Examining the Relationships of Student Perceptions of Online Self-Regulation Support, Academic Emotions, and Metacognitive Awareness

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Abstract: Supporting students self-regulated learning in online environments plays a critical role in enhancing students' academic success in online learning. In this study, features designed to prompt students' self-regulated learning behaviors were integrated into an existing online learning system and a pilot study was conducted to compare students' perceptions of the original system without the self-regulation support features with the enhanced system with the self-regulation support features. The results suggested that students perceived the enhanced system as better supporting the processes of planning, monitoring, and perception during learning. Students' perceptions were closely related with students' emotions but not with their metacognitive awareness, although several aspects metacognitive awareness were correlated with certain types of academic emotions.

Introduction

Research shows that the adoption of self-regulated strategies such as time management, metacognition, effort regulation, and critical thinking is positively related to academic success in online learning (Broadbent & Poon, 2015). Some researchers have studied the effects of creating self-regulation support using learning analytics dashboards (LADs), which display aggregated indicators about learners and learning processes (Schwendimann et al., 2017). However, based on the recent review by Matcha et al. (2020), there is limited evidence that existing LADs support self-regulation. There is a need to provide students with actionable feedback (Duan et al., 2022; Susnjak et al., 2022) that enables self-regulation behaviors. To address the gap, an LAD aimed at provoking immediate actions from learners was designed and integrated into an online learning system. This paper reports an exploratory study that examines students' perceptions of this self-regulation support features. The relationships of students' perceptions with their metacognitive awareness and academic emotions are also examined.

Literature Review

Self-Regulated Learning, Metacognitive Awareness, and Academic Emotion

Self-regulated learning is defined as "self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals (Zimmerman, 2005, p. 14). Self-regulated learning is a multidimensional, interactive process that involves not only the development of metacognitive awareness but also the implementations of strategic actions such as planning, monitoring and perception (Ridley et al., 1992). Metacognitive awareness, defined as "the process of using reflective thinking to develop awareness about one's own person, task, and strategy knowledge in a given context" (Ridley et al., 1992), produces a readiness for action. However, possessing metacognitive awareness is often insufficient when learners fail to develop the fundamental skills (Zimmerman, 2002). As a result, it is important to provide self-regulation support in online learning environment to facilitate the process of self-regulated learning.

Academic emotions are defined as "emotions tied directly to achievement activities or achievement outcomes" (Pekrun et al., 2007, p. 15). They play an important role in motivation and learning, and are closely related to students' learning strategies, cognitive resources, self-regulation, and so on (Pekrun et al., 2002). Although academic emotions are considered as key constructs of self-regulated learning (You & Kang, 2014), it is largely unclear whether students' academic emotions are related to how they perceive the self-regulation support in an online learning environment. In addition, it remains unknown whether students' metacognitive awareness plays a role in influencing their academic emotions.

Self-Regulation Support Features in STEM Fluency

STEM Fluency (https://stemfluency.org/) is an online learning system developed based on a set of research-validated principles and methods (Mikula & Heckler, 2017). It allows students to effectively practice basic math skills related to STEM learning to achieve mastery (Heckler & Nieberding, 2023). In this study, a few self-regulation support features were designed to provide actionable prompts for students to plan, monitor and evaluate their learning. First, LAD displays students' performance on their practice, which help students monitor and evaluate their learning. Second, based on their self-perception, students can also plan for their subsequent learning by creating practice sets with the problems that they want to practice. Third, a goal setting bar on the LAD allows students to set up goals after evaluating their learning. Figures 1 and 2 present screenshots of the self-regulation supporting features in the online learning system.

Method

A pilot study was conducted to address the following research questions:

1. Did students perceive the enhanced system better support the planning, monitoring, and evaluation phases of self-regulated learning as compared to the original system?
2. Were students' perceptions of the self-regulation support features related to their metacognition awareness or academic emotion?
3. Were students' metacognitive awareness related to students' academic emotion?

Participants and Setting

Participants were 129 students enrolled in an undergraduate physics class, with the majority of them being biology, applied health science, and engineering technology majors. There were 57 female and 72 male students. Their average age is 20.03 with a standard deviation of 1.38.

Procedures

At the beginning of the semester, students took a survey measuring their metacognitive awareness. This metacognitive awareness survey has 12 items of 7-point Likert Scale questions adapted from Schraw and Dennison's (1994) Metacognitive Awareness Inventory. Students were asked to rate each statement ranging from 1 – "not true at all" to 7 – "totally true". There are three subscales measuring students' metacognitive awareness in planning, monitoring, and evaluation respectively. Some example questions are "I pace myself while learning in order to have enough time." (planning); "I ask myself periodically if I am meeting my goals" (monitoring); and "I know how well I did once I finish a test" (evaluation).

From week 1 to week 10, all students used the original online learning system to complete their weekly assignments. From week 11 to week 15, in contrast, students used the enhanced system with the self-regulated learning features integrated. At the end of the semester, students completed a second survey with two sections. The first section contains 6 items of 7-point Likert Scale questions, where students rated how well the original and the enhanced systems support the activities of planning (2 items), monitoring (2 items), and evaluation (2 items) during learning, with 1 indicating "Extremely Poorly" and 7 "Extremely Well". Questions from the second section were based on the short version of Academic Emotion Questionnaire (Bieleke et al., 2021), which asked students to rate how they feel in general when studying in the online system throughout the semester. There are altogether 32 items, with four targeting each of the following academic emotions: enjoyment, hope, pride, anger, anxiety, boredom, hopelessness, and shame.

Data Analysis and Results

Students' ratings on all items within each subscale of the metacognitive awareness were added up to represent students' metacognitive awareness scores on planning, monitoring, and evaluation. Similarly, scores on how well the original and enhanced systems support students in terms of planning, monitoring, and evaluation were calculated by adding the scores of two items under each subscale, resulting three scores (on planning, monitoring, and evaluation respectively) for the original system and three scores for the enhanced system. Finally, the sums of students' ratings on all items within each subscale of the academic emotion survey were used to represent students' emotion scores.

The following statistical analyses were conducted. First, paired samples t-tests were conducted to see whether students' ratings on how well the original and enhanced systems support planning, monitoring and evaluation were significantly different. The results suggested that students perceived that the enhanced system was better at supporting their planning [$t(128)=2.41$, $p < .05$], monitoring [$t(128)=3.50$, $p < .001$], and evaluation [$t(128)=2.12$, $p < .05$] while they were practicing in the STEM Fluency system (See Table 1).

Table 1. Means (Standard Deviations) of Students' Perception Scores for the Original and Enhanced Systems with the t-test Results (n=129)

	Original System	Enhanced System	*t*
Planning	8.88 (2.95)	9.41 (2.99)	2.41 *
Monitoring	8.39 (3.21)	9.31 (2.98)	3.50 **
Evaluation	9.11 (3.29)	9.59 (3.04)	2.12 *

* p<.05; ** p<.001

Second, correlation analyses were conducted to identify the relationship of (a) students' metacognitive awareness scores and their ratings of both the enhanced and original systems and (b) students' academic emotion scores and their ratings of both the enhanced and original systems. The results showed no correlation between metacognitive awareness and their ratings of the systems, but significant correlations between academic emotion and their ratings of the systems (See Table 2).

More specifically, emotions including anger, anxiety, hopeless, and boredom are negatively correlated with students' ratings for both the enhanced and original systems, and emotions including enjoyment, hope, pride are positively correlated with students' ratings. The emotion shame is also negatively correlated with students' ratings on evaluation in both systems, and with students' ratings on planning and monitoring in the original system. This finding suggested a close association with student academic emotion and their perception of how self-regulation support features.

Table 2. Correlations between Student Academic Emotions and Perceptions of the Self-Regulation Support Features (n=149)

	Enjoyment	Hope	Pride	Anger	Anxiety	Shame	Hopelessness	Boredom
E-Plan	.380**	.397**	.405**	-.229**	-.253**	-.172	-.339**	-.251**
E-Monitor	.365**	.371**	.397**	-.209*	-.203*	-.137	-.335**	-.256**
E-Evaluation	.438**	.462**	.417**	-.273**	-.297**	-.204*	-.423**	-.316**
O-Plan	.474**	.447**	.407**	-.256**	-.300**	-.262**	-.369**	-.240**
O-Monitor	.375**	.317**	.380**	-.266**	-.233**	-.235**	-.210*	-.198*
O-Evaluation	.454**	.443**	.455**	-.246**	-.236**	-.246**	-.326**	-.304**

Note: * p<.05; ** p<.01; E-Plan, E-Monitor, and E-Evaluation refer to students' ratings of the enhanced system, and O-Plan, O-Monitor, and O-Evaluation refer to students' ratings of the original system.

Finally, correlation analyses were run to see whether students' metacognitive awareness is correlated to their academic emotions. A total of 65 students who completed the academic emotion survey also completed the metacognitive awareness survey. As a result, the analyses were conducted based on data collected from these 65 students. The results suggested that all three aspects of metacognitive awareness are positively correlated with enjoyment. In addition, hope is positively correlated with the metacognitive awareness of planning and monitoring; anger is negatively correlated with the metacognitive awareness of monitoring and evaluation; and boredom is negatively correlated with the metacognitive awareness of monitoring and evaluation.

Table 3. Correlations between Student Academic Emotions and Metacognitive Awareness (n=65)

	Enjoyment	Hope	Pride	Anger	Anxiety	Shame	Hopelessness	Boredom
Plan	.393**	.438**	.152	-.336**	-.220	-.139	-.217	-.237
Monitor	.369**	.417**	.195	-.336**	-.217	-.164	-.238	-.285*
Evaluation	.279*	.237	.212	-.230	-.152	-.193	-.195	-.260*

Note: * p<.05; ** p<.01

Significance of the Study

This study is significant in several ways. First, it contributes to the research literature by proposing a potentially effective design to promote and support students' self-regulation in online learning. Future research is needed to examine students' online learning behaviors for a deeper understanding of the effectiveness of this enhanced learning system. Second, the study shows that students' perceptions of how well the systems supported their self-regulated learning were strongly related to their academic emotions, suggesting a need to interpret students' evaluation with caution. Third, metacognitive awareness was not related to students' perceptions, but was highly related to academic emotions. This may suggest a potential mediating effect of metacognitive awareness on the relationship between student emotion and their perceptions, which is worth exploring in the future.

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