

## Self regulated Learning with Open and Distance Learning for Foundation of Applied Mathematics Course

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**Abstract:** Foundation of Applied Mathematics is one of the mathematics servicing courses for Diploma of Applied Science programme in Universiti Teknologi MARA (UiTM), Malaysia. This course was previously taught in a physical classroom using direct confrontation. A few negative factors were found to contribute to the course's failure rate: i) inadequate exercises, ii) poor study habit and iii) reluctance to consult the lecturer. Due to the ongoing COVID-19 outbreak, the students are forced to do independent learning at home. Ascribable to this issue, the lecturers were inspired to investigate their students' motivation and participation in this course, which associate to their self-regulated learning (SRL). This paper presents the implementation of open and distance learning (ODL) in teaching the subject of Foundation of Applied Mathematics. The ODL was intended to promote SRL for student, thereby increasing their motivation and participation in learning activities. At present, no literature has been found study on SRL in current ODL method, mainly for this course. Online questionnaires were collected at the end of March - July 2020 academic semester to investigate students' perception on ODL and its effect to Self-Regulated Learning (SRL). Descriptive analysis was used to analyze the data. The findings indicated that the level of agreement for ODL has positive contribution to the students' SRL.

**Keywords:** Mathematics; Self-Regulated Learning; Open and Distance Learning.

### Introduction

This study focuses on the teaching and learning of the Foundation of Applied Mathematics' (MAT238) students. This course is offered to full-time, third semester students of Diploma of Applied Science (AS120), Universiti Teknologi MARA (UiTM), Malaysia. This course was fully taught using face-to-face communication in a physical classroom, with the lecturer being the instructor. Based on June 2019's examination, MAT238 was identified as one of the highest failure rate courses, with less than 70% passing percentage.

This matter had driven the lecturers to investigate their students' self-regulated learning and self-motivation over this course. This has been supported by [1], [2] which indicated that factors such as motivation and study habits have influenced on students' academic performance in mathematics. The earlier challenge in learning this course included the students' failure to recall the fundamental concept of differentiation and integration that they learned in Calculus I, from their second semester. Some researchers believed that basic mathematics knowledge is important in learning new mathematics knowledge, and it has a great influence on students' performance [3]. According to [4], the students' previous achievements in mathematics highly contribute to their new mathematics course's performance outcome for their current semester. Another encountered issue was the students' difficulties in identifying a suitable method to solve a particular problem - such as differentiation and integration which has a few methods of application, as stated in [5]. They were confused with some integration and differentiation techniques due to their lack of practices [6].

Furthermore, the most difficult part in learning this course was the students' inability to think critically when they are given a complicated situation or solution process that are often long and tedious [5] and [7] - such topic involved the First Ordinary Differential Equation. These factors made them being unaware of what they were learning, and caused them to rely more on memorization of rules and procedures [8]. Understand that studying for mathematics is different from other subject, where mathematics is learned by solving problems [1], however, the researchers observed that most of the students who are less interested and lack of motivation in mathematics may cause student missed many exercises [2]. Furthermore students being passive learners, and having poor learning habits and attitudes towards mathematics [5] and [1]. One of the improper learning methods practiced by the students was copying example of solution in their notes or copying their peer's work without trying to complete the exercises themselves [5]. Hence, these clearly demonstrate deficient learning strategies with heavy reliance on others.

The COVID-19 outbreak urges many educators to change their teaching methods [9] and [10] by promoting innovative educational practices [11] that involves Open and Distance Learning (ODL) method. This method is being used as a continuity plan for schools, universities, and colleges around the world. It promotes student's

self-regulation in online learning environment. Since the online-based learning environment is now widely practiced, the research of predictors like self-regulated learning has increased rapidly [12].

At present, no SRL experimental studies in ODL method have been conducted by researchers, particularly for the Foundation of Applied Mathematics course. Hence, the objective of this paper is: a) to provide the fundamental design report on ODL that has been implemented for Foundation and Applied Mathematics and b) to present the level of SRL achieved using ODL method. This study hypothesizes that the students of the Foundation of Applied Mathematics course can develop their SRL even through the implementation of ODL.

### Literature Review

In this section, the literature review is further elaborated, and the improvement strategies are also named. ODL, type of interaction, SRL, and Foundation of Applied Mathematics are also further discussed.

### Improvement Strategies

Educators in third-level or tertiary education have begun doing a great research to improve their students' achievements in Mathematics. As mentioned in [4], student-centered method is more preferable than the traditional approach. It allows students to be actively involved in the learning process with the guidance of the lecturer as the facilitator. Furthermore, the students will eventually learn the relationship between mathematical concepts in a creative manner. Recent studies recommended educators to use learning technologies [13], [14] and

[15] to encourage students to boost their levels of self-regulation learning in online environment.

In the reviews, many researchers believed that motivational, metacognitive and behavioral process are important to enhance cognitive process in learning mathematics [16]. These processes embody the students' self-regulated learning (SRL), which emphasizes the active roles of the learners [17]. For mathematics, metacognitive knowledge is not only about the students' ideas regarding the nature of mathematics, since it also refers to mathematical processes and techniques that are acquired by them [18]. Nonetheless, educators must guide their students to become responsible for their own learning by using appropriate strategies that will allow them to control their own motivation, meta-cognition and learning behaviours to enhance mathematics performance.

### Open and Distance Learning (ODL)

Open and Distance Learning (ODL) is one of the methods to learn without attending a physical class. This method ignores geographical barriers and connects the students with their educators through a number of audio-video aids and other technologies [19]. The term 'Open and Distance Learning' is also interchangeably used with a term like e-learning [20]. ODL can be characterized by the following: i) educator and learner are separated by space and time; ii) self-paced study which allow student study what they want, when they want and where they want; iii) collaborative courses based on cohorts; and iv) learning materials delivered either synchronously or asynchronously [21]. For example, in 2020, the Commonwealth of Learning (COL) released a summary of "Open and Distance Learning: Key Terms and Definitions" which includes 32 different entries – those above and others such as "flipped classroom", "learning technologies", "open learning", and "virtual education".

The most frequently reported challenges in the ODL environment are the lack of adequate study time, difficulties in accessing and using ICT, ineffective feedbacks, and the lack of study materials [22]. Moreover, the fact that ODL is more flexible, student-centred, and autonomous than face-to-face learning, it requires the students to organize themselves and use self-regulated learning skills more frequently [23]. However, the new generation also prefers the attractive system [24]. Therefore, the implementation of ODL in this course is expected to help the students to improve their abilities by applying self-regulated learning strategies.

### Type of Interaction

Millions of students were unable to attend physical classes due to their concerns about the COVID-19 outbreak, where all levels of learning institutions were closed, and the students started to learn from home [9], [25]. They received instructional contents, submitted assignments, took tests, and interacted directly using online or virtual platforms. As stated in UiTM's guidelines on students' ODL involvement, several interactions in ODL delivery along with the media technology are suggested: a) traditional postage service; b) voice message (audio); c) short messages service (SMS); d) telephone; e) radio or television; f) social media or web 2.0 like Facebook, WhatsApp, Telegram, Twitter, YouTube, Blog, or Wikis; g) live chat; h) Learning Management System (LMS) like Google Classroom, Moodle, and Schoology, and; i) video conferencing (face to face).

### Self-Regulated Learning (SRL)

Self-regulation is not a mental ability or academic performance skill - it is a process of self-directing by which students change their mental abilities to become academic skills [26]. Self-regulation is increasingly important in the learning process of students to control their cognition, and enhance motivation and behaviour to achieve certain goals [27]. With the lack of self-regulated competency, most students may fail to find and understand teaching materials on their own [28]. SRL helps students improve their learning methods by enhancing their learning habits and study skills [29]. Many researches also identified SRL processes to be enabling learners to

successfully learn in online environments [30]. This is supported by the significant positive relationship between SRL strategies and online academic success found in [12].

According to [31], SRL involves several attributes like planning, organizing and self-evaluating to promote students' motivation through active learning. Zimmerman defines self-regulation as "self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" [32].

There are a few researchers who mentioned that the lack of ability to self-regulate, and the limited skills of self-regulatory can be the significant reasons that lead to demotivation of online learning environment, including ODL [33] [34]. However, online learning's interest can be higher than face-to-face learning [35] because of the students' preference in technology that may contribute to the demand of self-regulated learning skill that indirectly influences their academic achievement [36]. According to [37], based on their experiences with various generation of students in online, blended and face-to-face situations, they found that younger students are likely to have the strongest preference for technology. Being a self-regulated student is important when studying and working with mathematics [28]. SRL is a promising learning strategy that is proven to increase the students' motivation to learn [31].

### **Foundation of Applied Mathematics**

This course is drawn heavily from calculus and ordinary differential equations (ODEs) which entails four chapters. The students will learn calculus that mainly deals with differentiation and integration involving Inverse Trigonometric Functions, Hyperbolic and Inverse Hyperbolic Functions. It also covers the topics on the first and second orders of ODEs. This course aims to develop students' skills in demonstrating their abilities to apply creative, imaginative, and innovative thinking ideas to problems solving, and demonstrate the abilities to investigate problems and provide effective solutions. Usually, this course is taken by at least second year students who passed both Pre-Calculus and Calculus courses.

Teaching and learning differential equations are difficult in any mathematics course, particularly at pre-university level [38]. Besides that, according to UiTM Tapah's Academic Records, the researchers noticed that certain batches of students in this course periodically perform poorly. Before being able to solve integration techniques, the students are expected to have prior knowledge of differentiation and integration of the following functions: trigonometric, inverse trigonometric, hyperbolic, inverse hyperbolic, and exponential. These topics require the use of many formulas that are easily obtained from the appendix section, but requires guidance from the lecturer on how to use them effectively without memorizing [6].

The challenges faced by this course's students include the various integration techniques with long and tedious calculation processes [6]. Then, the students must master the integration techniques to solve first ODEs for the next chapter in this course. Many students were unable to solve the ODEs problems accurately due to inability to figure out the steps required in the solution procedure [39], [40]. In September 2019 - January 2020 semester, in order to help low-performing students and motivate them to do more exercises, one of the activities that was promoted by the lecturers was doing interactive exercises using Quizizz platform. However, due to the sudden change from physical class to online platform, this study was conducted to see how ODL method made a positive contribution to the SRL.

### **Methodology**

The aim of this study was to design ODL instruction for the Foundation Applied Mathematics coded as MAT238 in UiTM and to investigate the students' self-regulated learning. The data were mainly collected through questionnaire at the end of March – July 2020 academic semester that was created using Google Forms. The participants answered it anonymously with the option of indicating their ID number.

### **Participants**

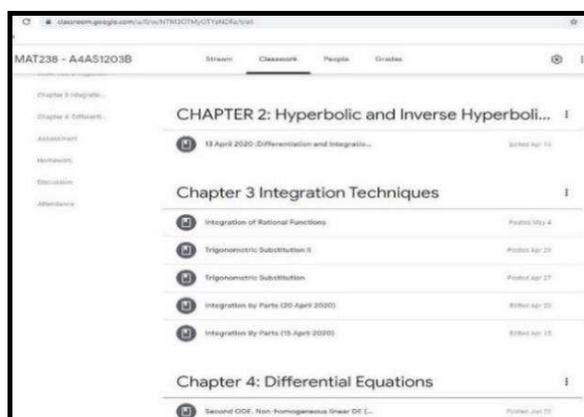
To determine the self-regulated learning with ODL for Foundation of Applied Mathematics course through questionnaire, the respondents of this study consisted of 67 students who enrolled for Foundation of Applied Mathematics (MAT238) in UiTM Perak Branch, Tapah Campus, from March to July 2020. This course offered to full-time Diploma Applied Science in the third semester. The course consisted of four chapters. Students were suggested by lecturer to manage their learning modules and time according to timetable set by UiTM. Students were informed that their participation will be counted into two main learning activities: a) watching video recording or attend live video and finishing quick exercises at the end online class and b) completing associated homework.

### **The Design of ODL for MAT238**

Various ODL implementation strategies can be put in place to ensure that learning will proceed. However, the approaches used need to take into account about the constraints faced by students and lecturers themselves - either synchronous or asynchronously [41]. Most of the lecturers chose low data consumption messenger

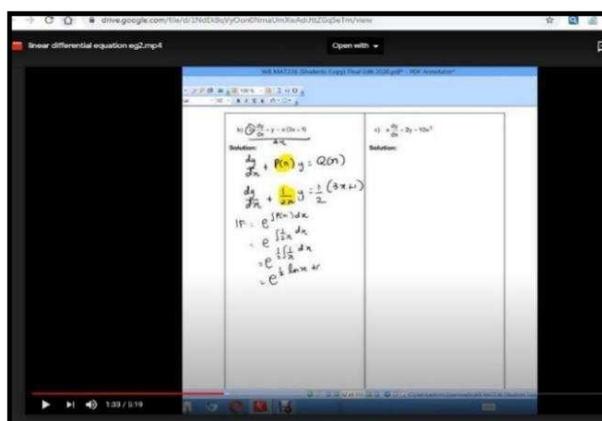
applications such as WhatsApp and Telegram as social media tools to interact with their students during the COVID-19 period. This platform delivers low bandwidth contents to everyone with smartphone – even to those with poor internet connection or limited data. The lecturers used these tools to send short messages, voice notes, PDFs or slides, notes, pictures, video recordings, and YouTube links.

Furthermore, the Learning Management System (LMS) which is Google Classroom (GC) is another popular platform used by most educators. One of the greatest aspects of GC is that the lecturers can easily organize learning contents to ensure their students to be able to catch up with the valuable learning materials that they shared as shown in following picture.



**Figure 1** Screenshot of learning contents (videos, notes, exercises, assessment questions) of Google Classroom for MAT238.

Figure 1 describes the learning materials provided in GC are similar for all topics where there is video recording, lecturer note, activities consisting of exercises that students may attempt after learning from the video to enhance their understanding. The written assessment helps to ensure that concepts are understood. All assessments are answered offline but need to be uploaded online. Video recordings have been prepared to show the solution for specific examples to guide students through the solution process so that they can complete other examples or exercises as shown in Figure 2.



**Figure 2** Screenshot of video recording

Video conferencing platform is another concept that is best for ODL teaching and learning. The strength of videoconferencing tools lie in their ability to attract the viewers through the use of visuals, interactive features and synchronous communication. While lecturers may not require their students to attend live meetings due to concerns about access, connectivity, and availability, these sessions can be recorded and posted on GC.

To keep the students engaged watching the videos, they were asked to join open discussions and answer few questions during online class in GC (using the Stream) or via WhatsApp/Telegram to confirm their comprehension – so that the students can ask questions and the lecturers can answer them immediately. After every online class, students were required to complete homework and submit the solution on GC before at the beginning of next week session.

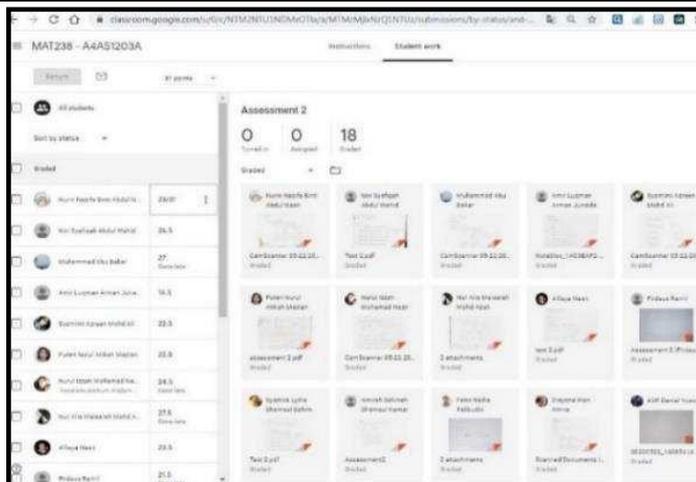


Figure 3 Screenshot of sample of students' assessments.

Figure 3 shows that, sample of students' assessments submitted on GC. This requires the students to prove their understanding and apply what they have learnt from the learning session by answering questions or submitting homework.

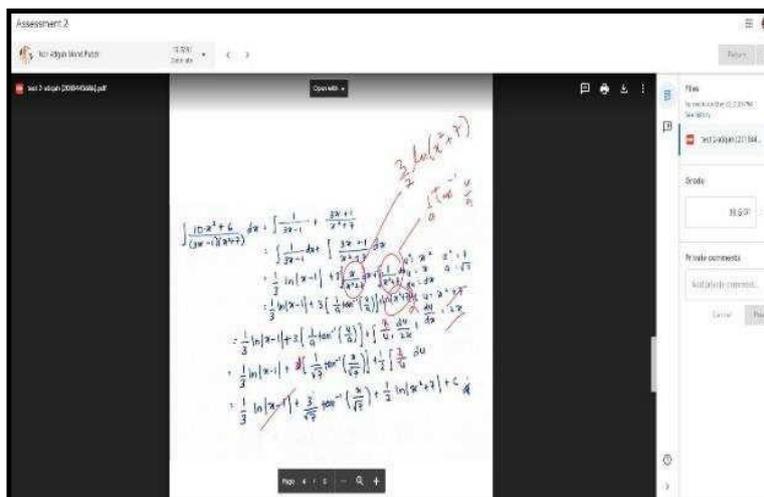


Figure 4 Screenshot of sample lecturer grades and comments on students' work

The lecturers can easily mark, grade the assignment, and provide feedbacks on their students' work, as well as evaluating all assessments that were given along the semester as shown in Figure 4. Monitoring students' involvement with the learning activities is very important and needs to be recorded so that the quality of delivery and learning from both parties are achieved. At least 83% students are able to complete the learning activities weekly. This number can be viewed as a measure that indicates a strong student commitment and motivation to complete the ODL. Therefore, it is also interesting to get students' view of SRL items from ODL.

**Instrument**

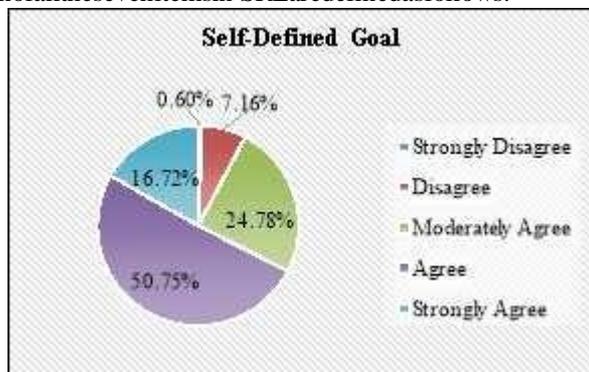
An online set of questionnaires was provided to gather the information of the students' perceptions and comments on SLR with ODL for the Foundation of Applied Mathematics course. The questionnaire contained a set of queries combination and modified version with reference to [42] and [43]. The questionnaire for students was generally divided into two sections. Section A comprised information about the respondents' demographics such as student ID, gender, and CGPA. Section B asked their perceptions towards SLR with ODL for MAT238 for March - July 2020 session. For this paper, seven SRL items are reported: i) self-defined goal setting, ii) environment structuring, iii) task strategies, iv) time management v) help-seeking, vi) self-evaluation, vii) task responsibility. The students were asked to rate each question based on their agreement levels of SRL: strongly agree/agree/moderately agree/disagree and strongly disagree. The questionnaire was answered by students who registered MAT238 during the semester break, after the final examination ended.

**Data Analysis**

Only descriptive analysis was used to analyse the data. As each question presents one item of the SRL, the frequency of each item can be directly presented in pie and bar charts. The results were used to test the research hypothesis of “the students were able to develop their SRL with ODL implementation”.

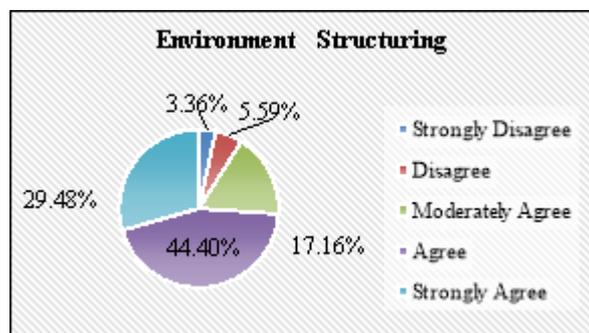
**Findings**

According to [44] the definition of all these seven items in SRL are defined as follows.



**Figure 5** Self-defined goal

Based on Figure 5, it describes the ability of the students to set study plans necessary for timing, sequencing, and planning for accomplishing their mathematics tasks. It showed that most of the students agreed that ODL made them self-define their own learning goals. Only 0.60% students were unable to self-define their learning goals. In terms of motivation activity, goal setting strategy was used in setting educational objectives in completing tasks related to this purpose [44],[45]. This comprised of activities like making a schedule for activities that they needed to do for mathematics class, remembering the ultimate goal in order to manage their study time and every task they performed, and making sure to be able to solve the things they needed to do for each mathematics topic.



**Figure 6** Environment structuring

The result from Figure 6 shows the percentage of how students initiated to arrange or select their learning environment to optimize learning. About 3.36% of the students did not organize their learning environment to minimize distraction and noise while doing mathematics task. But, 29.48% and 44.40% students respectively showed that they strongly agreed and agreed to initiate effort to create a distraction-free environment by isolating themselves from anything that disturbs them in doing mathematics tasks.



**Figure 7** Task strategies

Figure 7 reveals the result of task strategies in making thorough notes for mathematics course and work harder by doing more exercises in mathematics to master the course content during ODL. About 23.39% students strongly agreed that task strategies were enhanced by ODL, while 1.49% students strongly disagreed with independent learning in developing their learning strategies.

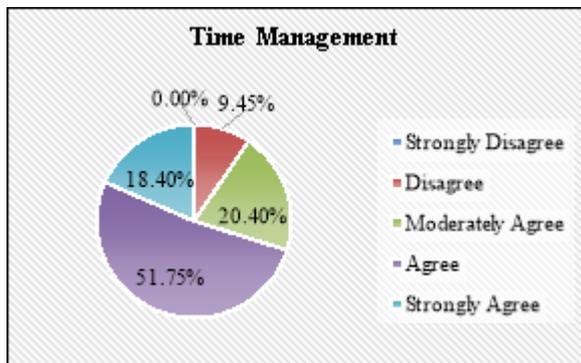


Figure 8: Time management

Figure 8 reveals the result for time management. This describes how students organized and planned their study time and task [46]. Most students agreed that ODL improved their time management exceptionally well.

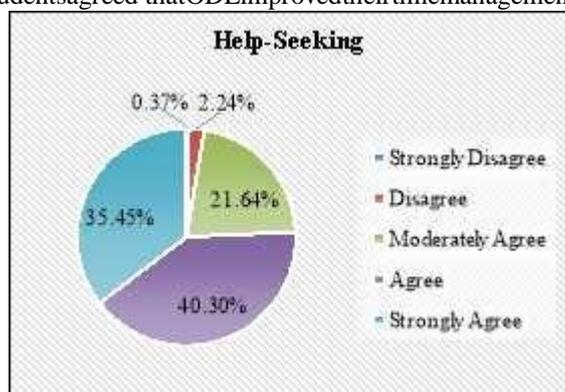


Figure 9: Help-seeking

Finding help is related to getting help from lecturers or friends, with the aim to overcome learning challenges. For example, contact someone who is knowledgeable in course content and get help from lecturers through emails/WhatsApp/Telegram for seeking clarification about learning content". The result is presented in Figure 9, where the largest percentage of students strongly agreed.

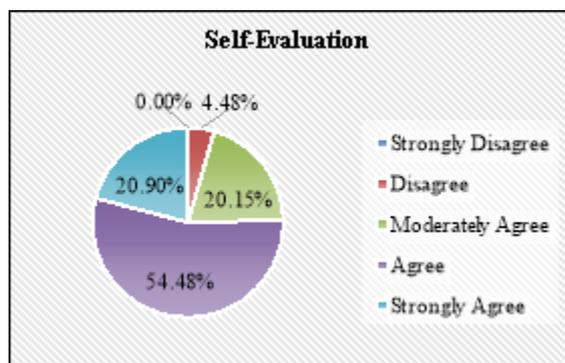


Figure 10: Self-evaluation

Figure 10 above shows the result for self-evaluation. Similarly, most of the students found that they had self-evaluation in ODL. As reported by [47], a student who is able to measure their performance in terms of understanding and knowledge in a particular learning is considered to have a clear direction to get higher success in learning. Furthermore, self-evaluation is related to the students' ability to establish evaluation or assessment of the progress. They may communicate with their peers to solicit feedbacks related to their work. About 20.15% students were unsure or lacked confidence with the knowledge they gained from ODL [31].

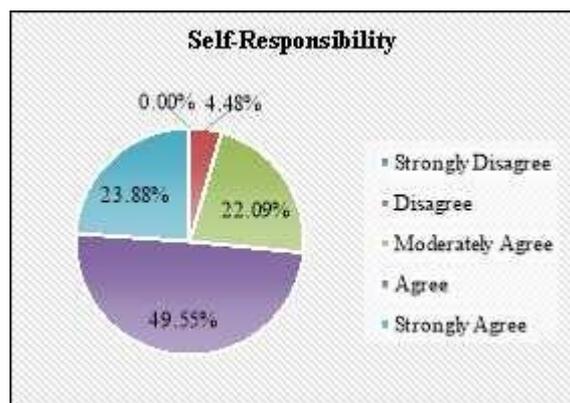


Figure 11:Self-responsibility

Figure 11 reveals the result of how students took responsibility for aspects of their mathematics learning and task. For example, recheck their homework to avoid casual errors, having concern with the deadline, finishing all homework first.

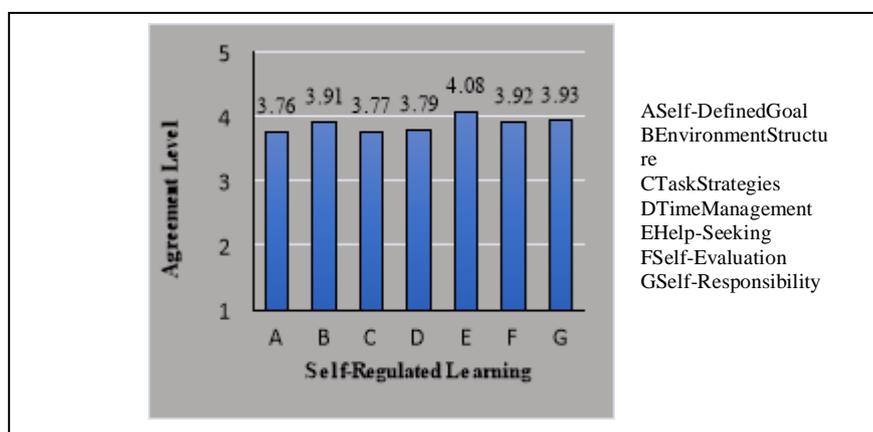


Figure 12:Agreement level on SRL

Figure 12 indicates how the students rated the level of agreement that they experienced during ODL for MAT238 course. The ratings were 1 = strongly disagree ... and 5 = strongly agree. There was only one SRL with more than four levels of agreement. Then, the remaining six items with above-average agreement levels managed to score above the mean rating of 3.0.

**Conclusion**

Throughout the COVID-19 period challenge, it is necessary to understand how students can best practice SRL to achieve academic success from ODL. SRL emphasises even more learning independence. This research paid attention to the identification of self-regulated learning levels in Foundation of Applied Mathematics course. The result showed that most of the students rated ‘agree’ in seeking necessary help. For example, they would approach their lecturers or learn from their peers when necessary. It shows that self-regulated students are not passive learners – yet they actively try to seek out information and assistance when needed. In adapting to the new norm, the implementation of ODL helped the students to become more aware of their responsibilities for their own learning, making them more active, and motivated to formulate their own learning goal and strategies. Generally, it is believed that ODL was designed for purposeful and disciplined students, which may increase the demand for them to work independently. Based on our findings, a further study can be undertaken to measure the relationship of ODL in developing SRL in terms of improving students’ achievement.

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