Impact of cognitive and metacognitive strategies on learning performance in digital learning: What’s working and what’s not in the age of brilliant technology

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Abstract. Ineffective cognitive processes result in learning difficulties online. Hence, how cognitive learning processes influence the way students engage and learn online needs further investigation. This study, therefore, examined cognitive engagement and metacognitive knowledge strategies on learning performance among Malaysian IT Undergraduates. A sample of 563 IT undergraduates from private higher education in Malaysia participated in this quantitative study that were collected through a questionnaire. Data was analysed using PLS-SEM. The findings of this study constitutes essential results where all cognitive engagement strategies and two of metacognitive knowledge strategies positively influence the students’ perception of learning performance. Nevertheless, one metacognitive strategy resulted in a negative relationship with learning performance which have led to a new finding. This study concluded that the acquisition of cognitive and metacognitive skills are needed to excel in digital learning for deeper learning. Lecturers can use the findings of this study to integrate the necessary cognitive and metacognitive learning approaches across all key learning areas in the digital learning without altering the curriculum.

1. Introduction
Digitisation has changed the economy comprehensively and students’ regular daily existences. Computerized developments, for example, advanced media, Big Data and the Internet of Things are reshaping the network, businesses and economy. The fast size of changes in the technological and advanced economy profoundly affect the lives of digital learners. In this situation of digitalisation, it is an unquestionable requirement for the education sector to likewise adjust to a dynamic digital environment as it enables it to keep pace with an aggressive world. Hence, the education sector has made digital technology an integral part of education [1]. Digital learning which envelops a wide range of practices are rising. It is an instructional practice that adequately utilizes technology to strengthen a student's learning experience.

Cognitive learning plays a huge part in the learning progression of an individual. It involves a thought process through which information is processed and knowledge is acquired. In a traditional classroom where cognitive strategies are used, the teacher fulfils a pivotal role, bridging the gap between student and content/skill to be learned. However, in a digital learning environment, the students takes up that pivotal role to manage the progression of their own learning. Therefore, the use of ineffective cognitive processes result in learning difficulties. Hence, how cognitive learning processes influence the way students engage and learn online needs further investigation [2].
The purpose of this paper is to identify which cognitive and metacognitive strategies works in a
digital learning environment for IT Education through the lens of cognitivism. The following section
presents the literature regarding digital learning, cognitive and metacognitive strategies. The research
method are presented in Section 3. Results and discussion are discussed in Section 4. Finally, this is
followed by Section 5 which presents the conclusion of the study.

2. Literature Review

2.1. Digital Learning
Digital learning which involves blended learning, mobile learning, online or e-learning, and many
others is any kind of learning which makes use of technology effectively. Learning can be online or
digital learners have some amount of control over certain aspects of their learning such as
time management, environment and learning pace. Digital learning enables collaboration and access to
content that extends beyond the classroom with personalized and engaging learning experience.

2.2. Theoretical Perspective
Learning is not about the mechanics of what a student does, but instead a process relying upon what
the student definitely knows (existing data) and their technique for gaining new information (how they
coordinate new data into their current patterns). Cognitivism is the study that focuses on mental
processes of the human mind including how people think, perceive, remember and solve problems. In
this context, the learner is viewed as the information processor conceptualising how information is
received, for information is processed and how the information is interpreted and organised.

Conceptualizing the student's learning processes is necessary for understanding how people learn [4].

Information procurement is an action comprising of inner codification of mental structures inside
the student’s mind. Innate to the theory, students must be a functioning member in their very own
learning process. Cognitive approaches mainly focus on the mental activities of the learner like
cognitive engagement and metacognitive knowledge strategies [5].

2.2.1 Cognitive Engagement
Cognition refers to the mental action of acquiring knowledge and understanding through thought
processes, attention, experience, senses and working memory. This competency is vital to ensure
digital learners are able to have a conscious thought essential for human learning. Cognitive
engagement comprises of four strategies which includes rehearsal which are best for simple tasks and
activation of information in working memory rather than acquiring new information in long term
memory, elaboration strategy that refers to the ability to connect prior knowledge with new
information with the objective of remembering the new material, organisation strategy which deals
with the ability of a learner to select the appropriate information and organise their thoughts during a
learning process and critical thinking is a cognitive process where an individual has the intellectual
ability to synthesize and evaluate online materials to make them increasingly significant and essential
[6]. Cacciamani and associates revealed that cognitive presence especially organisation strategy in
students does contribute to a better learning performance in digital learning [7]. In addition to that,
utilization of cognitive strategies promotes better student engagement online [8].
2.2.2 Metacognitive Knowledge
Metacognitive is an inward guide that empowers an individual to know about their cognition processes and to use the cognitive abilities to acquire knowledge. This internal guide can take numerous forms such as creating awareness, self-clarification, refocusing attention, understanding an action needs to take place, etc. Metacognitive strategies enable learners to supervise and control their thinking processes. Metacognitive strategies are used to plan, monitor and regulate their cognition process to attain a goal [9]. Planning activities include skimming an online material before reading, doing a task analysis of the problem, planning the sequence, timing, and completion of activities directed at learning goals. Besides that, monitoring activities of the learning process are in relation to defined learning goals. Regulation strategies care closely linked to monitoring strategies. As students monitor their learning progress, it needs some fine tuning and continuous adjustments to bring back academic behavior in line with goal-attainment.

Prior studies examined the effect of metacognitive strategies on learning performance. Results revealed that metacognitive strategies are beneficial for fostering learning performance [7, 10], and metacognitive strategies correlate positively with student engagement [11] and student satisfaction [12]. Interestingly, a study conducted by Goda and researchers reported that students with metacognitive skills managed their time better in the aspect of timely assignment submission and hence contributed to better learning performance [13].

Thus, the following hypotheses were posited:

**Hypothesis 1 (H1).** There is a positive relationship between rehearsal and perceived learning performance (PLP)

**Hypothesis 2 (H2).** There is a positive relationship between elaboration and perceived learning performance (PLP).

**Hypothesis 3 (H3).** There is a positive relationship between organisation and perceived learning performance (PLP)

**Hypothesis 4 (H4).** There is a positive relationship between critical thinking and perceived learning performance (PLP).

**Hypothesis 5 (H5).** There is a positive relationship between planning and perceived learning performance (PLP)

**Hypothesis 6 (H6).** There is a positive relationship between monitoring and perceived learning performance (PLP).

**Hypothesis 7 (H7).** There is a positive relationship between regulating and perceived learning performance (PLP).

3. **Research Methodology**

A quantitative cross-sectional survey design approach was employed in this study to examine the relationships between cognitive and metacognitive learning strategies and perceived learning performance. Learning performance assess the permanent change in behaviour of students’ understanding and abilities that support long-term retention and transfer of knowledge [14]. Performance of students’ learning in online learning is emerging as a crucial ingredient in the evaluation of digital learning environments.

Data was collected from IT undergraduates from private higher education institutions in Malaysia. The population sample comprised of private higher education institutions implementing a digital learning environment for their undergraduate programmes. The main instrument for this study was questionnaire.

Sample size was calculated with G power software (v 3.1) using significance level of 0.05, effect size of 0.15. The confidence level of 95% with 5% margin of error is accepted widely for most social science research [15]. G Power software which is based on the complexity of model/framework suggested a minimum sample of 129 for this study. However, a total of 770 questionnaires were distributed and 726 questionnaires were returned, with 563 being completed and usable for this study.
4. Results and Discussion
The sample for the final analysis was 563 as mentioned earlier. The response rate was more than 70% of the total number of questionnaire distributed. The final data set used for analysis consist of males (70.3%) and the remaining being females (29.7%). Almost half of the respondents fall in the age group of between 21 to 22 years of age (49.9%), followed by respondents aged 19 to 20 years old (45.1%), and the remaining 5% fell in the age group between 23 to 24 years old. The year of study for the IT undergraduates consisted mainly first-year respondents (37.7%), followed by second-year students (34.5%) and third-year students (25.7%). Vast majority of the respondents are Malaysians (85.1%).

4.1 Indicator Reliability Analysis
Based on Table 1, Cronbach’s Alpha and Composite Reliability values denote that the constructs are reliable. Average Variance Extracted (AVE) which explains the degree to which a latent construct explains the variance of its indicator have satisfactory values scores of higher than 0.5 to achieve adequate convergent reliability. Discriminant validity was also assessed to ensure constructs are truly distinct from one another, using cross-loading criterion, Fornell and Larcker’s criterion and HTMT [16]. Results revealed the study has no issue of discriminant validity. Thus, this indicates that discriminant validity had been completely ascertained.

| Constructs                      | Cronbach Alpha | Composite Reliability | AVE  |
|--------------------------------|----------------|-----------------------|------|
| **Cognitive Strategies**       |                |                       |      |
| Rehearsal                      | 0.789          | 0.819                 | 0.719|
| Elaboration                    | 0.775          | 0.744                 | 0.592|
| Organisation                   | 0.771          | 0.791                 | 0.655|
| Critical Thinking              | 0.727          | 0.756                 | 0.611|
| **Metacognitive Strategies**   |                |                       |      |
| Planning                       | 0.824          | 0.857                 | 0.750|
| Monitoring                     | 0.791          | 0.795                 | 0.663|
| Regulating                     | 0.801          | 0.804                 | 0.673|
| **Perceived Learning Performance** |            |                       |      |
| Perceived learning outcome     | 0.789          | 0.882                 | 0.556|
| Social Interactive Engagement  | 0.735          | 0.873                 | 0.579|
| Student Satisfaction           | 0.843          | 0.843                 | 0.538|

4.2 Path Analysis
The standardized beta (β), t-values, and p-values are displayed in Table 2. The predictors of all strategies except planning strategy were found to have t-value ≥ 1.645, with 0.05 level of significance. Six out of the seven tested hypotheses were significant and supported. Only one hypothesis was not supported and rejected. Planning strategy shows no relationship with PLP.
Table 2. Path Analysis

| Hypotheses Relationship | Std Beta,β | Std Error | t-value | p-value | Decision |
|-------------------------|------------|-----------|---------|---------|----------|
| H<sup>1</sup> Rehearsal -> PLP | 0.101 | 0.045 | 3.596** | 0.000 | Supported |
| H<sup>2</sup> Elaboration -> PLP | 0.091 | 0.041 | 2.196** | 0.029 | Supported |
| H<sup>3</sup> Organisation -> PLP | 0.158 | 0.045 | 2.291** | 0.022 | Supported |
| H<sup>4</sup> Critical thinking -> PLP | 0.105 | 0.046 | 2.233** | 0.026 | Supported |
| H<sup>5</sup> Planning -> PLP | 0.053 | 0.043 | 1.208 | 0.227 | Not Supported |
| H<sup>6</sup> Monitoring -> PLP | 0.159 | 0.044 | 3.484** | 0.001 | Supported |
| H<sup>7</sup> Regulating -> PLP | 0.160 | 0.044 | 3.645** | 0.000 | Supported |

**p<0.05**

In this study, rehearsal, elaboration, organisation, critical thinking, monitoring and regulating strategies was found to have a positive effect on perceived learning performance among undergraduates. However, planning strategy were found to have no relationship with perceived learning performance.

Hypothesis one to hypotheses four assessed the effect of cognitive engagement on learning performance perception in light of digital learning. The significantly positive outcome signify that students who use the four strategies (rehearsal, elaboration, organisation and critical thinking) of cognitive engagement domain has an impact on their learning performance. Cognitive engagement positively indicates that IT undergraduates uses these strategies to achieve success in their digital learning.

Fifth to seventh hypotheses describes metacognitive knowledge. The fifth hypotheses indicated a negative relationship between planning strategy and students’ views on learning performance whereas the sixth and seventh hypotheses revealed a positive relationship between monitoring and regulating strategy towards perceived learning performance. When learners engage in planning activities, they think through what they need to learn and set task-specific goal. But, the findings from this study indicate that students fail to perform this self-assessment skill of planning. Another possible explanation for this is may be digital learning activities lacks in offering planning for learning. This new finding can benefit instructional designers to carefully design learning activities that encourages learners to use more metacognitive skills online. Digital learning features can incorporate prompts to record study time, reflection exercises, and open doors for journaling.

5.0 Conclusion

Since digital learning has become a part of education, cognitive learning is needed as it provides a structure for learning and help students apply relevant cognitive and metacognitive strategies to individuals to learn, engage and participate through the use of technology. The use of rehearsal, elaboration, organisation and critical thinking learning strategies in digital learning has proven to foster learning performance among students in a digital learning environment. Cognitive techniques not only assist students with learning problems but it serves to help students create inner processes which empowers them to perform tasks that are mind boggling more efficiently.

Moreover, metacognitive strategies are an important variable during students’ thinking processes as it assists them to be aware of their thinking and thus control their thinking processes. From the findings of the study, monitoring and regulating learning strategies empirically confirmed that these strategies are crucial in digital learning. The results of the study also indicated that students fail to plan before starting a task in online. This could also be a hint for instructional designers to incorporate more features that requires planning in learning activities. Overall, using the right learning strategies
can raise students’ self-awareness and help cognitive and metacognitive thinking to happen more automatically as the way people learn impacts their behaviour. Lecturers can use the findings of this study to integrate the necessary cognitive and metacognitive learning approaches across all key learning areas in the digital learning without altering the curriculum.

Albert Bandura’s seminal research on human behavior sprouted the Social Cognitive Theory (SCT) which established that human functioning is directed by the interaction of personal, behavioral and environmental influence which are reciprocal in nature [17]. Personal influences comprises of individual’s knowledge and cognitive and metacognition capacities. Hence, future research could comprehensively tackle behavioural and environmental aspects as well to gauge the use of learning processes among students.

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