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MOOC IMPLEMENTATION IN ADDRESSING THE NEEDS OF GENERATION Z TOWARDS DISCRETE MATHEMATICS LEARNING

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ABSTRACT

Discrete mathematics is an important subject in the learning of information technology especially for programming and software development. It is a compulsory subject offered to first year students of Undergraduate Degrees in the Faculty of Technology and Information Sciences (FTSM). Discrete mathematics is a subject that is difficult to learn because it involves many theory and concepts. Until recently, Discrete Mathematics modules are mainly taught in a traditional way whereby students are given lectures and tutorials only in the classroom. Students rely on textbooks and lecture notes provided by lecturers. Such approach is not suitable for students in Generation Z. Students in Generation Z will find it hard to learn as learning happens only in the classroom and it leads to boredom. Massive Online Open Course (MOOC) is a web-based learning that can be accessed anywhere and anytime. Integrating the technology into learning process can help improve understanding of the subject matter. Therefore, MOOC implementation is recommended in this study so that generation Z learning preferences are met. In this work, MOOC development for discrete mathematic was implemented based on ADDIE Model. Videos between five and ten minutes were produced using Microsoft Powerpoint, Powtoon and GoAnimate software. Initial survey on the implemented MOOC for Discrete Mathematics showed that it motivated learning and it helped students to understand the subject better.

Keywords: *Generation Z, Massive Online Open Course, Discrete Mathematics, e-Learning, Learning Preferences*

1. INTRODUCTION

Discrete mathematics module is offered to students at the Faculty of Technology and Information Sciences (FTSM). It is a subject that is difficult to learn because it involves many theory and concepts [1, 2]. It is taught in a very much traditional way in which students are given lectures and tutorials only in the classroom. Students very much dependent on textbooks and lecture notes provided by lecturers. Effective student learning is always a main concern among lecturers who teach this subject in the faculty. Therefore, there is a need to identify suitable teaching strategies that accommodate student learning in the current generation [2].

There are four generations in this century: veterans, post-war generation, generation X, generation Y and generation Z [3]. Each of the generations exhibits distinct values and views. They differ from one another and they exhibit different behavior in work place and also in education. For example, post-war generation is interested to work hard but generation Y is interested to have balance work life. There are different age boundaries being assigned to generation Z [4]. For example, generation Z is coined for those who born from 1992 [3] and also from 1995 [4, 5] onwards. One thing in common is that they are born in an environment surrounded by advances of information technology [3, 5]. They are used to internet, mobile phones, digital gadgets and social media. The generation Z is described to be

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accustomed to social media to gain popularity, and even self-esteem [6].

The students in our faculty are between 19 to 23 years old. They are in generation Z. Research has shown that the generation Z has specific learning preferences. Generation Z does not like traditional teaching and learning [7]. They love teaching and learning through technology, for example, through online encyclopedia, "How to" video, and from various internet sources [4].

These students will find it hard to master the Discrete Mathematics as the learning happens only in the classroom and this causes students to be bored and lost the interest. Therefore, the current student learning preferences, in particular for generation Z students, should be identified and suitable teaching approach should be matched to meet their learning preferences.

MOOC is a recent development in higher education in Malaysia [16, 17] and not many guidelines are available to support generation Z learning needs in literature. There are authors provided some factors to be considered in developing MOOC content but it is for subjects in social sciences [22]. Thus, there is a need to investigate and identify suitable teaching and learning strategies to support generation Z learning needs, in particular for Discrete Mathematics MOOC. Thus, the research hypothesis of this work is: "The MOOC implementation is able to address the needs of Generation Z in Discrete Mathematics Learning".

In this research work, generation Z students learning preferences are investigated and identified. Suitable teaching approaches will be matched to their learning preferences based on the existing literature on teaching and learning. The outcome of the investigation has shown that MOOC is a viable approach to assist in teaching for the generation Z students. This paper will report on the research and implementation of MOOC that has been shown to be able to help lecturers in teaching Discrete Mathematics at the FTSM in Universiti Kebangsaan Malaysia.

2. GENERATION Z LEARNING PREFERENCES

Student characteristics and learning preferences, in particular for generation Z students, should be identified and suitable teaching and learning approaches should be matched to meet their preferences. Many researchers have shown that generation Z perceives smartphone technology and social media as a natural element. Their habitual usage of WhatsApp and social media hinted the potential effectiveness of using these platforms for mobile learning [6].

From many reported works, generation Z are described to expect teaching environment similar to their virtual world [5]. They expect instant results, answers, and rewards [5, 8, 9] and they exhibit lower attention time [8]. They prefer visual learning [5], usage of technology for interactions [10], fast knowledge acquisition and entertainment [9]. Generation Z students also prefer independent, self-paced and collaborative learning [4]. Figure 1 illustrates the generation Z characteristics and preferences obtained from various sources. Thus, a learning environment that aligns with the Generation Z characteristics must be created to suit the generation Z students. Such learning environment should consist of elements of technology, social media, visual forms, and also entertainment.

3. DISCRETE MATHEMATICS

Discrete Mathematics is one of the fundamental subjects in computer science and information technology. It is among subjects that are difficult to understand because they involve many concepts that need to be understood [1, 11]. Discrete Mathematics is traditionally taught based on lectures and tutorials. Students are expected to listen to the lectures given by lecturers in a class. They are also need to work on the tutorial assignments given by lecturers. Many students were struggling with this one-semester course in the past.

The students who involved in this research were from Year One undergraduates in the Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia. They are between 19 to 23 years old and they are in generation Z. They took the TTTR1333 Mathematics I (Discrete Mathematics) as a compulsory subject. These students were from three different academic programs: Multimedia, Industrial Computing and Information Science. The syllabus of TTTR1333 Mathematics I mainly comprises of topics from Discrete Mathematics, which include Logic, Set, Function and Relation, Integer and Cryptography, Pigeon Principles, Graph Theory, and Tree.

In this context, Discrete Mathematics lecturers need to find ways to help these students to improve

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their learning. Among many approaches, incorporating Information and Communication Technology (ICT) in education is found to be able to enhance student learning. Past research works have shown that conventional teaching complemented with ICT can be a promising approach [12, 13].

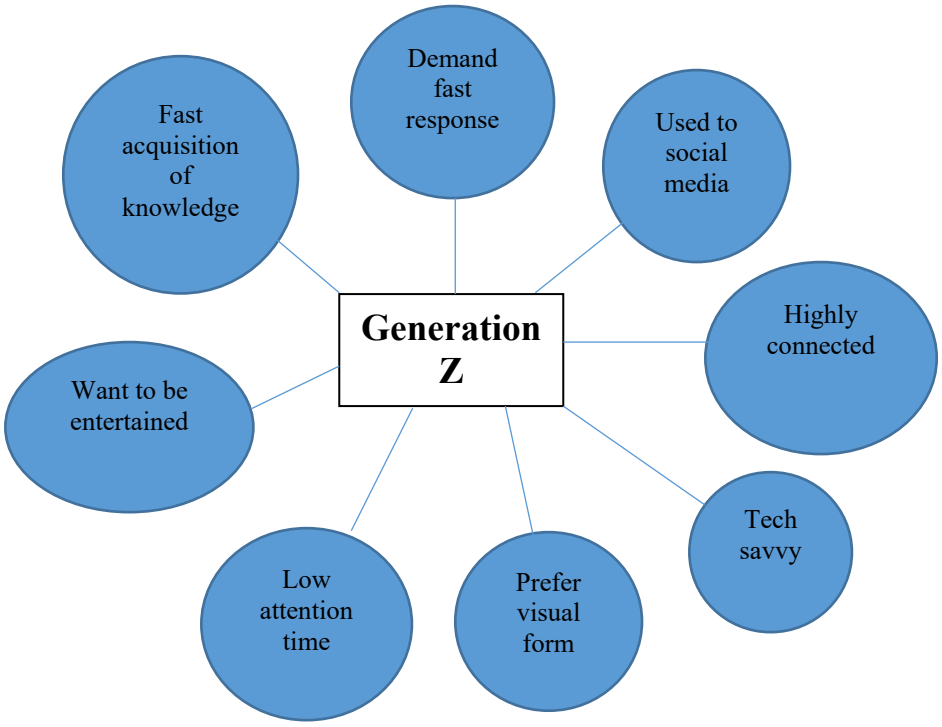

Figure 1: Generation Z characteristics [5, 8-10]

4. MASSIVE ONLINE OPEN COURSE (MOOC)

Incorporating Information and Communication Technology (ICT) in education is not new and it is becoming popular [12-17]. Incorporating ICT in teaching is found to be able to engage and enhance student learning. MOOC is a web-based technology that provides online courses which can be accessed anywhere, anytime and free enrollment. It is also a recent trends in e-learning [18-20]. MOOC can be considered as new form of e-learning that integrates social network, expert facilitation, and online learning resources. Such online learning is expected to give greater flexibility and control over the learning process [21].

A few researchers have demonstrated that MOOC could be used as a teaching and learning platform to enhance students learning [22]. Six universities were reported successfully implemented MOOCs and attracted many student participations. These universities include: MIT, Harvard, Standard University, Princeton University and University of Sheffield and UC Berkeley [18].

MOOC is a recent development in Malaysia [18, 19]. Since MOOC is relatively new in Malaysia, not many guidelines are available. In one of the recent MOOC implementations in Malaysia, four factors were being considered in developing MOOC content in Ethnic Relations course. Among the factors were: type of MOOC, type of videos lectures, integration of local culture, and communication approach [23]. However, these factors only provided limited guidelines to support generation Z learning needs. In another recent work, four initial recommendations of MOOC characteristics specifically for science and

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mathematics subjects were reported [18]. These recommendations were being examined and used as guidelines in this study.

MOOC allows massive participation, online access, online discussion, self-assessment, multimedia content videos lectures [20]. A typical MOOC course usually involves large number of participants and this leads to course management issue [20]. The quality of the course delivery and student performance may be affected. Thus, in this initial work, we have only tested our MOOC implementation among our faculty students who were taking Discrete Mathematics. We proposed to implement MOOC gradually for experimentation without major changes in the curriculum.

5. ADDIE MODEL

MOOC implementation for Discrete Mathematics requires careful planning so that the generation Z learning requirements are met in parallel with the use of learning materials. MOOC was implemented systematically using the ADDIE model. The ADDIE model is commonly used in the development of teaching and learning materials [24, 25].

The ADDIE model consists of five phases namely analysis, design, development, implementation and evaluation. The analysis phase is carried out to identify the problem as a whole by obtaining information about the goals of the study, the target audience and the resources needed. The design phase produces solutions that are in line with the objectives and development strategies. The development phase develops teaching and learning materials. Implementation phase examines learning outcomes and learning. While the evaluation phase was conducted to obtain student feedback on the teaching and learning materials that were built. Figure 2 shows the ADDIE model used in this study.

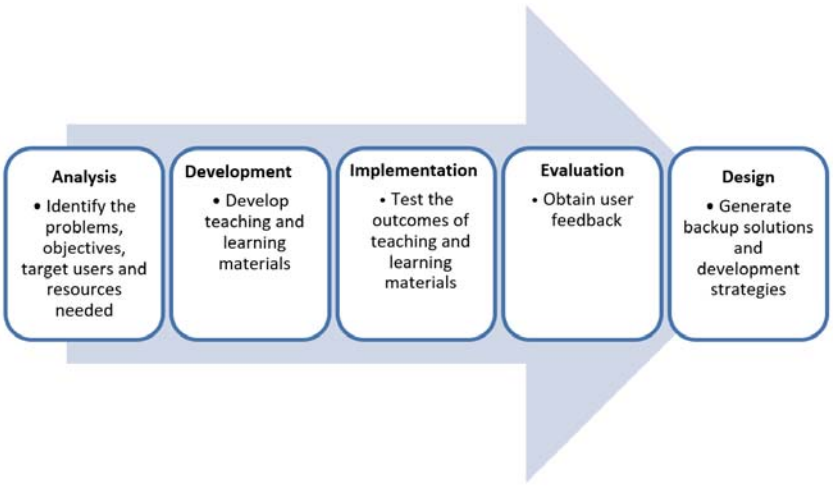

Figure 2: ADDIE model for MOOC implementation of Discrete Mathematics

5.1 Analysis Phase

The analysis phase is the first step in the study where the problems are identified in meeting the learning needs of generation Z. The objective of the study was to develop the MOOC for Discrete Mathematics that suits generation Z students. As described in Section 2, generation Z students prefer the teaching environment similar to their virtual world. They also prefer independent, self-paced and collaborative learning.

In our plan, the conventional approach of lectures, tutorials and formal assessment via written examination were maintained. The teaching of Discrete Mathematics is complemented by MOOC. Students will participate both in lectures and tutorials in classrooms as well as online learning in MOOC. The topics in the Discrete Mathematics syllabus is shown in Table 1. The lecture slides of each topic are used to develop into online videos and tutorials are converted into online quizzes or activities. These online videos, quizzes and activities allow students to have self-paced and self-gauged learning. A conceptual framework to integrate conventional teaching of the Discrete Mathematics with MOOC is depicted in Figure 3.

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Table 1: Discrete Mathematics syllabus

Topic	Name
1	Logics
2	Sets
3	Functions and Relations
4	Integers and Cryptography
5	Pigeonhole Principle
6	Graph Theory
7	Trees

As illustrated in Figure 4, eight teaching and learning strategies were being proposed to be applied in a MOOC to meet generation Z student characteristics and learning preferences. Openlearning has the necessary infrastructure that supports the implementation of the teaching and learning strategies. It is also providing MOOC platform to other universities in Malaysia, namely, University Putra Malaysia, University Technology Mara and University Malaysia Sarawak [18]. Thus, our Discrete Mathematics MOOC was also implemented via Openlearning.com as a platform in this study.

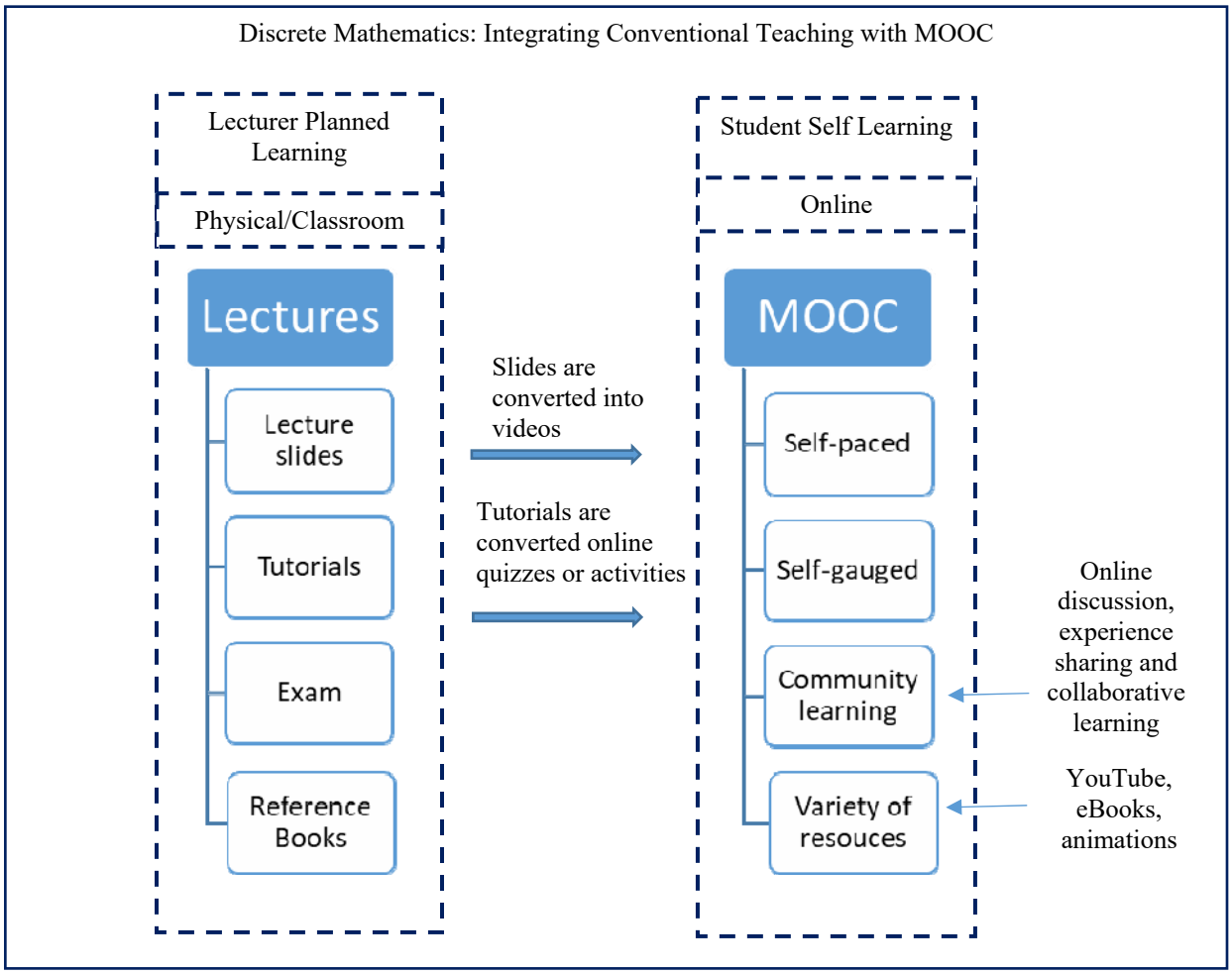

Figure 3: A conceptual framework to integrate conventional teaching of the Discrete Mathematics with MOOC

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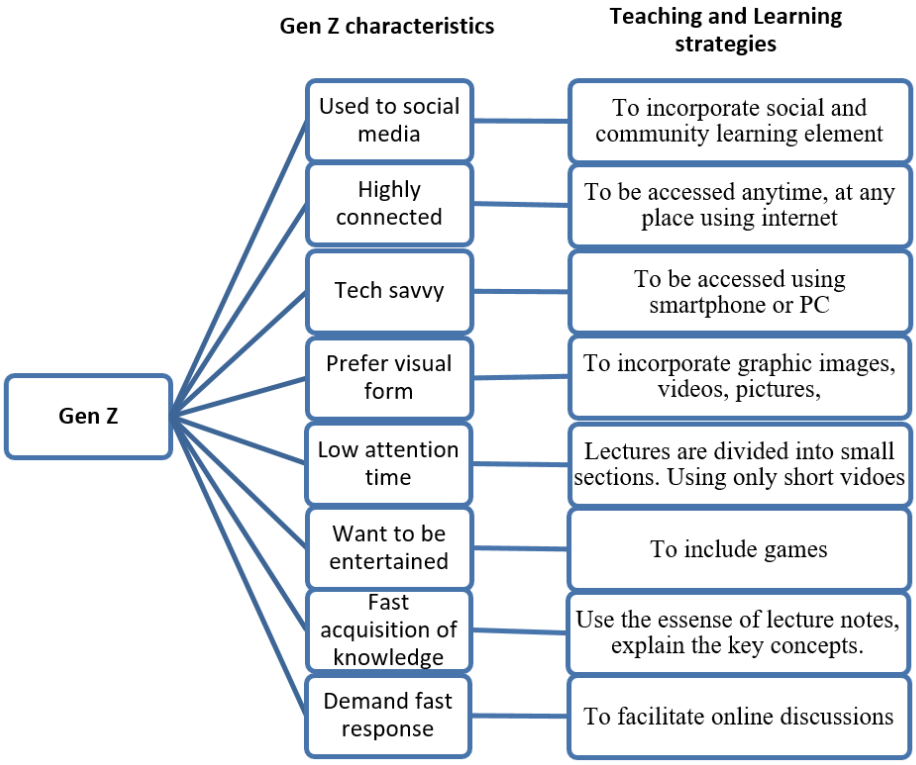

Figure 4: Teaching and learning strategies to be incorporated in Discrete Mathematics MOOC

5.2 Design Phase

The design phase outlines the development plan and strategies used for Discrete Mathematics MOOC and it has six activities. The activities involved are (1) design MOOC interface using Openlearning, (2) providing content of each topic, (3) designing and compiling storyboards for each topic, (4) producing videos, (5) uploading videos to platforms and (6) preparing activities for each topic for student self-assessment. Figure 5 shows a sample page of a storyboard for the topic on pigeonhole principle.

5.3 Development Phase

In this phase, videos for each topic (listed in Table 1) of Discrete Mathematics were developed. A total of 19 videos had been built and each video was between five to 10 minutes. The videos were built either using Microsoft Powerpoint, Powtoon or GoAnimate. They were edited and perfected several times before uploading to the MOOC platform. Figure 6 shows an example of a video on the topic of the Pigeonhole principle.

Each topic in Discrete Mathematics is provided with video and followed by activities such as quizzes, exercises, self-reflection to evaluate students' understanding. Students can perform all the activities on the MOOC platform at their own pace. The MOOC platform also provides discussion space among students and lecturers. This enhance cordial relationship where students and lecturers can interact with each other to discuss the topics they had learned.

5.4 Implementation Phase

In the implementation phase, the uploaded learning videos are being tested on Openlearning. Videos are viewed in terms of content validity, video smoothness and graphical appropriateness by field experts in order for any deficiencies to be resolved. Discrete Mathematics MOOC was further tested by FTSM first year students who took the discrete mathematics subject as a compulsory course. Students were asked to do activities in each topic and assess their level of understanding and to see the effectiveness of MOOC in fulfilling their learning needs. Figure 7 shows the MOOC user interface of Discrete Mathematics where each topic has an introduction, learning videos and activities.

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5.5 Evaluation Phase

The Evaluation phase was implemented to obtain user feedback on the effectiveness of Discrete Mathematics MOOC. Assessments need to be made by the instructors so that the learning outcomes for each topic are met by looking at the involvement of students in participating in the activities provided and their scores. Students evaluated the effectiveness of Discrete Mathematics MOOC by responding to a questionnaire. User feedback is important for Discrete Mathematics MOOC future improvements in meeting the needs of generation Z. We have collected a total of 88 responses. As shown in the Figure 8, Students have been using Discrete Mathematics MOOC throughout one semester course. Several topics were able to enhance students learning as shown in Figure 9.

TR1333 DISCRETE MATHEMATICS

STORYBOARD OF THE PIGEONHOLE PRINCIPLE

BY RUZZAKIAH JENAL

The pigeonhole principle is a well-known proof technique in mathematics. The pigeonhole principle talks about the consequences of dividing up some collection of things into a number of categories, and about how such divisions can be arranged. In this topic we are interested in the three forms of the pigeonhole principle. By the end of this topic, you should be able to:

1. Summarise the pigeonhole principle;

2. Apply the pigeonhole principles in solving problems.

DESIGN PHASE

TOPIC 5 : PIGEONHOLE PRINCIPLE

MATERIAL (teaching video recording, interviewing, drama acting, board discussing, mind mapping, animation, simulation, info-graphic, e-book)	**ACTIVITY** (self reflection, discussion, quiz, video)
Animation/powtoon	Discussion -give an open exercises -5 questions Quiz -multiple choice questions -5 questions Video -ask student to find a video related to the topic such as a video shows the example of pigeonhole principle.

TR1333 DISCRETE MATHEMATICS

DEVELOPMENT PHASE (STORYBOARD)

TOPIC 5 : PIGEONHOLE PRINCIPLE – LO: To explore the pigeonhole principle.

SKRIN 1	**ARAHAN GRAFIK**	**ARAHAN PENGARANGAN**
G1 T1 PIGEONHOLE PRINCIPLE A1	G1: Latar belakang. T1: Seperti di skrin. A1: Burung terbang berlegar-legar di skrin.	Skrin pertama. Narration starts when the texts T1 enter. N1: Hello everyone! N2: The topic for today is the pigeonhole principle.
G: gambar, T: teks, A: animasi, N: narration		

Figure 5: An example storyboard for the topic of the pigeonhole principle.

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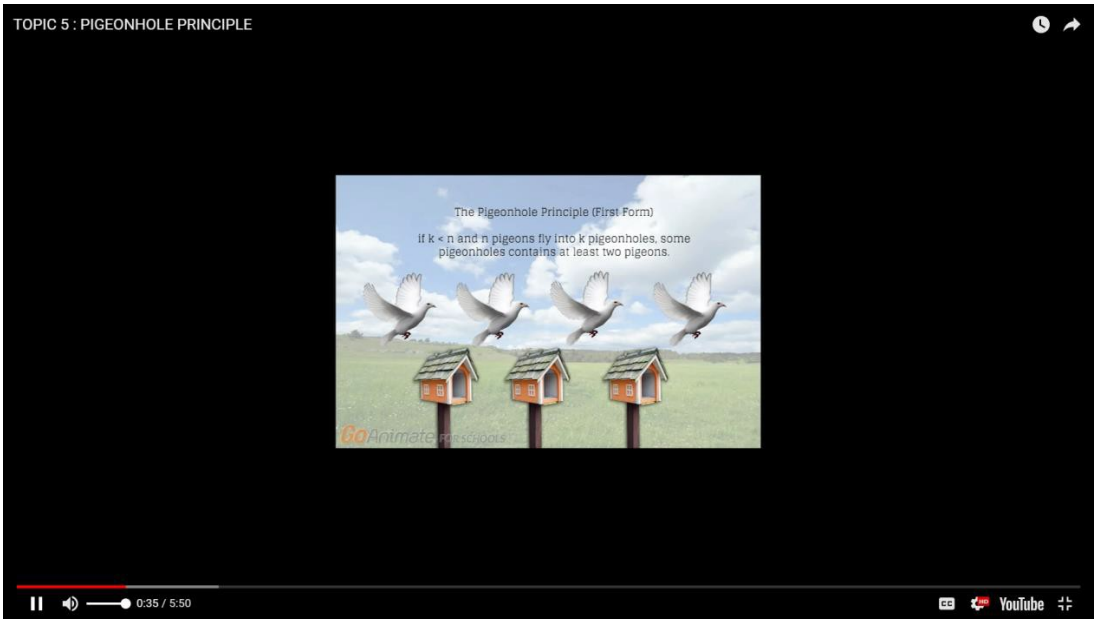

Figure 6: An animation explaining the Pigeonhole Principle

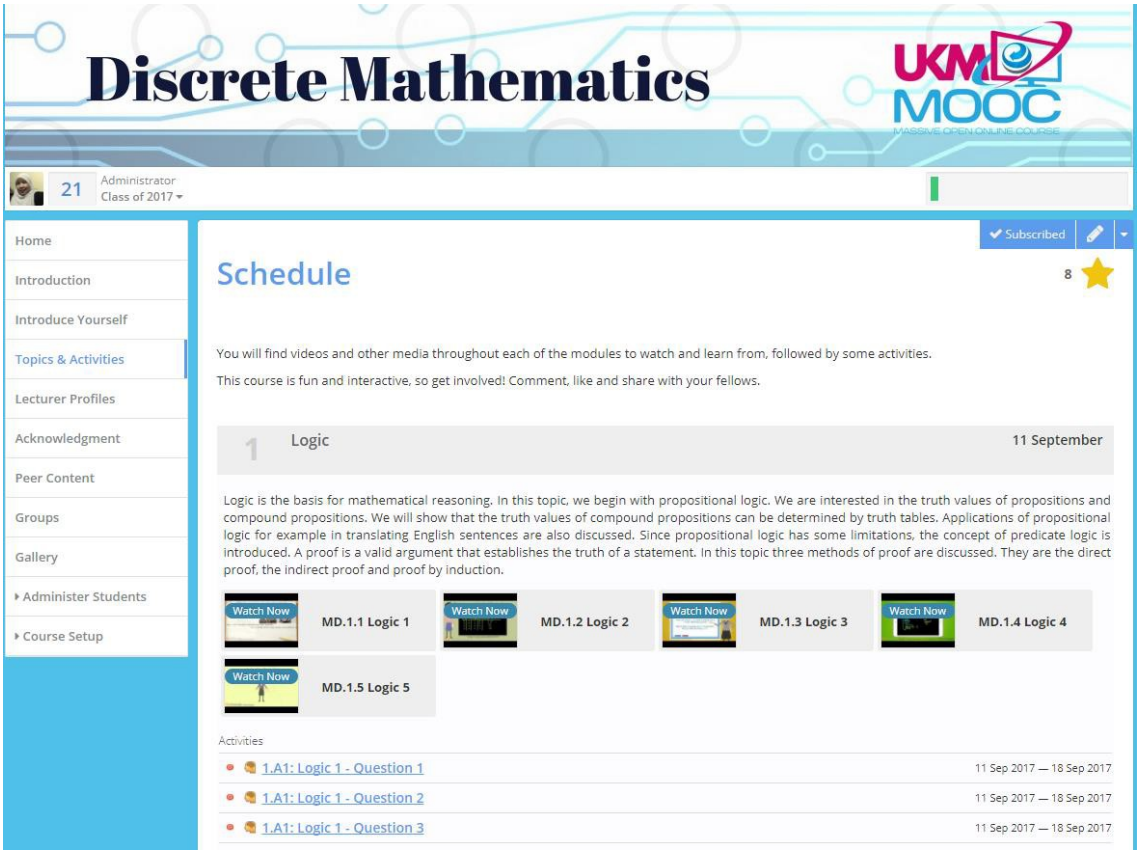

Figure 7: Discrete Mathematics User Interface in MOOC

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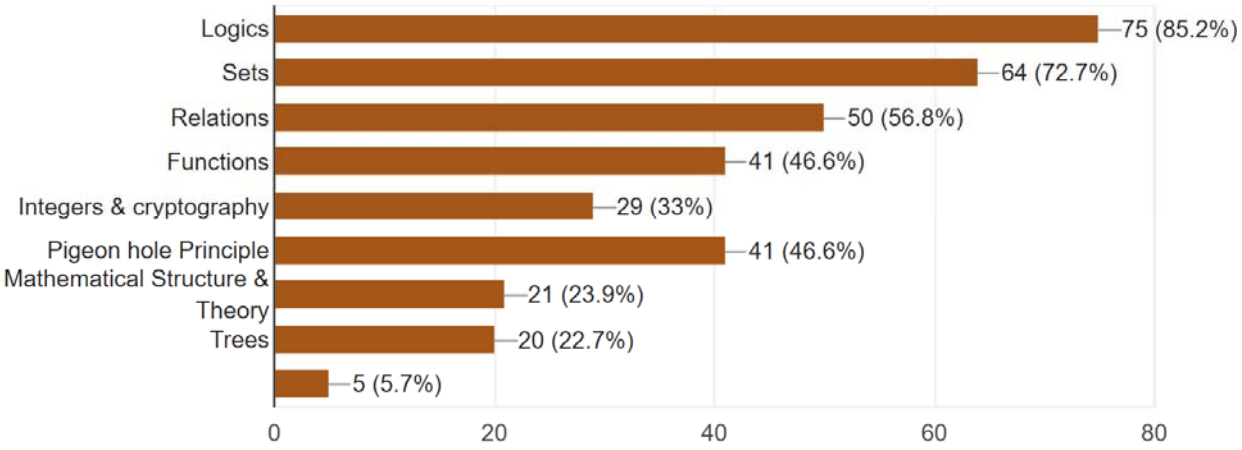

Figure 8: Student selected activities in the Discrete Mathematics MOOC

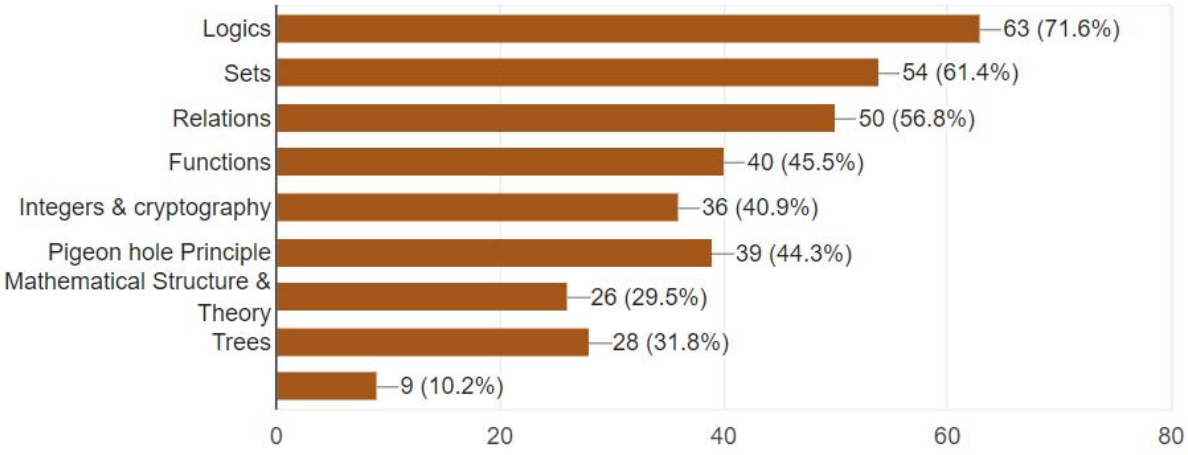

Figure 9: MOOC topics that enhanced with the learning (from student perspective).

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6. DISCUSSION AND CONCLUSIONS

MOOC is a recent development in higher education in Malaysia. There is only a few published work on guidelines in developing MOOC contents and are not specifically for generation Z students. Therefore, in this work, we have recommended eight teaching and learning strategies (as shown in Figure 4) to match the eight identified generation Z characteristics (as shown in Figure 1). The conceptual framework to integrate conventional teaching of the Discrete Mathematics and MOOC is also developed to give detailed description on our implementation (refer to Figure 3).

Discrete Mathematics MOOC was successfully constructed by producing 19 learning videos and various follow-up activities such as quizzes, training and self-reflection. Students and lecturers were also given a discussion room to create communication between the two parties. A questionnaire was distributed to the students and analysis of the effectiveness of Discrete Mathematics MOOC were conducted.

From the results of the questionnaires, the Discrete Mathematics MOOC was shown to be able to enhance our generation Z student learning especially on topics of: Logics, Set and Relations. We can conclude that the implementation of MOOC in Discrete Mathematics has helped students to understand these subjects better. However, further investigation need to be conducted to revise and improve the remaining subjects that were not very popular.

Upon success of this implementation, we can extend this course to reach out to more students, and even students from other institutions. This will facilitate our university future plan to create dual degree, joint degree, or even double degree programs with other universities.

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