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A dual-process motivation mediation model to explain female high school students' cognitive engagement and disengagement in emergency remote teaching and online learning in South Korea

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Abstract: High attrition/dropout rates and low engagement have been major concerns of online educators. This study examined female high school students' cognitive engagement and disengagement in an online learning context during the COVID-19 pandemic through the lens of self-determination theory's basic psychological needs. We investigated an extended dual-process motivation mediation model that emphasizes the mediating role of the need for competence, including an additional factor, technology self-efficacy, in a South Korean high school context ($n = 235$). Results from structural equation modelling provided evidence for the proposed model. Our findings indicated that the exogenous variables (ie, perceived autonomy support, perceived teacher control and technology self-efficacy) predicted cognitive engagement and disengagement with the mediating role of competence need satisfaction and competence need frustration. We found distinct processes including (a) "autonomy support-competence need satisfaction-cognitive engagement", (b) "teacher control-competence need frustration-cognitive disengagement", (c) "technology self-efficacy-competence need satisfaction-cognitive engagement" and (d) "technology self-efficacy-competence need frustration (negative effect)-cognitive disengagement". This

study suggests using autonomy support strategies to fulfil students' competence needs in online learning contexts. We also found a possible role of technology self-efficacy in influencing psychological competence needs, cognitive engagement and cognitive disengagement in online learning contexts. Implications of the findings are discussed.

KEYWORDS

cognitive disengagement, cognitive engagement, emergency remote teaching, online learning, self-determination theory, technology self-efficacy

Practitioner notes

What is already known about this topic

- High attrition/dropout rates and low engagement have been major concerns of online educators.
- Emergency remote teaching (ERT) has implications for online teaching beyond the ERT paradigm.
- Self-determination theory (SDT) has been adopted and adapted with the goal of determining how to achieve need satisfaction, optimize learner motivation and enhance student engagement in classroom settings.

What this paper adds

- This study applied a dual-process motivation mediation model to investigate both cognitive engagement and disengagement among female high school students in an ERT online learning environment.
- The extended dual-process motivation mediation model examined the role of an additional factor, technology self-efficacy in cognitive engagement and disengagement in online learning.
- This study examined the role of direct, indirect and cross-over effects focusing on both bright and dark aspects of the dual-process motivation mediation model in online learning in a South Korean girls' high school during ERT.

Implications for practice and/or policy

- This study proposes the use of autonomy support strategies in online learning contexts.
- Teachers should understand their students and provide support that addresses competence need satisfaction to enhance student cognitive engagement in online learning contexts.
- More efforts should be made to prepare teachers for designing online learning experiences that increase students' competence need satisfaction and decrease competence need frustration.

INTRODUCTION

The expectation for K-12 teachers to be prepared to teach in online settings was growing even before the onset of the COVID-19 pandemic (Moore-Adams et al., 2016). However, online teaching and learning in K-12 education was not widely adopted until the outbreak of the COVID-19 pandemic (UNESCO, 2020). The term "emergency remote teaching" (ERT) has been used to describe this "temporary shift from face-to-face instruction to online delivery in response to a crisis" (Hodges et al., 2020, para. 13). Educators and students operating under ERT have faced challenges such as public health crises, social isolation and economic recession caused by the pandemic (Wang, 2021). Studies have revealed that some ERT-related challenges are mostly consistent with those identified in studies of typical online teaching and learning contexts before the pandemic. These challenges include lack of social interaction, home support, home communication and accessibility, and can cause issues related to student engagement, attrition and achievement (An et al., 2021; Francom et al., 2021; Keramati et al., 2011; Trust & Whalen, 2020). Although ERT presents unique challenges and differs from the typical adoption of online teaching, which is often planned and developed in advance, a growing number of recent studies on ERT have implications for K-12 online teaching beyond the ERT paradigm (Lepp et al., 2021; Shamir-Inbal & Blau, 2021).

Low engagement and disengagement have been major concerns of online educators. Over the years, researchers have identified factors impacting students' engagement and disengagement in online learning, such as perceived support from teachers, instructions, technology skills, self-regulation skills and motivation (Chipchase et al., 2017; Cole et al., 2021; Hew, 2018; Park & Yun, 2018). Despite the heavy volume of research, there is a lack of studies explaining the mechanisms of how various factors impact students' online learning engagement and disengagement (Alemayehu & Chen, 2021; Chiu, 2021). Furthermore, an increasing number of studies have adopted a multidimensional concept of student engagement and disengagement (Bergdahl, 2022; Hu & Li, 2017). Thus, there is a need to examine each dimension of student engagement and disengagement for further discussion. This study examined the relationships among various factors impacting students' cognitive engagement and disengagement in an ERT and online learning context. The research context for this study was a public girls' high school in South Korea (all females). The purpose of the study was to explain how female high school students' perceived teacher effort (autonomy support/control), technology self-efficacy and student psychological needs for competence (satisfaction/frustration) relate to their cognitive engagement and disengagement in an ERT and online learning context in South Korea.

Self-determination theory's basic psychological needs

Deci and Ryan (1985) proposed self-determination theory (SDT) to explain the dynamics of the human mind, motivation and well-being within the immediate social context. This theory posits that people are driven by three basic and innate psychological needs: autonomy (the need to experience a sense of control and volition in one's behaviour/actions), competence (the need to feel competent with tasks and activities) and relatedness (the need to experience a sense of belonging, community and feel connected with and cared for by others) (Chen & Jang, 2010; Deci & Ryan, 1985, 2000; Jang et al., 2020). When learners' basic psychological needs are met (also known as need satisfaction) within supportive learning environments, they are more likely to have high motivation/self-determination, engage in learning tasks and feel satisfied with their learning experiences (Chen & Jang, 2010).

Researchers have adopted SDT extensively with the goal of determining how to achieve need satisfaction, optimize learner motivation and promote learning outcomes in typical school and classroom settings (Reeve, 2013; Xiang et al., 2017). Some studies have also tested the contributing power of the three needs posited by SDT on learning outcomes in online contexts (eg, Chen & Jang, 2010; Chiu, 2021; Hsu et al., 2019). For instance, Chen and Jang (2010) surveyed 267 adult students across five online courses and found that need satisfaction is the best predictor of other outcomes in online courses, while contextual support is the best predictor of course satisfaction. In their study, however, motivation/self-determination failed to predict other outcomes, such as hours per week spent studying, final grades and course satisfaction. Responding to Chen and Jang (2010), Hsu et al. (2019) surveyed 300 undergraduate students across seven online courses. Invariably, they found that need satisfaction and self-determination are well linked to learning outcomes (ie, perceived knowledge transfer, learning gains and course grades). Overall, SDT has been extensively researched in higher education and face-to-face settings. More research in K-12 and online learning contexts is necessary (Chiu, 2021; Hsu et al., 2019). Previous SDT studies have also reported inconsistent findings regarding the relationships or paths among SDT components (Chen & Jang, 2010; Donald et al., 2021; Standage et al., 2006) and have tested different sets of components. Also, researchers have cautioned against the use of the construct, need satisfaction, in SDT studies. This caution arises from either averaging conceptually distinct needs into an overall measure of need satisfaction or neglecting to explore the distinct mediating roles of different needs (Chiniara & Bentein, 2016; Van den Broeck et al., 2016). The current study therefore examined the mediating effects of competence need satisfaction and competence need frustration on cognitive engagement and disengagement.

Cognitive engagement and disengagement in online learning

Understanding student engagement is critical in many aspects. Positive and meaningful engagement protects students from dropout and learner isolation, and student engagement predicts how well students do in school, their academic progress and well-being (Dixson, 2010; Fredricks et al., 2004; Ladd & Dinella, 2009). Understanding student engagement also offers a helpful framework for teachers to assess their teaching efficacy. Researchers have studied student engagement extensively in online learning as they perceive it is different from student engagement in physical classrooms (Bergdahl, 2022). Martin et al.'s (2020) systematic literature review revealed that student engagement was the most popular theme in the research on online teaching and learning from 2009 to 2018. The authors, however, faced difficulties synthesizing studies since researchers used different terms to indicate the concept of student engagement. Additionally, the researchers did not specify the term or provide clear operationalized definitions (Bergdahl, 2022; Martin et al., 2020).

In general, student engagement refers to students' active involvement in learning activities to achieve desired educational goals and learning outcomes (Chiu, 2021; Reeve, 2013). A growing number of studies have adopted a multidimensional concept of student engagement (Hu & Li, 2017). In efforts to enhance multiple dimensions of student engagement, researchers have examined different teaching and learning strategies, as well as teachers' motivating styles in online learning contexts. For instance, Park and Yun (2018) surveyed 95 undergraduate and graduate students in online courses and found that Fredricks et al.'s (2004) three types of engagement (behavioural, cognitive and emotional) were predicted by different motivational regulation strategies. Their findings include those two

motivational regulation strategies, enhancing personal significance and using performance avoidance self-talk, predicted cognitive engagement after controlling for the academic level and learning environment type. Chiu (2021) surveyed 1201 Grade 8 and 9 students during the COVID-19 pandemic in Hong Kong and found that perceived competence support was the primary predictor of cognitive engagement while perceived relatedness support was the most important predictor of behavioural, emotional and agentic engagement. Perceived autonomy support was a predictor for all dimensions of student engagement. These studies suggest that different motivational scaffolding should be provided to enhance each dimension of student engagement.

Among the diverse dimensions, this study focuses on cognitive engagement. Cognitive engagement refers to the mental effort students spend during learning activities in terms of using sophisticated rather than superficial learning strategies, such as critical thinking, deep processing and elaboration (Chiu, 2021; Jang et al., 2016; Reeve, 2013). There also have been studies exploring other factors affecting cognitive engagement in online learning contexts. The factors include teacher–student interaction, perceived peer support, digital literacy, gamification and educational affordance (Lin et al., 2022). However, to delve deeper into the topic, it is necessary to conduct additional studies on independent and mediating factors influencing cognitive engagement in online learning contexts.

Student disengagement is highly relevant to passivity, discouragement, poor academic performance, school dropouts and career challenges (Adigun et al., 2022; Wang & Fredricks, 2014). Student disengagement, however, has received relatively less attention in online learning studies (Bergdahl, 2022; Maimaiti et al., 2021). Bergdahl (2022) explored 10 K-12 teachers' perceived student engagement and disengagement in online learning environments applying a mixed-method grounded theory. As a multidimensional concept, their constructs of student engagement and disengagement included behavioural, cognitive, emotional and social dimensions. The study findings confirmed that engagement and disengagement are distinct concepts and revealed the co-occurrence of student engagement and disengagement and the influences within and between dimensions and context. Maimaiti et al. (2021) also explored postgraduate student disengagement (ie, not participating or withdrawal; not considered a multidimensional construct) in synchronous online learning settings from an activity theory perspective and identified the factors affecting disengagement such as limited use of web-based videoconferencing tools and different expectations of instructor and student roles (Maimaiti et al., 2021). Our study explored a dual-process motivation mediation model that incorporates students' cognitive disengagement (ie, defined as the absence or use of disorganized learning strategies, Elliot et al., 1999). This research therefore contributes to current discussions regarding student disengagement in online learning environments.

A dual-process model of engagement and disengagement

A dual-process model shows that the process of "support-satisfaction-engagement" (ie, the bright side) is conceptually and empirically distinct from the process of "control-frustration-disengagement" (ie, the dark side) (Jang et al., 2016). Researchers have argued that there are conceptual distinctions between the two aspects of perceived support–motivation–outcome constructs, just as need satisfaction (eg, "*I feel connected with people*") is not simply the opposite of need frustration (eg, "*I feel unappreciated by people*"), but a separate and independent experience (Jang et al., 2016; Sheldon & Hilpert, 2012). Need frustration is more closely related to active need thwarting than it is to need neglect or the lack of need satisfaction opportunities, which are often referred

to as need dissatisfaction (eg, "*I often feel like I don't have opportunities to interact with others*," Costa et al., 2015, p. 15). These findings have supported that the support–satisfaction–engagement side of constructs can predict optimal outcomes, while the other side of the dual-process model can predict non-optimal outcomes (Jang et al., 2016; Li et al., 2018). The overall theoretical direction that has emerged from this line of research has been to expand the basic motivational mediation model into the more comprehensive dual-process motivational mediation model (Bartholomew et al., 2011; Costa et al., 2015; Jang et al., 2016; Shim et al., 2022). Based on this logic, the current study examined a dual-process model of motivation grounded in SDT theory within an online learning context. Considering the mixed findings from previous studies, this study examined the direct, indirect and cross-over effects focusing on both bright and dark aspects of the dual-process model exploring the mediating role of competence need satisfaction and competence need frustration.

Technology self-efficacy

Technology self-efficacy is generally defined as one's belief that they have sufficient abilities when dealing with a technology-related task (McDonald & Siegall, 1992; Wang et al., 2013). Technology self-efficacy (also known as computer self-efficacy) plays an important role in online learning settings. Prior literature has provided evidence for the impact of technology self-efficacy on student engagement and performance in online learning settings (Rashid & Asghar, 2016; Wang et al., 2013) and the relationships between lower technology self-efficacy and higher levels of anxiety related to technology use for learning (Holden & Rada, 2011; Shu et al., 2011). Technology self-efficacy is often predetermined or considered as an antecedent variable to learning experiences. Therefore, during the COVID-19 pandemic—especially at its onset, when the sudden transition from in-person to online classrooms was inevitable—the success of both teachers and students with low technology self-efficacy was unpredictable (Ogodo et al., 2021; Owusu-Agyeman et al., 2021). Recent studies have reported successful cases of interventions and their positive effects on reducing technology anxiety or enhancing technology acceptance and technology self-efficacy during the pandemic (Al-Maroof et al., 2020; Turnbull et al., 2021). However, further research on the relationships between student technology self-efficacy and cognitive engagement/disengagement, along with other factors that emerged during the pandemic, remains less explored.

The current study examined how the exogenous variables (ie, perceived autonomy support, perceived teacher control and technology self-efficacy) are directly linked to both cognitive engagement and cognitive disengagement through the mediating effect of competence need satisfaction and competence need frustration. Our hypotheses are presented in Table 1 and Figure 1.

METHODS

This study aimed (a) to test a model of motivation grounded in self-determination theory (SDT) with a specific group of students (ie, all females with ages ranging from 15 to 18 years old) within the context of a high school in South Korea; (b) to explore the dual-process motivation mediation model; and (c) to expand the model with the technology self-efficacy variable and to test it in the online learning context. This study (1) examined the direct and indirect effects focusing on the bright aspect of the dual-process model;

TABLE 1 Research hypotheses.

	Dual process	Direct/Indirect effects	Hypotheses
RQ1	Bright aspect	Direct	H1. Technology self-efficacy (TSE) has a direct positive effect on CNS H2. Perceived autonomy support (PAS) has a direct positive effect on competence need satisfaction (CNS) H3. CNS has a direct positive effect on cognitive engagement (COEN)
		Indirect	H4. TSE has an indirect positive effect on COEN, mediated by CNS H5. PAS has an indirect positive effect on COEN, mediated by CNS
RQ2	Dark aspect	Direct	H6. Perceived teacher control (PTC) has a direct positive effect on competence need frustration (CNF) H7. CNF has a direct positive effect on cognitive disengagement (CODISEN)
		Indirect	H8. PTC has an indirect positive effect on CODISEN, mediated by CNF
RQ3	Cross-over	Direct	H9. TSE has a direct negative effect on CNF H10. PAS has a direct negative effect on CNF H11. PTC has a direct negative effect on CNS H12. CNS has a direct negative effect on CODISEN H13. CNF has a direct negative effect on COEN
		Indirect	H14. TSE has an indirect negative effect on CODISEN, mediated by CNS H15. PAS has an indirect negative effect on CODISEN, mediated by CNS H16. PTC has an indirect negative effect on COEN, mediated by CNS H17. PTC has an indirect negative effect on CODISEN, mediated by CNS H18. TSE has an indirect negative effect on COEN, mediated by CNF H19. TSE has an indirect negative effect on CODISEN, mediated by CNF H20. PAS has an indirect negative effect on COEN, mediated by CNF H21. PAS has an indirect negative effect on CODISEN, mediated by CNF H22. PTC has an indirect negative effect on COEN, mediated by CNF

(2) investigated the direct and indirect effects focusing on the dark aspect of the model; and (3) further examined the cross-over effects that contain both bright and dark aspects of the model.

Participants and research context

Participants in this cross-sectional design study were 235 students at a public girls' high school in South Korea (all females, 10th graders = 138, 11th graders = 97, ages ranging from 15 to 18 years old). The school has transitioned to delivering schooling remotely to cope with the COVID-19 pandemic since Spring 2020. The participants were recruited from 10 online

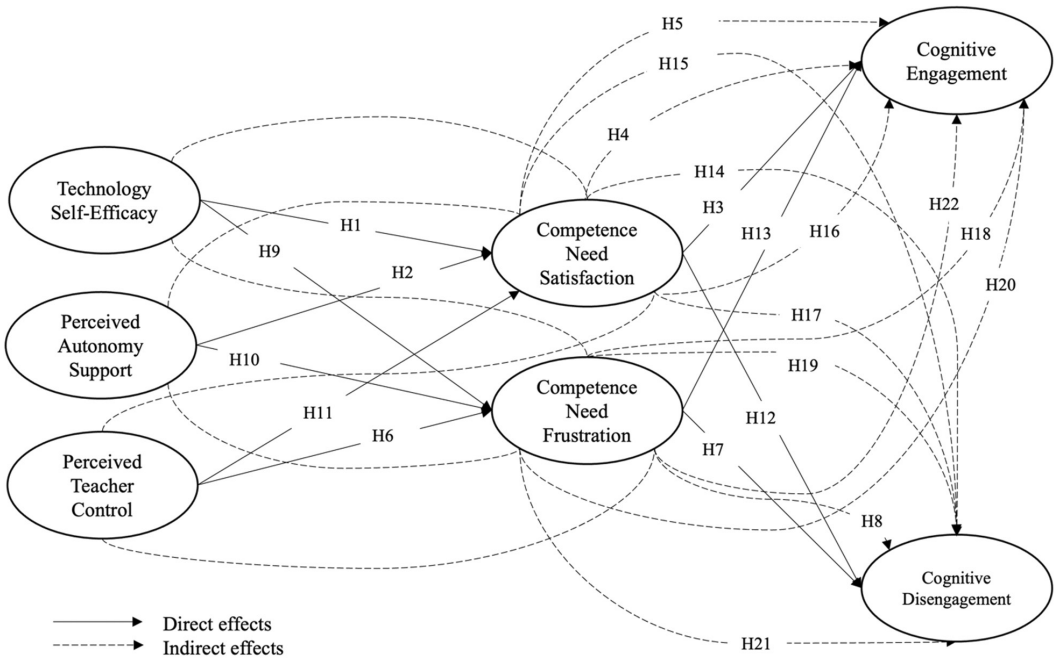

FIGURE 1 Research hypotheses.

classes in Summer 2020. The online classes were hosted on two platforms, EBS Online Class platform, mainly to upload lesson videos, and RIRO School platform, to facilitate interactive activities (eg, quizzes and feedback). The classes commonly contained lecture videos and short quizzes for each lesson.

Data collection

Preceding the collection of data, consent to conduct the study was obtained from the students. We also asked for parental permission for students' participation. Participants completed an SDT questionnaire that included measures of perceived autonomy support, perceived teacher control, competence need satisfaction, competence need frustration, cognitive engagement and cognitive disengagement. The questionnaire was adapted from Jang et al.'s (2016) study considering the remote teaching context (18 items for this study, Appendix). For this study, the stem, "in this online class" was merged into each item. Five-point Likert scales containing a range from 1 (strongly disagree) to 5 (strongly agree) were used. We added a set of questions about student technology self-efficacy to the questionnaire (3 items) for this study. The participants were asked to choose one of the online courses they took during the pandemic as a reference for their responses to the survey.

Research model and structural equation modelling

A hypothesized structural equation model (SEM) was constructed (Table 1). To access validity and reliability, we used AMOS (Version 29), structural equation modelling software. Additionally, for further examination of the model fit and proposed structural equation model,

TABLE 2 Standardized factor loadings, construct validity, reliability and explained variance for the hypothesized model.

Parameter ($n = 235$)	Factor loadings	AVE	CR	R^2
Technology self-efficacy (TSE)		0.624	0.832	
TSE 1	0.772			0.595
TSE 2	0.667			0.445
TSE 3	0.680			0.462
Perceived autonomy support (PAS)		0.614	0.826	
PAS 1	0.817			0.668
PAS 2	0.799			0.639
PAS 3	0.727			0.529
Perceived teacher control (PTC)		0.634	0.838	
PTC 1	0.631			0.398
PTC 2	0.707			0.499
PTC 3	0.712			0.506
Competence need satisfaction (CNS)		0.560	0.792	0.777
CNS 1	0.729			0.532
CNS 2	0.756			0.572
CNS 3	0.719			0.517
Competence need frustration (CNF)		0.506	0.754	0.591
CNF 1	0.714			0.510
CNF 2	0.628			0.394
CNF 3	0.714			0.510
Cognitive engagement (COEN)		0.664	0.854	0.897
COEN 1	0.896			0.803
COEN 2	0.882			0.777
COEN 3	0.679			0.460
Cognitive disengagement (CODISEN)		0.624	0.833	0.665
CODISEN 1	0.808			0.653
CODISEN 2	0.822			0.675
CODISEN 3	0.853			0.727

we employed MPlus (Version 8) with the maximum likelihood with robust standard errors (MLR) estimation technique. All variables met the normality criteria based on skewness and kurtosis. The overall model fit was considered a combination of fit indices suggested by Hu and Bentler (1999) and included chi-square test of model fit (χ^2), comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA) and standardized root mean squared residual (SRMR).

RESULTS

Validity and reliability

A confirmatory factor analysis was conducted, and average variance extracted (AVE) values were calculated to confirm that the combination of items was suitable for the model. As shown in Table 2, the item grouping of the seven factors was supported and the factor loadings for

TABLE 3 Correlation matrix for the latent factors.

	1	2	3	4	5	6	7
(1) TSE	1.000						
(2) PAS	0.242*	1.000					
(3) PTC	−0.023	−0.491**	1.000				
(4) CNS	0.424**	0.730**	−0.454**	1.000			
(5) CNF	−0.264*	−0.473**	0.658**	−0.730**	1.000		
(6) COEN	0.453**	0.598**	−0.225*	0.721**	−0.434**	1.000	
(7) CODISEN	−0.366**	−0.489**	0.459**	−0.579**	0.789**	−0.575**	1.000

Abbreviations: CNF, competence need frustration; CNS, competence need satisfaction; CODISEN, cognitive disengagement; COEN, cognitive engagement; PAS, perceived autonomy support; PTC, perceived teacher control; TSE, technology self-efficacy.

*$p < 0.01$; **$p < 0.001$.

TABLE 4 HTMT results.

	1	2	3	4	5	6	7
(1) TSE							
(2) PAS	0.227						
(3) PTC	0.013	0.492					
(4) CNS	0.416	0.733	0.450				
(5) CNF	0.242	0.479	0.649	0.737			
(6) COEN	0.456	0.645	0.228	0.739	0.460		
(7) CODISEN	0.362	0.506	0.462	0.580	0.802	0.574	

Abbreviations: CNF, competence need frustration; CNS, competence need satisfaction; CODISEN, cognitive disengagement; COEN, cognitive engagement; PAS, perceived autonomy support; PTC, perceived teacher control; TSE, technology self-efficacy.

all 21 items exceeded 0.60. All AVE values were greater than the acceptable value of 0.50. Composite reliability (CR) values were also calculated to assess the internal reliability of the multi-item subscales. All CR values ranged from 0.75 to 0.85 and can be considered reliable based on the $\alpha = 0.70$ criterion set for the psychological domain (Raykov, 1997). Table 2 shows factor loadings, AVE, CR and *R*-square values. Table 3 shows the relationships between latent factors calculated by Pearson correlation coefficients. The discriminant validity was also met as Table 4 shows that Heterotrait–Monotrait (HTMT) ratio scores are all lower than the HTMT criteria, 0.85 (Ab Hamid et al., 2017).

Structural equation modelling

Measurement model

To evaluate the adequacy of the fit of the proposed model (Figure 1) to the data, a combination of fit indices was considered. The fit indices for the proposed model revealed a good fit for the baseline model (χ^2 (175) =260.329, $p < 0.001$; CFI = 0.951; TLI = 0.941; RMSEA = 0.046; and SRMR = 0.057). We further examined the measurement paths and structural paths as shown in Table 5.

TABLE 5 Measurement paths and structural paths.

	Bright aspect of the dual-process model (positive directions)	Dark aspect (positive directions)	Bright and dark aspects (negative directions)
Direct effects	H1. TSE → CNS H2. PAS → CNS H3. CNS → COEN	H6. PTC → CNF H7. CNF → CODISEN	H9. TSE → CNF H10. PAS → CNF H11. PTC → CNS H12. CNS → CODISEN H13. CNF → COEN
Indirect effects	H4. TSE → CNS → COEN H5. PAS → CNS → COEN	H8. PTC → CNF → CODISEN	H14. TSE → CNS → CODISEN H15. PAS → CNS → CODISEN H16. PTC → CNS → COEN H17. PTC → CNS → CODISEN H18. TSE → CNF → COEN H19. TSE → CNF → CODISEN H20. PAS → CNF → COEN H21. PAS → CNF → CODISEN H22. PTC → CNF → COEN

Abbreviations: CNF, competence need frustration; CNS, competence need satisfaction; CODISEN, cognitive disengagement; COEN, cognitive engagement; PAS, perceived autonomy support; PTC, perceived teacher control; TSE, technology self-efficacy.

The bright aspect of the extended SDT dual-process model

The bright aspect of the baseline model included three direct effects (H1-H3). The direct positive effects between technology self-efficacy and competence need satisfaction (H1: $\beta = 0.350$, $SE = 0.076$, $p < 0.001$); between perceived teacher autonomy support and competence need satisfaction (H2: $\beta = 0.582$, $SE = 0.095$, $p < 0.001$); and between competence need satisfaction and cognitive engagement (H3: $\beta = 0.816$, $SE = 0.069$, $p < 0.001$) were significant. The bright aspect of the model also included two indirect positive effects (H4 and H5). Competence need satisfaction mediated the relationships between technology self-efficacy and cognitive engagement (H4: $\beta = 0.285$, $SE = 0.071$, $p < 0.001$); and between perceived autonomy support and cognitive engagement (H5: $\beta = 0.475$, $SE = 0.088$, $p < 0.001$).

The dark aspect of the extended SDT dual-process model

The dark aspect of the baseline model included two direct effects (H6–H7). The direct positive effects between perceived teacher control and competence need frustration (H6: $\beta = 0.615$, $SE = 0.116$, $p < 0.001$); and between competence need frustration and cognitive disengagement (H7: $\beta = 0.662$, $SE = 0.101$, $p < 0.001$) were significant. The dark aspect of the model included one indirect positive effect: Competence need frustration mediated the relationship between perceived teacher control and cognitive disengagement (H8: $\beta = 0.407$, $SE = 0.076$, $p < 0.001$).

The bright and dark aspects (cross-over) of the extended SDT dual-process model

The relationships between the bright and dark aspects were examined (H9–H22). Among them, the direct negative effect between perceived technology self-efficacy and competence

TABLE 6 Results of the hypotheses.

Hypothesis	Path	*β*	*SE*	*p*
H1	TSE → CNS	0.350	0.076	<0.001
H2	PAS → CNS	0.582	0.095	<0.001
H3	CNS → COEN	0.816	0.069	<0.001
H4	TSE → CNS → COEN	0.285	0.071	<0.001
H5	PAS → CNS → COEN	0.475	0.088	<0.001
H6	PTC → CNF	0.615	0.116	<0.001
H7	CNF → CODISEN	0.662	0.101	<0.001
H8	PTC → CNF → CODISEN	0.407	0.076	<0.001
H9	TSE → CNF	−0.276	0.092	<0.01
H10	PAS → CNF	−0.160	0.104	0.125
H11	PTC → CNS	−0.208	0.107	0.052
H12	CNS → CODISEN	−0.177	0.101	0.080
H13	CNF → COEN	0.103	0.087	0.236
H14	TSE → CNS → CODISEN	−0.062	0.039	0.115
H15	PAS → CNS → CODISEN	−0.103	0.060	0.089
H16	PTC → CNS → COEN	−0.170	0.090	0.059
H17	PTC → CNS → CODISEN	0.037	0.029	0.202
H18	TSE → CNF → COEN	−0.029	0.026	0.268
H19	TSE → CNF → CODISEN	−0.183	0.072	<0.05
H20	PAS → CNF → COEN	−0.017	0.016	0.287
H21	PAS → CNF → CODISEN	−0.106	0.075	0.158
H22	PTC → CNF → COEN	0.064	0.060	0.289
		Standardized indirect effects		
Path		***β***		***p***
TSE → COEN		0.257		<0.001
PAS → COEN		0.458		<0.001
PTC → COEN		−0.106		0.163
TSE → CODISEN		−0.245		<0.01
PAS → CODISEN		−0.209		<0.05
PTC → CODISEN		0.444		<0.001

Note: The model under examination exclusively incorporates indirect effects of exogenous variables (ie, perceived autonomy support, perceived teacher control and technology self-efficacy) on cognitive engagement and cognitive disengagement.

Abbreviations: CNF, competence need frustration; CNS, competence need satisfaction; CODISEN, cognitive disengagement; COEN, cognitive engagement; PAS, perceived autonomy support; PTC, perceived teacher control; TSE, technology self-efficacy.

need frustration (H9: $\beta = -0.276$, $SE = 0.092$, $p < 0.01$) was found to be significant. In contrast, the other direct paths (H10, H11, H12 and H13) were not significant.

We also examined the indirect negative effects among the bright and negative constructs (H14–H22). Among them, competence need frustration mediated the relationship between technology self-efficacy and cognitive disengagement (H19: $\beta = -0.183$, $SE = 0.072$, $p < 0.05$). In contrast, the other indirect paths (H14, H15, H16, H17, H18, H20, H21 and H22) were not significant.

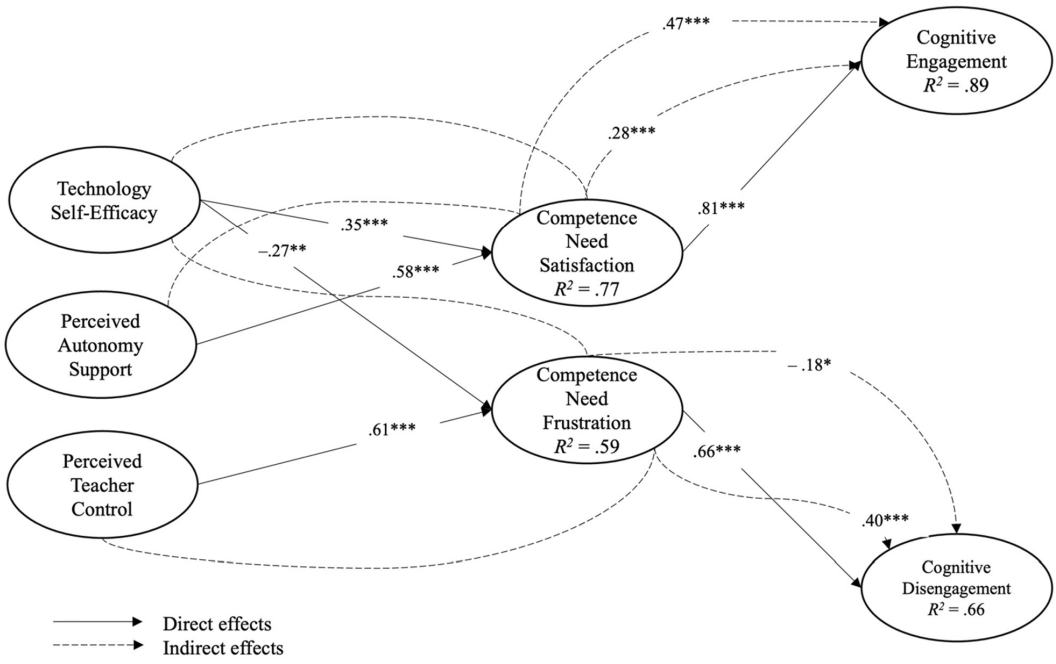

FIGURE 2 SEM model results. For the sake of clarity, only significant paths and effects are presented. *$p < 0.05$, **$p < 0.01$; ***$p < 0.001$.

Overall, technology self-efficacy, perceived teacher autonomy support and perceived teacher control explained 77% of the variance in competence need satisfaction ($R^2 = 0.77$) and 59% of the variance in competence need frustration ($R^2 = 0.59$). Additionally, the extended SDT dual-process model accounted for 89% of the variance in cognitive engagement ($R^2 = 0.89$) and 66% of the variance in cognitive disengagement ($R^2 = 0.66$). Table 6 shows the results of the hypotheses and the results of the structural model's indirect/total effects with latent factors. Figure 2 depicts the standardized path coefficients, significance of the relationships among the variables and R^2 values of the endogenous variables in the model.

DISCUSSION

In this section, we discuss our findings and contributions to the literature related to the research context, dual-process motivation mediation model and technology self-efficacy. Then, practical implications for teachers are presented. Finally, we discuss the limitations of the study and provide suggestions for future research.

Research context

Researchers have conducted self-determination theory studies in different cultures to address questions about the cross-cultural generalizability of the theory. Previous studies have provided evidence of generalizability, however, they have also reported cultural variations, such as Chinese students' relatively lower levels of various SDT-related factors (Yu et al., 2018), the greater importance of competency support in the West (Nalipay et al., 2020)

and the culturally different operationalization of self-determination between Italian and American adolescents (Ginevra et al., 2015). This study adds to the findings of prior SDT studies by targeting a specific group of students (ie, all females between 15 and 18 years old) in the context of collectivistically oriented South Korea (Jang et al., 2009). Aligned with previous SDT studies conducted in South Korea, especially those emphasizing the role of autonomy support in face-to-face classrooms (Cho & Seo, 2019; Jang et al., 2012, 2016), our findings confirm that even in the online learning context, female high school students' perceived teacher autonomy support positively predicts their competence need satisfaction. Additionally, competence need satisfaction is likely to foster students' cognitive engagement. A growing number of SDT studies have been conducted in online learning contexts. Our findings also align with those of previous SDT studies (Chiu, 2021; Hsu et al., 2019).

SDT dual-process motivation mediation model

This study exploring a dual-process motivation mediation model is in line with previous SDT studies (Jang et al., 2016; Li et al., 2018). We reported the correlations among the factors (Table 3). There were significant and negative correlations between perceived autonomy support and perceived teacher control ($r = -0.49$), between competence need satisfaction and competence need frustration ($r = -0.73$) and between cognitive engagement and cognitive disengagement ($r = -0.57$). These correlations are higher than those found in some previous research (Bartholomew et al., 2011; Haerens et al., 2015; Jang et al., 2016), while other studies have reported similarly high levels of correlations (Li et al., 2018; Tang et al., 2021). However, the CFA (Table 2), HTMT ratio scores (Table 4) and measurement model (Figure 2) provide evidence that participants clearly differentiated the factors associated with the bright versus the dark aspects of the model.

Our findings revealed several significant indirect positive effects. The exogenous variables (ie, perceived autonomy support and perceived teacher control) predicted cognitive engagement or cognitive disengagement with the mediating role of competence need satisfaction or competence need frustration. This finding is in line with previous studies (Chiu, 2021; Earl et al., 2017). We suggest that teacher supports do not always guarantee students' positive learning experience. For teacher support to prove effective, it should satisfy online students' needs for competence. Instructors should understand their students and provide “perceived support” (not “received support”), leading to desired learning outcomes (Chen & Jang, 2010, p. 750). It can be argued that effective teacher autonomy support strategies should address online students' competence need satisfaction thus enhancing their cognitive engagement (Chiu, 2021).

Our findings also reveal that the distinct process of (a) “autonomy support-competence need satisfaction-cognitive engagement” is empirically distinct from the process of (b) “teacher control-competence need frustration-cognitive disengagement”. We did not identify any additional cross-over processes such as “autonomy support-competence need satisfaction-negative cognitive disengagement”. These findings highlight that when teacher autotomy support satisfies students' competence need satisfaction, students cognitively engage more in online learning. The findings also reveal that non-optimal teacher support (teacher control) causes students to feel frustrated, thus cognitively disengaging more in online learning. This finding is consistent with previous studies of the SDT dual process model (Al-Yaaribi et al., 2016; De Meyer et al., 2014; Jang et al., 2016; Soenens et al., 2012), however, those studies were not conducted in online learning contexts. Also, previously the competence need satisfaction/frustration and cognitive engagement/disengagement were not separately examined. Our findings reinforce the relevance of the SDT dual-process model in online learning contexts.

Technology self-efficacy

Technology self-efficacy was intentionally chosen for this study since it has been a critical factor influencing online learning experience (Rashid & Asghar, 2016; Wang et al., 2013). Students' capacities to use technology are particularly important given the context of ERT, wherein students have had to continue their learning in an online mode without a sufficient technological and online pedagogical preparation period (Chiu, 2021; Ogodo et al., 2021; Owusu-Agyeman et al., 2021). Our findings provide evidence that supports the potential value of adding technology-related factors to the extended SDT model in online learning contexts. We identified the dual-process sets (a) "technology self-efficacy-competence need satisfaction-cognitive engagement (ie, the positive indirect effect)" and (b) "technology self-efficacy-competence need frustration-cognitive disengagement (ie, the negative indirect effect)". However, the extent of the impact was relatively lower than the other exogenous factors (ie, perceived autonomy support and perceived teacher control) and was only tested with one sample. Further research is necessary to support this argument.

Practical implications

This study proposes the use of SDT-based support strategies in online learning contexts. Teachers should understand their students' need for competence and adopt appropriate autonomy-supportive strategies to enhance students' cognitive engagement in their online classrooms. We suggest that teachers create an open and learner-centred classroom climate where students can freely express their feelings, thoughts, needs and concerns (Chen & Jang, 2010; Núñez & León, 2019). As online programmes are likely to continue expanding even after the pandemic, it is crucial and necessary to consider teacher training programmes, guidance or other forms of intervention to help teachers design online learning experiences that increase students' competence need satisfaction and avoid competence need frustration (Chiu, 2021; Earl et al., 2017).

Limitations and future directions

This study has limitations. First, among three dimensions of need satisfaction/frustration (ie, autonomy, competence and relatedness) and four dimensions of engagement/disengagement (ie, behavioural, cognitive, emotional and agentic), our dual-process model incorporates only one dimension of need satisfaction/frustration and one dimension of engagement/disengagement. Each of these dimensions could be explored individually, as highlighted by Chiu (2021) and Van den Broeck et al. (2016).

Second, this study focused on perceived autonomy support and teacher control as teachers' effort or motivating styles (Jang et al., 2016; Reeve, 2009) and their impact on competence need satisfaction/frustration and cognitive engagement/disengagement. Future studies could consider other motivating styles (eg, competency support and relatedness support) or student–student relationships in online learning contexts. Further research could also examine different or multiple social agents such as peers, parents and schools (Standage et al., 2005). Assessing multiple social agents simultaneously would provide a more comprehensive insight into how these agents impact student needs in the online learning context.

This study relied on self-reported data from students' perspectives. Although a high correlation between observed and self-reported behaviours has been demonstrated (De Meyer et al., 2014), follow-up studies could use different data sources such as interviews, diaries

and/or content analysis of teaching and learning materials, and additionally, could examine teachers' perceptions.

We did not examine the online teaching strategies and supports the teachers deployed or how instructors facilitated online learning. Follow-up studies could connect specific online teaching strategies and supports with empirical evidence on students' motivation and engagement (Chiu, 2021; Hsu et al., 2019; Núñez & León, 2019).

This study was conducted at an academic-focused girls' high school in South Korea. We acknowledge the limited generalizability of our findings. The Korean classrooms and academic-focused secondary-grade classrooms might be more teacher centric and more formal than Western classrooms, vocationally focused classrooms and elementary classrooms (Jang et al., 2009, 2016). The suggested model might show different results in other learning contexts and other countries. Subsequent research can test the same model or an extended model using a broader research sample.

CONCLUSIONS

This study proposed and tested a dual-process SDT-grounded motivation mediation model with an additional factor, technology self-efficacy, in an emergency remote teaching and online learning context. This survey study was conducted in an academic-focused girls' high school in South Korea during the COVID-19 pandemic. Results from structural equation modelling provided evidence for the proposed model that explains both bright and dark sides of perceived teachers' efforts (autonomy support/control), student technology self-efficacy, student psychological needs for competence (satisfaction/frustration) and their relationships with cognitive engagement and cognitive disengagement in the online learning context. Our findings indicated the distinct processes including (a) "autonomy support-competence need satisfaction-cognitive engagement", (b) "teacher control-competence need frustration-cognitive disengagement", (c) "technology self-efficacy-competence need satisfaction-cognitive engagement" and (d) "technology self-efficacy-competence need frustration-cognitive disengagement (the indirect negative effect)". After considering the strength of the relationships, this study concluded that teacher autonomy supports addressing students' needs regarding their competence are likely to lead to students' cognitive engagement. On the other hand, teacher control affecting frustration among students regarding their competence is likely to lead to students' cognitive disengagement. Our findings also provide evidence that demonstrates the potential value of adding technology-related factors to an extended dual-process model in online learning contexts. However, due to the relatively lower extent of the impact, we suggest that further research is necessary to support this argument. This study is one of the few studies applying the SDT dual-process model in an online learning context. Further studies are required concerning contextual support, students' needs, motivation and learning outcomes to address the persistent attrition and low engagement issues of online learning environments.

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CONFLICT OF INTEREST STATEMENT

We declare no conflict of interest in the work that we are reporting here.

DATA AVAILABILITY STATEMENT

Anonymous analysis results are accessible upon request.

ETHICS STATEMENT

This study was conducted with University Institutional Review Board (IRB) approval. Being constrained by the human subject protection policies, the original study data are not open.

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APPENDIX

SURVEY ITEMS

Technology self-efficacy (TSE)
1. I feel confident in writing using Word programs
2. I feel confident in creating presentation materials using PowerPoint or Prezi
3. I feel confident in participating in online discussion forums

Perceived autonomy support (PAS)
1. My teacher provides me with choices and options in this online class
2. I feel understood by my teacher in this online class
3. My teacher tries to understand how I see things before suggesting a new way to do things in this online class
Perceived teacher control (PTC)
1. My teacher is inflexible in this online class
2. My teacher uses forceful language in this online class
3. My teacher puts a lot of pressure on me in this online class
Competence need satisfaction (CNS)
1. I do well in this online class, even on the hard things
2. In this online class, I feel successful in terms of completing difficult tasks and projects
3. I like and accept the hard challenges in this online class
Competence need frustration (CNF)
1. In this online class, I expect failure and to feel incompetent
2. I feel incompetent in this online class
3. I struggle with tasks that I should be good at in this online class
Cognitive engagement (COEN)
1. When learning for this online class, I try to explain the key concepts in my own words
2. When learning about a new topic in this online class, I usually try to summarize it in my own words
3. When thinking about the concepts in this online class, I try to generate examples to help me understand them better
Cognitive disengagement (CODISEN)
1. I am not sure how to study for this online class
2. In this online class, I find it difficult to organize my study time effectively
3. When I study for this online class, I have trouble figuring out what to do to learn the material

Note: The questionnaire was adapted from Jang et al.'s (2016) study considering the remote teaching context.