The use of metacognitive strategies for uninterrupted online learning: Preparing university students in the age of pandemic

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Abstract

The primary objective of this study is to evaluate the relationship between the use of metacognitive strategies and learning performance in online learning among university students. The global lockdown due to the Covid-19 global pandemic outbreak has resulted in major interruptions in students' learning and education at all levels around the world. One of the consequences of university closures is that students suddenly find themselves having a lot more responsibility for their learning. Surprisingly, many students are not fully equipped with the relevant skills to excel in online learning despite being born into technology. Students are not aware of how to look inward to examine how they learn and to judge which methods are effective especially when faced with new forms of learning online because they lack metacognitive skills. Metacognition is crucial to the talent of learning. Although many researchers affirmed that metacognitive skills are crucial in any learning, a study on the impact of the use of metacognitive strategies on learning performance is still rudimentary. The study was carried out with 770 university IT students who have taken at least one online learning course. Data was collected using a self-administered instrument that was adapted from multiple sources. Three hypotheses were formulated and structural equation modeling was employed to conduct path modeling analysis. The findings from this study affirmed that students who use metacognitive strategies in online learning are indeed capable of evaluating their understanding of the course content and are capable of adding more effort in regulating their learning process. In view of the findings, this study will be useful for course instructors and students to establish practices on how to utilise metacognitive strategies to enhance students' learning performance as those lacking in metacognition may find themselves at a huge disadvantage.

Keywords Metacognitive strategies · Online learning · Higher education · Learning performance · Age of pandemic

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1 Introduction

The global lockdown due to the Covid-19 global pandemic outbreak has resulted in major interruptions in students' learning and education at all levels of education including in Higher Education Institutions (HEI) around the world. One of the consequences of university closures is that students suddenly find themselves having a lot more responsibility for their learning. In Malaysia, the national lockdown, known as the Movement Control Order (MCO) began on 18 March 2020. Since then, HEIs in Malaysia have started transitioning to online learning with the implementation of Google Classroom and other learning management systems. Thus, in this online learning scenario, students need to maintain concentration, manage, and organise their work without the usual support from their lecturers.

Numerous studies have shown that metacognitive strategies have a significant positive correlation with online learning performance and necessary for academic success (Dumford & Miller, 2018; Broadbent & Poon, 2015; Goradia & Bugarcic, 2017; Cho & Heron, 2015). Metacognition is a tool that not only involves students in the process of learning but also concedes the learning duty to themselves. In other words, metacognition can be referred to as “thinking about thinking” and it is about how an individual knows what they know. Students with metacognitive abilities can deal with their learning and its execution through managing thoughts, assessing learning, and evaluating the time required for study through the use of appropriate strategies. Although previous research has shown that students in higher education are capable of monitoring and reflecting on their strategy use (Roth et al., 2016), the findings from a recent study by Anthonysamy et al. (2020) revealed that metacognitive knowledge is still lacking among university students. Furthermore, an article published by the Harvard Business Review revealed that the biggest issue in learning is that students do not engage in metacognition enough (Boser, 2018). They do not stop to ask themselves if they get a skill or concept. This means, that although university students are expected to be proactive and engaged when online, literature seems to suggest that university students exhibit limited use of metacognitive strategies in their learning (Anthonysamy et al., 2020). These students who lack metacognitive strategies are not able to see the bigger picture of the task at hand through planning, monitoring, and regulating academic tasks online as compared to a knowledgeable user of metacognitive strategies. In other words, university students are still lacking in self-awareness and understanding of their thought process that is often achieved through self-reflection by utilising planning, monitoring, and regulating strategies. Although Puška and associates reported that metacognitive strategies directly and positively affect students' learning performance when using online learning (Puška et al., 2020), literature affirmed that the use of metacognitive strategies among university students is still very low (Hashemyolia et al., 2015). This limitation in the use of metacognitive strategies had contributed to low learning performance among university students (Hu & Li, 2017; Terras & Ramsay, 2015; Moreno-Marcos et al., 2019).

To the researcher's knowledge, limited studies are investigating the use of metacognitive strategies in learning performance among university students.

Furthermore, only a few studies on metacognitive skills have been conducted (Anthonysamy et al., 2020) specifically in the context of Asia (Li et al., 2018) compared to Europe and America (Richardson et al., 2012). With the rise in the use of digital technologies in online learning in institutions of higher learning globally, research on the use of metacognitive strategies is necessary considering its relevance and importance for ensuring students' success in online learning (Deschacht & Goeman, 2015; Spanjers et al., 2015; Abdul Wahab et al., 2016). Such finding calls for research on the phenomenon so that better insight and understanding can be gleaned.

Therefore, the purpose of this study is to examine the relationship between the use of metacognitive strategies on learning performance among university students in universities in Malaysia. The paper starts with a literature review of the main concepts which are metacognition and learning performance to formulate the research hypotheses. This is followed by the research method, data analysis and results, and discussion. The implications of the study for educational practice were also discussed. Subsequently, the last section presents the limitations, future research direction, and the overall conclusion of the study.

2 Literature review

2.1 Metacognition

John Flavell introduced the term metacognition which refers to the awareness and understanding of one's thought process (Flavell, 1979). Metacognition is an internal guide that enables an individual to be aware of their cognitive processes and to use the cognitive abilities to learn. This internal guide can take many forms such as self-awareness, self-explanation, ability to refocus attention, realising an action needs to take place, and many others. Metacognition is concerned with what, how, and when to apply a particular strategy for a specific task. It relates to what, how, and when to apply a particular strategy for a specific task. In other words, metacognition is a set of skills that enable students to become aware of how they learn and to be aware of how to assess and adapt these skills to become increasingly effective at learning. Metacognitive strategies are used to plan, monitor, and regulate the cognition process to attain a goal (Zimmerman & Martinez-Pons, 1986). An example of metacognitive knowledge is when a student, before attempting a task, performs some form of planning. Thus, students who are mindful of their metacognition knowledge will be able to make better use of their knowledge and in their learning journey. Helping students to develop metacognitive skills is important because it can play a crucial role in making their learning successful in that students would know how to manage their learning progression themselves. Hence, metacognitive skill is necessary for students because it is a constructive process where learning engagement occurs through regulation and control of their cognition, motivation, and behaviour to accomplish learning goals. Metacognitive knowledge denotes in-depth thinking in which a student is well aware of their cognitive processes. Students who are aware of their metacognition knowledge will therefore be able to make better use of

their knowledge and skills in their learning journey. For example, fine-tuning and checking through an academic task before a submission is an act of metacognitive thinking.

2.2 Metacognition cyclic phases model

The metacognition cyclic phases model was developed by Zimmerman & Moylan, 2009. It represents the Cyclic Phases which explains the three stages individuals go through during a learning process as presented in Fig. 1. This model is also known as Zimmerman Model (Panadero, 2017). The first stage is Forethought or also known as the planning stage is where the task is analysed, goals and strategic planning are set. The second stage is Performance, where the task is carried out is monitored through self-control and self-observation strategies. The final stage is the self-reflection or regulating stage where task performance is evaluated and

Fig. 1 Cyclic phases model (Zimmerman & Moylan, 2009)

feedback is reviewed to improve learning strategies in the future. In other words, the self-reflection stage is where the task is refined further.

2.3 Learning performance

Learning performance is a measure that quantifies students' overall attitude towards learning using subjective measures such as student satisfaction, student engagement, and attitude towards learning. Conversely, academic performance measures student achievement through objective measures such as Grade Point Average (GPA), examination results, and final course grades (Yang et al., 2016; Vo et al., 2017). While there is a plethora of research investigating the use of metacognition and its impact on academic performance (Broadbent & Poon, 2015), there is a dearth of research on the use of metacognitive strategies and their impact on learning performance in learning in Higher Education Institutions (Li et al., 2018).

2.4 The use of metacognitive strategies in a traditional and online learning environment

It has been observed that the use of metacognitive strategies in a traditional and online learning environment is different (Broadbent & Poon, 2015). In other words, the same strategies work differently in both the traditional and online settings as reported in the literature. Past works of literature imply that the use of metacognitive strategies in the online learning environment is impacted by learning and interaction methods. For example, when learners shift from traditional settings to online settings, learners may have faced challenges they have never encountered before such as using metacognitive strategies in isolation. For example, when students monitor their work in a traditional setting, the instructors are there to support students' plan, monitor, and evaluate their learning. However, in an online learning environment, social interaction is indirect (Anthonysamy et al., 2020). Contrariwise, one study reported that the use of metacognitive strategies is rare in a traditional learning context because students become dependent on their instructors to provide the learning direction (Ellis et al., 2014). This finding is echoed by another earlier finding which reported similar results where traditional teaching practices do not encourage students to utilise metacognitive strategies (Haidar & Al Naqabi, 2008). Moreover, online learners may also face technological anxiety (Tsai, 2009; Broadbent, 2017) or technological self-efficacy (Anthonysamy et al., 2020) when learning online. This challenge will impact their use of metacognitive strategies in an online learning environment (Anthonysamy et al., 2020; Tsai, 2009). Interestingly in contrast, although students can gain better control over their learning in an online learning setting compared to a traditional setting learning (Tsai, 2009), the demands to self-regulate metacognitive strategies are higher in an online learning environment than in traditional settings. The traditional learning environment involves face-to-face learning (Broadbent, 2017) and opens more room for continuous and direct interaction between the instructor and the students. Hence, it offers personal guidance for students in the preparation of exams or assignments.

Thus, it seems reasonable to suggest that learners utilize metacognitive strategies in both traditional and online learning contexts differently. Research has shown students who can self-regulate, have demonstrated better use of metacognitive strategies in online learning despite having to learn in isolation (Anthonysamy et al., 2020; Lilian et al., 2021). Nevertheless, students who lack self-regulation have shown to have the inability to transfer their learning strategies directly from a traditional to an online learning environment and are said to lack metacognitive skills (Lilian et al., 2021; Cao, 2012). Thus, this explains how the use of metacognitive strategies can be affected in two different learning settings.

2.5 Metacognitive strategies and learning performance

Metacognitive strategies are the key to getting students to learn with greater depths and understanding (Flavell, 1979) as metacognitive strategies can help students who are lacking in deep learning especially in the online learning environment by acting as a form of support for the students (Azevedo & Aleven, 2013; Barak et al., 2016). Metacognitive knowledge increases students' mental strength as this skill helps them to be more aware of their cognitive abilities and thus be more capable of taking charge of their learning. Most models of metacognition include three types of strategies used in various phases of the learning process, and these strategies are planning, monitoring, and regulating (Zimmerman & Martinez-Pons, 1986).

Planning strategy enables students to search through and manage the vast information available online and to use that information to achieve the learning goals in digital learning. Planning strategy enables students to approach task planning more efficiently, leading to better learning performance. Planning activities include skimming through online materials before doing a task analysis of the problem (Pintrich, 1999), planning the sequence, timing, and completion of activities directed at the learning goals (Zimmerman & Martinez-Pons, 1986). Goda et al. (2015) reported in their study that students with planning skills managed their time better in the aspect of timely assignment submission and this contributed to better learning performance.

Monitoring activities include monitoring the learning process to achieve learning goals. Monitoring the learning process can lead to a successful learning outcome because students can check their understanding against some self-set goals. Furthermore, monitoring activities represent higher-order cognitive and educational processing (Greene et al., 2015; Tauber & Dunlosky, 2016). Monitoring strategies include setting goals (Van Den Hurk, 2016), optimising attention and focus, tracking progress while doing an online task as well as self-testing through questions about the online material (Pintrich, 1999). Monitoring is a critical component of learning because it provides awareness of one's level of knowledge, which then leads to changes in one's learning performance, cognition, and behaviour. Accurate monitoring enhances the regulation of learning because it provides feedback on what students already know and where they need to focus their resources.

Regulation strategies are closely linked to monitoring strategies. As students monitor their learning progress, some fine-tuning and continuous adjustments are

needed to realign academic behaviour so that it is consistent with goal-attainment (Zimmerman & Martinez-Pons, 1986). An example of the regulation process is when a student while reading online content, revisits and re-reads the portion of text to align with the goals needed to be achieved. Students should be given opportunities to reflect upon what they are accomplishing online through self-check questions as this would help the students to be mindful of their learning progression.

Previous findings have revealed that metacognitive strategies are most conducive to fostering learning performance based on the positive correlation found (Dumford & Miller, 2018; Broadbent & Poon, 2015; Goradia & Bugarcic, 2017; Cho & Heron, 2015). One study found metacognitive strategies to be good predictors of student satisfaction (Kuo et al., 2013) while in another study, metacognitive strategies were found to be positively correlated with student engagement (Pellas, 2014). High-performing students were also found to be significantly better at goal setting compared to low-performing students (Lawanto et al., 2014). Azevedo et al. (2008) discovered that students frequently used ineffective metacognitive strategies within the online learning environment despite knowing the importance of metacognitive strategies in online learning. Closer to home, Hashemyolia et al. (2015) reported that Malaysian university students scored very low in their usage of metacognitive strategies.

Based on the above discussion, it is clear that there is a dearth of research investigating the relationship between metacognitive strategies and learning performance especially in the Malaysian education setting, and this justifies the need to test the following hypotheses. Although the use of metacognitive strategies in traditional settings appears to be generally applicable to the online learning environment, it cannot be assumed that the use of metacognitive strategies in an online learning environment is the same. (Broadbent & Poon, 2015). Based on the above discussion, therefore, the following hypotheses were derived:

Hypothesis 1 (H1): *There is a positive relationship between Planning and Learning Performance (PLP) in an online learning environment.*

Hypothesis 2 (H2): *There is a positive relationship between Monitoring and Learning Performance (PLP) in an online learning environment.*

Hypothesis 3 (H3): *There is a positive relationship between Regulating and Learning Performance (PLP) in an online learning environment.*

3 Method

This study was based on a structured quantitative research design via the distribution of a self-administered questionnaire. This study is aimed at assessing the relationships between the use of metacognitive strategies on learning performance. The purposive sampling method was used as a method of data collection among 770 IT university students from private universities located within the central region of Malaysia. They were approached through permission granted by the respective program coordinators or course instructors. Respondents were restricted to those who have taken at least one online learning course. Of these, 726 completed the questionnaires, contributing to 94.2% of the response rate. G

Power was also used to determine the ideal sample size where it yielded a suggested sample size of 129 for this study. Therefore the 726 questionnaires that were collected are more than adequate for path modeling analysis in Partial Least Squares-Structured Equation Modelling (PLS-SEM).

The self-administered questionnaire was designed in three sections. Section A consists of the general demographic characteristics of respondents. Section B comprised questions about the use of metacognitive strategies in online learning and Section C contained questions on the perception of the learning performance of students. The questionnaire used two different Likert scaling methods to measure the items to avoid undesirable response patterns such as straight-lining which could trigger inflated correlations among the indicators' error terms (Hair et al., 2019). Section A and B utilised a five-point Likert scale whereas Section C used a six-point Likert Scale. The decision to choose a 6-point Likert scale instead of a 5-point or a 7-point one was due to the reason that in purposive sampling, the respondents were chosen purposively. Hence, in this study which employed purposive sampling, the respondents should have a perception of their learning performance. Moreover, Moser and Kalton (1972) reiterated that having a 7-point Likert scale may lead respondents to answer based on the mid-point, thus providing uninformative data. Likert-type scale guidelines developed by Brown (2010) was followed because it fitted the research goal of this study which sought to evaluate the use of metacognitive strategies among university students and its impact on learning performance.

To develop the questionnaire, several prior relevant and validated studies were chosen to ensure that a comprehensive list of measures was included. To examine how metacognitively active are the respondents' in an online learning environment, the Motivated Strategies for Learning Questionnaire (MSLQ) was adapted because it has been widely used to assess students' self-regulatory behaviour (Pintrich et al., 1991). The three subscales of metacognitive behaviour that were tested were planning, monitoring, and regulating. Planning items sought to identify whether students were engaged in planning activities during online learning. Examples include scheming through online materials before organising them and setting learning goals. Monitoring items checked to what extent students practice self-questioning and progress check when attempting online tasks. Regulating strategies examined to what extent students would put the effort to fine-tune and perform continuous adjustments to the online tasks before submission.

Additionally, the items to measure learning performance were adapted from several validated scales. The Cognitive Affective Psychomotor (CAP) Perceived Learning scale was used to measure perceived learning outcomes within the cognitive, affective, and psychomotor domains within the online learning environments in higher education (Rovai et al., 2009) as it is a valid and reliable instrument. Apart from the above, other resources were also used in designing the questionnaire in this study (Eom et al., 2006; Trowler, 2010; Yang et al., 2016; Wu et al., 2010). Appendix Table 5 presents the items in the questionnaire that were adapted from multiple sources. The data were analysed using SmartPLS 3.0 which is a second-generation multivariate statistical approach that analyses the measurement model and structural relationships between the exogenous and endogenous variables in the same data analysis (Fig. 2).

Fig. 2 Proposed research framework

4 Data analysis and results

4.1 Descriptive statistics

Table 1 presents the descriptive analysis of the demographic profile of respondents. The demographic profile of the respondents shows a majority of male students (75.2%) while the remaining 24.8% were female students with the majority being Malaysians (83.2%). As for the age group of these students, 82.8% fell in the age group between 18 to 20 years of age, 16.3% fell in the age group between 21 to 23 years old and 0.9% of students were either 24 years old or older. The university students consisted mainly of first-year respondents (60.6%), followed by second-year students (30.6%) and third-year students (8.8%).

4.2 Internal consistency reliability

The measurement model tested the internal consistency of the framework. Internal consistency is a measure of reliability. Reliability measures the consistency of an instrument if it were to be reproduced. Although Cronbach Alpha has been the predominant measure, McNeish (2017) proposed researchers stay away from Cronbach Alpha and examine alternative reliability measures such as using composite reliability (CR) and average variance extracted (AVE). AVE which explains the degree to which a latent construct explains the variance of its indicators was assessed through satisfactory values scores of higher than 0.5 to achieve sufficient convergent validity.

Table 1 Demographic profile of respondents

Variable	Frequency	Percentage (%)	Variable	Frequency	Percentage (%)
Gender			Year of Study		
Male	546	75.2	Year 1	440	60.6
Female	180	24.8	Year 2	222	30.6
			Year 3 and above	64	8.8
Age (years old)			Nationality		
18–20	601	82.8	Malaysian	604	83.2
21–23	118	16.3	Non - Malaysians	122	16.8
24 and above	7	0.9			

Table 2 Indicator reliability analysis

Construct	Item	Loading	AVE	CR	VIF
Metacognitive Knowledge	PL	0.866	0.667	0.857	1.804
	MO	0.808	0.512	0.795	1.334
	RE	0.818	0.525	0.804	1.146
Perceived learning performance	PLO	0.744	0.840	0.882	1.727
	SIE	0.760	0.818	0.873	1.309
	SS	0.808	0.824	0.883	1.763

Table 3 Discriminant validity evaluation

Heterotrait-Monotrait ratios				
	Monitoring	Planning	Learning Performance	Regulating
Monitoring				
Planning	0.42			
Learning Performance	0.372	0.31		
Regulating	0.325	0.428	0.333	

Moreover, the acceptable CR value is between 0.70 and 0.90 (Hair et al., 2019). The item loadings, CR, AVE, and VIF are presented in Table 2.

Next, HTMT ratios were used to gauge the discriminant validity of indicators. This evaluation is important to evaluate the extent to which the indicators are empirically distinct from other constructs (Hair et al., 2019). HTMT values must be greater than 0.85 (Kline, 2011) or greater than 0.9 (Gold et al., 2001). Table 3 indicates that all constructs exhibit satisfactory discriminant validity which reveals that the study has no issue of discriminant validity.

4.3 Hypothesis testing

The structural model tested the three hypothesised relationships developed for this study using a bootstrapping procedure of 5000 bootstrap samples as suggested by Hair et al. (2017). Table 4 shows the statistical results for the structural model including standardized beta (β), standard error, t-values, and p values. All exogenous variables (i.e planning, monitoring, and regulating) accounted for 27.3% of the total variance explained in the use of metacognitive strategies on the endogenous variable which is learning performance ($R^2=0.273$). Following Cohen's (1988) guidelines for predictive accuracy, R^2 values of 0.26, 0.13, and 0.02 are deemed substantial, moderate, and weak, respectively. Therefore,

Table 4 Hypotheses testing

Hypothesis	Std Beta	Std Error	t-value	p value	Decision
H1 Planning -> Learning Performance	0.258	0.04	2.559**	0.00	Supported
H2 Monitoring -> Learning Performance	0.117	0.045	6.763**	0.00	Supported
H3 Regulating -> Learning Performance	0.199	0.043	4.754**	0.00	Supported

** $p < 0.05$

Fig. 3 Results of path analysis (t-values)

the R^2 values indicate that the structural model is a substantial model. All exogenous variables were found to have t-values ≥ 1.645 , indicating a significant impact on learning performance as presented in Fig. 3.

5 Discussion

This study aimed at examining how metacognitive strategies can contribute to better learning performance in online learning. The study was motivated by poor utilization of metacognitive strategies which led to low performance among university students in online learning. The study examined the three specific metacognitive strategies which are planning, monitoring, and regulating. The results of this study affirmed that all three metacognitive strategies enhance learning performance in online learning. The rationale and possible explanation of the results are explained below:

H1: There is a positive relationship between Planning and Learning Performance (Supported).

Based on the path coefficient and t-values in Table 4, the planning strategy had a significant impact on learning performance ($\beta_1 = 0.258$, t-value = 2.559, $p > 0.05$). Hence, H1 is supported. Literature has also confirmed similar findings where planning activities such as scheming through the online task before attempting it or doing a task analysis of the problem do help foster learning performance among university students (Zimmerman & Martinez-Pons, 1986). The results of this study echoed the works of Mohebi and associates who reported that planning empowers an individual to identify their strengths and weaknesses and subsequently, they can make targeted planning better (Mohebi et al.,

2018). Additionally, the results of this study might also imply that students who lack planning skills might not be able to see the bigger picture of the task at hand. Thus, this strategy is important for students to acquire to foster learning performance.

H2: There is a positive relationship between Monitoring and Learning Performance (Supported).

The findings from this study also revealed that monitoring strategies also had a significant impact on learning performance ($\beta_1 = 0.117$, $t\text{-value} = 6.763$, $p > 0.05$). Thus, H2 is strengthened. Monitoring strategies in this study are seen to have the highest significant impact on learning performance probably because monitoring strategies are critical in helping students to be aware of their level of knowledge which can contribute to their cognition and behaviour which subsequently leads to the enhancement of learning performance. Zimmerman (1990) explained that performing self-monitoring helps students through their thought process to actively participate in their learning process. The ability to self-monitor has been viewed as a desirable quality in students as students with these skills know how to control and manage their learning environment, leading to successful learning performance.

H3: There is a positive relationship between Regulating and Learning Performance (PLP) (Supported).

H3 hypothesized that the relationship between regulating strategies and learning performance is significant. The results offered confirmation to the H3 hypotheses that the use of regulating strategies enhances learning performance among university students ($\beta_1 = 0.199$, $t\text{-value} = 4.754$, $p > 0.05$). The possible explanation for the significant relationship may be attributed to the notion that regulating strategies help students become increasingly effective at online learning because this strategy involves fine-tuning their online task to achieve the learning goal. Moreover, regulating strategies help in the success of future planning as well as in self-efficacy (Mohebi et al., 2018). This regulating process not only involves students in the process of learning but also concedes the learning duty to themselves.

Overall, although the study reported that all three metacognitive strategies can foster learning performance in online learning, the weightage of importance for each metacognitive is different as shown in Fig. 4. It can be postulated that monitoring strategies play the most important role, followed by regulating strategies, then planning strategies in fostering learning performance in online learning. For example, before attempting an online task, students need to be aware of what they need to plan, monitor their progress as well as refine their task before submission.

6 Implications for educational practice

The results of this study indicate that metacognitive strategies are important predictors of enhancing students' learning performance. Students do not automatically use metacognitive strategies unless they are taught to use them and they are forced to use these strategies (Mohebi et al., 2018). Therefore, to cultivate these strategies in students, it is necessary

Fig. 4 Relative values of path analysis

to emphasize the use of metacognitive strategies in their learning culture. Universities need to look into how well these skills can be absorbed in the curriculum and how well equipped are the course instructors in the aspect of knowledge and facilitating the development and acquisition of metacognitive skills among students. Furthermore, universities have a critical responsibility in identifying effective ways to train, encourage and support course instructors to be aware of metacognitive strategies, providing a channel for them to equip themselves with knowledge, skills, and experience so that they may assist students in their acquisition and development of metacognitive skills.

In addition to that, instructional designers can keep in mind metacognitive strategies when designing online learning tools (Bernard et al., 2014). Online learning environments should provide opportunities and conditions to enable students to apply and use metacognitive strategies in their learning processes such as planning learning activities, structuring learning situations, evaluating learning processes themselves and, revising learning processes. Through this practice, students will have a greater responsibility for their learning, thus leading to a successful learning performance (Heo & Joung, 2003).

7 Limitations and future direction

It is acknowledged that there are several limitations to this study. First, this study adopted a cross-sectional study design where questionnaires were distributed to full-time IT students from selected private universities in the central region of Malaysia. Therefore, the study did not cover all the regions in Malaysia due to the pandemic constraint. Thus, it is recommended for future scholars to include comprehensive coverage of the area to aid in the research generalizability of the findings. This study may also be extended or replicated to students from other programmes, other types of higher

education institutions (i.e colleges, public universities), or other learning situations such as distance learning or blended learning setting.

Secondly, a self-report instrument was used for data collection. In future studies, qualitative research methods or mixed-method approach could be used to perform an in-depth examination on the use of metacognitive strategies among students. In this context, students can be interviewed to analyse their use of metacognitive strategies in online learning so researchers can better understand in what situations do students use metacognitive strategies. Moreover, log data extracted from learning management systems can also be used to analyse students' use of metacognitive strategies in online learning. In addition to that, experimental design can be conducted to examine the actual use of metacognitive strategies among students in online learning.

Thirdly, the readiness of course instructors as implementers of metacognitive learning in the classroom can be conducted. This is important to ensure instructors are ready to initiate the right activities in class to incorporate metacognitive skills among students. Fourthly, a potential additional study can be studied to examine the moderating effects of gender on the relationships between metacognitive strategies and learning performance. This would enable researchers to have a deeper understanding of the use of metacognitive strategies among male and female students.

8 Conclusion

This study examined the use of metacognitive strategies and their impact on learning performance in online learning among university students. The results of this study revealed that all three strategies of metacognition strategies (i.e planning, monitoring, and regulating) are predictors of students' learning performance. Students with metacognitive abilities can deal with their learning and its execution through managing thoughts, assessing learning, and evaluating the time required for study through the use of appropriate strategies.

With the sudden shift in many universities from face-to-face classroom learning to online learning because of the pandemic, it is expected that the adoption of online learning will continue to persist post-pandemic and continue to be the new norm for most universities. The results of this study are expected to contribute to creating awareness among students to practice metacognition mindfulness to help optimise their focus and attention in their online learning to progress smoothly in their learning journey. The study also highlights the important role of course instructors to cultivate metacognitive strategies among students as a way to support student learning. Supervision and guidance from course instructors are necessary to encourage students to evaluate their learning and to reflect on their learning actions. Course instructors and the learning environment play a crucial role in supporting and shaping students' metacognitive awareness.

Metacognitive strategies are crucial to getting students to learn with greater depths and understanding as it is in enhancing students' learning performance in online learning. Thus, to survive in this new digitally connected and complex world, students must be prepared to master metacognitive strategies to achieve success in the online learning environment especially since it is increasingly becoming an integral component of university learning worldwide.

Appendix

Table 5 Measurement of instruments

Variable	Item	Reference Source
Planning	When my lecturer gives an online task, I analyse it first before starting it (e.g., read the questions properly, know the expected outcome, objective, etc.).	Pintrich et al. (1991)
Monitoring	I set some standards (what I need to achieve) for my online task. When doing an online task, I question myself to help me understand the task better.	
Regulating	When doing an online task, I check my progress with my lecturer to ensure I am on track with my task. If I get confused during an online task, I use other methods to learn the task (e.g., watch YouTube, Google, Ask Friends, etc.).	
Learning Performance	I check over my online task to make sure I did everything correctly before submitting it.	Rovai et al. (2009)
	I can apply the content learned in the online learning course.	
	I can intelligently critic (to give your own opinion) the content in the online learning course.	
	I am more independent after an online learning course.	
	I am a better thinker after an online learning course.	
	I can use my hands-on skills (e.g using Internet programs/software) learned in an online learning course outside of class.	
	I can demonstrate to others my hands-on skills learned in an online learning course.	
	I acquire some useful knowledge by interacting with other students during the online learning course.	
	I acquired some useful knowledge by interacting with my lecturer during the online learning course.	
	Engaging with online learning tools has enhanced my skills in using Web 2.0 applications (E.g Kahoot, Powtoon, Coogle, etc.)	
	I fully engage in online learning tasks to learn more than what is required of me.	Eom et al. (2006); Trowler (2010); Yang et al. (2016)
	I am interested to do online tasks as I enjoy learning.	
	I am satisfied with the online learning course(s).	
	Completing online tasks was more difficult than other non-online tasks.	Sun et al. (2008); Wu et al. (2010); Eom et al. (2006)
	The online tasks help me understand the face to face activities for a subject.	
	The knowledge I gained from blended learning was as good as face-to-face subjects.	
	I would gladly take another blended learning subject.	

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Declarations

Conflicts of interest/Competing interests Not applicable

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