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Assessing students' metacognitive strategies in e-learning and their role in academic performance

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ABSTRACT

The presence of e-learning as a new way of learning in the education system has attracted the interest of researchers worldwide. Higher education still uses the system as part of the method. The critical issue in e-learning is how to promote academic performance. Metacognition theory argues that students' skills determine academic performance. Through metacognitive, students set their own goals, learning, monitoring, and evaluating in e-learning. However, less is known about how students use strategies in e-learning in the Indonesian context. Also, there is a scarcity of empirical evidence about the role of on academic performance. This study aims to assess students' metacognitive strategies and their impact on academic performance (i.e., engagement and achievement) in the e-learning context. One hundred and fifty students participated in the present study. Descriptive statistics and structural equation modeling were performed for data analysis. This study revealed that students have high skills in metacognitive strategies in e-learning. Our study suggested that metacognitive strategies for self-regulated learning were significantly associated with achievement and engagement in e-learning. In comparison, metacognitive for time and environment was only significantly associated with students' attention but not achievements. The contribution of this study to academic practice was explored.

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INTRODUCTION

The integration of digital technology and the presence of e-learning for several decades has led to massive growth in the number of e-learning courses globally. One of the most significant current discussions regarding e-learning as a new system in education is how to promote students' academic performance, including their active participation, particularly in e-learning. Students' engagement has been perceived as a primary challenge the teacher faces in e-learning (Sharif Nia et al., 2022). Metacognition knowledge theory (Veenman et al., 2006) argues that students' academic performance (e.g., engagement and achievements) was closely associated with their skill in

regulating and evaluating their strategies knowledge. Therefore, to promote academic performance, students should use metacognition strategies.

Metacognition refers to a set of regulatory meta-abilities and meta-skills that are intentionally employed to smooth the cognitive and psychophysiological system (Drigas et al., 2022). Metacognition refers to the knowledge about and regulation of one's mental activities in learning (Veenman et al., 2006). Therefore, the terminology of metacognition constitutes knowledge and strategy of cognition. Taxonomically, metacognition can be divided into metacognitive declarative and metacognitive procedural. Metacognitive declarative refers to one's beliefs about their ability or general knowledge. At the same time, metacognitive procedural refers to the control and regulation process (Csíkos, 2022). Metacognitive strategies in our study guide to the metacognitive procedural, where the investigation of this metacognition relates to how students regulate, control, and evaluate their learning. Metacognition promotes academic performance (Anthonysamy, 2021; Csíkos, 2022; Dignath & Veenman, 2021).

Academic performance refers to the students' output, such as engagements, grades, taking exams, giving presentations, etc. (Credé & Kuncel, 2008). In the present study, we emphasized the academic performance on students' engagement and grades. Student engagement is a student's psychological investment in an effort directed toward learning, understanding, or mastering knowledge, skills, or craft that academic work is intended to promote (Kong et al., 2003). Engagement refers to the student's involvement in educationally effective practices and commitment to educational goals and learning (Chiu, 2022). There are several forms of engagement in academic performance: cognitive, emotional, and behavioral. Our investigation will focus on behavioral and cognitive engagement in the present study. Behavioral engagement refers to the extent involved students are in learning activities in terms of attention, participation, effort, intensity, and persistence (Chiu, 2022).

Numeral studies have tried to address the link between metacognitive strategies and academic performance. Student's academic performance in an e-learning context, such as student engagement and achievement, has resulted from metacognitive strategies (Y. Zhang et al., 2022). For example, Csíkos and Steklács (2010) pointed out that metacognitive strategies in the intervention class have been found to run more excellent students' performance in academic reading and mathematics skills. Burin et al. (2020) suggested that students with high metacognitive skills tend to perform better in answering comprehensive questions. Valencia-Vallejo et al. (2019) indicated that students who used the metacognitive strategy presented better achievement than their classmates who did not involve metacognitive skills. Not only has metacognition influenced academic achievement, but also it has been found to play a significant role in promoting academic engagement (Coelho et al., 2019). Sun and Rueda (2012) reported that how students regulate their learning strategies was found to be significantly correlated with three types of academic engagements (cognitive, emotional, and behavior). Overall, from the previous studies, the role of metacognitive strategies in academic performance is crucial.

Although the role of metacognitive strategies in academic performance has been extensively researched in previous studies (Burin et al., 2020; Csíkos, 2022; Csíkos & Steklács, 2010), the extent to which students use metacognitive strategies in the Indonesian context has been rarely investigated, particularly for metacognitive in E-learning. E-Learning and offline learning are different. In offline learning, teachers and students can interact actively with each other. In the e-learning context, students are more independent. Therefore, the role of metacognitive strategies is crucial. Several metacognitive strategies are relevant to promote students' academic performance, such as metacognitive strategies for self-regulated learning and metacognitive for time and environment (Pintrich, 2015). Metacognitive strategies for self-regulated learning refer to the awareness, knowledge, and control of cognition. Metacognitive for time and climate refers to the students' strategy to manage and schedule their education (Pintrich, 2015).

In Indonesia, most of the higher education has already used the e-learning system as the new way of learning. During the pandemic, learning has been transformed into an online system. After the pandemic, learning has come back to offline learning. At the same time, e-learning still has been used in higher education. However, the extent to which students involve in metacognitive

strategies has hardly been studied. Also, few studies have addressed the effect of these skills on academic performance in the e-learning context. Therefore, to contribute to the existing gap in the previous study, this research aim is to assess students' metacognitive skills and their relations to academic performance in the Indonesian context. Gender differences were also examined in the present study. Because gender become an essential issue in several countries regarding academic performance (Shafiq, 2013). For instance, Ciascai and Lavinia (2011) pointed out significant differences between boys and girls students in their metacognitive skills. L. Zhang (2018) suggested that males use higher metacognitive skills than female students. Accordingly, the research questions below will guide our investigations.

1. What is the level of Indonesian students' metacognitive strategies in the e-learning context?
2. Do gender differences exist in terms of metacognitive strategies for e-learning in the Indonesian context?
3. Do the students' metacognitive strategies in e-learning affect their academic performance?

METHOD

Our study's purpose is to explore the effect of students' metacognitive strategies in e-learning and to explore the role of these metacognitive in shaping perceived autonomy and academic performance. This cross-sectional study was conducted in Indonesia. Using snowball random sampling methods, 157 students from two higher education participated in the study. All of the samples in the present research fully participated in e-learning systems. 76% were female students, and 24 % were male students. 38% were second semester, 26% were fourth semester, 16 % were sixth semester, and 20 % were eighth semester.

Concerning the measurement tools, several instruments were adapted to measure students' metacognitive strategies and students' academic performance. The adaptation of the instruments has been through the translation of the instruments from English to the Indonesian language. We measure metacognitive strategies with metacognitive self-regulated learning and metacognitive time and study environment questionnaire. All the questionnaires were rated with a 5-point Likert scale (1= = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5= = strongly agree).

We adapted nine metacognitive strategies self-regulated learning items from the motivated strategies for learning questionnaire (MSLQ]; Pintrich et al., 1991) to measure students' *metacognitive strategies*. We modified the items of this questionnaire for the e-learning context. For instance, "I ask myself questions to make sure I understand the material in e-learning" and "When I join e-learning, I set my goal to direct my activities." Four items were also adapted from the same questionnaire to measure students' metacognitive time and study environments. For example, "I study in a place where I can focus on my e-learning" and "I make good use of my study in e-learning." We measure academic performance with students' engagement and achievements. Six items were adapted from need support satisfaction (Standage et al., 2005) to measure students' engagement. For example, "I often discuss with my friend what I learn in e-learning" and "I regularly participated in class discussions." We asked students' grade point averages to measure their achievements. All the instruments were distributed through Google Forms. Students were invited to complete this questionnaire using WhatsApp.

The data analysis has been conducted with several steps. First, we examined the validity of our instruments with exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). Several criteria were used to investigate the fit model of this instrument. These are the comparative fit index (CFI), Tucker Lewis Index (TLI), RMSEA, and SRMR. The cutoff value for CFI and TLI should be > .90, RMSEA < .08, and SRMR < .05, indicating the model fit (Hair et al., 2019; Hu & Bentler, 1999). Second, students' metacognitive strategies were explored using descriptive statistics. The students' metacognitive strategies level was also examined based on their gender differences by performing a t-test. Multiple regression analysis examined the association between students' metacognitive strategies and academic performance.

RESULT AND DISCUSSION

Result

Confirming the validity and reliability

We confirmed the validity and reliability of our instrument by performing confirmatory factor analysis (CFA) using Mplus 8 software. CFA result showed the fit model of our instruments, Chi-square = 181.29, df = 63, CFI = .92, TLI = .91, RMSEA = .07, SRMR = .06. According to Hair et al. (2019) and Hu and Bentler (1999) the cut off criteria CFI, TLI should close to .95 and RMSEA should < .08. The loading factors range from 0.52 to 0.78 which indicated that the items were valid to measure the latent variables. We deleted two items (a4 and a6) of academic engagement and 1 item of metacognitive self-regulated learning (Ms5). Cronbach alpha was used to confirm the internal consistency of our instruments. The coefficients of Cronbach alpha for our instruments indicated that metacognitive strategy for self-regulated learning, metacognitive for time and study environments, and engagement instruments were reliable. .87, .83, and .82, respectively.

Concerning the convergent validity, we evaluated it based on the values of average variance extracted (AVE). Although the AVE for metacognitive self-regulated learning and metacognitive time and environment was lower than 0.5, the composite reliability (CR) for these scales was higher than 0.7. Therefore these instruments were acceptable (Hair et al., 2019). The convergent validity was evaluated based on the root of AVE. The data showed that all the roots of AVE were higher than the correlation between factors. Therefore, our instruments fulfilled the discriminant validity criterion (Hair et al., 2019).

Descriptive statistics and correlations

Table 1. describes the descriptive and the correlations among variables in the present study. The data showed that students have high skills in metacognitive self-regulated learning and metacognitive time and environment according to the mean result of a 5-point Likert scale. Students also viewed they were engaging in e-learning. The correlations data showed that metacognitive self-regulated learning and metacognitive time were strongly correlated with metacognitive time and environments. Both metacognitive strategies were also strongly correlated with students' engagement in e-learning.

Table 1. Descriptive statistics and correlations

No.	Variables	Mean	SD	1	2	3	4	5
1.	Metacognitive self-regulated learning	3.56	.62	**.71**				
2.	Metacognitive time and environment	4.07	.76	.56**	**.64**			
3.	Engagement	3.77	.66	.68**	.63**	**.77**		
4.	Gender	-	-	.15	.03	.08		
5.	GPA	-	-	.41**	.30**	.34**	.02	
6.	AVE	-	-	.50	.41	.60	-	-
7.	CR	-	-	.87	.73	.70	-	-
8.	Skewness	-	-	-.32	-1.49	-.46	-	-
9.	Kurtosis	-	-	1.59	3.70	1.32	-	-

Note. ** significant in the level.001 (p <.001), * significant in the level .05 (p <.05). AVE = Average variance extracted; diagonal values are the root square of average variance extracted. CR = Composite reliability.

RQ1: What is the level of Indonesian students' metacognitive strategies in e-learning?

Table 2 describes the students' metacognitive skills in e-learning. Overall, the data indicated that students used metacognitive skills. In the e-learning, most students expressed that they noted every critical information. It means that students not only used the information provided in the tools, but also, they recorded each piece of information. Students also expressed that they have changed their strategy if they were difficult to understand the course in e-learning.

Table 2. Descriptive statistic of students' metacognitive strategies in e-learning

No.	Variables	Mean	SD
1.	Metacognitive Strategies for self-regulated learning		
2.	During e-learning, I noted the importance of information	3.77	0.90
3.	When I read the course in e-learning, I make up questions to help my focus	3.21	0.83
4.	When I become confused about something I'm reading in e-learning, I try to figure it out.	3.72	0.95
5.	If course materials are challenging to understand, I change the way I read the material	3.45	0.95
6.	I ask myself whether I understand the topic or not in e-learning	3.55	0.82
7.	I try to change the way I study to fit the course requirements	3.65	0.83
8.	In e-learning, I try to determine which concepts I don't understand well.	3.59	0.80
9.	In e-learning, I set goals to direct my activities in each study period.	3.68	0.95
10.	Metacognitive strategies for time and environment		
11.	I join e-learning regularly	4.39	0.88
12.	I make good use of my study time in e-learning	3.85	0.93
13.	I have a regular place set aside for study	4.12	0.93
14.	I study in a place where I can concentrate on my coursework	3.92	0.99

Concerning the skill of managing time and environment, the data showed that most students expressed that they were good at managing their time and environment. They said that they were regularly joining e-learning. They were strategic in setting their time and environment to reach their desired goals. Students showed that they were strategic in finding a comfortable place in e-learning. They could see a comfortable place when joining e-learning.

RQ2: Do gender differences exist regarding metacognitive strategies for e-learning in the Indonesian context?

An Independent sample t-test was used to examine whether male and female students were equal regarding their metacognitive strategic skills. The t-test result showed that gender inequality did not exist in this study. Both male and female students have the same level of metacognitive strategy for self-regulated learning (M (SD) = 3.41 (0.69) vs. M (SD) = 3.62 (0.59), respectively, F = 0.19, p = 0.7). Both of them were also equal in metacognitive strategy for time and environment skills (M (SD) = 4.03 (0.82) for male vs. M(SD) = 4.09 (0.74) for female, F = .00, p = .72)

RQ3: Do the students' metacognitive strategies in e-learning affect their academic performance?

Covariance Based- Structural equation modeling (CB-SEM) was performed to examine whether students' metacognitive skills positively impact academic performance. There are two exogen variables and two variables' endogens. Metacognitive skills, self-regulated learning, and metacognitive time and environment were exogen variables in the present study. Students' engagement and achievement were endogen variables in this study.

Figure 1 the standardized association between metacognitive strategy skills and academic performance. MSR = metacognitive for self-regulated learning, MTE = metacognitive skills for time and environment, AEG = Engagements, GPA = Grade point academic, ms1 – ms9 = the item 1 of metacognitive for self-regulated learning, tm1-tm4 = the items of metacognitive for time and environment, a1-a6 = the items of academic engagement.

The normality data was evaluated based on skewness and kurtosis. We accept the |3| criterion for skewness and |8| for kurtosis (Kline, 2005). We found the fit model of the relations between metacognitive strategy skills and academic performance, Chi-square = 192.08, df = 113, $p < .001$, CFI = .94, TLI = .93, RMSEA = .06, SRMR = .06. Metacognitive strategy for self-regulated learning were positively associated with GPA ($\beta = .38$, $p < .001$) and academic engagements ($\beta = .59$, $p < .001$). At the same time, the metacognitive skills for time and environment were positively associated with academic engagements ($\beta = .41$, $p < .001$). The association between metacognitive skills for time and setting and students' achievement was insignificant ($\beta = .09$, $p = .45$).

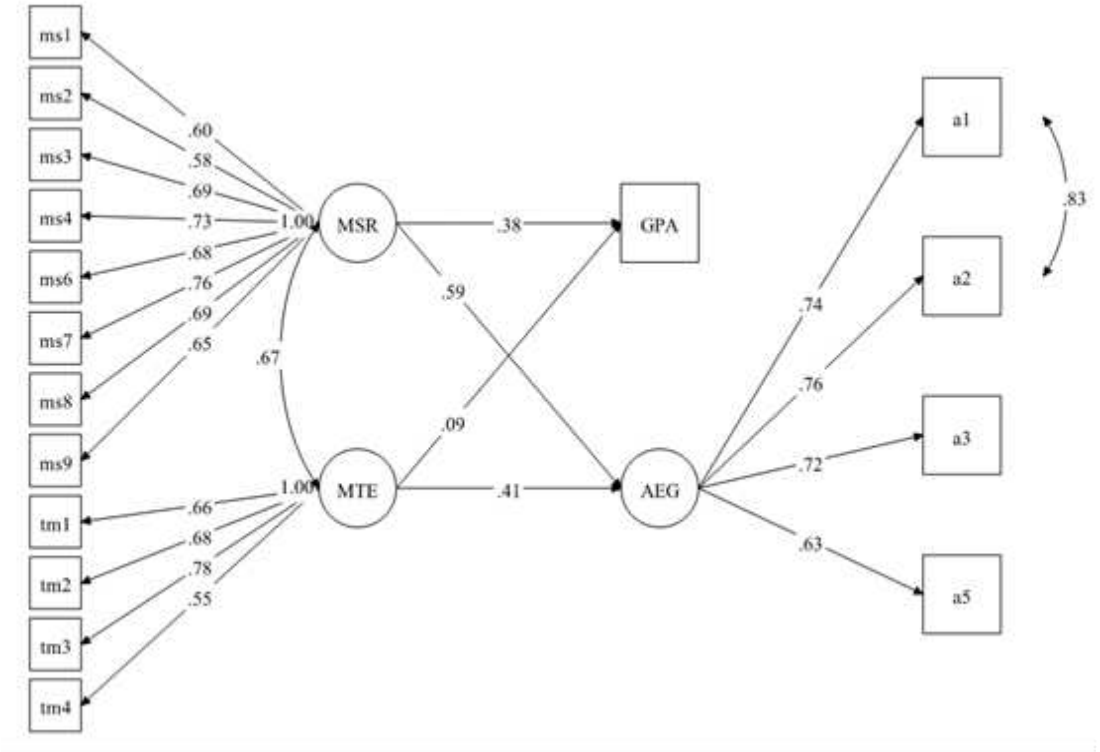

Figure 1. Standardized Association

Discussion

Our main study is to explore students' metacognitive strategy skills in e-learning and their effect on academic performance. The finding of this study contributed to providing data on the level of students' metacognitive skills and how to improve students' academic performance in e-learning. The first finding of this study told us that students have good metacognitive strategy skills in e-learning. Students expressed that they were strategic in regulating their ways to reach the goal, such as, "If course materials are difficult to understand, I change the way I read the material." In the context of e-learning, Barnard et al. (2009) argued that the strategy may fluctuate in the learning environment context.

Most importantly, students also have attempted to reflect on whether or not they understand the e-learning courses. In other words, students in e-learning tend to practice metacognitive strategy skills. The experience in using e-learning before and after the pandemic may contribute to students' metacognitive skills in Indonesia. However, further investigation is whether Indonesian students still use these skills for an extended period of the e-learning system. Because, in some cases, students can drop out of e-learning. For instance, in the MOOC context, students tend to drop out of online learning (Vilkova, 2022).

The second finding of this study told us that male and female students were equal in terms of metacognitive strategies. This finding contradicts Ciascai and Lavinia (2011) and L. Zhang (2018), who found significant differences in metacognitive skills between male and female students. This study aligned with Hidayatullah et al. (2023), who suggested that male and female students were equal in their metacognition beliefs in the Indonesian context. Our interpretation in this stage is that students have the same chance in online learning contexts. Therefore, gender was not a big issue regarding metacognitive strategies in e-learning. The third finding of this study revealed that metacognitive strategies for self-regulated learning influenced their engagement and their academic performance. In other words, when students regulate their own learning, they gained better achievement in academic performance. The more strategic students were in learning, they became

more active. This finding is in line with the study by Coelho et al. (2019), which suggested that the more strategic students in regulating their learning, the they were more engaged in academic performance. Sun and Rueda (2012) argued that in distance education, their environment determined personal factors, such as the metacognitive for self-regulated learning skills. E-learning may provide a situation that pushes students to be more autonomous and organize their learning. Also, this study found that metacognitive strategies for self-regulated learning were positively associated with their grade point academics (GPA). This finding revealed the same result as the previous studies (Ajisuksmo & Saputri, 2017; Jain & Dowson, 2009; Wang et al., 2013) that suggested the role of these skills in academic performance. It means that the level of students' metacognitive strategies for self-regulated learning determined their performance. The decreasing of their skill in metacognitive strategies for self-regulated learning has been found to be a serious problem for their achievements. Surprisingly, metacognitive time and environment was only significantly associated with students' engagement but not with academic performance. Our interpretation of this stage is that by the time students set their schedule and the environment, they become more comfortable discussing and interacting with their peers.

To summarize this finding, our study told us that metacognitive strategies were very important to promote academic performance, such as grade point academic and academic engagements. Metacognitive strategies for self-regulated learning were not only associated with their academic grade but also associated with their engagements. Although metacognitive for time and environment was insignificant to grade point academics, it was significantly associated with their engagements.

CONCLUSSION

The finding of this study contributes to the teaching and learning practice. Our study showed that metacognitive strategies play a significant role in academic performance. Therefore, for the teacher, demonstrating how to use metacognitive strategies to their students would help students in increasing their engagement and academic achievement. For example, encourage students to reflect on whether they are understood or not the courses in e-learning—training students to find some questions and focus on e-learning. Training students in setting their goals, schedule, and environment would also increase their academic performance and active participation in e-learning. Although our study provided important data for academic discourse and practice for teaching, several limitations should be reminded for the next study. This study is cross-sectional based. Therefore, each association between variables cannot be claimed as a causal relationship relation. For the next study, it is important to consider the longitudinal design study approach. This study only measured students' responses to e-learning. It is necessary for further investigation to involve students' metacognitive strategies in offline learning contexts. Our sample in this study was quite small, which affected the generalizability issue. For future research, expanding the sample is necessary.

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