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General Learning Strategies in Engineering: A Case of Digital Electronic System in Electrical Engineering

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Abstract

Digital Electronic System is an important course for electrical engineering students as they prepare toward Fourth Industrial Revolution (4IR). Thus, learning strategies are crucial to ensure students can empower themselves in theoretical and practical knowledge. The objective of this study is to identify the learning strategies used by students when they learn Digital Electronic System. This quantitative analysis is conducted to investigate how learners use cognitive and metacognitive in the course. The instrument used in this study is a survey adapted from Wenden & Rubin (1987). A sample size of 31 participants were selected to respond to the survey. The respondents are electrical engineering students enrolled in Digital Electronic System at Universiti Teknologi MARA (UiTM), Johor Branch Pasir Gudang Campus. The survey has 4 key elements which consist of demographic profile, cognitive components, metacognitive self-regulation and resource management. The findings of cognitive components showed that learners preferred memorizing key word to remember important concepts in classes. Besides, they also going through the readings and class note besides trying to find the most important ideas. Subsequently, they will try to link the reading and concept gained from the lectures to get better understanding on course materials. In metacognitive strategies, the students have good awareness on metacognitive learning strategies when they have proper schedule, goals setting and planning some activities in each study period. In environment management strategies, students preferred to learn the course throughout classes. In effort management strategies, they setting a regular place for studying. In seek-seeking strategies, the students are self-initiative and asking their friends for help if they have problem or question on course materials. The findings of this study can help educators to identify effective learning strategies can be practised by learners particularly in Digital Electronic System.

Keywords: Digital Electronic System, Cognitive strategies, Metacognitive strategies, Resource Management strategies, Fourth Industrial Revolution, Internet of Things

Introduction

Digital Electronic System is an engineering course that combines knowledge of electric, electronic device and circuitry in digital system. The course required learners to understand the fundamental knowledge of electronic circuit from device level to its application. Learning strategies in engineering can be subjective to the learners depending on types of assessment conducted on them such as cognitive, affective and psychomotor skills. The aims of engineering courses to equipped the learners with up-to-date knowledge which relevant with industry practise, fostering technical skills, soft-skills and problem-solving skills which important for learners when joining the workforce. In order to gain those skills, learning strategies are important to help them excel in the course.

Learning strategies defined as learning skillsets used by the learners to complete various tasks to accomplish learning objectives and outcomes (Gonzales, 2016). Flexible learning strategies are important to help students adapt with dynamic assessment implemented on them such as written test, assignment and mini-project. Technology used by the industries always evolving over the time and required the students to keep continuously upgrading their knowledge to make themselves relevant to the industry which required the latest technical and strong problem-solving skills.

Self-regulated learning strategies can help the students become self-initiative and independent in solving the problem which crucial when joining the workforce. Besides, such technique can foster the learners to empower their lifelong learning skill. Learning in Digital Electronic System can help the electrical engineering students to prepare themselves with the need of Fourth Industrial Revolution (4IR) which in line with Ministry of Higher Education Blueprint as illustrated in Figure 1.0. The learners required to understand the application of electronic components and its circuitry, subsequently can be further implemented for an Internet of Things (IoT) application (Baygin et al., 2016). The knowledge covers both in theoretical and practical skills so that the learners able to adapt their knowledge with different case scenario in industry which acquired them to empower self-regulated learning.

Digital Electronic System is a core subject for the electrical engineering students. The course covers from fundamental to its application of digital electronic system thus certain learners may have problems accepting the course based on the types of assessments used on them. At the undergraduate diploma level in UITM, digital electronic system is a mandatory subject where the students need to attend the class in semester 4 and passing the subject before graduating. In order to ensure the students able to adapt with the course, thus learning strategies feedback is important to help the student to overcome challenges in learning the course materials.

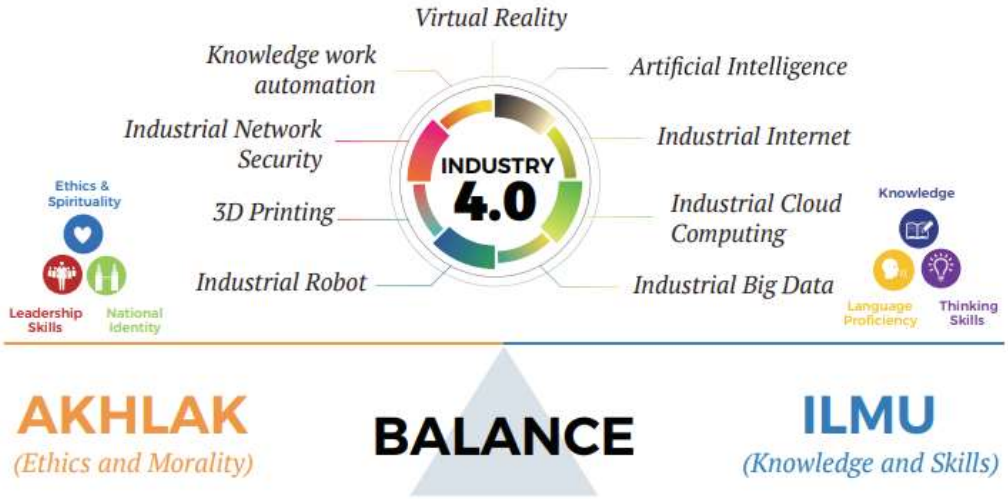

Figure 1.0: Framing Malaysian Higher Education 4.0
(Source: www.jpt.mohe.my)

Statement Of Problems

Digital Electronic System is a fundamental course to electrical engineering students which apart of prerequisite knowledge of science, technology, engineering and mathematics (STEM). In this course, it involves 3 major domains include technology, engineering and mathematics. Learners must have good learning strategies to help them excel in the course. Self-regulated learning has gained great attention due to its flexibility can support in both traditional learning environment (face to face) and digital learning environment (online). SRL strategies have contributed positive impact on academic achievement of learners (Richardson et al., 2012) in traditional learning environment. Besides, SRL also become key competence in learning in digital learning environments (Dent et a., 2016). Self-regulated learners can be visualized as motivated, metacognitively involved and active in their own learning process (Zimmerman,1986). Besides, they are persistent, manage their time effectively, and seek assistance when necessary (Zimmerman,1986; Pintrich et al., 1993).

According to Theobald et al. (2021), self-regulated learning strategies consist of three methods include cognitive strategies, metacognitive strategies, and resource management strategies. Cognitive learning strategies refers to ability of learners to process information such as summarizing the notes in classes (Weinstein & Mayer, 1986). Metacognitive learning strategies depends on learners' awareness to control their own cognitive learning process include planning, monitoring and evaluating their learning progress (Broadbent et al.,2015). Resource management strategies aims to organize and control learning environment of learners to motivate them engaged with learning process (Pintrich, 1999; Vrugt and Oort, 2008).

Self-regulated learning has gained great attention due to its flexibility can support in both traditional learning environment (face to face) and digital learning environment (online). SRL strategies have contributed positive impact on academic achievement of learners (Richardson et al., 2012) in traditional learning environment. Besides, SRL also become key competence in learning in digital learning environments (Dent et a., 2016). Self-regulated learners can be visualized as motivated, metacognitively involved and active in their own learning process (Zimmerman,1986). Besides, they are persistent, good time management, and seek assistance when necessary (Zimmerman,1986; Pintrich et al., 1993).

Anais et al (2012) have studied motivational and cognitive learning strategies used by first-year undergraduate students of Civil Engineering for the Calculus course. The assessment made based on Motivated Strategies Learning Questionnaire (MSLQ). The results shown that motivational and cognitive learning strategies give positive impact on student learning process. Liebendorfer et al (2022) have reported that cognitive learning strategies (repeating and practicing) in mathematics course have positive correlations to student's performance. Quantitative analysis conducted by Fang et al (2017) have reported that learning strategies have strong correlation with learning styles (visual, auditory and kinesthetics) and motivation to engineering students. Students with a visual learning style have higher motivation and learning strategies than other students.

Analysis of metacognitive learning strategies have been conducted by Whisler et al., (2019) on the first-year engineering students. The aims of this analysis to help the students whose calculus skills are insufficient to enrolled Calculus 1 in their first semester. Entangled Learning framework was used to foster metacognitive skills and successfully have created awareness among the learners by using the Skillful Learning videos.

Lawanto et al (2013) have evaluated on self-regulated learning strategies of engineering student in Fundamental Electronics for Engineers course with enhanced guided note. The analysis focused on implementation of metacognitive learning strategies on guided note by learners. Butler and Cartier's SRL model were used to construct a survey instrument to measure SRL strategies. The outcome of analysis to determine the impact of guided note on learners' performance. The results revealed that the students with improved grade have good awareness of metacognitive skills compared to non-performing students.

Literature in previous studies limited to certain learning strategies such as cognitive and metacognitive skills particularly in engineering course. There is less work analyzed on resource management learning strategies despite it is important to the learners (Kasalak et al.,2020). Engineering course is aimed to equipped learner with soft-skills, technical-skill and problem-solving skills. Thus, a comprehensive study on learning strategies is crucial to ensure the learner able to meet the outcome of the course in term of cognitive, affective and psychomotor domains.

Hence, the objective of this study is to get an overview and feedback from learners on their learning strategies used in Digital Electronic System. Besides, the analysis also can help the instructor identifying the problem faced by students in shaping and improvising their learning strategies. The analysis covers in three areas include cognitive, metacognitive and resource management learning strategies which could contribute to the process of learning. Thus, this study aims to cater the following research questions:

- How do learners use cognitive components to learn Digital Electronic System?
- How do learners use metacognitive self-regulation strategies to learn Digital Electronic System?
- How do learners use resource management to learn Digital Electronic System?

Literature Review

Strategies for Learning

Learning is a complex and individualized process that varies from person to person. However, there are several effective strategies and improve the retention of information. Learning strategies are deliberate, organized approaches or techniques that individuals use to acquire, understand, retain, and apply new information and skills. These strategies are employed to enhance the learning process and improve overall learning outcomes. Learning strategies can

encompass a wide range of activities, behaviours and methods tailored to suit student's unique learning style and the specific context in which learning occurs. Adapting and customizing learning strategies to match various learning environments and individual preferences is essential because what proves effective for one person might not yield the same results for another, underscoring the importance of flexibility.

Generally, learning strategies often involve active engagement with the material. Instead of passively receiving information, students actively interact with it through methods like taking notes, discussion or problem solving. Learning strategies aim to optimize the learning process by making it more efficient. Strategies help students make the most of their time and effort, resulting in improved retention and understanding of information. Certain learning approaches encompass self-evaluation and contemplation, wherein students gauge their advancement, identify strengths and weaknesses and modify their tactics in response. Students who are considered as efficient, often use a variety of strategies depending on the type of content they are learning, their personal strengths, and the learning context. A diverse set of strategies can cater to different aspects of learning. Significantly, many learning strategies are backed by research and educational psychology. They are developed based on scientific principles and studies that have shown their effectiveness in improving learning outcomes.

Past Studies on Strategies for Learning

Many studies have been done to investigate the learning strategies in acquiring knowledge for Electrical and Electronics Engineering courses. Considering all the strategies outlined, active learning strategies, including problem-solving exercises, are effective in improving students' comprehension and retention of digital electronic concepts. Students who are actively engage with problems and design challenges is reflected by their readiness to accept new knowledge thus enhancing their skills. Study conducted by Ridwan et.al. (Ridwan, n.d.) at some universities in Malaysia aimed to measure students' readiness for learning embedded system using Rasch model. Out of 376 eligible participants, 365 completed the questionnaires, thus, the final dataset used for analysis consisted of 365 records, resulting response rate of 97.1%. The respondents answered ten items of technical readiness scale ranging from computer literacy, programming languages and hardware/software systems.

According to the person and items scale fit, a person reliability of 0.72 and an item reliability of 1.00, along with a Cronbach's alpha of 0.75 were achieved, thus the Rasch model analysis demonstrates the statistical reliability and validity of all the items within the cognitive scale. Based on the results obtained, less than 1% students were unable to validate any of the scale items, suggesting that they were computer illiterate while 45.58% students were comfortable using computers. 39.41% students had experience working with hardware/software systems and programming. The remaining students had deeper knowledge in embedded systems. In general, from the Rasch model it showed that most students were not technically prepared for learning embedded systems. It also highlights the importance of student's readiness for learning that is reflected in students' performance. However, the study only conducted based on students' cognitive elements while metacognitive and resource management components were not considered.

The study conducted by Pellicano et.al. (Pellicano et al., 2020) aimed to develop a baseline assessment on students studying embedded systems that would increase students'

competencies. The data collected through a survey conducted based on student motivation scale comprises a set of inquiries aimed at assessing factors that either amplify or diminish motivation and achievement behaviour, referred to as 'boosters' and 'guzzlers,' respectively. A total of 15 students participated in the pre-interview survey showed high average scores for booster thoughts consist of self-belief (92.4%), value of schooling (88.6%) and learning focus (96.2%). Average scores were computed by summing up the responses from participants and converting them into a 100-
point scale. An interview was conducted after the survey to investigate the course and code development correlation. The most significant correlation is observed in courses that adopt a hands-on approach to learning, involving physical coding or system construction that may incorporate embedded systems. Conversely, courses with the least pronounced correlations tend to adhere to traditional theoretical methods for introducing and teaching concepts. However, as highlighted in the paper, datasets from both the pre and post interviews had constraints as it consists of small dataset. The survey relied solely on self-reported data from the participants and did not incorporate external sources, such as teacher assessments. Additionally, increase of standard deviation of answers due to not every student who participated had taken every class that was questioned. Based on the studies, readiness for learning is not a fixed trait and can vary from one situation to another. It can be
nurtured and developed over time through educational experiences, support, and personal growth. Recognizing and addressing factors that influence readiness can help educators and students optimize the learning process for better outcomes. Factors like prior knowledge, motivation and emotional state of a student are the key aspects of students' readiness for learning digital electronic system. This research acts as a guiding beacon, aiding the advancement of teaching and learning strategies, with the goal of delivering a more comprehensive and improved learning experience.

Conceptual Framework

Conceptual Framework of learning strategies in Figure 1.1 adapted from (Wenden & Rubin, 1987; Theobald et al., 2021). In general, there are 3 learning strategies can be implemented by learners such as cognitive components, metacognitive self-regulation and resource management. Cognitive strategies assist learners to gain and process the information and applied it as structure of knowledge. Cognitive strategies can be divided into four sub-strategies: (a) Elaboration, (b) Organisation, (c) Rehearsal and (d) Critical thinking. For elaboration strategies, learners required to link new information to existing knowledge which help them to integrate new information in long-term memory. In organization strategies, it allows complex information accessible for learning. Rehearsal strategies help the learners to review and practising the material repetitively to strengthen the integration of new information. Critical thinking required learners to perform analysis, synthesis and evaluate the information.

Metacognitive learning strategies is aimed to allow learners to control their own learning process include planning, controlling and regulating cognitive processes. Resource management strategies involved with internal and external resources. Internal resources used time and effort management while external resource based on peer learning and help seeking.

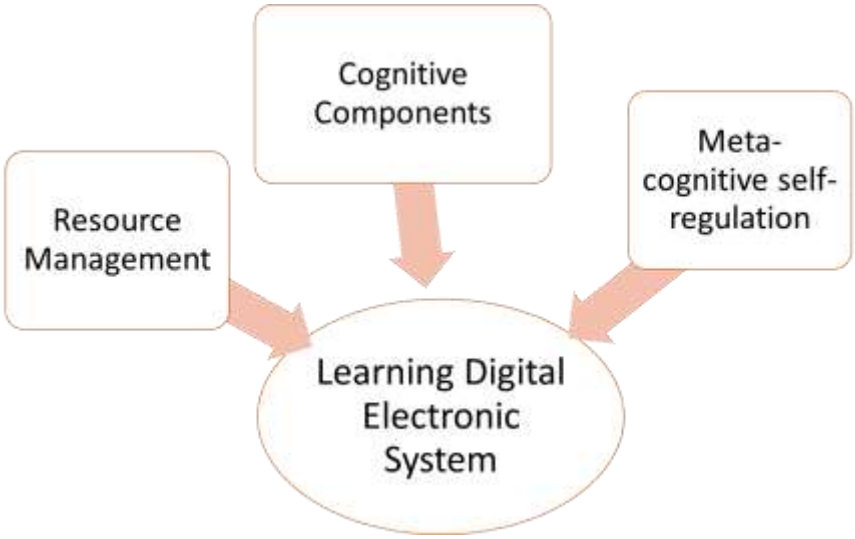

Figure 1.1: Conceptual Framework for Study Learning Strategies in Digital Electronic System

Methodology

The objective of this quantitative research is to explore motivation factors for learning embedded system among diploma student. A purposive sample of 31 participants responded to the survey. The instrument used based on a survey adapted from (Wenden &Rubin, 1987). Besides, 5 Likert-scale is used to measure the motivation factors and is initiated from Abeeleh and Al-Sobh (2021) based on reading comprehension problems to reveal the variables as shown in Table 1. The survey consists of 4 sections. Section A has described on demographic profile, Section B measured on cognitive components, Section C discussed on metacognitive self-regulation and Section D identified on resource management.

Table 1
Distribution of Items in the Survey

B	COGNITIVE COMPONENTS	(a)	Rehearsal	4	19
		(b)	Organization	4	
		(c)	Elaboration	6	
		(d)	Critical Thinking	5	
C	METACOGNITIVE SELF-REGULATION				11
D	RESOURCE MANAGEMENT	(a)	Environment Management	5	11
		(b)	Effort Management	4	
		(c)	Help-Seeking	2	
			Total no of items		41

Table 2 shows the reliability statistics parameter for the instrument. Cronbach's alpha of 0.92 was obtained from the Cronbach formula. Such value indicates a high internal reliability of the instrument used. Data was collected online using Google form. Data was analysed using

Excel 2023. Analysed data is presented in the form of mean scores to answer the research questions.

Table 2
Reliability of Survey

Parameters	Values
No of items	41
Cronbach's Alpha	0.92

Findings

Findings for Demographic Profile

This quantitative research was performed on respondents enrolled Diploma of Electrical Engineering, at UITM Pasir Gudang and taking subject for Digital Electronic System offered in the semester 4. The respondents enrolled the course commencing from March 2023 to October 2023. All respondents are male and in range of 20-29 years old.

Findings for Cognitive Components

This section describes data to answer research question 1: How do learners use cognitive components to learn Digital Electronic System? There are 19 sub-strategies used for the cognitive component. These sub-strategies include rehearsal, organization, elaboration and critical thinking.

A. Cognitive Components (19 items)

(a) Rehearsal (4 items)

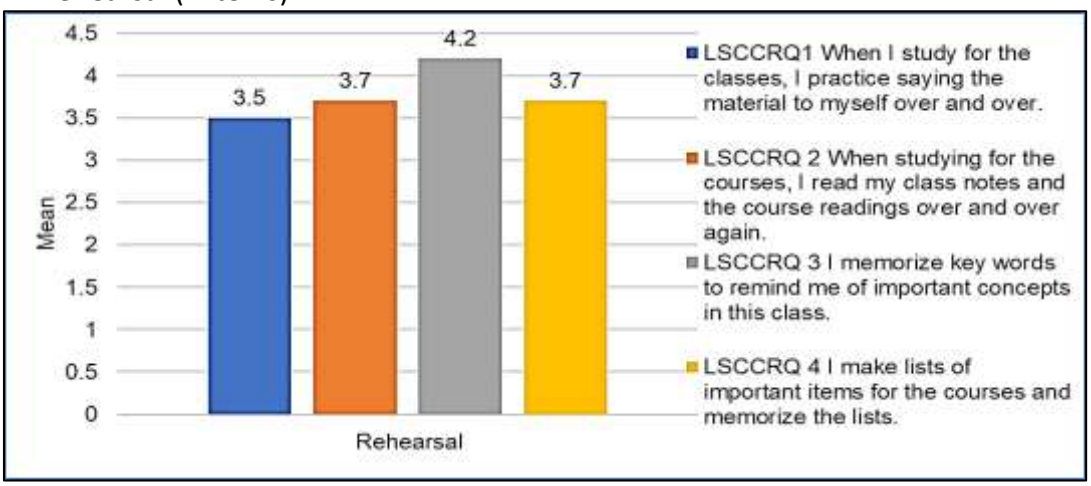

Figure 2.0: Mean for rehearsal

Figure 2.0 indicates that most of the learners memorize keywords (M=4.2) to grasp basic understanding on digital electronic system. The learners also prefer to list out important items of the courses and memorize them (M=3.7). In addition, revision on courses is important for the learners to enhance their understanding on lesson materials as they read the class note repetitively (M=3.7).

(b) Organization (4 items)

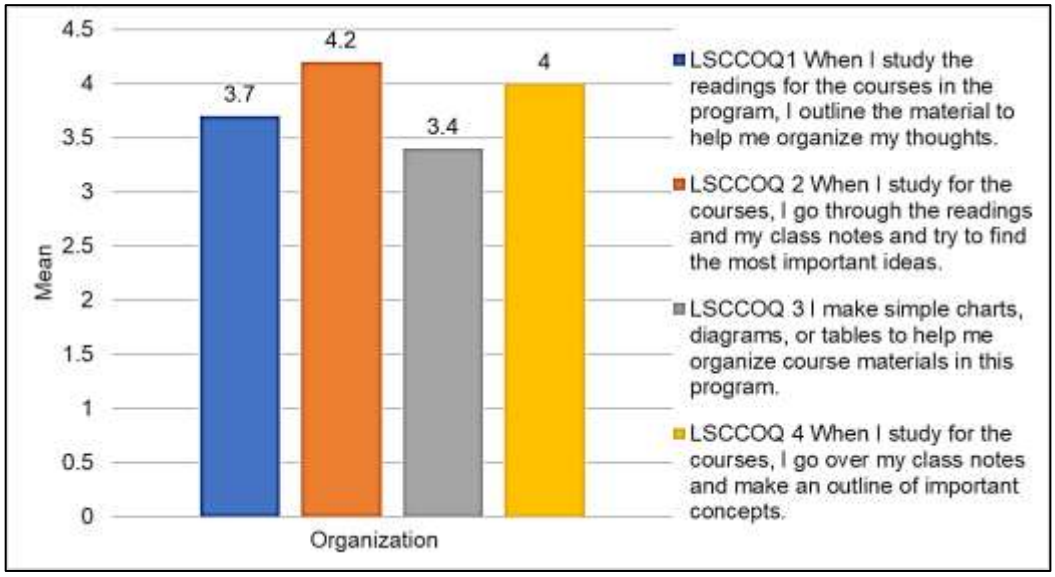

Figure 2.1: Mean for organization

Figure 2.1 shows that the highest mean of study organization is going through the readings and class note as well as try to find the most important ideas (M=4.2). The learners also refer to their class notes and make an outline of important concepts (M=4) when they study the courses. Besides, the learners outline the material to help them to organize their thoughts (M=3.7). Learners are less interested in creating basic charts, diagrams, or tables to help them organize course information (M=3.4).

(c) Elaboration (6 items)

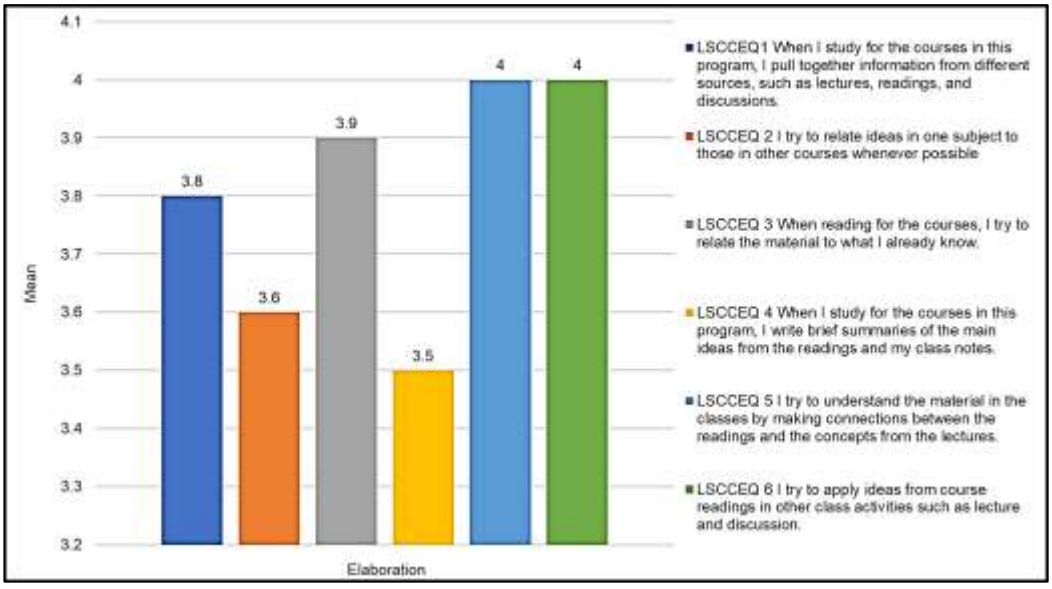

Figure 2.2: Mean for elaboration

In the analysis result for mean of elaboration in Figure 2.2, students preferred to understand the material in the classes by making connections between the readings and the concepts gained from the lectures besides apply the ideas from course reading during class activities such as lecture and discussion (M=4). When reading the lectures note, the students also try to relate the material to what they already know. Learners will gather information from

different sources include lectures, reading and discussion during the study revision of digital electronic system (M=3.8). Learners are less interested to relate the ideas in the subject to those in other courses whenever possible (M=3.6) and write brief summary of the main ideas from the readings and their class notes (M=3.5).

(d) Critical Thinking (5 items)

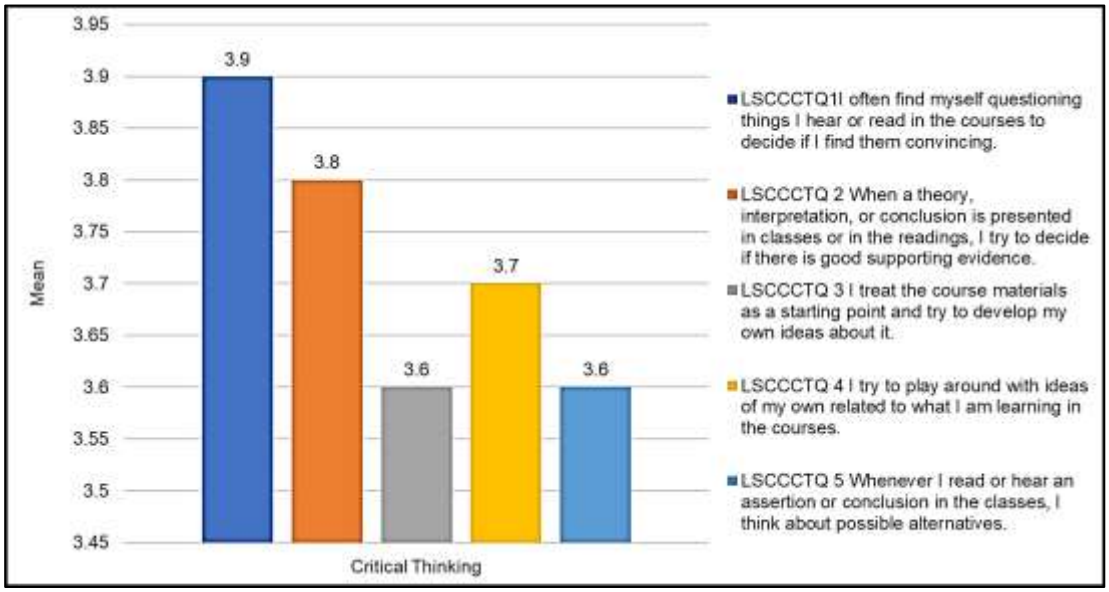

Figure 2.3: Mean for critical thinking

Figure 2.3 illustrates the result of critical thinking strategies used by the students. The students find themselves questioning things they hear or read in the courses to decide if they found them convincing (M=3.9). Students prefer to decide if there is good supporting evident when the courses involved with element of theory, interpretation or conclusion during classes or in the readings (M=3.8). Besides, the students try to play around with ideas of their own related to what they have studied in the Digital Electronic System (M=3.7). Least number of students treat the course material as a reference and try to develop their own idea it (M=3.6). Besides that, they also think possible alternatives whenever they hear or read an assertion or conclusion discussed in classes (M=3.6).

Findings for Metacognitive Self-Regulation

This section describes data to answer research question 2: How do learners use metacognitive self-regulation strategies to learn Digital Electronic System?

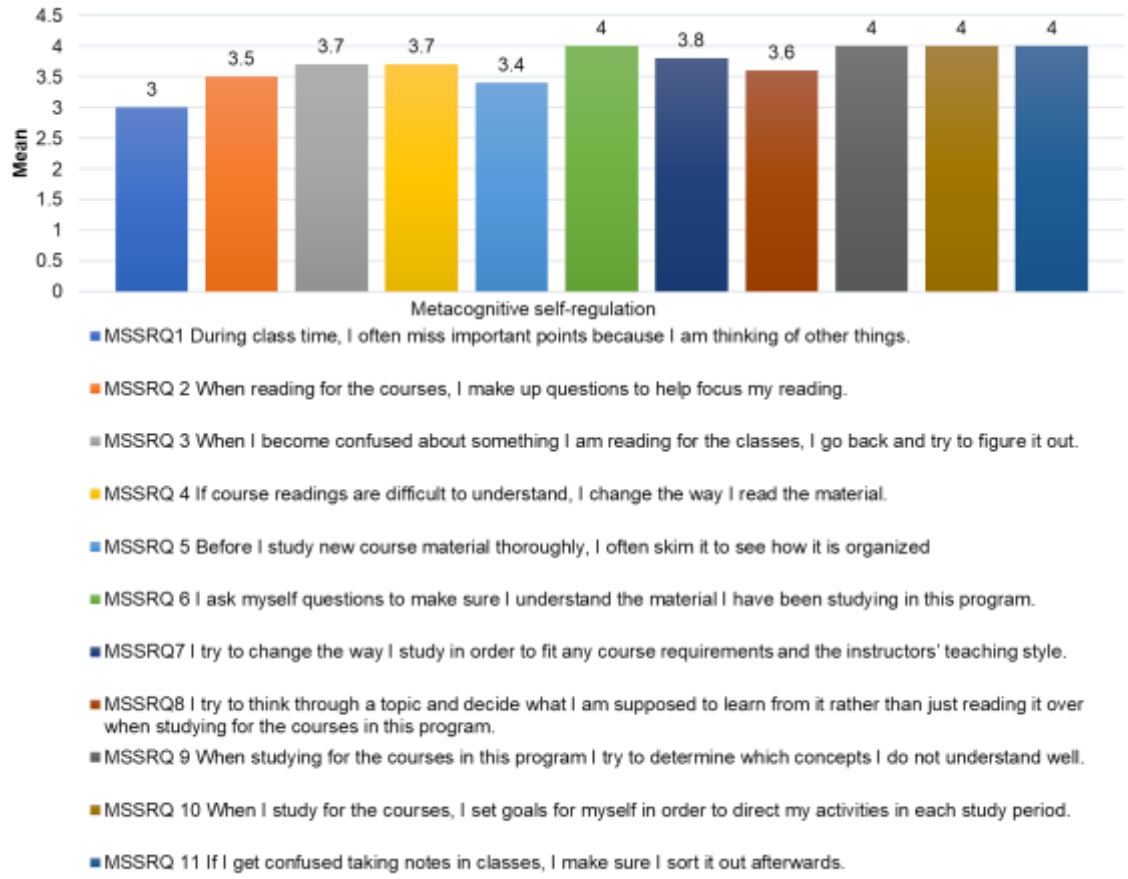

Figure 2.4: Mean for metacognitive self-regulation

Figure 2.4 shows the result of mean for metacognitive self-regulation strategies used by the learners in Digital Electronic System. Most of the learners agreed that when they study for the courses, they will set goals and planning specific activities in each study period (M=4). Besides, the learners also ask themselves questions to make sure fully understand the course material (M=4) and identifying which concepts, they do not understand well (M=4). Some of the learners change their learning style in order to fit any course requirements and the instructor's teaching style (M=4). If students having difficulty in understanding the courses, they will change the way of reading (M=3.7). Sometimes, if they confused about something on class material, they will go back and try to figure it out by themselves (M=3.7). They also make up the question to increase their understanding in reading course material (M=3.5). Several students often skim the course material and observe how the lessons being organized before study new course material (M=3.4). Only a few students are unable to concentrate throughout class, causing them to miss important points because thinking of other things (M=3).

Findings for Keyword Resource Management

This section describes data to answer research question 3: How do learners use resource management to learn Digital Electronic System? The findings are described by looking at the resource management component.

(a) Environment Management (5 items)

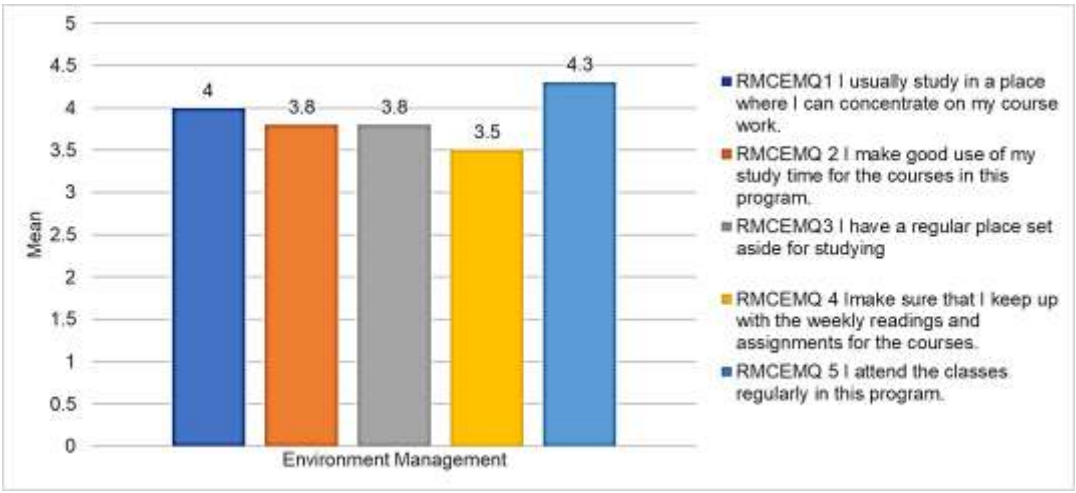

Figure 2.5: Mean for environment management

Figure 2.5 describes the mean score for environment management. Most of students preferred to attend the classes regularly to learn Digital Electronic System (M=4.3). Besides that, students also usually study in a place where they can concentrate on their course work (M=4). They also agreed that make good use of their study time and have a regular place set aside for studying can help them to increase their understanding in course material (M=3.8). Only some students agreed that they keep up with the weekly reading and assignments for the courses (M=3.5).

(b) Effort Management (4 items)

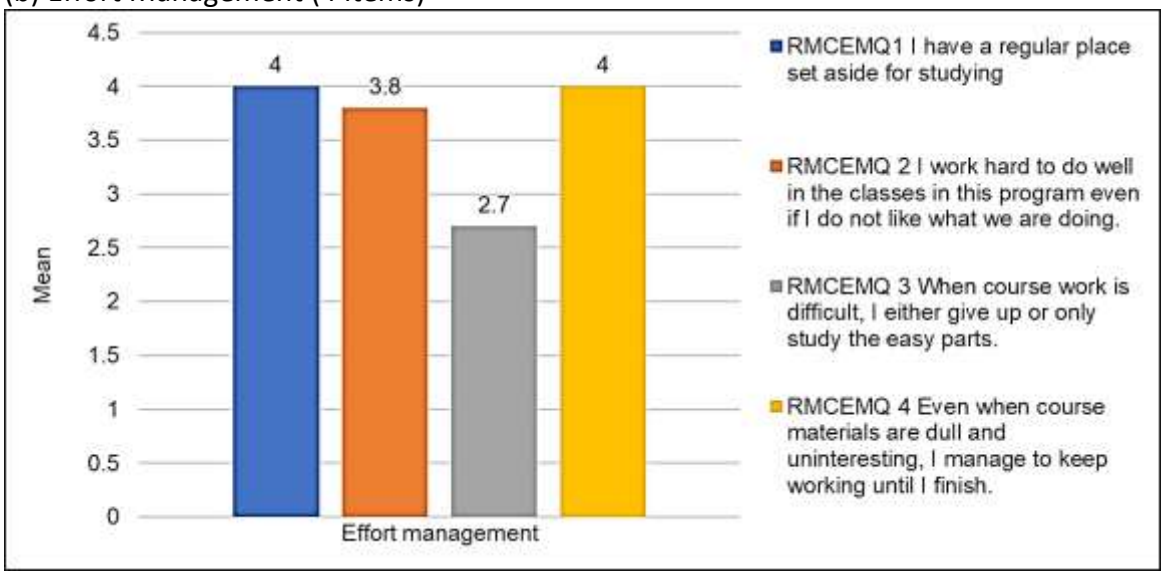

Figure 2.6: Mean for effort management

Figure 2.6 describes the mean score for effort management. The data indicated that students have strong interest in learning when they have a regular place aside for studying (M=4) besides manage to keep working until they finish even the course materials are dull and uninteresting (M=4). They also persistent in their learning when they work hard to do

well in the classes even if they are not like what they are doing (M=3.8). Only some of students either give up or only study the easy parts when course work is difficult (M=2.7).

(c) Help-Seeking (2 items)

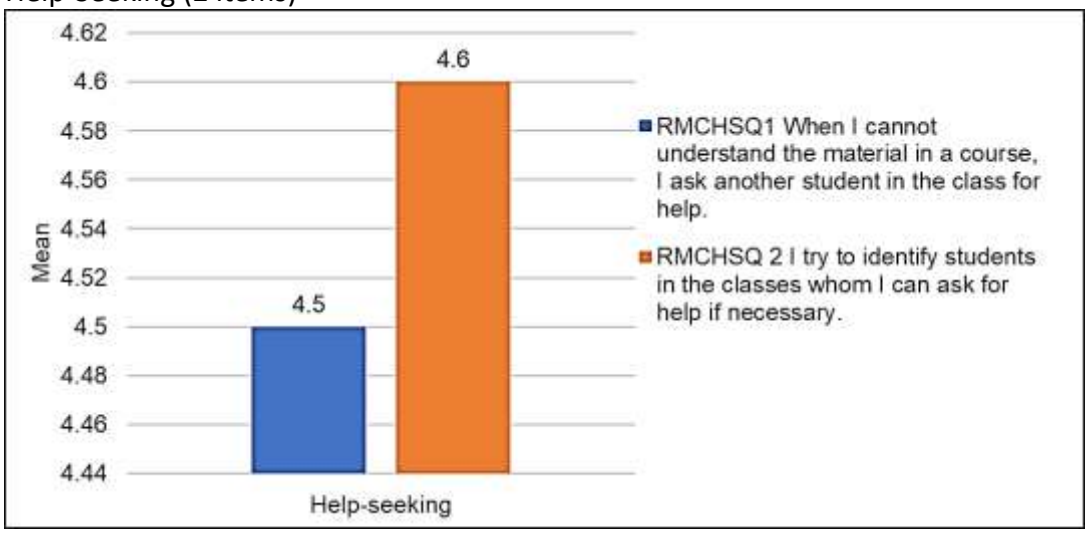

Figure 2.7: Mean for help-seeking

Figure 2.7 indicates the result for mean for help-seeking among the learners. The learners showed positive attitude and self-initiated in learning when they tried to identify students in the classes whom they can ask for help if necessary (M=4.6). They will also ask another student in the class for help when they cannot understand the course material (M=4.5).

Conclusion

Summary of Findings and Discussions

Learning strategies of Digital Electronic System were discussed and presented based on cognitive, metacognitive and resource management strategies. The results showed that in cognitive component of rehearsal, learners preferred rehearsal strategies by memorizing key word to remember important concepts in classes. In organization learning strategies, learners going through the readings and class note besides trying to find the most important ideas. Meanwhile, in elaboration strategies, students tried to link the reading and concept gained from the lectures to get better understanding on course material, subsequently applied the ideas in class activities such as lecture and discussion. Students often questioning things they heard during classes to foster the critical thinking skill. In metacognitive strategies, result revealed that the students have good awareness on metacognitive learning strategies. They have proper schedule, goals setting and planning some activities in each study period. They also ask themselves question to get better understanding on courses besides able to change and adapt their learning style based on course environment and requirement. In environment management strategies, students preferred to learn the course throughout classes indicates that the students aware with their own responsibilities. For effort management strategies, students are committed to learn the course by setting a regular place for studying and completed reading the course. Moreover, the students are self-initiative and asking their friends for help if they have problem or question on course material. The findings revealed that the learner averagely engaged with cognitive, metacognitive, and resource management learning techniques. However, learners need to improve on their learning strategies particularly in critical thinking. Thus, the findings of this study may motivate educators to

employ strategic teaching methods to improve their students' learning strategies. The findings revealed that the learner averagely engaged with cognitive, metacognitive, and resource management learning techniques. However, learners need to improve on their learning strategies particularly in critical thinking. Thus, the findings of this study may motivate educators to employ strategic teaching methods to improve their students' learning strategies.

Pedagogical Implications and Suggestions for Future Research

It is important for educators to know students' learning strategies in order to improve course delivery and student engagement. Furthermore, during class activities such as tutorials and assignments, teachers can encourage students to diversify their learning methodologies at their own pace. To lessen cognitive load experienced by learners, educators should examine effective learning methodologies employing various delivery modalities such as enhanced course materials and references, videos, and technology in future research directions. Any modifications in course delivery and their impact on students' learning techniques should be assessed through extensive surveys and questionnaires.

References

Gonzalez. (2016). Powerful Learning Strategies You MUST Share with Students. https://www.cultofpedagogy.com/learning-strategies/. Retrieved September 10, 2023. https://www.cultofpedagogy.com/learning-strategies/

Baygin, M., Yetis, H., Karakose, M., & Akin, E. (2016). An effect analysis of industry 4.0 to higher education. In 2016 15th international conference on information technology based higher education and training (ITHET). In 15th international conference on information technology based higher education and training (ITHET), IEEE,1-4.

Framing Malaysian Higher Education 4.0 Future-Proof Talent, Department of Higher Education, Ministry of Higher Education, (2023). Retrieved September 10, 2023. https://jpt.mohe.gov.my/portal/index.php/en/publication/61-framing-malaysian-higher-education-4-0-future-proof-talent

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. Psychological Bulletin, 138(2), 353.

Dent, A.L.; Koenka, A.C. (2016) The relation between self-regulated learning and academic achievement across childhood and adolescence: A meta-analysis. Educ. Psychol. Rev., 28, 425–474.

Pintrich, P. R., Smith, D. A., García, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). Educational and Psychological Measurement, 53(3), 801–813.

Theobald, M. (2021) Self-regulated learning training programs enhance university students' academic performance, self-regulated learning strategies, and motivation: A meta-analysis. Contemp. Educ. Psychol., 66, 101976.

Weinstein, C.E., & Mayer, R.E. (1986). The teaching of learning strategies. In M.

Wittrock (Ed.), Handbook of research on teaching. New York, NY: Macmillan,315-327.

Broadbent, J.; Poon, W.L. Self-regulated learning strategies & academic achievement in online higher education learning environments: A systematic review. Internet High. Educ. 2015, 27, 1–13.

Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. Int. J. Educ. Res. 31, 459–470. doi:10.1016/S0883-0355(99)00015-4

Vrugt, A., and Oort, F. J. (2008). Metacognition, achievement goals, study strategies and academic achievement: pathways to achievement. Metacogn. Learn. 3, 123–146. doi: 10.1007/s11409-008-9022-4

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? Contemporary Educational Psychology, 11(4), 307–313.

Anais, M. J., Hojas, A. M., Bustos, A., Letelier, C., Zuzulich, M. S., Cabieses, B., & Zubiaguirre, M. (2012). Motivational and cognitive learning strategies used by first-year engineering undergraduate students at Universidad Católica in Chile. Creative Education, 3(06), 811.

Liebendörfer, M., Göller, R., Gildehaus, L., Kortemeyer, J., Biehler, R., Hochmuth, R., ... & Schaper, N. (2022). The role of learning strategies for performance in mathematics courses for engineers. International Journal of Mathematical Education in Science and Technology, 53(5), 1133-1152.

Fang, N., bin Daud, M. F., Al Haddad, S. A., & Mohd, K. (2017). A quantitative investigation of learning styles, motivation and learning strategies for undergraduate engineering students. Global Journal of Engineering Education, 19(1), 4-29.

Whisler, L., Stephan, A. T., & Stephan, E. A. (2019). Promoting metacognitive awareness in a first-year learning strategies course for cohorted general engineering students. In 2019 ASEE Annual Conference & Exposition.

Lawanto, O., & Santoso, H. (2013). Self-Regulated Learning Strategies of Engineering College Students While Learning Electric Circuit Concepts with Enhanced Guided Notes. International Education Studies, 6(3), 88-104.

Kasalak, G., & Dagyar, M. (2020). University student satisfaction, resource management and metacognitive learning strategies. Teachers and Curriculum, 20, 73-85.

Pellicano, F. G., Haven, W., Haven, W., Martinez, C., & Haven, W. (2020). Establishing Baseline Data on Student Success in Embedded Systems Education. 2022 IEEE Frontiers in Education Conference (FIE), 1–4. https://doi.org/10.1109/FIE56618.2022.9962525

Ridwan, I. I. (n.d.). Rasch Measurement Analysis for Validation Instrument to Evaluate Students Technical Readiness for Embedded Systems. 2016 IEEE Region 10 Conference (TENCON), 2115–2119. https://doi.org/10.1109/TENCON.2016.7848399

Wenden A and Rubin J (1987) Learner Strategies in Language Learning. New Jersey: Prentice Hall.

Abu Abeeleh, T. W., Al-Ghazo, A., & Al-Sobh, M. (2021). Reading comprehension problems encountered by EFL students at Ajloun National University. International Journal of Language and Linguistics, 8(1), 6-15.