Learning Experience with LearnwithEmma

Clara Susaie[1], Choo-Kim Tan[2,*], Pey-Yun Goh[3]

[1,2,3] *Faculty of Information Science and Technology, Multimedia University, Jalan Ayer Keroh Lama, 75450 Bukit Beruang, Melaka, Malaysia.*
[*]Corresponding author: (cktan@mmu.edu.my, ORCiD: 0000-0001-9034-316X)

Abstract - The presence of Covid-19 was a game-changer in all the sectors that traditional learning, working, selling even living methods have changed from basic methods to something else to curb Covid-19. The impact was huge on most sectors due to the lack of experience in overcoming pandemics. One of the sectors that face the most struggle was educational institutions. For many years, face-to-face learning and teaching method have been in practice. While during Covid-19, everyone was forced to attend online classes as a precautious measure. Online learning is completely based on digital study without the physical presence of students or lecturers. Implementing such learning approaches gradually in education allows students to expose to both learning methods. Many subjects such as languages, and theory-based topics have been taught with an online learning approach; however, less attention was paid to mathematics. Therefore, this study aimed to examine students' experience in learning Discrete Mathematics online through LearnwithEmma. LearnwithEmma is a learning platform that was designed for students in this study. During a month, students' learning was assisted by an agent, Emma. Students were given a questionnaire that involved questions about their experience and their current understanding of the subject. Students opined that their performance significantly improved after learning via LearnwithEmma. About 77.2% strongly agreed that they excel in Mathematics after fully utilizing LearnwithEmma. Most of them agreed that they were able to perform better in their exam after using LearnwithEmma. 75.4% of the students agreed that they have scored better in their exams after using LearnwithEmma. 61.4% of the participants preferred to learn Discrete Mathematics through an online class compared to a traditional class. This study recommends that educators and researchers may enhance online learning by introducing new platforms such as LearnwithEmma or integrating other multimedia elements.

Keywords— Online learning, Traditional Learning, Teaching Agent, Logic and Proofs

I. INTRODUCTION

The presence of Covid-19 was a game-changer in all the sectors that traditional learning, working, selling even living methods have changed from basic methods to something else to curb Covid-19. The impact was huge on most sectors due to the lack of experience in overcoming pandemics. One of the sectors that face the most struggle was educational institutions. For many years, face-to-face learning and teaching method have been in practice. While during Covid-19, everyone was forced to attend online classes as a precautious measure.

This research introduced a learning platform for students in learning. The purpose of this research is to investigate students' experience adapting to the learning platform and how it has significant effects on students' performance in

learning mathematics. The students' feedback was collected through a self-designed questionnaire to determine how the learning platform has improved their mathematics performance with the assistance of a learning platform - LearnwithEmma.

II. LITERATURE REVIEW

A. Online Learning

Online learning refers to delivering all the teaching, assignments, study materials, and exercises online where students can access them from anywhere via the internet [1]. There will be no face-to-face interaction between the learners and educators. In other words, students will be studying and learning independently. Computer-based online-based teaching sessions carry more advantages over the face-to-face learning approach [2]. Online learning is more flexible, learner can access it from anywhere or any part of the place to acquire the lesson. It overcomes the problem of a large group in the lecture hall always ignoring the needy individual. In addition, learners who have time constraints and are unable to attend classes found online learning is better and up to their convenience. Learners also had the privilege to repeatedly learn the lesson as they can pause and playback the video clips for a better understanding while they are unable to do in the face-to-face learning approach. The online teaching approach has equal effectiveness to face-to-face teaching approach. One of the factors is the quality of learning. Online learning should provide better-quality learning materials. This includes better video quality, integration of multimedia components instead of just text-based presentation, clear voice projection, and choosing the right font style and size during presentation[3][4]. Online learning can be very effective if it meets the right component in teaching and learning. Especially, discursive, adaptive, creative, interactive, and reflective components are significantly good if they can be integrated into the learning environment [5][6]. There are studies show that students' performance can improve through online learning. Firstly, by getting instance responses from the lecturers or educators. When lecturers or educators provide comments to students during online class, it made students to pay more attention and keep engaging. They are able to think that the lecturers are interested in providing answers for their questions or comments [7].

B. Teaching Agent

Teaching agent has various definitions provided by the researchers. Some defined it as pedagogical agents, where they can act as motivators or instructors with the learners through facial expressions, gestures, and natural language [8]. They are considered as lifelike characters presented during online classes that teach students on learning platforms [9]. The animated pedagogical agent provides fun and boosts the interest of participants. They are specially designed just like a real human being [10]. Furthermore, the animated pedagogical agent has the capacity to reduce stress among the learners and is able to draw students' attention during learning. [11]. In addition, teaching agents motivate the students and increase their confidence to participate in learning more often [12]. In this study, the teaching agent is designed as a lifelike character that has a human look, gestures, human voice, facial expression, and is able to show emotions [13].

C. Discrete Mathematics

Computer Science or Information Technology programme requires the students to study Discrete Mathematics subject since programming requires logic and reasoning. Discrete Mathematics may be difficult to some of the students compare to their secondary school mathematics. Discrete Mathematics enhances students' thinking and communication skills [5]. Students must have a high level of thinking skills to understand properly the concept of Discrete Mathematics. A study [14] mentioned a few topics that have been included in Discrete Mathematics. There are Logic which contains a study of reasoning; Set Theory included collection of elements, followed by Algebra System and Graph Theory [15]. However, [16] mentioned that Discrete Mathematics is always a challenging subject to be taught and learnt. Discrete Mathematics plays an important role, and it is a prerequisite subject of many specialized subjects. In addition, the study stated that mainly for Discrete Mathematics is a subject that an enclosed subject and not required prior knowledge.

To add, there is less involvement of technology in learning process of Discrete Mathematics. Discrete Mathematics also can be used to develop different mathematical skills. Discrete Mathematics also helps the students to develop and improve their ability to reason and think mathematically and logically. In fact, Discrete Mathematics creates

interest and provides new opportunities to experience joy in mathematics classes. Besides, Discrete Mathematics provides advantages to overcome ongoing problems in mathematics and helps to develop in teaching and learning mathematics [17]. Yet, students find it difficult to learn the concept and notation. Students face difficulties in applying the reason and logic. Since Discrete Mathematics is rich in content and it is very abstract, it will burden to students in learning process. Understanding theoretically and the knowledge about Discrete Mathematics will never help whereas students should have ideas of how to apply the Discrete Mathematics in life.

Technology today has made our life easier. Everywhere and every corner of today's world is connected with devices, technology in every sector. Hence, we may adopt these technologies in education to produce a better and advance future for them. This study aimed to examine students' experience in learning Discrete Mathematics online through LearnwithEmma.

The following section of this paper will discuss about the research methodology which includes participants, instrument, research procedure, etc. Moving on, the fourth section is about results and discussions of the study. Finally, recommendations and conclusion will be made.

III. RESEARCH METHODOLOGY

A. Participants

The students involve in this experiment were all Information Technology (IT) undergraduate students in a private university, Malaysia, who were require registering for Discrete Mathematics subject. This subject is a common core subject which all different program major students must study it.

The sample consisted of 57 IT students, aged from 18-26 years old (Table 1), who enrolled in Discrete Mathematics class in a trimester volunteered to participate in this project. The sample is a convivence sampling as the group was easy to access, willing to participate and available at given time [18]. It was found that majority of them were Security Technology students (47.4%), followed by Information Technology Management (25%), Artificial Intelligence (12.3%), Data Communications and Networking (12.3%) and Bioinformatics (3%) (Table 2). There were more female students (66.7%) as compared to male students (33.3%) (Table 3).

With the approval from the faculty and the lecturer who taught Discrete Mathematics, the researcher approached students to participate in experiment voluntarily.

Table 1. Age of the participants

Age Range	Number of Participants	Percentage
18 – 22	35	61.4%
23-26	22	38.6%

Table 2. Undergraduates' majoring programme

Majoring	Number of Participants	Percentage
Security Technology	27	47.4%
Bioinformatics	2	3%
Artificial Intelligence	7	12.3%
Information Technology Management	14	25%
Data Communications and Networking	7	12.3%

Table 3. Gender analysis of the participants

Gender	Number of Participants	Percentage
Female	38	66.67%
Male	19	33.33%

B. Instrument

In this research, quantitative method was used to collect data. Two instruments were designed and verified by the panel of experts. The first instrument was used in the pre-experiment stage. There were two sections in this instrument. In the first section, a consent form was provided to students. In this consent form, students were briefed and provided description about the study before participating the study. All the information provided by students were kept used for the purpose of this research. Once students signed the consent form, they will be redirected to second section. In this section, students are required to give personal information. The personal information includes name, student identity card number (ID), national resident identity card number, age, majoring, race, and gender.

The second instrument was designed to collect students' preference and their experience using the learning platform. It was administered in the post-experiment stage. In the first section, for verification purpose, student ID was required in this questionnaire. In the section, a set of questionnaires was prepared to identify students' preferences and experiences on using LearnwithEmma. Participants respond to all the questions using the Likert Scale by indicating 1,2,3, 4 or 5, in which these numbers indicate strongly disagree, disagree, neutral, agree and strongly agree, respectively. At the end of the questionnaire, students may provide their suggestions or improvements on the learning platform.

C. Research Procedure

In this study, the experiment period was divided into three stages: pre-experiment, experiment, and post-experiment.

In the pre-experiment stage, the researcher approached the faculty and the lecturer who taught Discrete Mathematics for getting their approval on conducting the experiment. After obtaining the approval from both parties, all students were given a briefing via Google Meet about the study. Google Meet was used in this session as the private university at the time of this experiment was conducted leverage this online platform to deliver lectures and tutorials. The researcher is aware of other online platforms such as Microsoft Teams, Zoom, Webex. Google Meet used for the purpose of students' familiarity and convenient. During the briefing, the researcher explained on the experiment, purpose of the experiment, how they will benefit from the experiment and the duration of the experiment, etc. After the briefing, a consent form was distributed to students to obtain their agreement on their voluntarily participation in the experiment. Out of 198 students, about 57 decided to participate voluntarily in this study.

In the second stage, during the experiment period, students were given one-month time to use the online learning platform called LearnwithEmma, to learn Logics and Proofs. The classes were conducted via online due to the pandemic crises. Since a sudden drift from traditional learning to online learning since pandemic hit, this study examines students' experience in learning Mathematics through online classes leveraging LearnwithEmma. The students first attend lectures as usual with the lecturer. Then for revision purpose and to do extra activity or question, they utilize LearnwithEmma. However, students can also listen to lecturing video provided by LearnwithEmma.

In the last stage, post-experiment stage, where students were given a set of questionnaires to provide their insights about the learning platform and learning Discrete Mathematics online. The trimester has total of 14 weeks. Each week the participants will learn each topic from the Discrete Mathematics. Utmost to cover the Logic and Proofs topic took about two weeks. Then the participants will move forward to other topics. The extra two weeks has been given to students to continue use the platform to have a better understanding on the topic. After the one month of intervention, another two weeks' time was allocated to collect the data. After collecting the data, the data was analysed. All the results collected were presented in descriptive statistics. Only percentage and frequencies were used to compare and to contrast the data analysis.

D. The system

A simple learning platform was designed carefully for the students to learn Logic and Proofs of Discrete Mathematics subject. The platform was named as LearnwithEmma (Figure 1). A teaching agent is designed and developed to deliver the content of the chapter. The agent was named as Emma. Emma is a young and female character. Emma will teach the students on Logic and Proofs topic and guide them through the tutorial questions. The character of Emma was designed as a very friendly and motivating agent. Her dialogues involved motivation words such as "You can do this", "Do not worry", "You have second chance", "I'm with you" etc.
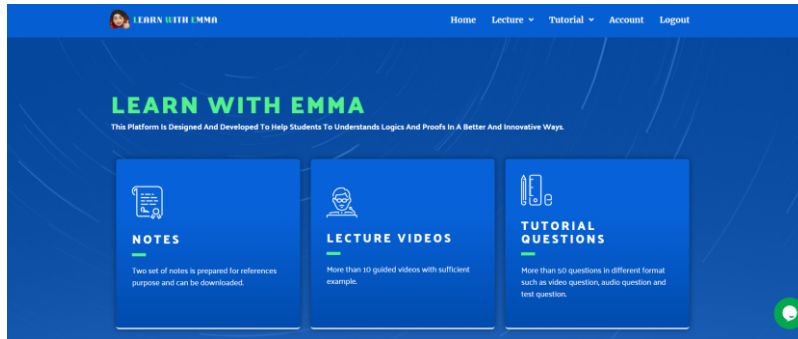
Figure 1: The learning platform

In the lecture webpage, all the lecture videos for Logic and Proofs have been uploaded there. The topic was divided into Part 1 and Part 2. In Part 1, sub-topics included were What is Logic, Propositions, Non-propositions, Logical Equivalence, Conjunctive Normal Form, Disjunctive Normal Form, and Formal Reasoning. In Part 2, the contents were Predicate Logic, Universal Quantifier, Existential Quantifier, Negating Quantification, Nested Quantifier, and Rule of Inferences.

In the tutorial webpage, questions related to Logic and Proofs were provided and were divided into three different set of tutorials. Students may attempt these tutorials as many times as possible. The questions involve were categorised into video question, text-based question, and audio-based question.

IV. RESULTS AND DISCUSSIONS

A. Results

The results obtained from the survey of this experiment were divided into 4 components, i.e., effectiveness, ease of use, self-efficacy. In the survey form, a suggestion/recommendation section was provided to students to gather their opinions. Some students have provided a few suggestions which help to enhance the study.

Firstly, students were given a statement stating "LearnwithEmma was helpful and easier to learn Logic and Proofs." 84.2% (48), majority of the students agreed with the statement. Only 1.8% (1) disagreed and the rest 14% (8), stayed neutral (Figure 2).
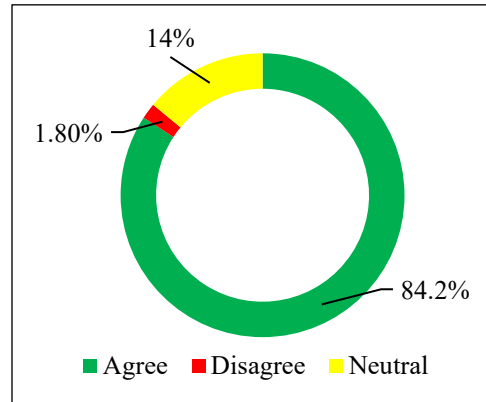
Figure 2. Students' responses on statement **"**LearnwithEmma was helpful and easier to learn Logic and Proofs.".

Besides, it was revealed that majority of the students had a good perception about learning Discrete Mathematics via online. About 63.2% (36) of the participants agreed that they are able to perform better in Discrete Mathematics during online class compared to physical class. Only 10.5% (6) of them have said the otherwise. The remaining participants 26.3% (15) stayed neutral in their decision. During pandemic all the classes conducted via online learning. The students were able to measure their performance in mathematic before and during the pandemic (Figure 3).
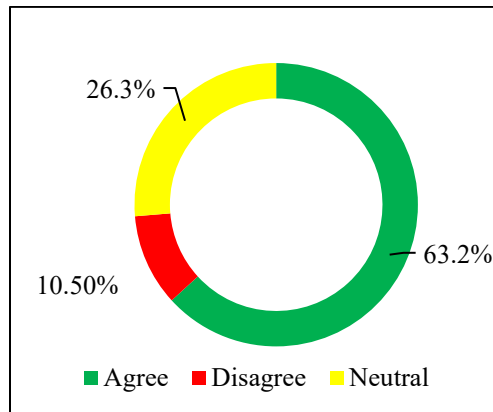
Figure 32. Students' perception on statement "I am able to perform better in Logic and Proofs during online class compared to physical class."

Thirdly, students were asked whether the resources provided in LearnwithEmma was sufficient for their learning. Resources here include extra lecture notes, lecture videos and different set of tutorial questions. Majority of the students which is 75.5% (43), came to an agreement that it was sufficient, only 3.6% (2) of them disagreed, whereas the remaining stayed unbiased to their decision (Figure 4).
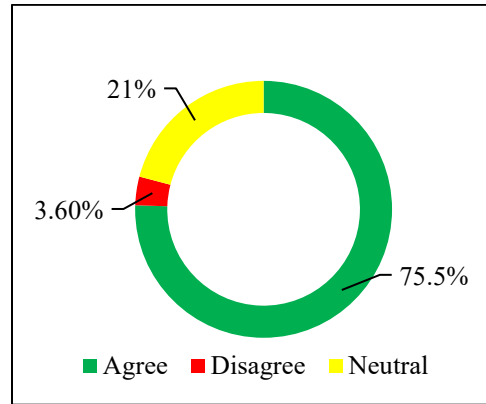
Figure 4. Students' responses on statement "LearnwithEmma provide sufficient resources for learning including lecture notes, videos, and a few sets of tutorial questions."

Followed by another statement given to students to determine whether the resources given were at the understandable manner. The result of the statement revealed that "The lecture videos and tutorials in LearnwithEmma was understandable" 73.7% (42), majority of the students agreed that the resources are understandable except for 1.8% (1) who disagreed with this statement. The remaining students choose to be neutral, neither agreed nor disagreed with this statement (Figure 5).
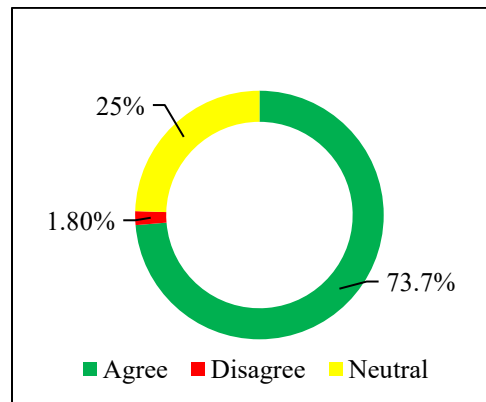

Figure 5. Students' responses on statement "The lecture videos and tutorials in LearnwithEmma was understandable."

Besides that, to understand whether how convenient was LearnwithEmma for learning, students were given another statement "I can use LearnwithEmma anytime I want to learn or do tutorial about Logic and Proofs". The findings show that 84.2% (48) of the students strongly admitted and surprisingly, none of them disagreed. However, 15.8% (9), were fair-minded (Figure 6).
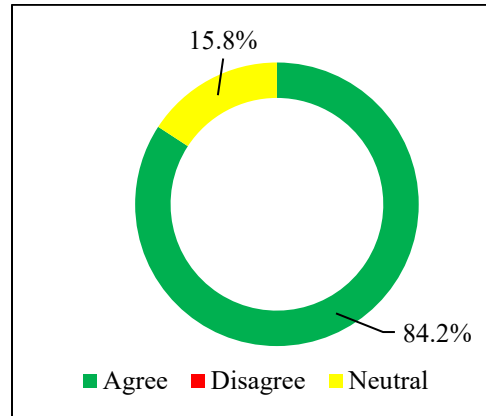
Figure 6. Students' responses on statement "I can use LearnwithEmma anytime I want to learn or do tutorial about Logic and Proofs."

In addition, 82.5% (47) of the student strongly acknowledge to the following statement that, "LearnwithEmma was useful for revision purpose.", whereas only 1.8% (1) of them denied. About 15.8% (9) of them remained neutral to their decision (Figure 7).
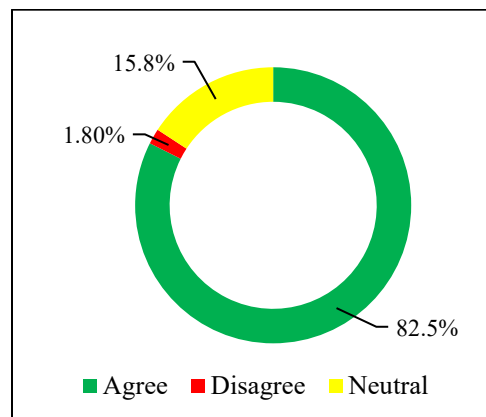

Figure 7. Students' responses on statement "LearnwithEmma was useful for revision purpose."

Another expected result was most of them agreed that "I can prepare in advance in LearnwithEmma for tutorial and lecture." which contributes to majority of the voting 71.9% (41), only 1.8% (1) disagreed. 26.3% (15) of the students remained neutral in their opinion (Figure 8).
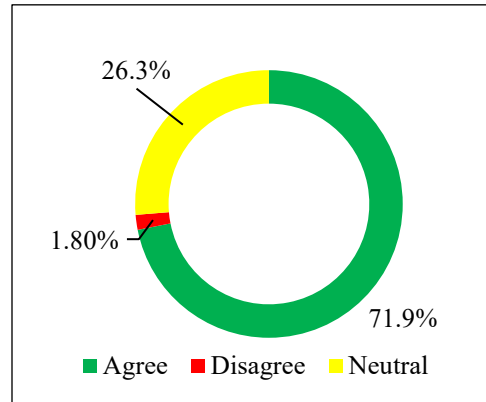
Figure 8. Students' responses on statement "I can prepare in advance in LearnwithEmma for tutorial and lecture."

Overall, for effectiveness component, majority of the students, 84.2% (48) agreed that LearnwithEmma was useful to learn Discrete Mathematics subject.

Furthermore, online class has helped to increase students' communication skills with their peers. 56.1% (32) of them strongly agreed that their communication skills have been improved, whereas 12.3% (7) denied (Figure 9).
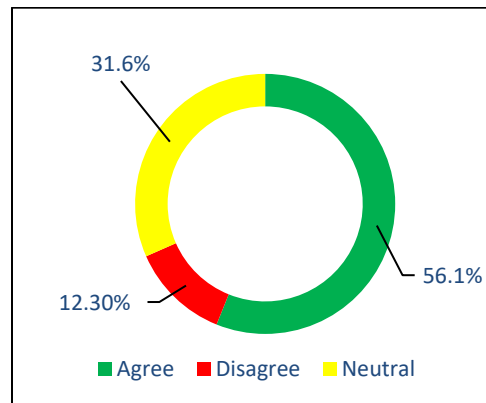

Figure 9: Students' perception on statement "I am able to communicate with my assignment group members easily in online learning compared to physical learning."

Moreover, majority of the participants believed that they are able to save a lot of time during online class as compared to physical class (Figure 10). The result reveals that about 78.9% (45) of them agreed on this statement. This included saving time by avoid walking long distance to reach the class. 19.3% (11) of them stayed neutral to their decision, however, only 1.8% (1) of them disagreed to the statement. In sum, majority of the students can save time if the class is conducted through online.
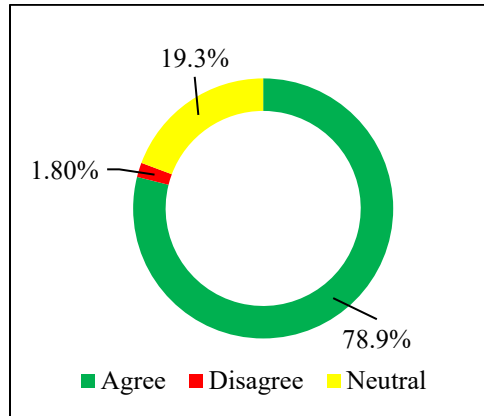
Figure 10. Students' perception on statement "I am able to save a lot of time during online class compared to physical class where I need not to walk long distance before reach class."

Students were also given some statements to assess the ease-of-use component of LearnwithEmma (Figure 11). Firstly, they were given a statement "Navigation in LearnwithEmma was easy". Most of the students, 82.4% (47), strongly agreed that, it was easy to use the learning platform and none of them disagreed with the statement. Minority of the students,17.5% (10) remained neutral in their opinion. Furthermore, students were asked about the complication they faced during the learning with LearnwithEmma. Majority of them, 68.4% (39) totally agreed that the presentation of the content helped them stayed focused. Only 5.3% (3) disagreed while the rest, 26.3% (15) remained fair-minded.
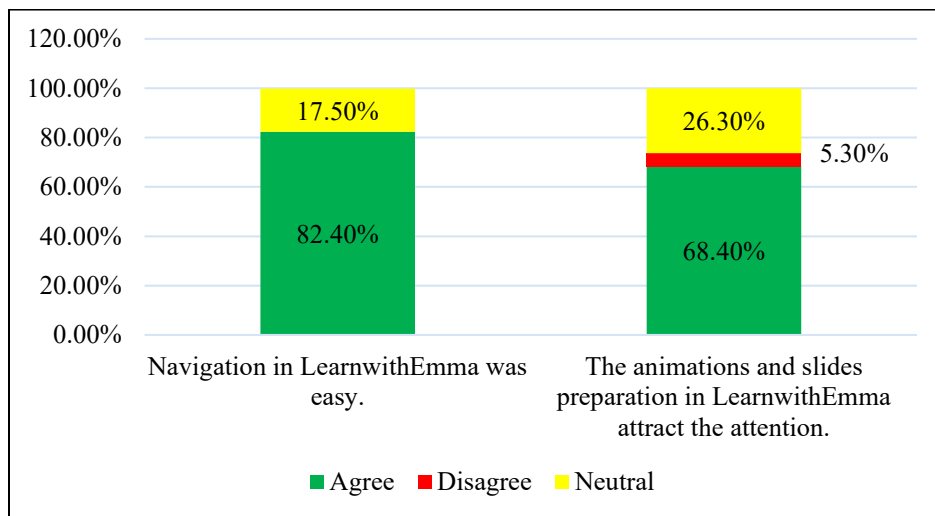

Figure 11. Students' responses on statements to assess the ease-of-use component of LearnwithEmma

For the self-efficacy component, the first statement stating, "*I can easily understand the tutorial questions provided by Emma*." (Figure 12). The statement obtained the finding that 72% (41) of the students are able to understand the tutorial questions that were prepared and given to them. However, 7% (4) of the students were unhappy about it. It was later known that the tutorial question was given in three different formats, and those are audio, video, and text-based format. Many of the students did not understand audio-based questions. About 21.0% (12) of the students remained fair minded.
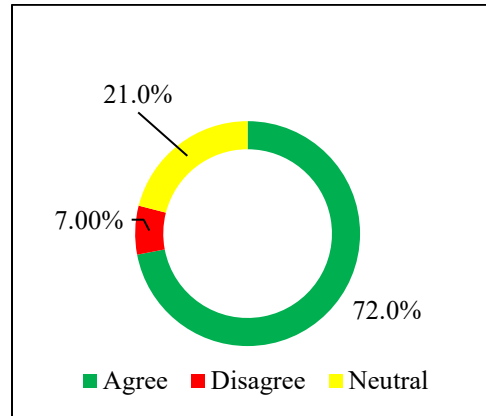
Figure 12. Students' responses on statements "I can easily understand the tutorial questions provided by Emma."

Followed by, to comprehend more, the researcher provided another statement regarding lecture videos. "*I can easily understand the explanation in lecture videos provided by Emma*" was the statement given and expectedly about 82.5% (47) of the students strongly agreed and only 1.8% (1) disagreed. Only about 15.8% (9) remained neutral (Figure 13).
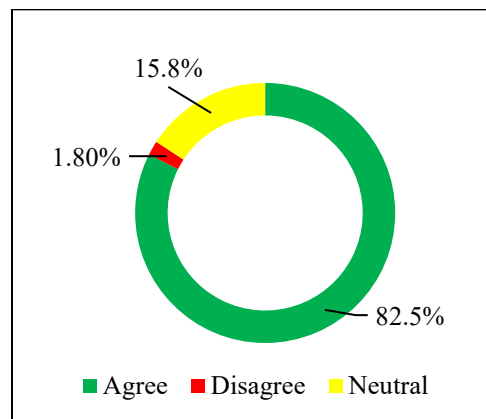

Figure 13. Students' responses on statements to "I can easily understand the explanation in lecture videos provided by Emma."

Besides that, another most expected result was students were able to perform better with the assistance of the learning platform. About 77.2% (44) strongly agreed that they were able to perform better in Discrete Mathematics after using LearnwithEmma. Only 1.8% (1) disagreed whereas the rest 21.2% (12) remained neutral (Figure 14). Also, majority of the students acknowledged that leveraging LearnwithEmma in online learning, enabled them to enhance their understanding towards Discrete Mathematics. Majority of them, 77.2% (44), agreed while 3.5% (2) disagreed with the statement (Figure 13). In other word, the minority of them disagreed that LearnwithEmma did not help them to enhance their understanding in Discrete Mathematics. The overall result shows that 80.7% (46) satisfied with the learning platform.
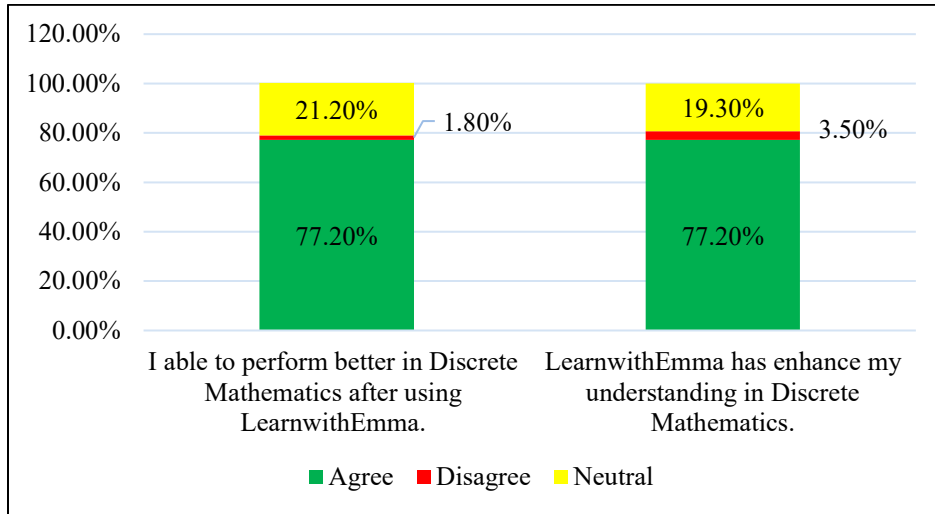
Figure 14. Students' responses on statements "I am able to perform better in Discrete Mathematics after using LearnwithEmma" and "LearnwithEmma has enhanced my understanding in Discrete Mathematics."

The figure below shows overall findings on students' preference to learn Discrete Mathematics by using LearnwithEmma and whether students have benefitted from using this learning platform.

The overall findings show that many students prefer to learn Discrete Mathematics by using LearnwithEmma. To support the statement, majority of the students agreed on this which is 63.2% (36), whereas only 3.5% (2) disagreed. Another small number of the students, 33.3% (19) remained standing neutral to their decision. The finding also shows that students were able to perform better in exams by using LearnwithEmma. Surprisingly, 75.4% (43) of the students agreed that they have benefitted from using this learning platform. Minority of them, 3.5% (2) however, disagreed with this statement. The remaining participants stayed unbiased to their decision (Figure 15).
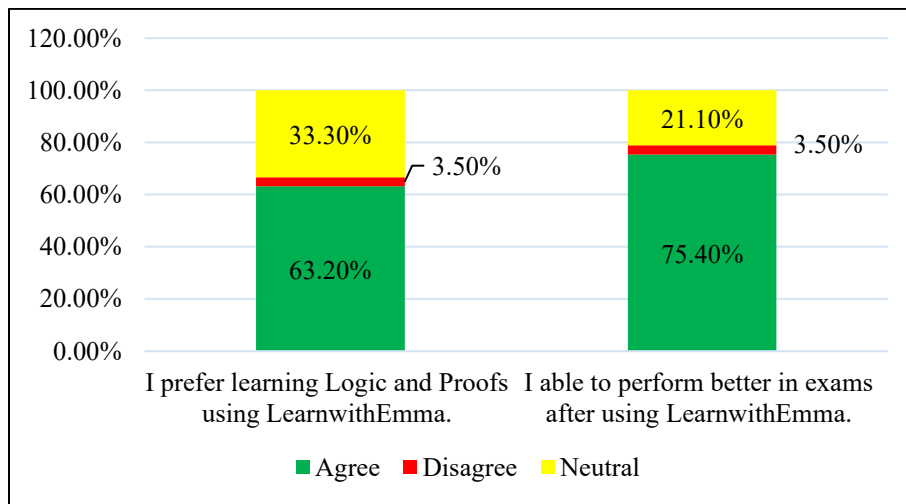

Figure 15. Students' responses on statements "I prefer learning Logic and Proofs using LearnwithEmma." and "I am able to perform better in exams after using LearnwithEmma."

Besides that, some of the students quoted that the learning platform was very helpful for them. They have mentioned almost the same opinion in different words such as "everything is perfect", "very good", "overall is good", "everything is good", "it is a good learning website overall", and etc. In a nutshell, from the feedback, most of the students were benefitted using this learning platform. In addition, some students have recommended to develop the website by including more chapters as well. He/she added that, the website was very helpful for the learning purpose. The sample

feedback was "*If you are free, please continue this series not only for chapter 1, thank you for your help in developing this helpful website*!!". The other participant recommended the same as "*Looking forward to have more contents in this website*".

B. Discussions

The result shows that majority of the students have experienced some sort of flexibility in their online learning, whether learning with their lecturer or with the learning platform, they had a chance to learn at their own pace [19] . Online learning platform could make the students stayed focused and enjoyable because of its feature. As per the findings, the presentation of the content, the way website has been designed, simple navigations are contributing factors in offering a productive and convenient learning environment [20]. Online learning allows students to have more time for their revision. Compared to traditional learning, needing to commute to class every day, move to one class to another class, meeting friends, rushing to class by skipping lunch sometimes are some reasons on how students get tired. However, online learning offers the opposite experience to students, where they able to sit in one place, invest their time devotedly for their classes and have extra time for revision. The findings also revealed that online learning has helped the students to have more revision time which contributes to their improvements in learning mathematics[21]. As supported by a research and findings of this research revealed that learning Discrete Mathematics via online does help to improve students' performance[22] [23]. In this study about 63.2% of the students agreed that their performance have increased in a good way when learn Discrete Mathematics through online class.

A well-designed and implement right element for the teaching agents will make the students to be more involved in learning. However, the elements should be up to date. Such the character, animations, gestures of the teaching agents, speech and transition that used for deliver the content [24][4]. In this study, students agreed that the deliverables provide by the agent mostly understandable and easy to digest. Students have described their experience throughout online learning platform and how it affects their performance positively. Though it was difficult at first to adapt to online learning at the time of Covid-19, along the way students believe and also are able to improve their performance especially in Mathematics through online learning [25], particularly with LearnwithEmma. Integrating multimedia technology in learning helps students to improve their thinking skills and ability to self-learn. In this study, some multimedia technology that integrated were animated teaching agent with real human voice with movements, animated video, usage of different colours and more [26]. These types of deliverables are able to promote reliability in learning as students are able to experience the real learning environment. Most of the students which is 82.4% agreed that incorporating technology in learning helped them to perform better in Discrete Mathematics. This result was supported by [14], [27] which various approach has been taken to teach Discrete Mathematic through online to examine the improvement in their performance.

The agent's motivational speech as improved students' learning capabilities. Study reveals that a motivational agent have improved the learning outcomes of the students [28]. Emma has designed and developed in a way it can help the students to have a sustainable learning environment. With the help of motivational speech during the lectures class, the engagement of students able to keep static.

Overall, the students prefer to have learning platform like LearnwithEmma for online learning. Such platforms motivate students and provide a joyful learning environment. These factors have helped the students to perform better in their studies especially in Discrete Mathematics [29], [30]. In fact, most of them requested to build this type of website to all the subjects as it helped them do better in their studies. Human minds tend to react differently when see certain colours [31]. Same principles apply here, when study the materials that have the right colour and other multimedia elements, it would change the perception of students towards learning and by implementing them in online learning would increase positive impact on students' performance. There are other factors that need to be considered before generalizing these findings. The approach used by educators, the learning environment, the equipment used by students, other online approach that is used to deliver the topics are considered some factors that could affect the performance of students in Discrete Mathematics.

V. CONCLUSION

Early 2020, the global faced a huge crisis with the presence of Coronavirus. No one can deny that Covid-19 has drastically changed everything include education. Everyone witnesses the way lecturer teach and students learn. This new trend soon going to be normal and slowly some of the institutions trying to get used to online learning due to the

severity of this Coronavirus. Pandemic has taught that teaching can be done anywhere, and learning can be happened anytime. There are several reasons why educators should shift from traditional teaching method to online. The main reason is the new technology immerses in education every day, and if we are not getting adapt to that, soon or later, the education system will be outdated. This study shows that how a simple learning platform could bring a huge difference in students' performance in mathematics. There are several reasons why students prefer using LearnwithEmma as discussed above.

As mentioned in the results section, student shows significant improvement in their mathematics. They have stated that the online learning platform was easy and convenient to use. The platform is accessible from anywhere and anytime the students want. All the resources provided in the platform were sufficient for them. Besides all of them, the students have strongly agreed that the platform helped them to perform better in their exams and studies. It is highly recommended for the educators to use such learning tools to be used in teaching, especially for Mathematics. The findings of the study had showed the positive impacts on students' performance in mathematics using the learning platform. However, the main limitation of this study is the generalisation of the results to other population. This study was conducted in a private university on a sample of students who have enrolled Discrete Mathematics subject. Therefore, the extent of findings on other topics, subjects, schools, or location are yet to be seen. Also, the study was conducted over a month when students were getting into the syllabus of Logic and Proofs during the trimester. In future, the study should be conducted over a longer intervention period to obtained more enhance results.

However, some recommendations can be leveraged for future research. It is recommended that future research could be conducted on a larger sample. Besides, other mathematics topics should be included in the learning platform. By doing so, it will help the students to perform better in their mathematics.

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