. In the same vein, Akbari et al.(2015) reported that students perceive themselves to be more autonomous, have greater relatedness, and exhibit more competence in an online learning context than in face-to-face learning. Thus, students' achievement of motivation in online learning is higher than their achievement motivation in offline learning. It was also suggested that these psychological needs influence learning outcomes (Akbari et al., 2015). Similarly, Jeno et al. (2019) indicated that the level of perceived autonomy and perceived competence produce greater achievement in digital learning. Nevertheless, satisfying needs often remains a challenge during

online learning, in particular for perceived relatedness and perceived competence. Little work has addressed perceived competence and perceived relatedness matter in the online learning context. A more comprehensive investigation of the satisfaction of psychological needs in online learning is imperative.

Online self-regulation learning

Self-regulation theory is founded on the idea that the control and regulation of learning to achieve certain goals rest with the learner (Dignath & Veenman, 2021). Self-regulated learning falls under the umbrella of metacognition theory, which emphasizes knowledge about and regulation of one's own cognitive activities and learning process (Veenman et al., 2006). Csíkos (2022) suggested that metacognitive knowledge consists of declarative and procedural knowledge. Declarative metaknowledge refers to beliefs or factual knowledge about one's own knowledge, while metacognitive procedural knowledge enables controlling and regulating processes (Csíkos, 2022). Self-regulated learning is a process of monitoring, managing, and regulating one's own learning behavior and metacognitive functions to achieve personal goals (Rahimi & Cheraghi, 2022; Schuitema et al., 2016; Wang et al., 2013; Zimmerman, 1990; Zimmerman & Kitsantas, 2014). A self-regulated learner should adopt enactive metacognition strategies to conduct their self-regulated learning, including controlling, monitoring, and evaluating learning strategies (Dignath & Veenman, 2021; Luo et al., 2021). Thus, self-regulated learning represents personal matters through motives and skills self-regulations (Józsa & Molnár, 2013).

A construct for self-regulated learning was articulated by Zimmerman (1990), who suggested that it contained personal goal orientation, planning, self-monitoring, and self-evaluation. Pintrich (2000) proposed six theoretical frameworks for self-regulated learning: goal orientation, environment structuring, time management, task strategies, help-seeking, and self-evaluation. The scale that is commonly used to measure self-regulated learning is the Motivated Strategies for Learning Questionnaire (MSLQ), developed by Pintrich (Pintrich, 2015). However, this questionnaire was not developed specifically for online learning and may not be the most appropriate for use in this area.

Online learning is different from offline learning. To begin with, students and teachers are not physically present in a shared classroom. Students are more responsible for their own learning, such as in structuring their environment and managing their time (Wang et al., 2013). Therefore, if self-regulated learning is important for offline learning, self-regulated learning likely plays a more important role in promoting academic performance in online learning (Barnard et al., 2009). Barnard et al. (2009) developed the online

self-regulated learning questionnaire (OSLQ) to measure self-regulation in online learning and in the e-learning context. The questionnaire adopted an earlier theoretical framework (Pintrich, 2000), consisting of six dimensions: goal setting, environmental structuring, task strategies, time management, help-seeking behavior, and self-evaluation. Goal orientation refers to students' ability to set their own learning goals to determine what approach should be used to reach these goals (Lu & Wang, 2022; Wilson et al., 2022). Environmental structuring refers to students' choices and restructuring of their environment to support their learning. Task strategies are students' strategies of selecting the essential parts of their tasks (Barnard et al., 2008). Time management deals with students' ability to schedule and manage their time effectively in an online learning framework. Help-seeking relates to students' strategy to solve their problem or difficulties through asking other students or their teacher. Self-evaluation refers to students' strategies for reflecting on their performance based on the effort they previously made to succeed at the next learning occasion, which includes self-monitoring during online learning (Lu & Wang, 2022; Raković et al., 2022; Yu et al., 2022). Our study applied these six dimensions of online self-regulation to measure students' ability to regulate their personal online learning.

Role of psychological need satisfaction in online self-regulated learning

SDT (Ryan & Deci, 2000) argues that the level of academic performance results from individual motivation, which comes from the psychological need for satisfaction. Thus, the extent to which students are involved in self-regulated learning in an online learning context is associated with the satisfaction of psychological needs. Numerous studies (Ryan & Deci, 2000; Schuitema et al., 2016) have explored the link between the two in the context of online learning. For example, Schuitema et al. (2016) noted that the more autonomy that students feel that they have, the more they tend to be strategic in planning and monitoring of their comprehension. Where their autonomy is supported by the instructor, students can organize their own comprehension, such as through their self-monitoring and structuring strategies. In this vein, Bai and Gu (2022) suggested that the level of perceived autonomy influences students' online self-regulated learning. Overall, there is some evidence that indicates that the need for the satisfaction of psychological needs in SDT matters in online self-regulated learning. However, most previous work has investigated the effects of perceived autonomy on a general self-regulated learning construct, but the effects of perceived competence and perceived relatedness on self-regulated learning are neglected. The effects on and the mediation of the satisfaction of three psychological needs for general self-regulated learning have been confirmed (Xia

et al., 2023). However, less is known concerning the inter-relationship between the psychological needs simultaneously in the context of online self-regulated learning, particularly in terms of online self-regulated learning, as suggested by Barnard et al. (2009) and Pintrich (2000), which contains six aspects: goal setting, environment structuring, task strategies, time management, help-seeking, and self-evaluation. Through investigation of the relationship between three psychological needs and six dimensions of online self-regulated learning, this study addresses gaps in the previous study.

Research questions

As noted, the satisfaction of psychological needs is an important consideration for student strategies in regulating online learning. It is less known, however, whether the three dimensions of need satisfaction (perceived autonomy, competence, and relatedness) positively predict online self-regulated learning (goal setting, environment structuring, task strategies, time management, help-seeking, and self-evaluation). The questions we pose below will guide this investigation.

1. How far does students' perceived autonomy predict their online self-regulated learning?
2. How far does students' perceived competence predict their online self-regulated learning?
3. How far does students' perceived relatedness predict their online self-regulated learning?

Methods

Participant

This study had a cross-sectional study approach. We recruited 315 college students from four higher education institution in Indonesia. All participants in this study were fully participating in online learning. The participants' background varied, with 9.2% studying in the faculty of law, 50.8% in the faculty of education, 16.2% in the faculty of health, 20.6% in the faculty of economics and business, and 3.2% in faculty of engineering. The participants were asked to complete a questionnaire colleting socio-demographic information and with 39 questionnaire items.

Procedures

This study received ethical approval. The researcher translated the instruments into Indonesian. Following this, the researcher opened communication with researchers in higher education in Indonesia. Then, the questionnaires were disseminated and administered using an online platform.

Random snowball sampling methods were used to gather the data. Participation in the present study was voluntary. The participants were invited through the WhatsApp application. The participants were informed that their data would be kept confidential before they began to respond to the questionnaire.

Instruments

This investigation focused on the association between psychological needs and SRL in online learning. We adopted a questionnaire to measure how students perceived the satisfaction of their basic psychological needs and SRL during online learning. There were 39 items across the two scales (15 for psychological needs and 24 for OSLQ). The questionnaires were administered using a 5-point Likert scale (1 = strongly disagree and 5 = strongly agree).

Psychological need satisfaction

The 15 items on psychological needs, were adapted from a needs satisfaction questionnaire to measure students' need satisfaction in the online learning context (Standage et al., 2005). This questionnaire featured three dimensions: perceived autonomy, competence, and relatedness. *Perceived autonomy* was measured in five items ($\alpha = 0.80$), for instance, "In the online class, I can decide which activities I want to practice" and "In my online class, I have to force myself to do the activities." The reliability of this instrument was .80. *Perceived competence* contained five items ($\alpha = 0.87$), for example, "I think my performance is pretty good during my online learning" and "I am satisfied with my performance during online learning." *Perceived relatedness* consisted of five items ($\alpha = 0.87$), for instance, "With the other students in during online class, I feel supported" and "With the other students in during online class, I feel understood."

Self-regulation online learning

Our study measured students' approach to regulating their strategies during online learning: 24 items of self-regulated learning were adapted from OSLQ. This scale was developed by Barnard et al. (2009) to measure students' self-regulated learning in both online learning and e-learning. This scale featured six dimensions "*goal setting, environment structuring, task strategies, time management, help-seeking,* and *self-evaluation.*" We found the fit model of this questionnaire for Indonesian context: chi-square (246) = 680.57, p < 0.05, comparative fit index (CFI) = 0.95, Tucker–Lewis index (TLI) = 0.93, root mean squared error of approximation (RMSEA) = 0.06. *Goal setting* was measured by four items ($\alpha = 0.95$), for example, "I set standards for my

assignments in online courses" and "I set short-term goals as well as long-term goals." *Environment structuring* included four items ($\alpha = 0.92$), for example, "I choose the location where I study to avoid too much distraction" and "I find a comfortable place to study." *Task strategies* contained four items ($\alpha = 0.93$), such as "I prepare my questions before joining online class" and "I work extra problems in my online courses." *Time management* included three items ($\alpha = 0.87$), for example, "I allocate my time for online courses because I know it" and "I try to schedule my time regularly in the online class." *Help-seeking* included four items ($\alpha = 0.96$), for example, "I find somebody who can help me if I need help for my online learning" and "I share my problems with my classmates online." *Self-evaluation* contained four items ($\alpha = 0.94$), for example, "I ask myself questions about the material during online class" and "I communicate with my classmate to evaluate my activity during an online class."

Data analysis

All of the data in this study were analyzed using SPSS 25 and *MPlus* 8. Our study had several steps. First, confirmatory factor analysis was performed to identify the construct validity of the questionnaire. The Maximum Likelihood Estimation parameter estimate was applied to provide unbiased estimates (Schafer & Graham, 2002). Chi-square, CFI, TLI, the RMSEA, and standardized root mean square residual (SRMR) were examined to check the fit model. RMSEA should range between .05 to.08 for an acceptable fit (Hooper et al., 2008; Hu & Bentler, 1999; MacCallum et al., 1996). Convergent validity and discriminant validity were also examined. Convergent validity was evaluated based on the average variance extracted (AVE) coefficient value, which should be higher than 0.5. Discriminant validity refers to cross-loadings. Outer loading should be higher than the correlation between variables (Hair et al., 2019a, 2019b). Cronbach's alpha and composite reliability (CR) were also

calculated to examine the internal reliability of each item. Second, descriptive statistics and Pearson correlation were used to describe the data and correlations among the latent variables. Third, the normality distribution of the data was evaluated using skewness and kurtosis. Kline (2005) suggested a cutoff value ± 3 for skewness and ± 10 for kurtosis indicate that the distribution is not severely non-normal. As seen in Table 1, the skewness value ranged between -0.07 and -1.01, and the kurtosis range between .39 and 1.888. Because the data meet the criteria for skewness and kurtosis, our data may not be severely non-normal. Finally, the full structural equation modeling was performed to explain the model fit model and the dimensions of each need dimension and the online self-regulated learning dimensions.

Results

Confirming the validity of instruments

CFA were performed to confirm the construct validity of the psychological need satisfaction questionnaire and online self-regulated learning for the Indonesian context. First, the physiological needs instruments contained three latent variables: perceived competency, relatedness, and autonomy. We found the fit model of this construct in the Indonesian version, as follows: chi-square $= 165.79$, $df = 60$, $p < 0.001$, CFI $= 0.97$, TLI $= 0.96$, RMSEA $= 0.07$, SRMR $= 0.05$. However, we deleted three items (two items on perceived autonomy and one on perceived competence) because their factors loadings were below .40. The factors loading for the other items ranged from .68–0.88. Cronbach's alpha was computed for the internal consistency of each latent variable. The results showed that competence, relatedness, and autonomy were reliable. For these factors, the alpha coefficients were .89, 0.91, and 0.83, respectively (see Table 1).

Table 1 Descriptive statistics and reliability

Variables	Mean	SD	Skewness	Kurtosis	alpha	CR	AVE
Perceived autonomy	3.69	0.72	-0.18	0.39	0.89	0.87	0.75
Perceived competence	3.45	0.71	0.13	0.72	0.91	0.91	0.71
Perceived relatedness	3.64	0.85	-0.56	0.79	0.83	0.95	0.75
Goal setting	3.69	0.73	-0.54	1.18	0.84	0.84	0.58
Environment structuring	3.99	0.75	-1.01	1.88	0.83	0.84	0.56
Task strategies	3.44	0.72	-0.07	0.57	0.73	0.75	0.47
Time management	3.60	0.73	-0.17	0.55	0.82	0.82	0.60
Help-seeking	3.78	0.88	-0.54	0.76	0.75	0.75	58
Self-evaluation	3.65	0.71	-0.22	0.84	0.82	0.82	0.56

The highest mean was environmental structuring (M = 3.99, SD = 0.75), followed by help-seeking (M = 3.78, SD = 0.88). The lowest mean was task strategies (M = 3.44, SD = 0.72). CR = composite reliability, AVE = average variance extracted

Our study confirmed the construct validity of OSLQ. This instrument contained six latent variables: goal setting, environment structuring, task strategies, time management, help-seeking, and self-evaluation. We deleted one item from goal setting, two from help-seeking, and one from task strategy due to the loading factor issue. We found the fit model for OSLQ: chi-square = 379.81, $df = 153$, $p < 0.001$, CFI = 0.93, TLI = 0.92, RMSEA = 0.06, SRMR = 0.04. All of the items had good loading factors, ranging from .64 to .85. The Cronbach's alpha values (see Table 1) also indicated that all of the scales in this instrument were reliable: goal setting ($\alpha = 0.84$), environment structuring ($\alpha = 0.83$), task strategies ($\alpha = 0.73$), time management ($\alpha = 0.82$), help-seeking ($\alpha = 0.75$), and self-evaluation ($\alpha = 0.82$).

We also evaluated the internal reliabilities of our instrument by computing their CR. The data indicated CRs ranging between .75 and .95 (see Table 1). For convergent validity, the data indicated that the coefficient value AVE for each variable was greater than .50 (see Table 1). We evaluated the discriminant validity using the Fornell Larcker criterion, which suggests that the correlation between factors should not be higher than the root of the AVE (Hair et al., 2019a, 2019b). The value of the coefficient for the square root of AVE was also higher than the correlation for each variable (see Table 2). Therefore, the construct of the instruments in the present study was valid.

The data showed that all psychological needs (competence, relatedness, and autonomy) were positively correlated with the online self-regulated learning dimensions (see Table 2). Time management and peer self-evaluation had the highest correlations ($r = 0.67$, $p < 0.001$). Thus, the greater the perceived autonomy, the more strategies that students used to organize their learning schedules during online learning. The lowest correlations are shown in the peer of perceived relatedness and task strategies ($r = 0.41$, $p < 0.001$).

SEM analysis

Covariance-based SEM analysis (CB-SEM) was performed to analyze the relationship between psychological need satisfaction and online self-regulated learning. The hypothesis model showed a good fit (chi-square = 970.19, $df = 428$, $p < 0.001$, CFI = 0.93, TLI = 0.91, RMSEA = 0.06, SRMR = 0.05). The data (Fig. 1) indicate that goal setting, environment structuring, task strategies, time management, help-seeking, and self-evaluation could be explained by psychological need satisfactions. The total variance was 49% ($R^2 = 0.49$), 36% ($R^2 = 0.36$), 56% ($R^2 = 0.56$), 59% ($R^2 = 0.59$), 53% ($R^2 = 0.53$), and 59% ($R^2 = 0.59$), respectively. However, the weight of path regression varied for the association between the variables of physiological need satisfaction and online self-regulated learning.

Perceived autonomy was positively associated with goal setting ($\beta = 0.43$, $p < 0.001$), environmental structuring ($\beta = 0.38$, $p < 0.001$), time management ($\beta = 0.32$, $p < 0.001$), and self-evaluation ($\beta = 0.21$, $p < 0.001$). However, the association between perceived autonomy and task strategies ($\beta = 0.13$, $p = 0.08$) and help-seeking ($\beta = 0.07$, $p = 0.32$) was not significant. Perceived competence was positively associated with goal setting ($\beta = 0.27$, $p < 0.001$), task strategies ($\beta = 0.61$, $p < 0.001$), time management ($\beta = 0.45$, $p < 0.001$), help-seeking ($\beta = 0.35$, $p < 0.001$), and self-evaluation ($\beta = 0.42$, $p < 0.001$). The direct association between perceived competence and environment structuring ($\beta = 0.10$, $p = 0.21$) was insignificant. Perceived relatedness was positively associated with environment structuring ($\beta = 0.22$, $p < 0.001$), help-seeking ($\beta = 0.43$, $p < 0.001$), and self-evaluation ($\beta = 0.28$, $p < 0.001$). Goal setting ($\beta = 0.10$, $p = 0.11$), task strategies ($\beta = 0.08$, $p = 0.25$), and time management ($\beta = 0.11$, $p = 0.50$) did not have perceived relatedness.

Table 2 Discriminant validity for the measurement model

Variables	AU	CM	RT	GS	ES	TS	TM	HS	SE
AU	**(0.87)**								
CM	0.65**	**(0.84)**							
RT	0.50**	0.52**	**(0.87)**						
GS	0.60**	0.52**	0.45**	**(0.76)**					
ES	0.51**	0.39**	0.43**	0.54**	**(0.75)**				
TS	0.50**	0.60**	0.41**	0.58**	0.47**	**(0.69)**			
TM	0.64**	0.63**	0.48**	0.63**	0.57**	0.68**	**(0.77)**		
HS	0.45**	0.54**	0.57**	0.48**	0.47**	0.55**	0.57**	**(0.76)**	
SE	0.58**	0.61**	0.57**	0.62**	0.57**	0.64**	0.67**	0.71**	**(0.92)**

*p < 0.05, **p < 0.001

AU perceived autonomy, *CM* perceived competence, *RT* perceived relatedness, *GS* goal setting, *ES* environment structuring, *TS* task strategies, *TM* time management, *HS* help-seeking, and *SE* self-evaluation. The diagonal elements in bold are the square roots of the average variance extracted values, the off-diagonal correlations are between variable constructs

Fig. 1 Standardized structural relationship of the three psychological need satisfaction and online self-regulated learning. *CM* perceived competence, *RT* perceived relatedness, *AU* perceived autonomy, *GS* goal setting, *ES* environment structuring, *TS* task strategies, *TM* time management, *HS* help-seeking, *SE* self-evaluation
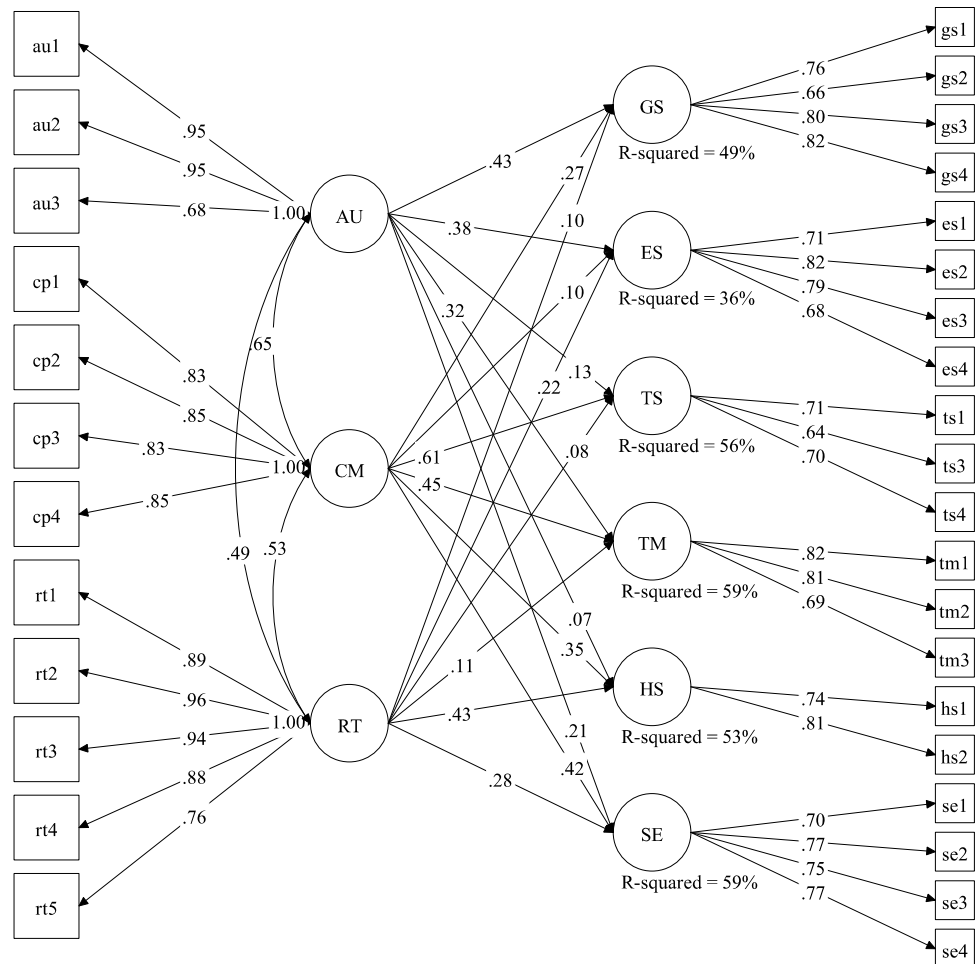
Discussion

This study examined the predictive power of the satisfaction of three psychological needs (perceived autonomy, competence, and relatedness) for online self-regulated learning in higher education. According to the SDT, these psychological needs are the factor behind students' self-regulation motivation (Deci & Ryan, 2008; Deci et al., 1991; Zimmerman, 1990). This finding confirmed that the satisfaction of psychological needs was positively associated with online self-regulated learning. However, the weight of path regression for satisfaction of the three psychological needs on online self-regulated learning dimensions varied.

The findings of this study indicated that perceived autonomy is positively associated with online self-regulated learning but not with help-seeking and task strategies. This finding is in line with those of Hsu et al. (2019) and Schuitema et al. (2016), who found that perceived autonomy predicted the personal capability to regulate and choose strategies in online learning. SDT (Deci et al., 1991) argues that environments with support autonomy encourage the motivation to retain natural curiosity and develop autonomous forms of self-regulation. Thus, for online learning, students could feel greater autonomy, greater motivation to set personal goals, manage their study schedules, restructure their study place to be most comfortable, and evaluate their own achievements. In the context of SDT, perceived autonomy does not refer to being independent or selfish but rather to having volition that can accompany any act, whether independent or dependent, individual or collective (Ryan & Deci, 2000). Thus, once students perceived sufficient autonomy in online learning, they began to be more strategic in setting their personal study goals. The findings of this study confirm the argument by Deci et al. (1991), who stated that perceived autonomy is the stronger factor for determining students' outcomes, such as academic emotions, motivation, and cognition. Our study found that perceived autonomy had its strongest association with goal setting and environment structuring but did not have a strong relationship with other SRL dimensions. Surprisingly, perceived autonomy was not associated with help-seeking and task strategies in the present study. A possible reason for this is that in online learning, as students feel more autonomous, they seek out their own solutions using internet sources. which they prefer to asking their peers

or their teachers. Another possible interpretation found in the existence of correlations between among three physical needs that might control each other. While perceived autonomy was nonsignificant for help-seeking and task strategies, this need was significant for other SRL dimensions. The implication for teaching practice, relates to the importance for teachers of establishing a climate study that providing autonomy support for students. With support for autonomy, students would be more strategic in terms of their goal setting, environment structuring, time management, and self-evaluation in online learning.

Our findings also showed that perceived competence was positively related to goal setting, task strategies, help-seeking, time management, and self-evaluation in online learning. This is consistent with prior research (Akbari et al., 2015; Jeno et al., 2019) that found that psychological needs play a critical role in academic performance, including engagement in SRL (Xia et al., 2023). According to SDT, perceived competence encompasses understanding how to achieve internal and external outcomes and performing the requisite actions efficaciously (Deci et al., 1991). Thus, when students come to understand that they are capable and competent, they become more confident (Travis & Bunde, 2022) in their choices of the best strategies for solving their tasks, monitoring their own performance and achievements, and communicating with others to address their difficulties. Our study found that the greater the competence, the more the sophistication in setting goals, solving problems, and seeking help from others. In addition, the feeling of greater competence was associated with engagement in managing one's time and engagement in evaluating one's own performance. Nevertheless, this study found that perceived competence was nonsignificant in relation to how students structure their environment in online learning. That is, in terms of online learning, the way that students structured their environment was not affected by their perceived competence but was by their perceived autonomy. Teachers should, in practical environments, support competence. If their competence is supported, students will be more strategic in their goal setting, task strategies, help-seeking, time management, and self-evaluation.

This study revealed that perceived relatedness is positively associated with environment structuring, help-seeking, and self-evaluation in online learning. Previous studies (Akbari et al., 2015; Schuitema et al., 2016) have found that the feeling of relatedness determines individual strategies to manage their study and influence their academic performance. The findings of this study indicate that as students felt more connected with their peers during online learning, this droves their motivation to address their difficulties by querying their peers or other people. This can be interpreted by the observation that students' success in online learning was predicted by their interactions with others (Palmer

et al., 2008). Thus, when students considered themselves more connected with their classmates, this increased their motivation to seek help from their friends or their teachers, find a more comfortable place, or evaluate their performance by asking others about their performance. At the same time, perceived relatedness is not associated with goal setting, task strategies, and time management. The results of this study are consistent with Xia et al. (2023), who suggested that the direct effect of perceived relatedness on self-regulated learning was nonsignificant. One possible explanation for this is that goal setting and time management are more closely associated with perceived autonomy and perceived competence. By comparison, task strategies are more closely associated with perceived competence than perceived relatedness.

Thus, our study found that supporting the satisfaction of students' psychological needs is important for encouraging students' online self-regulated learning. However, the weight of the path coefficient for each need satisfaction on the online self-regulated learning varied and complemented each other. For instance, perceived autonomy is not associated with help-seeking or task strategies. Instead, help-seeking and task strategies must be found as the result of perceiving competence. At the same time, perceived relatedness was only associated with help-seeking behavior, environmental structuring, and self-evaluation but not with goal setting and time management. This means that needs satisfaction should be provided by educators simultaneously to promote students' online self-regulated learning.

Conclusion and implication

Our findings in this study shed light on the unpacking of the relationship between students' satisfaction of their psychological needs based on SDT and self-regulation in online learning. The finding of this confirms the SDT that online self-regulation was the result of students' motivation during online learning. When students perceived that they were more autonomous, competent, and related, it increased their motivation to perform self-regulated learning. However, feeling less autonomous, competent, and related provoked a greater risk of failure of self-regulation during online learning.

The findings of this study provide theoretical contributions. They enrich the literature on the association between the satisfaction of psychological needs and online self-regulated learning, which has been little explored but should receive wider empirical study. Our findings may encourage researchers to re-investigate and test their theories by investigating the interrelationship between basic psychological needs and self-regulation in online learning.

The findings of this study can inform academic practice. This study informs us that online self-regulated learning is the result of psychological need satisfaction, it is important for the teacher to provide psychological need satisfaction. As part of a strategy to increase students' perceived autonomy, teachers can encourage them to express their feelings on their classes and clarify the objectives and expectations of the lessons. Teachers should also demonstrate openness and attentiveness to students' needs. Using self-reporting, students can take greater ownership of their own learning and set personal goals, manage their time, choose their preferred study locations, and assess their own progress. Teachers can guide students in the effective use of this strategy for online courses. This approach helps promote greater independence, and, in turn, it will produce more strategic online learning.

While our study found that perceived competence did not have a significant impact on environmental structuring, it is still important for promoting goal setting, task strategies, time management, help-seeking, and self-evaluation. Thus, teachers should encourage increased competence in online learning by showing that they believe in their students' abilities, even if the students make mistakes. Teachers should also acknowledge their students' feelings and allow them to direct their own learning. This approach will encourage students to feel more competent and autonomous rather than feeling pressured due to evaluation, threats, or deadlines that reduced their sense of competence.

Our study found that perceived relatedness is positively linked to environment structuring, help-seeking, and self-evaluation. Thus, it is crucial for teachers to incorporate group work that fosters peer support into their lessons, which can help students to have a deeper connection with their classmates. As students come to feel more connected to each other, they become more motivated to evaluate their own progress and seek help from others in challenging times. Our study found a positive link between perceived relatedness and environmental structuring, help-seeking, and self-evaluation. It is therefore crucial for teachers to incorporate group work that fosters peer support and can help students become more connected to their classmates. As students come to feel more connected to each other, they become more motivated to evaluate their own progress and seek help from others when they are challenged. An emphasis on group working as a process rather than a scored element in online learning can promote students' feeling of relatedness. As a result, if psychological needs are provided appropriately provided for, this will boost students' capability to produce online self-regulated learning.

Limitations and future research

Although our study provides a wealth of information on the association between the satisfaction of the three physical needs and the six dimensions of online self-regulated learning, some limitations should be kept in mind for future research. Our study measured the correlation between variables in the online learning context but did not investigate whether both variables could predict academic achievement in terms of the achievement of emotions, cognition, and behavior. Future research should investigate the contribution that needs satisfaction and self-regulation make to academic performance, including satisfaction and engagement. Second, this study only measured the relationship between the two in the online learning context. Future research and investigation should compare whether the findings of this study are consistent with findings in a face-to-face learning context. Third, this study is based on a cross-sectional study. A longitudinal study should be undertaken to confirm the causal relationship between the two. Fourth, the sample in the present study was made up of students in the higher education context. Future investigations conducted in elementary or secondary school would provide a more comprehensive understanding of the role of needs satisfaction for self-regulated learning and academic performance.

Data availability Not applicable. Code availability Applicable.

Declarations

Conflict of interest The author(s) have stated no potential conflict of interest.

References

Akbari, E., Pilot, A., & Robert-Jan Simons, P. (2015). Autonomy, competence, and relatedness in foreign language learning through Facebook. *Computers in Human Behavior, 48*, 126–134. https://doi.org/10.1016/j.chb.2015.01.036

Bai, X., & Gu, X. (2022). Effect of teacher autonomy support on the online self-regulated learning of students during COVID-19 in China: The chain mediating effect of parental autonomy support and students' self-efficacy. *Journal of Computer Assisted Learning, 38*(4), 1173–1184. https://doi.org/10.1111/jcal.12676

Barnard, L., Lan, W. Y., To, Y. M., Paton, V. O., & Lai, S. L. (2009). Measuring self-regulation in online and blended learning environments. *Internet and Higher Education, 12*(1), 1–6. https://doi.org/10.1016/j.iheduc.2008.10.005

Barnard, L., Paton, V., & Lan, W. (2008). Mediator in the relationship between online course perceptions with achievement. *International Review of Research in Open and Distance Learning, 9*(2), 1–11. https://doi.org/10.19173/irrodl.v9i2.516

Chiu, T. K. F. (2022). Applying the self-determination theory (SDT) to explain student engagement in online learning during the COVID-19 pandemic. *Journal of Research on Technology in Education, 54*(S1), S14–S30. https://doi.org/10.1080/15391523.2021.1891998

Cho, M. H., & Heron, M. L. (2015). Self-regulated learning: The role of motivation, emotion, and use of learning strategies in students' learning experiences in a self-paced online mathematics course. *Distance Education, 36*(1), 80–99. https://doi.org/10.1080/01587919.2015.1019963

Csíkos, C. (2022). Metacognitive and non-metacognitive processes in arithmetic performance: Can there be more than one meta-level? *Journal of Intelligence*. https://doi.org/10.3390/jintelligence10030053

Danesi, M. (2016). *Learning and teaching mathematics in the global village : Math education in the digital age*. Springer International Publishing.

Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology, 49*(3), 182–185. https://doi.org/10.1037/a0012801

Deci, E. L., Ryan, R. M., Vallerand, R. J., & Pelletier, L. G. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist, 26*(3–4), 325–346. https://doi.org/10.1080/00461520.1991.9653137

Dignath, C., & Veenman, M. V. J. (2021). The role of direct strategy instruction and indirect activation of self-regulated learning—Evidence from classroom observation studies. *Educational Psychology Review, 33*(2), 489–533. https://doi.org/10.1007/s10648-020-09534-0

Durksen, T. L., Chu, M. W., Ahmad, Z. F., Radil, A. I., & Daniels, L. M. (2016). Motivation in a MOOC: A probabilistic analysis of online learners' basic psychological needs. *Social Psychology of Education, 19*(2), 241–260. https://doi.org/10.1007/s11218-015-9331-9

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (2019). *Multivariate data analysis, multivariate data analysis* (Vol. 87, Issue 4). Cengage Learning, EMEA.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM abstract. *European Business Review, 3*(1), 3–24. https://doi.org/10.1108/EBR-11-2018-0203

Hidayatullah, A., & Csíkos, C. (2023). The role of students' beliefs, parents' educational level, and the mediating role of attitude and motivation in students' mathematics achievement. *The Asia-Pacific Education Researcher*. https://doi.org/10.1007/s40299-023-00724-2

Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods, 6*(1), 53–60.

Hsu, H. C. K., Wang, C. V., & Levesque-Bristol, C. (2019). Reexamining the impact of self-determination theory on learning outcomes in the online learning environment. *Education and Information Technologies, 24*(3), 2159–2174. https://doi.org/10.1007/s10639-019-09863-w

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Jeno, L. M., Vandvik, V., Eliassen, S., & Grytnes, J. A. (2019). Testing the novelty effect of an m-learning tool on internalization and achievement: A Self-determination theory approach. *Computers and Education, 128*, 398–413. https://doi.org/10.1016/j.compedu.2018.10.008

Józsa, G., Zaw Oo, T., Amukune, S., & Józsa, K. (2022). Predictors of the intention of learning in higher education: Motivation, self-handicapping, executive function, parents' education, and school achievement. *Education Science*. https://doi.org/10.3390/educsci12120906

Józsa, K., & Molnár, É. D. (2013). The relationship between mastery motivation, self-regulated learning, and school success: A Hungarian and wider European perspective. In K. C. Barrett, N. A. Fox, G. A. Morgan, D. J. Fidler, & L. A. Daunhauer (Eds.), *Handbook of Self-Regulatory Processes in Development: New Directions and International Perspectives* (Issue April 2016, pp. 265–304). Taylor & Francis. https://doi.org/10.4324/9780203080719-24

Kline, R. B. (2005). *Principles and practice of structural equation modeling*. The Guilford Press.

Lu, H., & Wang, Y. (2022). The effects of different interventions on self-regulated learning of pre-service teachers in a blended academic course. *Computers and Education, 180*, 104444. https://doi.org/10.1016/j.compedu.2022.104444

Luo, Y., Lin, J., & Yang, Y. (2021). Students' motivation and continued intention with online self-regulated learning: A self-determination theory perspective. *Zeitschrift fur Erziehungswissenschaft, 24*(6), 1379–1399. https://doi.org/10.1007/s11618-021-01042-3

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods, 1*(2), 130–149. https://doi.org/10.1037/1082-989X.1.2.130

Palmer, S., Holt, D., & Bray, S. (2008). Does the discussion help? the impact of a formally assessed online discussion on final student results. *British Journal of Educational Technology, 39*(5), 847–858. https://doi.org/10.1111/j.1467-8535.2007.00780.x

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In *Handbook of Self-Regulation* (pp. 451–502.). https://doi.org/10.1016/b978-012109890-2/50043-3

Pintrich, P. R. (2015). Motivated strategies for learning questionnaire (MSLQ). *Mediterranean Journal of Social Sciences, 6*(1), 156–164. https://doi.org/10.13140/RG.2.1.2547.6968

Rahimi, A. R., & Cheraghi, Z. (2022). Unifying EFL learners' online self-regulation and online motivational self-system in MOOCs: A structural equation modeling approach. *Journal of Computers in Education*. https://doi.org/10.1007/s40692-022-00245-9

Raković, M., Bernacki, M. L., Greene, J. A., Plumley, R. D., Hogan, K. A., Gates, K. M., & Panter, A. T. (2022). Examining the critical role of evaluation and adaptation in self-regulated learning. *Contemporary Educational Psychology*. https://doi.org/10.1016/j.cedpsych.2021.102027

Rivers, D. J., Nakamura, M., & Vallance, M. (2022). Online self-regulated learning and achievement in the era of change. *Journal of Educational Computing Research, 60*(1), 104–131. https://doi.org/10.1177/07356331211025108

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*. https://doi.org/10.1016/j.cedpsych.2020.101860

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods, 7*(2), 147–177. https://doi.org/10.1037/1082-989X.7.2.147

Schuitema, J., Peetsma, T., & van der Veen, I. (2016). Longitudinal relations between perceived autonomy and social support from teachers and students' self-regulated learning and achievement. *Learning and Individual Differences, 49*, 32–45. https://doi.org/10.1016/j.lindif.2016.05.006

Seiver, J. G., & Troja, A. (2014). Satisfaction and success in online learning as a function of the needs for affiliation, autonomy, and mastery. *Distance Education, 35*(1), 90–105. https://doi.org/10.1080/01587919.2014.891427

Standage, M., Duda, J. L., & Ntoumanis, N. (2005). A test of self-determination theory in school physical education. *British Journal of Educational Psychology, 75*(3), 411–433. https://doi.org/10.1348/000709904X22359

Travis, J., & Bunde, J. (2022). Self-regulation in college: The influence of self-efficacy, need satisfaction, and stress on GPA, persistence, and satisfaction. *Current Psychology, 41*(9), 6185–6195. https://doi.org/10.1007/s12144-020-01091-7

Veenman, M. V. J., Van Hout-Wolters, B. H. A. M., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning, 1*(1), 3–14. https://doi.org/10.1007/s11409-006-6893-0

Vilkova, K. (2022). The promises and pitfalls of self-regulated learning interventions in MOOCs. *Technology, Knowledge and Learning, 27*(3), 689–705. https://doi.org/10.1007/s10758-021-09580-9

Wang, C. H., Shannon, D. M., & Ross, M. E. (2013). Students' characteristics, self-regulated learning, technology self-efficacy, and course outcomes in online learning. *Distance Education, 34*(3), 302–323. https://doi.org/10.1080/01587919.2013.835779

Waterhouse, P., Samra, R., & Lucassen, M. (2022). Distance education students' satisfaction: Do work and family roles matter? *Distance Education, 43*(1), 56–77. https://doi.org/10.1080/01587919.2021.2020622

Wei, H. C., & Chou, C. (2020). Online learning performance and satisfaction: Do perceptions and readiness matter? *Distance Education, 41*(1), 48–69. https://doi.org/10.1080/01587919.2020.1724768

Welesilassie, M. W., & Nikolov, M. (2022). Relationships between motivation and anxiety in adult EFL learners at an Ethiopian university. *Ampersand, 9*, 100089. https://doi.org/10.1016/j.amper.2022.100089

Wilson, J., Potter, A., Cordero, T. C., & Myers, M. C. (2022). Integrating goal-setting and automated feedback to improve writing outcomes: a pilot study. *Innovation in Language Learning and Teaching*. https://doi.org/10.1080/17501229.2022.2077348

Xia, Q., Chiu, T. K. F., Chai, C. S., & Xie, K. (2023). The mediating effects of needs satisfaction on the relationships between prior knowledge and self-regulated learning through artificial intelligence chatbot. *British Journal of Educational Technology*. https://doi.org/10.1111/bjet.13305

Xia, Q., Yin, H., Hu, R., Li, X., & Shang, J. (2022). Motivation, engagement, and mathematics achievement: An exploratory study among Chinese primary students. *SAGE Open, 12*(4), 1–13. https://doi.org/10.1177/21582440221134609

Yu, J., Huang, C., He, T., Wang, X., & Zhang, L. (2022). Investigating students' emotional self-efficacy profiles and their relations to self-regulation, motivation, and academic performance in online learning contexts: A person-centered approach. *Education and Information Technologies, 27*(8), 11715–11740. https://doi.org/10.1007/s10639-022-11099-0

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist, 25*(1), 3–17. https://doi.org/10.1207/s15326985ep2501_2

Zimmerman, B. J., & Kitsantas, A. (2014). Comparing students' self-discipline and self-regulation measures and their prediction of academic achievement. *Contemporary Educational Psychology, 39*(2), 145–155. https://doi.org/10.1016/j.cedpsych.2014.03.004