

## Article

# Global Pandemic Prevention Continual Learning—Taking Online Learning as an Example: The Relevance of Self-Regulation, Mind-Unwandered, and Online Learning Ineffectiveness

Hsien-Hua Yu, Ru-Ping Hu and Mei-Lien Chen \* 

Department of Industrial Education, National Taiwan Normal University, Taipei 106, Taiwan; generaladmin@apps.ntpc.edu.tw (H.-H.Y.); huru@ntnu.edu.tw (R.-P.H.)

\* Correspondence: lyt129@lygsh.ilc.edu.tw

**Abstract:** Since the global COVID-19 pandemic began, online learning has gained increasing importance as learners are socially isolated by physical and psychological threats, and have to face the epidemic and take preventive measures to ensure non-stop learning. Based on socially situated cognition theory, this study focused on exploring the relevance of online learning ineffectiveness (OLI) predicted by self-regulated learning (SRL) in different phases of learning (preparation, performance, and self-reflection) and its interaction with mind-unwandered during the COVID-19 pandemic. The subjects of the study were senior general high and technical high school students. After completing the online questionnaire, the PLS-SEM method of the structural equation model was used to analyze the data. Results demonstrated that self-regulation in two phases of preparation (i.e., cognitive strategy and emotional adjustment) and performance (i.e., mission strategy and environmental adjustment) in SRL are positively related to mind-unwandered in online learning. Moreover, mind-unwandered in online learning was positively related to the self-reflection phase (i.e., time management and help-seeking) of SRL. Additionally, self-reflection of SRL was negatively related to online learning ineffectiveness. PLS assessments found that the preparation and performance sub-constructs of SRL were negatively related to online learning ineffectiveness mediated by mind-unwandered and self-reflection of SRL. The results suggest that teachers can enhance their students' self-regulation in online learning, and assist them in being more mind-unwandered in online learning.



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**Keywords:** COVID-19; mind-unwandered; self-regulated learning; online learning ineffectiveness; online learning

## 1. Introduction

Since the outbreak of COVID-19 in January 2020, China has experienced two suspensions of classes and non-schooling. Considering the school closures during the epidemic, educators have focused their research on how to improve the effectiveness of online learning. The focus of previous research was on the correlation between online learning behaviors (e.g., attendance and number of discussions) and learning outcomes, and on the comparison of traditional learning with online learning in terms of their overall effectiveness [1]. During the COVID-19 outbreak, however, the effectiveness of students' online learning has been influenced by their learning strategies, approaches, and the focus of their online learning at home [2]. Socially situated cognition theory [3] refers to an individual's mental activity in which they reflect on what they are doing in detail. This mental reflection takes into account the social context in various learning activities to determine the learning strategies to be adopted. In particular, if there is a dangerous or uncertain social situation, it will influence the individual to change their original thinking patterns and reconstruct their

knowledge [4]. According to this social situated cognition theory, the learning strategies and the attention of online learning in social contexts during the COVID-19 epidemic will also be affected, which in turn will affect the learning outcomes.

According to Zimmerman [5], there are three processes of SRL: forethought, performance, and self-reflection. In addition, SRL involves a proactive process, a reactive process, and a continuous and iterative cycle [6]. Accordingly, the dynamic interplay between the SRL processes adopted by students during the COVID-19 epidemic and how their mental states mediate their learning outcomes at the time of learning are worth investigating. Yet, there has been limited research examining the correlation between SRL “preparation and execution” strategies and students’ mental states with “reflective” learning strategies. Therefore, this study aimed to investigate the correlation between students’ self-regulation before online learning, their state of mind-unwondered during online learning, and their reflection and perceived learning effectiveness after online learning. The study results can be applied to online learning during the COVID-19 pandemic in order to improve learning outcomes.

## 2. Literature Review

### 2.1. Self-Regulated Learning

Self-regulation has been conceptualized as comprising three cyclical phases, namely forethought, performance, and self-reflection. In addition, broadly speaking, three different SRL approaches are categorized as the preparatory phase, the performance phase, and the evaluation phase [7], or as reflective-oriented, adaptive, and monitoring self-regulated behaviors [8]. According to Martinez-Lopez et al. [9] and other scholars, moderation is used to set up six sub-scale constructs, namely Self-evaluation, Mood-adjustment, Task-strategies, Environment-structuring, Help-seeking, and Time Management. The first two constructs (Self-evaluation and Mood-adjustment) are the preparation phase, the middle two constructs (Task-strategies and Environment-structuring) are the implementation phase, and the last two constructs (Help-seeking and Time-management) are the reflection phase. Previous research has suggested that there are three factors associated with the three-phase model of SRL: personal characteristics, learning environment, and learning strategies [6]. That is, the online learning environment is related to the effectiveness of SRL. Thus, the three cyclical phases of self-regulation were adopted in this study to explore students’ self-regulation in online learning.

The efficacy of online learning seems to rely on students’ attitudes towards and engagement with online learning and their SRL skills [10]. Previous studies addressed students engaged in task preparation, for example, organizing appropriate messages to make connections, demonstrating their ability to engage in new situations, and continuously improving their performance to complete tasks [11]. For example, learners’ adaptive self-regulated behaviors are pre-considered as they engage in online learning. If learners have difficulty adapting emotionally, they have worse performance in school learning [12]. In online learning environments, SRL strategies play a critical role in assessing student learning. For example, Atmojo et al. [13] found that the average score of self-regulated learning was 74.59 (good) and the average learning achievement was 74.59 (good). Implementing self-regulated learning during the COVID-19 pandemic was carried out online. The learning design and the application of SRL strategies determined the learning effectiveness in learning activities during the COVID-19 pandemic [14]. Institutions and teachers can therefore provide students with effective support. A correlation has been found between academic achievement and SRL [15]. Therefore, this study aimed to examine self-regulation during online learning in the COVID-19 pandemic period.

### 2.2. Mind-Unwondered

Mind wandering is a mental state that people often experience while they are shifting attention from an ongoing task toward internal thoughts; it results in them decoupling from the outside world [16]. In online learning environments, learners can perform online

searches to find the information that meets their goals, but they have to pay close attention to the learning tasks [17]. In other words, in online learning environments, task-focused attention is related to the control of cognitive activity, which in turn is related to current message processing. Attention is often dichotomized as inattention versus total attention, where inattention is seen as a distraction because of loss of attention while performing tasks, while total attention is defined as mind-unwandered because as attention is fully focused on tasks. At different levels of cognitive processing, mind-unwandered allows the learner to focus their attention on external inputs and to maintain their cognitive processing [18]. In psychology, the mind-unwandered usually refers to a mindfulness to focus on a task at hand and be aware of the present moment [19]. Thus, it is suggested that COVID-19 leads to the need for students in online courses to maintain attention in learning processes; we therefore intended to explore the correlation between mind-unwandered and learning in online educational contexts. Previous research showed that mind-unwandered during COVID-19 online learning predicted learning effectiveness [2]. Therefore, this study evaluated participants' mind-unwandered in COVID-19 online learning and its mediating effect on SRL and online learning ineffectiveness.

### 2.3. Perceived Online Learning Ineffectiveness

Technology can be used to reduce the time and space of learning, and to enhance the outcomes of learning and training. The engagement of students emphasizes the amount of time and effort they put into their online learning. The purpose of activities determines the learning outcomes, specifically whether the desired result was achieved. Despite the many benefits of technology, accessibility for students on online platforms is still a challenge [18]. Magalhães et al. [20] found that online learning had greater benefits for students' learning outcomes than traditional learning. However, determining learning effectiveness depends upon the value that students perceive after learning online [21]. The perception of value can be positive or negative, according to attribution theory [22], with adolescents having positive attitudes towards themselves when their behaviors are result in success, but blaming others when their behaviors lead to unsuccessful results [7]. In other words, because of their sense of self-identity, adolescents rate their behaviors higher than others' behaviors [23,24]. However, it is easy to have a negative mindset regarding perceived learning effectiveness when responding to questionnaires [25]. Previous research also indicated that adolescents manipulate their activities, often predicting bad outcomes due to overconfidence and self-attribution [26]. For example, Rabin, Henderikx, Yoram, and Kalz et al. investigated various barriers that participants faced in massive open online courses (MOOCs) that contributed to the problem of poor learning outcomes [27], and Hong et al. explored the poor learning outcomes of students during the COVID-19 pandemic [28]. Therefore, this study adopted perceived online learning ineffectiveness as a substitute for learning effectiveness during the COVID-19 pandemic lockdown in the context of the persistent pandemic.

## 3. Hypotheses and Model

### 3.1. Hypotheses

In the current study, we applied socially situated cognition in order to examine the effects of self-regulation during students' pre-online learning, online learning, and post-online learning during the COVID-19 pandemic. Accordingly, the following hypotheses were proposed for the online learning environment.

#### 3.1.1. SRL and Mind-Unwandered

SRL involves the learner's use of learning strategies and mental engagement [29,30]. According to Zimmerman's SRL model, learners must regulate the space, tasks, and emotions of learning to achieve their goals in ways that enhance their cognitive abilities in learning. SRL also affects learners' attention during the learning process [31]. Cárdenas-Robledo and Peña-Ayala noted that SRL enhanced cognitive focus [32]. Zimmerman

explicitly regarded SRL as involving proactive processes. It is thus worth exploring whether the proactive “preparation and execution” phase of self-regulation is related to mental attention [6]. We put forward the following hypotheses:

**Hypothesis 1 (H1).** *Self-evaluation is positively related to mind-unwandered.*

**Hypothesis 2 (H2).** *Mood-adjustment is positively related to mind-unwandered.*

**Hypothesis 3 (H3).** *Task-strategy is positively related to mind-unwandered.*

**Hypothesis 4 (H4).** *Environmental-structure is positively related to mind-unwandered.*

### 3.1.2. Mind-Unwandered and Self-Regulation Time-Management and Help-Seeking

According to the attention and emotion theory, the executive functions of the human brain can facilitate or inhibit learners’ cognitive and affective responses [33]. That is, the focus of the brain affects the cognitive function and emotional regulation of the individual and reflects on whether or not the goals were achieved [34]. This mechanism requires full attention during the learning process to reflect on and improve the application of learning time and the effectiveness of help-seeking [35]. Accordingly, in reviewing the effectiveness of self-regulation, it is important to understand whether the focus on learning has an impact on the effectiveness of self-regulation to improve the application of learning strategies [36]. To understand the effect of mind-unwandered on the self-regulation of the reflection phase in online learning, the following hypotheses are proposed in this study.

**Hypothesis 5 (H5).** *Mind-unwandered is positively related to time-management in SRL.*

**Hypothesis 6 (H6).** *Mind-unwandered is positively related to help-seeking in SRL.*

### 3.1.3. The Reflection of SRL and Online Learning Ineffectiveness

With the flexibility-stability of strategy, the ability to adjust one’s strategies flexibly can enhance or inhibit the stability of the effect [37]. That is, the effects of continuous strategic adjustment may not be better than before as the effects are determined by the content and demands of the work or learning, which in turn affect the effectiveness of the work or learning [38]. SRL has both antecedent and consequent aspects that affect learning outcomes [6]. Self-reflection can enhance their strengths and improve their learning outcomes. In addition, self-assessment can directly or indirectly improve learning styles and affect learning outcomes, and thus is a prerequisite for assessing learning performance [39]. This study explored the perceptions of self-regulation in the reflection phase and their relation to online learning ineffectiveness, hypothesized as follows:

**Hypothesis 7 (H7).** *Help-seeking is negatively related to online learning ineffectiveness.*

**Hypothesis 8 (H8).** *Time-management is negatively related to online learning ineffectiveness.*

### 3.1.4. The Preparation and Execution Phases of Self-Regulation and Online Learning Ineffectiveness

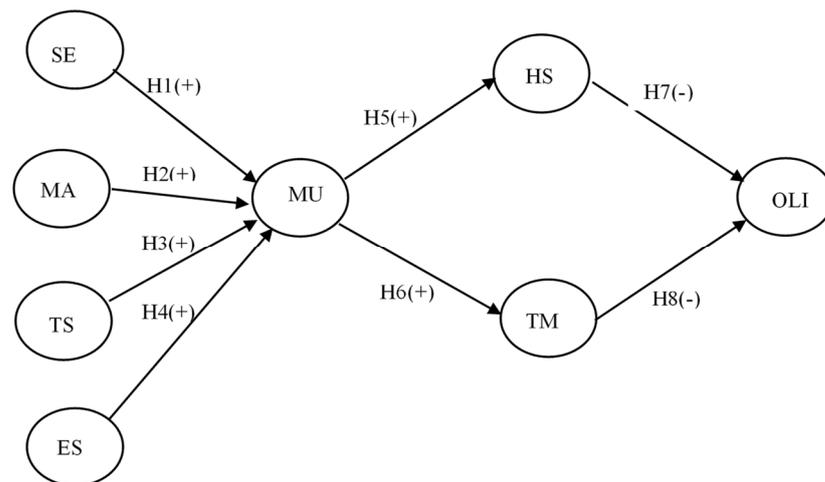
Perceptual, cognitive and motor processes are associated with the interpretation and coordination of physical and cognitive responses to situations in which cognitive and emotional states are being learned [40]. The impact of SRL on course learning outcomes and academic achievement has been widely studied [41]. Learners’ attention was found to affect learning effectiveness during the learning process [42]. In particular, the reflection phase improves the quality of learning and increases efficiency [41,43]. In addition, the reflection phase of self-regulation could cycle back and enhance the preparation and execution phases, which in turn could continuously improve learning effectiveness [44].

Therefore, according to these findings, the correlation between the SRL subframe and the inefficiency of online learning during the COVID-19 period was hypothesized as follows:

**Hypothesis 9 (H9).** *The self-regulation preparation and execution phases are indirectly negatively related to online learning ineffectiveness.*

### 3.2. Research Model

The cognitive and affective theories of multimedia learning pointed out that the effect of students' learning in different contexts lies in their own perceptions of the interactivity of media and contexts, and the power of interpretation of learning content [38]. From affection-to-cognition, students' self-regulated strategies positively or negatively affect their learning achievements [45], and these strategies affect the attention of students during the learning process, which influences the state of learning progress as well [46]. Thus, attention plays a relevant role in both learners' self-regulation and their achievements [47]. Three cyclical phases of SRL for learning were proposed by Zimmerman, namely the forethought phase, the performance phase, and the evaluation phase. SRL involves proactive processes, reactive processes, and continuous and iterative cycles [6]. Based on a previous study, we set up the "preparation and execution" phase of self-regulated strategies for online learning that influences the "evaluation" phase of self-regulation, and further explored online learning ineffectiveness, as illustrated in the research model shown in Figure 1.



**Figure 1.** Research model.

## 4. Method

The research methods adopted in this study are presented as follows.

### 4.1. Participants and Data Collection

After the outbreak of COVID-19 in January 2020, teachers in mainland China were linked to a WeChat community by internet mail during the epidemic period and were asked to send the questionnaires to groups of students who had participated in online courses for at least 2 months. We used the snowball sampling method to gather data from students, and the questionnaires were collected for 2 weeks from 1 May 2020 to 15 May 2020. Also, according to the ethical rules in our country, an anonymous questionnaire survey can be categorized as a review-exempt category and therefore does not require full ethical approval. These studies do require students to be provided with information about what they are being asked to do and to provide consent (with the option of withdrawing from the study). Students were aware that they were taking part in an evaluation study and that the data they provided were anonymous and that the study might be published.

#### 4.2. Sample Analysis

There were 441 questionnaires received from high school/vocational students in this study. After eliminating 66 invalid questionnaires with incomplete answers and omissions, the total number of valid questionnaires was 375, with a response rate of 85.0%. Participants were aged between 15 and 19 ( $M = 17.92$ ,  $SD = 3.30$ ); 237 (63.2%) were senior high school students and 138 (36.8%) were high school students; 152 (40.5%) were male and 223 (59.5%) were female; 132 students (35.2%) took 91–100% of their classes online, 95 students (25.3%) took 81–90%, 85 students (22.6%) took 71–80%, and 63 students (16.8%) took 70% or less of their classes online. Their average online learning time was 6.21 h per day.

### 5. Instruments

#### 5.1. Development of the Questionnaire

The questionnaire items were designed with reference to previous research and were modified according to experts' feedback. A 5-point Likert scale was adopted where 1 indicates *strongly disagree*, 2 *disagree*, 3 *no opinion*, 4 *agree*, and 5 *strongly agree*. First-order confirmatory factor analysis (CFA) was performed to examine the internal and external validity of the questionnaire, and constructs were tested for reliability and validity. The questionnaire items are described as follows.

1. Self-regulation measures of various domains (self-evaluation, mood-adjustment, task-strategy, environment-structuring, time-management, help-seeking): The questionnaire design was adapted from the SRL framework proposed by Pintrich [48] as a theoretical basis, and with reference to the study on SRL of online learning by Hong et al. [2].
  - (1) Self-evaluation example items: Before online learning, I would first understand the amount of learning to be done and set objectives; Before online learning, I would find out what I do not understand and try to ask questions in class.
  - (2) Mood-adjustment example items: Before online learning I liked to finish miscellaneous tasks of my learning to avoid not being able to pay attention in class; When online learning, I respond patiently when the teacher asks me questions.
  - (3) Task-strategy example items: During online learning, I adjusted the network system to avoid the inferior quality of the system which affects the learning efficiency; During online learning, I recorded the teacher's lessons for fear of losing attention and missing some key points.
  - (4) Environment-structuring example items: During online learning, I removed environmental interference from the class; During online learning, I found an environment that was not interfered with by external interferences (e.g., people walking around).
  - (5) Time-management example items: After online learning, I will set the time to review my homework; After online learning, I will review the execution of my study time.
  - (6) Help-seeking example items: After online learning, I will use the resources which are available around me (e.g., the learning websites) to improve my learning effectiveness; After online learning, I will ask my classmates for the key points or for assistance with problems that I didn't understand in class.
2. Mind-unwandered: mindfulness is used to measure the participant's attention to the present moment [49]. Paying attention is the core of mind-unwandered [50]. Therefore, the mind-unwandered state was considered when designing the survey items about attention being fully attentive to both internal and external stimuli. For example, in online learning, I could follow the teacher's teaching steps while learning even when I was not with the teacher; In online learning, I was extremely focused on the interactive discussions with my classmates.
3. Online learning ineffectiveness: Ruhland and Brewer noted [51] that learning outcomes should prove what students know and should also capture the changes that

occur in cognitive and emotional development during the learning process. Therefore, what participants perceive as learning outcomes refers to their insights into how the online learning program meets their needs and experiences. As noted above, given adolescents' social norms, this study used ineffectiveness instead of effectiveness to design students' perceived online learning performances. For example, my learning efficiency has deteriorated since online learning, and the quality of my work has deteriorated since online learning.

### 5.2. Item Analysis

We performed first-order CFA to ascertain the model of each observed variable, and to test the internal reliability and stability of the items. A factor loading value less than 0.5 was the criterion used to screen out invalid items. Those items that had higher residual values for each construct were removed until the validated factors met Hair et al.'s [52] recommended determination values. We then examined the external validity of each item, and we employed the independent samples *t* test to analyze the discriminatory validity of the high and low subgroups of items. After deleting those items that did not meet the criteria, four items each remained for the constructs of "self-evaluation," "mood-adjustment," "task-strategy," "environment-structuring," "time-management," and "help-seeking," while eight items remained for the constructs of "mind-unwandered" and "online learning ineffectiveness." SmartPLS version 3.3.2 was used for the analysis of all items in the structural model.

### 5.3. Construct Reliability Analysis

Nunnally [53] suggested that a Cronbach's  $\alpha$  value from 0.7 to 0.98 across constructs ensures the internal consistency of the constructs and can be considered as a high confidence level; if it was lower than 0.35, the construct should be deleted. The Cronbach's alpha values for this study were between 0.71 and 0.94, which matched the suggested requirement. As for the composite reliability (CR) of the constructs, Chin [54] suggested that it should be higher than 0.7, which means that the internal consistency of the constructs is high. In addition, the external consistency analysis of the constructs showed that the composite reliability (CR) values ranged from 0.82 to 0.95, which were in line with the threshold values and therefore the reliabilities were good, as shown in Table 1.

**Table 1.** Reliability and validity analysis.

Dimension	<i>M</i>	<i>SD</i>	FL > 0.7	Cronbach's $\alpha$	CR	AVE
Self-evaluation	3.75–3.95	0.78–0.92	0.75–0.81	0.80	0.87	0.62
Mood-adjustment	3.77–3.89	0.80–0.91	0.74–0.81	0.78	0.86	0.60
Task-strategy	3.67–4.02	0.80–1.05	0.71–0.80	0.71	0.82	0.54
Environment-structuring	3.78–4.10	0.78–0.90	0.71–0.77	0.71	0.82	0.53
Time-management	3.78–3.40	0.81–0.86	0.73–0.79	0.77	0.85	0.60
Helping-seeking	3.76–3.94	0.77–0.91	0.74–0.78	0.76	0.85	0.58
Mind-unwandered	3.43–3.91	0.88–1.14	0.70–0.81	0.90	0.92	0.58
OLI	2.25–2.36	0.97–1.11	0.81–0.87	0.94	0.95	0.71

Online learning ineffectiveness (OLI).

### 5.4. Construct Validity Analysis

The average variance extracted (AVE) and factor loading (FL) values should be greater than 0.5 [52]. The factor loading values ranged from 0.7 to 0.87 which were all higher than 0.7 and so could be considered as an acceptable result. Table 1 shows that the AVE values of the constructs in this study ranged from 0.53 to 0.71, which also fit the suggestions and are in line with Hair et al. [50].

In order to pass the discriminant validity test, it is required that the square root of the average variance extracted (AVE) of each latent construct exceed the absolute value of the Pearson correlation coefficient [55]. Although the "time-management" Pearson correlation

coefficient was equal to that of “task-strategy” to 2 decimal places, the square root of AVE of the “task-strategy” raw data was still higher than the Pearson correlation coefficient of “time-management”. Table 2 shows that the discriminant validity was confirmed and suitable for further structural model analysis.

**Table 2.** Construct discriminant analysis.

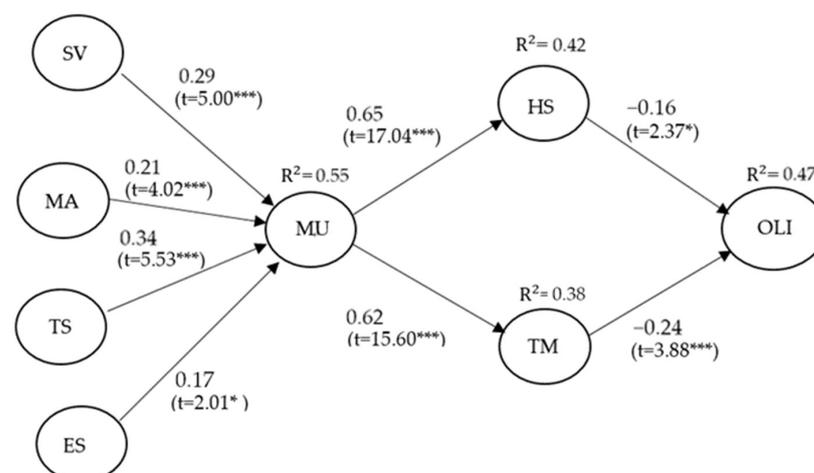
Construct	1	2	3	4	5	6	7	8
Self-evaluation	(0.79)							
Mood-adjustment	0.66	(0.78)						
Task-strategy	0.72	0.62	(0.73)					
Environment-structuring	0.55	0.62	0.59	(0.73)				
Time-management	0.75	0.65	0.73	0.64	(0.77)			
Helping-seeking	0.66	0.67	0.70	0.62	0.71	(0.76)		
Mind-unwandered	0.67	0.61	0.68	0.49	0.65	0.61	(0.76)	
OLI	0.59	0.51	0.60	0.50	0.61	0.61	0.65	(0.84)

Online learning ineffectiveness (OLI).

## 6. Results

### 6.1. Construct Analysis

We used Smart PLS (v.3.3.2) to analyze the paths among the constructs in the study framework. The data were analyzed by Bootstrapping with 5000 replicate sampling paths to determine whether the hypotheses were valid. A two-tailed test with a significance level ( $p$ -value) of lower than 0.05 was used [53]. Figure 2 shows that H1: self-evaluation was positively related to mind-unwandered ( $\beta = 0.29$ ,  $t = 5.00$  \*\*\*), H2: mood-adjustment was positively related to mind-unwandered ( $\beta = 0.21$ ,  $t = 4.02$  \*\*\*), H3: task-strategy was positively related to mind-unwandered ( $\beta = 0.34$ ,  $t = 5.53$  \*\*\*), H4: environmental-structure was positively related to mind-unwandered ( $\beta = 0.17$ ,  $t = 2.01$  \*), H5: mind-unwandered was positively related to help-seeking ( $\beta = 0.65$ ,  $t = 17.04$  \*\*\*), H6: mind-unwandered was positively related to time-management ( $\beta = 0.62$ ,  $t = 15.60$  \*\*\*), H7: help-seeking was negatively related with online learning ineffectiveness ( $\beta = -0.16$ ,  $t = 2.37$  \*), and H8: time-management was negatively related to online learning ineffectiveness ( $\beta = -0.24$ ,  $t = 3.88$  \*\*\*).



**Figure 2.** Verification of research model. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ ; \*  $t > 1.96$ , \*\*  $t > 2.58$ , \*\*\*  $t > 3.29$ .

Hair et al. [52] indicated that explanatory power values of 0.25, 0.50, and 0.75 represent weak, moderate, and strong explanations. The test results showed that the explanatory power of self-evaluation, mood-adjustment, task-strategy, and environment-structuring for mind-unwandered was 55%. The explanatory power of mind-wandered for help-seeking

and time-management was 42% and 38%, and the explanatory power of help-seeking and time-management for online learning ineffectiveness was 47%. Therefore, the explanatory variance ratio (VAF value) could be used, and the VAF value of  $20\% < \text{VAF} < 80\%$  indicates a partial mediation [52].

### 6.2. Mediation Effects Analysis

The mediating effect test showed that self-evaluation, mood-adjustment, task-management, and environment-structuring were indirectly and significantly negatively related to online learning effectiveness. The model was examined for multi-mediation effects using the bootstrap method. The data were compiled and the mediating effects of mind-unwandered are shown in Table 3. For H9: self-regulation preparation and execution strategies via mind-unwandered and online learning ineffectiveness, the results of this study showed a negative correlation.

**Table 3.** Mediation analysis.

Independent Variable	Intervening Variable	Dependent Variable	Indirect Effect	Total Effect	VAF	Confidence Interval 2.50%	Confidence Interval 97.50%
Self-evaluation	Mind-unwandered	OLI	−0.06 ** (−2.82)	−0.23	26.00%	−0.08	−0.01
Self-evaluation	Reflection phrase	OLI	−0.05 * (−2.02)	−0.22	23.00%	−0.07	−0.01
Mood-adjustment	Mind-unwandered	OLI	−0.03 * (−1.97)	−0.04	75.00%	−0.06	−0.01
Mood-adjustment	Reflection phrase	OLI	−0.02 ** (−2.68)	−0.03	66.67%	−0.05	−0.01
Task-strategy	Mind-unwandered	OLI	−0.05 ** (−3.02)	−0.21	23.80%	−0.20	−0.06
Task-strategy	Reflection phrase	OLI	−0.04 * (−2.02)	−0.20	20.00%	−0.20	−0.06
Environment-structuring	Mind-unwandered	OLI	−0.03 * (−1.99)	−0.10	30.00%	−0.18	−0.05
Environment-structuring	Reflection phrase	OLI	−0.02 * (−1.98)	−0.09	22.00%	−0.16	−0.05

\*  $p < 0.05$ , \*\*  $p < 0.01$ ; online learning ineffectiveness (OLI).

## 7. Discussion

Zimmerman proposed three cyclical phases of self-regulation for learning [5]: forethought, performance, and evaluation. SRL involves proactive processes, reactive processes, and continuous and iterative cycles [6]. Thus, this study set up the “preparation and execution” phase of self-regulation strategies for online learning to examine its influence on the “evaluation” phase of self-regulation, and further explored its correlation with online learning ineffectiveness during the COVID-19 pandemic.

### 7.1. SRL and Mind-Unwandered

According to Zimmerman’s SRL model, learners must regulate the space, tasks, and emotions of learning to achieve their goals and enhance their cognitive performance in learning [28]. SRL involves the learner’s use of learning strategies and mental engagement [28,29]. Ju and Lien [56] highlighted that the tendency of mind wandering is related to working memory capacity when a self-regulation process is required (i.e., under online learning); McCar, Cárdenas-Robledo, and Peña-Ayala [32] also suggested that SRL could enhance cognitive focus in learning. To investigate whether SRL with proactive processes is related to mind-unwandered in online learning, the results of this study showed that the four subcomponents: cognitive, emotional, task, and environmental, are correlated with mind-unwandered. That is, when faced with a learning challenge, students’ mind-unwandered during learning is influenced by their environment and their mood, and SRL also affects their attention during the learning process [33].

### *7.2. Mind-Unwandered, Time-Management, and Help-Seeking of SRL*

According to the attention and emotion theory, the executive functions of the human brain facilitate or inhibit the cognitive and affective responses of learners [33]; to put it another way, the brain's attention affects the cognitive functioning and emotional regulation of the individual, and reflects on whether one's learning style achieves one's goals [34]. The content of a given thought might be linked to (1) noticing something in our environment which indicates an ongoing cognitive process or (2) thoughts triggered by mental state, for example, mind wandering leading to an increased number of negative thoughts about past activities [57,58]. In line with this, this mechanism requires the learner to be mind-unwandered during the learning process, and to reflect on and improve the application of learning time and the effectiveness of help seeking [35]. So as to enhance the application of learning strategies, it is important to understand whether mind-unwandered has an impact on the effectiveness of self-regulation [59]. In this study, we investigated the correlation between students' mind-unwandered and self-regulation in online learning during the COVID-19 pandemic, and found that the results were positive. That is, the more mind-unwandered learners were during online learning, the more they were able to reflect on and improve their time-management and help-seeking strategies.

### *7.3. The Reflection Phase of SRL and Online Learning Ineffectiveness*

In the flexibility-stability strategy, the ability to adjust one's strategies flexibly can enhance or inhibit the stability of the effect, and the effect of the activity is examined in the continuous adjustment of one's strategies, but the effect of their continuous adjustment may not be for the better [37]. Effectiveness is determined by the content and demands of the work or learning, which in turn affect their effectiveness [38]. In addition, the self-regulated responsiveness of learning also affects learning effectiveness [6]. For example, evaluations of learning at the end of the SRL learning cycle can inform planning and behavior changes in a subsequent learning cycle, which then increases the enactment of effective learning strategies that can predict the improvement of performance in complex learning tasks [60]. In other words, continuous reflection afterwards to understand one's own strengths and weaknesses and to make improvements can enhance one's learning effectiveness. That is, in the SRL cycle, students will reflect on the demands of their course and will evaluate their past learning behaviors (i.e., judge what studying approaches did and did not work well for them) [61]. However, the results of this study indicated that there was a negative correlation between self-regulation and perceived online learning ineffectiveness while students were reflecting on their online learning during the COVID-19 pandemic. The reflection phase of SRL directly or indirectly improved learning styles and affected learning performance; thus, reflection is a prerequisite for improving learning performance [39].

### *7.4. The Preparation and Execution Phases of SRL and Perceived Online Learning Ineffectiveness*

The cognitive affective theory of learning with media suggests that the effectiveness of learning in different contexts depends on students' own perceptions of the interactivity of media and contexts, which leads to the interpretation of learning content [40]. When performing SRL, the focus of the learner affects the effectiveness of their learning [40]. In addition, the correlation between SRL in learning and academic achievement has been widely supported [41]; in particular, self-improvement of the quality and quantity of learning during the reflection phase increases learning effectiveness [41,43]. To succeed in active learning, students who underestimate their performance need to self-regulate their subsequent learning [62]. For those who underestimate their performance, self-regulated learning training programs focusing on the "preparation and execution" phase can enhance university students' academic performance [63]. Irvine et al. [11] showed that students who took task preparation seriously demonstrated their ability to engage in new contexts and continuously improved their performance to complete tasks. These self-regulated behaviors are related to reflexivity, adaptability, and monitoring. Overall, there is a correlation between academic achievements and SRL [13,64]. However, this study

investigated the correlation of self-regulation in the preparation and execution phases with ineffectiveness, and the results showed a negative correlation.

## 8. Conclusions

Online learning has been adopted for the continuation of academic activities across all schools worldwide during the COVID-19 pandemic [65]. COVID-19 is a physical disease that poses a contagious psychological threat with an increasing number of deaths and coverage [66]. During an epidemic, online learning becomes one of the main activities of instruction within the constraints of social distancing. Study results indicated that there was a significant and positive relation from self-evaluation, mood-adjustment, task-strategy, and the environment-structuring phase of self-regulation to mind-unwandered, while there was a negative relationship between mind-unwandered and perceived online learning ineffectiveness, with mind-unwandered and the reflection phase (help-seeking, time-based self-regulation) being partially mediated.

### 8.1. Practical Recommendations

Therefore, the conclusions of the study are important to present in the COVID-19 pandemic. The pandemic has caused physical and psychological panic among humans, and new findings have been made regarding maintaining a socially detached teaching environment, and have painted a generalized picture of online learning during the pandemic. The findings provide educational researchers with a clear understanding of the influence of different phases of self-regulation on learners' perceived ineffectiveness when facing the pandemic in a specific learning environment. They further provide educators with the thinking and understanding to control the possibilities of online learning in different contexts of time and space in the future after temporal and spatial variation.

### 8.2. Limitations and Future Study

During the COVID-19 pandemic, students need greater ability to refocus their attention while they are engaged in online learning [67]. Previous research has indicated that students who lack self-regulation are easily distracted and lose interest in online learning [68]. The results of this study showed that the cognitive, preparation, and execution phases of self-regulation were significantly and positively related to mind-unwandered. Zimmerman noted that there are three phases of self-regulation: preparation, execution, and reflection [5]. In the present study, mind-unwandered was added after the self-regulation preparation and execution phases to mediate the reflection phase of self-regulation. However, the three phases can be cyclical in Zimmerman's discussion [5], so it is suggested that future research refer to the three-phase studies.

This study was conducted under the health principle of maintaining social distance and preventing learning from stopping during the COVID-19 period to investigate the correlation among the six different domains of self-regulation, mind-unwandered, and perceived online learning ineffectiveness. In the future, we may incorporate differences in student classification, gender, or age, or examine other factors such as self-efficacy and self-direction to enrich the study.

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