Creative Online Assignments in Mathematics Learning: The Implementation and Users Experience

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Abstract
With the advancement of technology, many university students are equipped with internet connection and electronic devices. Many universities have adopted online learning as one of the teaching and learning approaches in this 21st century. The objective of this study is to evaluate the implementation of online platforms for creative online assignment that can increase students' interest in learning mathematics. In this study, Quizizz, IXL Learning and Kahoot are three online platforms that were chosen to implement the online assignment. Teaching and learning approaches were documented and discussed. From the students' feedback on these online assignments, students generally like to play game. They were happy as these online assignments were incorporated with game-based learning feature. Lecturers who applied these online platforms found that they could easily monitor students' performance by analyzing report from these platforms. The study has shown that these platforms benefited both lecturers and students in learning mathematics. These online assignments would gain its popularity in this era where technology is evolving and advancing rapidly. The results of the study could serve as a reference for educators in adopting creative online assignments that could give students an enjoyable, purposeful online learning experience and encourage self-regulated learning in mathematics.
Keywords: Mathematics Learning, Online Learning, Online Assignment, COVID-19, Online Platform

Introduction
The outbreak of COVID-19 pandemic has largely affected the learning method among the students from all levels including early childhood education, primary, secondary school learning, undergraduate or even postgraduate studies (Basar et al., 2021; Samat et al., 2020). Despite the challenges faced during the pandemic, educators from all levels creatively made a shift from face-to-face classroom learning to online learning.

In order to enhance students' understanding in virtual online environment, a group of educators in Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus has explored

various forms of online assignments that can be implemented in mathematics courses. The campus is a higher learning institution offering various programs such as Diploma in Mechanical Engineering, Civil Engineering, Chemical Engineering, Electrical Engineering and Business Studies. Mathematics is a compulsory subject to be taken by the diploma students. By learning mathematics, students can acquire useful arithmetic and critical thinking skills. These skills are crucial for them to understand their respective core subjects where calculations are involved.

Students from different programs are required to take different mathematics courses. Business Mathematics and Business Statistics are the mathematics courses for students undertaking business studies. Through the Business Mathematics, students can learn the essential arithmetic techniques in solving mathematical problem in banking, finance, trading, retailing and accounting. Data analysis is a very important skill for business students that can be learned from Business Statistics. For students who take engineering programs, they could learn the techniques of differentiation and integration from the mathematics courses such as Calculus I, Calculus II and Further Mathematics for Engineers. The mathematical concepts and arithmetic skills learned from these courses are very useful for them to solve the problem in engineering and sciences applications.

During the online distance learning, the assignments have mostly conducted in online. This paper presents several creative online activities that were assigned in mathematics courses during the online learning. The primary objective of this study is as follow:

- to evaluate the implementation of online platforms for creative online assignment that can increase students' interest in learning mathematics.

Literature Review

Mathematics is a subject where the students should first understand the concept of the topic and then apply the concept to solve problems. Most lecturers would use formal lecture session to deliver the lesson to the students. In order to enhance students' understanding, assignments are given to the students after the lecture is conducted. Some assignments are to be completed by the students during class session as lecturer could provide appropriate advice or assistance to the students. Since mathematics is a subject that need thorough understanding and frequent practices, most lecturers will prepare some assignments as homework. Students can complete the homework using their self-learning time. Rosário et al. (2015) reported that homework assignment that is well-designed with a specific purpose has positive impact to students' mathematics achievement. Eren & Henderson (2008) also presented that homework assignment and students' achievement are positively correlated.

In general, there are two types of assignments, namely non-graded assignment and graded assignment. The Figure 1 shows the differences between the non-graded assignment and graded assignment. Non-graded assignments are given to the students for practicing purpose and the assignments do not contribute to the percentage of course assessment. Some lecturers assign the non-graded assignments as homework to students. According to Latif & Miles (2020), one of the benefits of homework is to enhance student learning. Non-graded assignment can help students to self-assess how well they understand the lesson. This type of assignment usually covers a specific topic, and it is given right after the lecture of the topic is conducted.

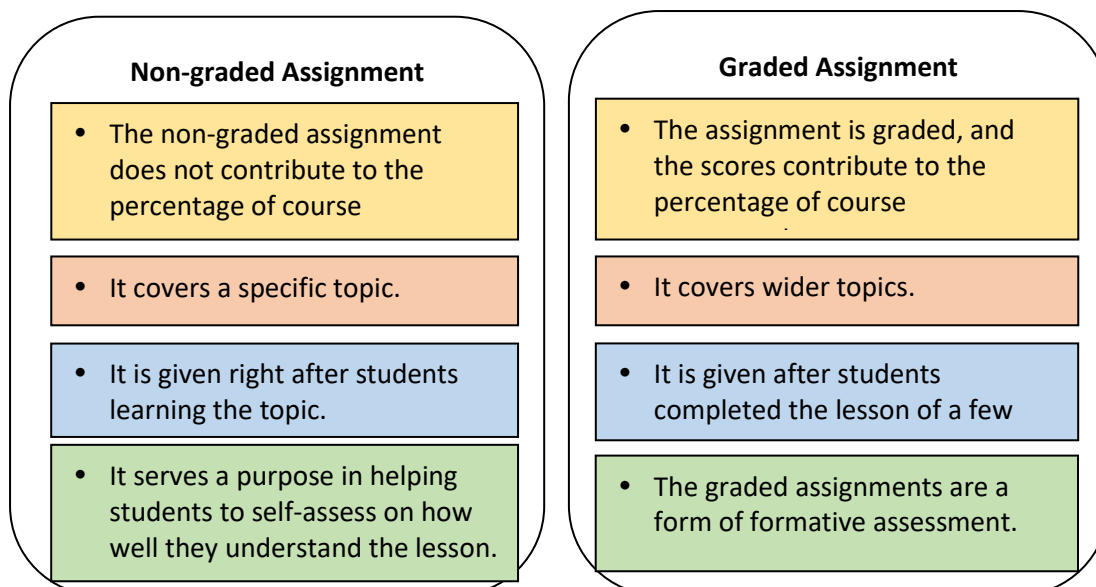| Non-graded Assignment	Graded Assignment
• The non-graded assignment does not contribute to the percentage of course	• The assignment is graded, and the scores contribute to the percentage of course
• It covers a specific topic.	• It covers wider topics.
• It is given right after students learning the topic.	• It is given after students completed the lesson of a few
• It serves a purpose in helping students to self-assess on how well they understand the lesson.	• The graded assignments are a form of formative assessment.

Figure 1. Non-graded Assignment and Graded Assignment

To evaluate students' performance in mathematics courses, another type of assignment is conducted, that is graded assignment. Graded assignments contribute to the percentage of course assessment. Some graded assignments are named as quizzes, tests or projects. The graded assignment covers wider topics, and it is given after students have learned a few related topics. These assignments will be marked by lecturers according to the rubrics of assessment and the scores will be recorded. Students usually pays more attention to the graded assignment, and they are more likely to submit the graded assignment on time (Rehfeldt et al., 2010). The graded assignments are given during the semester as a form of formative assessment. Students could identify which topics they need to improve based on the result of the formative assessment. Although non-graded assignment and graded assignment serve different purposes, both assignments are equally important in the teaching and learning process in mathematics courses. It is reported in Karadimitriou (2016) that students performed well in the final examination on the part that are relevant to the assignments.

Traditionally, most of the assignments in mathematics courses are conducted in the form of paper based. In this era where technology is advancing, online assignment has become popular in mathematics course. Kersaint (2007) reported that the use of technology enabled students to engage in active learning strategies, visualize mathematics, possess positive attitudes and building confidence in their ability in learning mathematics.

Online assignments can be conducted using smartphone or laptop. Nowadays, smartphone penetration among university students in Malaysia is very high (Hong et al., 2014; Mothar et al., 2013; Osman et al., 2012). Based on several studies, university students are showing a trend of actively using smartphone for educational purposes (Taleb & Sohrabi, 2012; Reese, 2013; White & Mills, 2014). As most of the students possess electronic devices, online assignments can be easily carried out in mathematics courses (Darmawan & Jainuddin, 2021; Ilmadi, 2020).

The outbreak of COVID-19 pandemic has forced many higher learning institutions adopting online distance learning or blended learning. With the advancement of technology and more students are equipped with internet connection, the acceptance of online learning

among university students is getting higher. Various studies have shown that online learning would inevitably be a way of learning in 21st century (Muthuprasad et al., 2021; Mulenga & Marbán, 2020; Chow et al., 2007). Despite various challenges faced by students during COVID-19 pandemic, they have gradually accepted and mastered the skills and techniques in online distance learning (Tukiman et al., 2020; Ng et al., 2021). Online learning promotes the usage of audio-visual interactive features. It can stimulate the interest and motivation of students to engage in their learning process. With the fact that online learning is more flexible and student-centered, online learning encourages students to be more organize, self-regulated and actively seek out information and assistance when needed (Yahya et al., 2021). The studies by Muthuprasad et al (2021) stated that quizzes given at the end of the class improved the learning effectiveness. Numerous online activities can be conducted in the virtual environment during the online learning. Hamid & Kamarudin (2021) recommended that it is important to design an appropriate and innovative learning activities that could increase students' understanding and interest in mathematics.

Methodology

The study uses qualitative method where teaching and learning approaches were observed and documented. The study was conducted in Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus. It is a higher learning education institution in Johor, located in Peninsular Malaysia. Several platforms of creative online assignments for mathematics courses were explored and implemented in the online distance learning during COVID-19 pandemic.

The flow to implement the creative online assignment is shown in Figure 2. After the students attended the lesson of a topic, the assignment is given to students to assess their understanding of the lesson. Students are required to submit the scores of the online assignment to the lecturer as a proof of completion of assignment. They can assess their learning performance based on the scores.
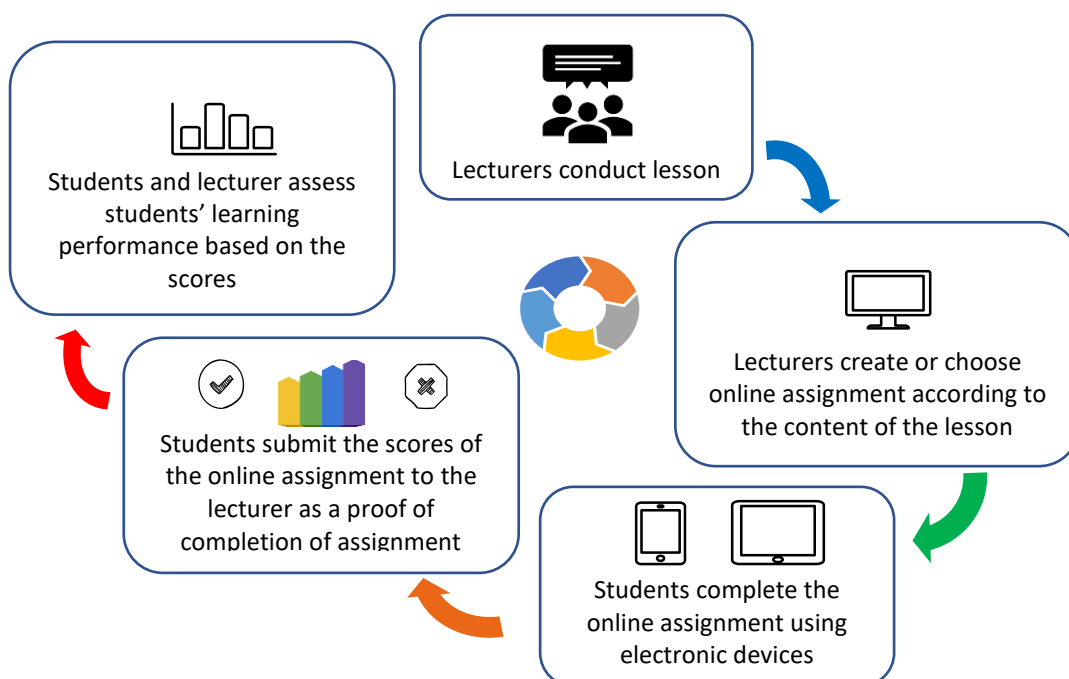

Figure 2. Flow to Implement Creative Online Assignment

Quizizz, IXL Learning and Kahoot are three platforms that were chosen to implement the online assignment. The students who participated in this study were a few classes of diploma students. Quizizz was assigned as online assignment in two classes. The students who participated in Quizizz were 17 students from Diploma in Electrical Engineering who took Calculus I and another 16 students from Diploma in Civil Engineering who took Further Mathematics for Engineers. IXL Learning had been applied to two classes of students who took Calculus I. The students who participated in IXL Learning consisted of 21 students from Diploma in Chemical Engineering studies and 19 students from Diploma in Mechanical Engineering studies. Kahoot was applied to one class with 21 students from Diploma in Business Studies who took Business Mathematics. Quizizz and IXL Learning were applied as individual non-graded online assignment while Kahoot was applied as individual graded online assignment. After the online assignments were conducted, interview was done to collect feedback and comments from students about their opinions on using the platforms as assignment.

Results and Discussion

The results of this study are presented in two main sections. First section presented the implementation of the creative online assignments using the platform of Quizizz, IXL Learning and Kahoot. The second section presented users' experience of these online assignments. To conceal the identity of students, users' names were erased in the figures in this paper.

Implementation of Creative Online Assignments
Quizizz as An Individual Non-Graded Gamified Assignment

Quizizz was chosen as a gamified assignment, and it was applied in mathematics courses. The Quizizz is chosen because it can be easily created by lecturer from website. Although the interface of the gamified assignment is provided by the website, but the content of the assignment is specifically designed by the lecturer. This can ensure that the assignment is relevant to the lesson learned. Figure 3 shows the setting in a Quizizz that was created by lecturer for the topic of "Introduction to Functions" in Calculus I. To conduct the assignment, lecturer has the choices of assigning it as synchronous live quiz or asynchronous online homework.
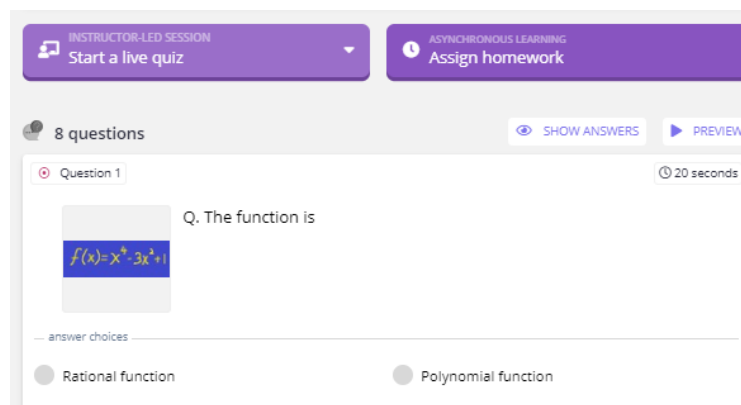

Figure 3. Quizizz Interface for Lecturer to Design the Questions

In designing the questions, lecturer needs to set a time limit for each question and there is an option of showing answers after students completed the assignment. In this Quizizz, 8 questions related to "Function" were created and 20 seconds were limited for each

question.

After the students attended the lesson, the assignment was given to students to assess their understanding on "Function". This Quizizz was assigned as asynchronous online homework. Lecturer gave a link of the game to students. Each student completed the game at their own time. The game can be easily accessed using electronic devices such as smartphone or laptop. The flow of implementation of this gamified assignment is as discussed previously in the Figure 2. After students completed the game, they submitted their score to the lecturer. Based on the score, lecturer gave feedback to the students whether they have learned well on the lesson, or they should do revision again on the lesson.

Quizizz was an interesting learning tool because the great sound effect and the attractive presentation styles in Quizizz increased students' interest in learning. When students played Quizizz, it was a game with music running in background and the interface of the game was colourful. Figure 4 shows some screenshots of the Quizizz when students played the game for the topic of "Function".
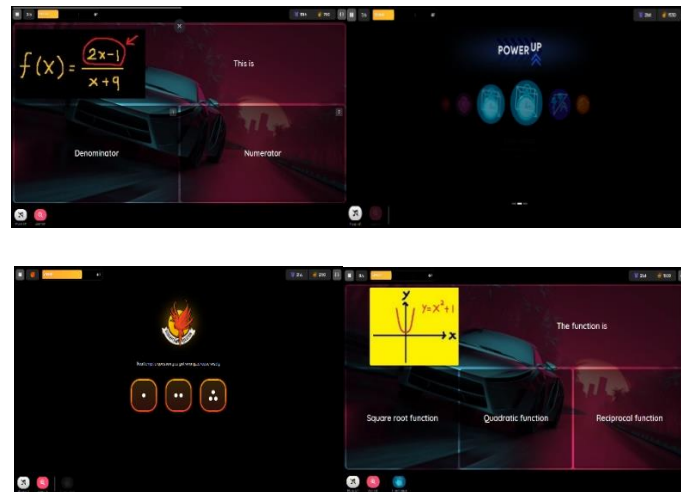

Figure 4. Quizizz Interface when Students Playing the Game

During online distance learning, some classes were conducted in live session. For example, a Quizizz was given as a synchronous live online quiz for the topic of "Definition of Matrix" in Further Mathematics for Engineers. After the lesson was delivered, lecturer gave the Quizizz as an online assignment to students. To begin the live quiz, lecturer gave a 6-digit code to students to join the game together. All students from the same class competed among their classmates to complete the game at a same time. The scores and ranking of the students were visible to students while they played the game. When the game ended, students could see a podium showing the top three winners (Figure 5). Students were very excited in this live Quizizz session. They were able to learn mathematics in a fun game platform.
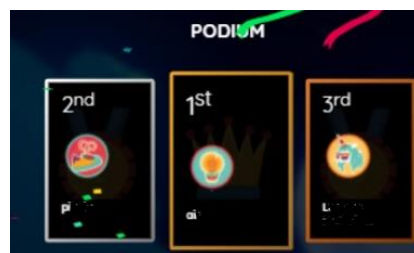

Figure 5. Podium at the End of the Live Quizizz Session

The Quizizz is a non-graded assignment where the scores of the game does not contribute to the overall course assessment. The purpose of this online assignment is to motivate students to self-assess how well they understand the topic. Lecturer could obtain a report from the Quizizz after the session ended. Figure 6 shows the Quizizz report that consists of the performance at class level and individual level. The report on class level shows the number of students answer correctly for each question while the report on individual level shows the performance for every student in this Quizizz session. Based on the scores obtained from the game, students could revisit the lesson if they did not score well. If they scored high in the game, it shows that they have mastered this topic.

Figure 6. Report in Quizizz at (a) Class Level and (b) Individual Level

IXL Learning as An Individual Non-Graded Gamified Assignment
IXL Learning (www.ixl.com) was chosen as one of the learning methods in our lesson plan and used as an individual non-graded assignment in mathematics course. We chose this web-based application due to a few of the syllabus content in this web matching with our syllabus. From our observation, this web was innovatively designed to create more effective ways for students to learn mathematics as well as a few subjects such as language arts, science, social studies and Spanish from lower grades Pre-K to higher education level. Here, we focused on mathematics subject only. The topics of calculus in higher education level were chosen through this web-based application. This application executed about 98 skills in learning calculus. The interface of IXL Learning of Calculus subject and the number of its skills is shown in Figure 7. IXL developed rigorous learning activities to ensure students deeply engaged with concepts, help learners build a strong foundation of knowledge, understand problems in multiple contexts, and prepare students for higher-level thinking.
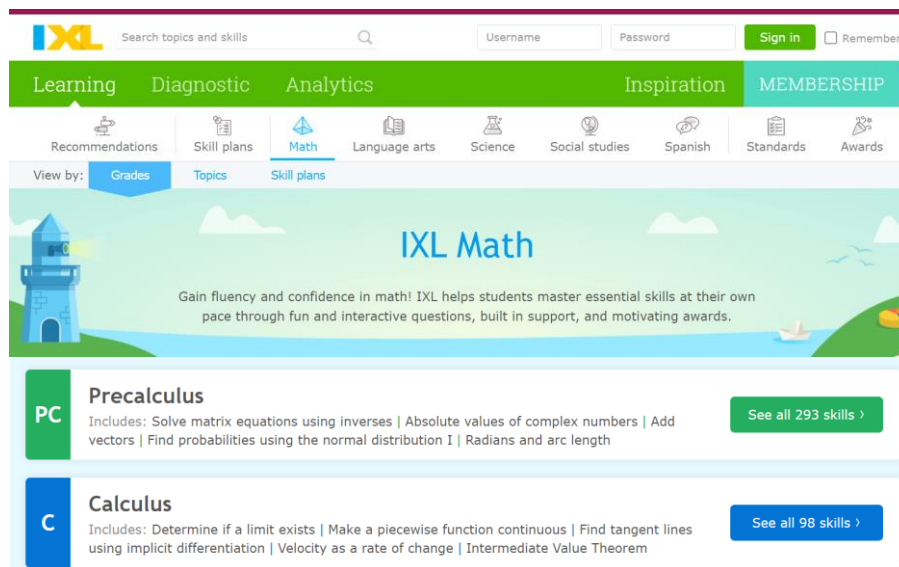
Figure 7. IXL Learning Interface for the Calculus Subject in Higher Education Level

By using this application, lecturer and students need to sign in the IXL Learning through the link www.ixl.com. Students and lecturer have their own interface. The lecturer created class or group of students and system gave username and password to the students. This trial version IXL application had been applied for two classes in one month only during the online distance learning. There were three main components for lecturer to monitor their students. The components were learning, diagnostics and analytics. The learning component was about content or topics to be learned by students. There was a total of 14 subtopics in Calculus and represented by alphabets from A to N. The detailed topics of Calculus are shown in Figure 8.
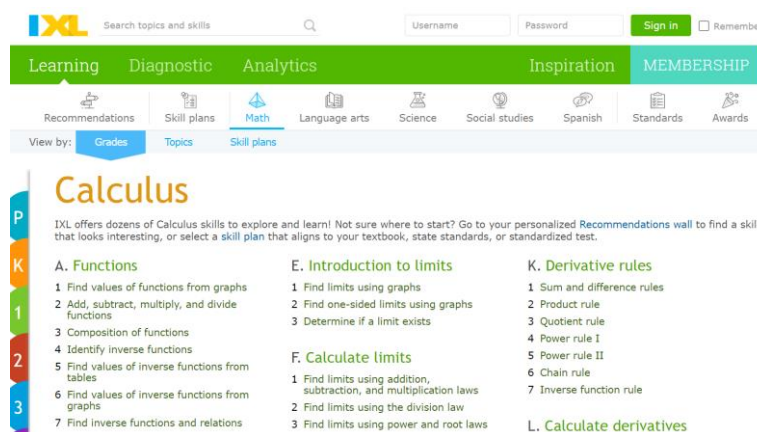
Figure 8. Subtopics in Calculus in IXL Learning

From the 14 subtopics available in IXL Learning, we have chosen three topics that match in our syllabus in Calculus, that are: J – Introduction to derivatives, K – Derivative rules and L - Calculate derivatives. The snapshot of the three chosen subtopics that were applied in study is shown in Figure 9.

J. Introduction to derivatives
1 Average rate of change I
2 Average rate of change II
3 Find instantaneous rates of change
4 Velocity as a rate of change
5 Find values of derivatives using limits
6 Find the slope of a tangent line using limits
7 Find equations of tangent lines using limits

K. Derivative rules
1 Sum and difference rules
2 Product rule
3 Quotient rule
4 Power rule I
5 Power rule II
6 Chain rule
7 Inverse function rule

L. Calculate derivatives
1 Find derivatives of polynomials
2 Find derivatives of rational functions
3 Find derivatives of trigonometric functions I
4 Find derivatives of trigonometric functions II
5 Find derivatives of exponential functions

Figure 9. Three Chosen Subtopics in Calculus that Applied in Study

As instructional learning activities, students need to complete the individual assignment from this application. There are many questions in each topic. Students can choose to answer the question immediately or they can click the button "learn with an example" before answering the questions. Figure 10 shows an example of question in subtopic "Introduction of Derivatives".

Calculus > J.5 Find values of derivatives using limits 9KU

Learn with an example ⌄

Find the derivative of $k(x) = 1$ at $x = 8$.

Write your answer as an integer or a fraction. Simplify any fractions.

Submit
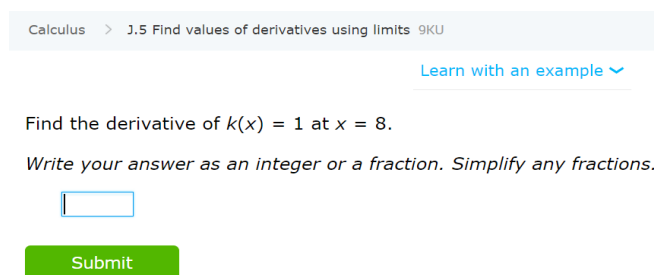
Figure 10. A Question in the Subtopic "Introduction of Derivatives"

Through module "Learn with an example", students can view the key idea and suggested solution that is shown step by step. Therefore, students can easily learn from examples and after that they can apply the same concept to answer different questions as exercises. Figure 11 shows a snapshot of "Learn with an example" in the subtopic "Introduction of Derivatives".

Learn with an example

question
Find the derivative of $k(x) = x$ at $x = -2$.
Write your answer as an integer or a fraction. Simplify any fractions.

key idea
The **derivative** of $f(x)$ at $x = a$ is:
$$f'(a) = \lim_{h \to 0} \frac{f(a + h) - f(a)}{h}$$
The derivative $f'(a)$ is both
• the **instantaneous rate of change** of $f(x)$ at $x = a$, and
• the slope of the **tangent line** to the curve $y = f(x)$ at $x = a$.
When $f(x)$ is a linear function, the derivative is always equal to the slope.

solution
Since $k(x) = x$ is a linear function with slope 1, the derivative is 1.

Figure 11. "Learn With an Example" in the Subtopic "Introduction of Derivatives"

Once students submitted their answers as individual assignment in IXL Learning, they could see their scores, time answer and their achievement from this application. Lecturer was

able to monitor and kept track of their student's assignment progress at home or in the class through the diagnostics and analytic module in this web. The overall quick view of students' performance is shown in Figure 12. The Figure 12 shows students' performance in assignments by subtopics, time spent doing the assignments, skills developed in subtopics and number o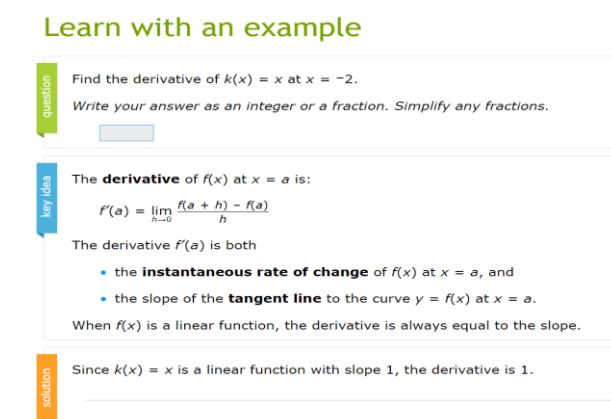f questions practiced at home or in the class by each day. Based on the students' performance, lecturer could identify students who were not good at the subtopic. Lecturer would take action by encouraging the weak students to do more exercises in the subtopic. From the diagnostics and analytic module in this web, lecturer could also identify students who performed well and gave them rewards. The good students can also be mentor to other weak students.

Figure 12. Overall Quick View of Students' Performance in Assignments

Figure 13 shows the report of scoring mark for each student in a class. From the report, the lecturer could monitor students' ability and the level of their understanding of each subtopic. If the score is low, the lecturer could take immediate action to help the students by giving more exercises to master the topics.

Figure 13. Scoring Marks Report from a Class

IXL Learning was implemented with the aim of helping student to develop their skills in Calculus and polish their confident level in answering the questions.

Kahoot as An Individual Graded Gamified Assignment
In the 21st century, online gamified assignment is one of the alternative methods in teaching and learning. The use and skills of technology in learning are very important to improve the learning quality for students. Therefore, a graded gamified assignment was assigned in a mathematics course named Business Mathematics. The study was conducted on 21 students from a class who were taking Diploma in Business Studies. The assignment for the Business Mathematics was created by lecturer using game-based design. Kahoot has been selected as

an individual graded assignment. Kahoot can increase student motivation in learning in the online classroom. The use of this Kahoot application is an interactive learning that emphasizes pedagogy by involving the relationship between student's active thinking with lesson content that emphasizes the attention, retention, and purpose of student's learning. Moreover, Kahoot gives equal opportunity to students to participate.

Kahoot is created from website. In this assignment, 10 questions were generated by the lecturer based on course learning outcomes and programme learning outcomes as defined by Bloom's Taxonomy. The game can be easily accessed using electronic devices such as smartphone or tablet or laptop. The flow of implementation of the graded gamified assignment is discussed below.

Firstly, lecturer constructed the quiz questions on the Kahoot portal as shown in Figure 14. To create graded gamified assessment, lecturer needed to first register an account at https://kahoot.com/. Then, lecturer planned and prepared learning gamified assessment in the form of quizzes, discussions, and surveys that were appropriate to the learning objectives. After registration, lecturers could directly login using the URL https://create.kahoot.it/ to visit the Kahoot website.
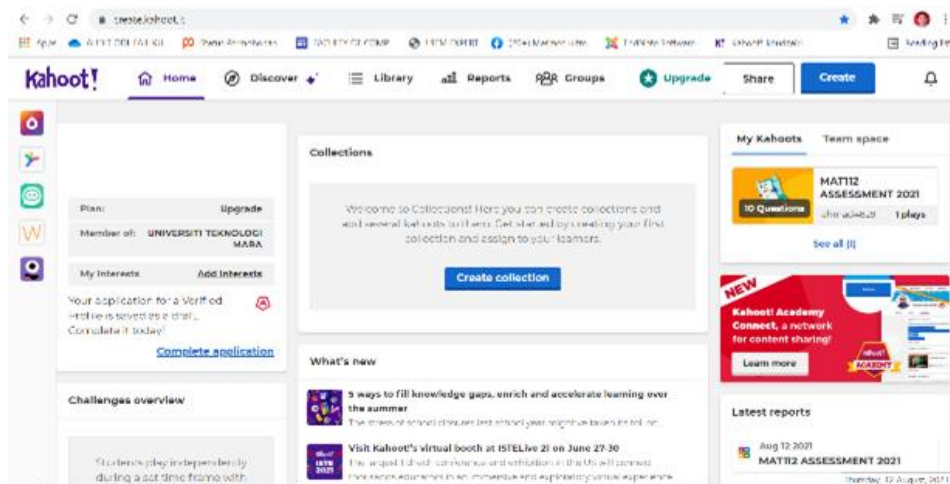

Figure 14. Create Quiz Questions on the Kahoot Portal

Before starting this gamified assignment, lecturer made sure all students are in the mode of ready on the online meeting platform such as Google Meet. Then, lecturer pressed the start button once all the students have checked in. Figure 15 shows the pin number displayed on the screen for students to participate in the Kahoot gamified assessment.
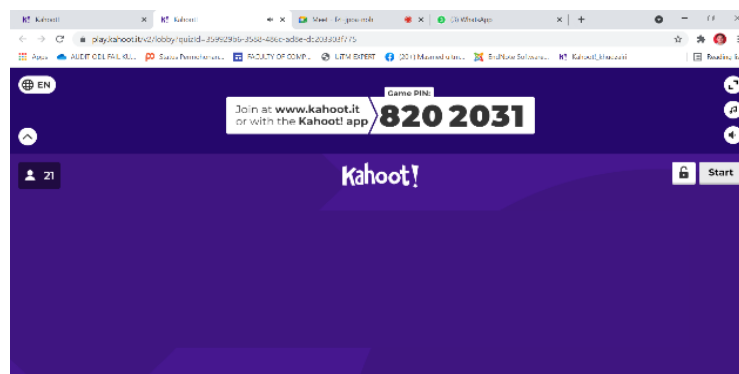

Figure 15. Pin Number and Kahoot Waiting Room

The interactive gamified assessment began by requiring all the students to answer questions created by the lecturer. The questions were constructed by having four multiple choice answers with the time given and set by the lecturer. Figure 16 is an illustration of one of the questions provided and to be answered by the students.
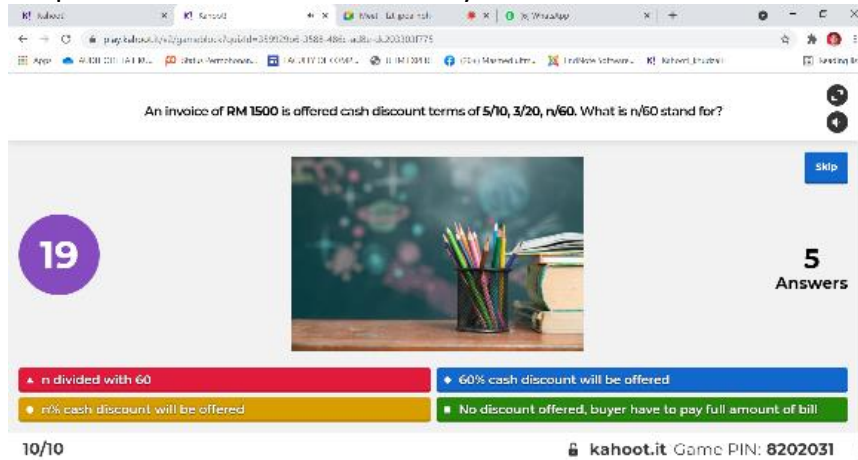

Figure 16. Kahoot gamified assessment interface

The results of the students were displayed after each time the question ended and at the end of the quiz, students knew their current score and rank (Figure 17).

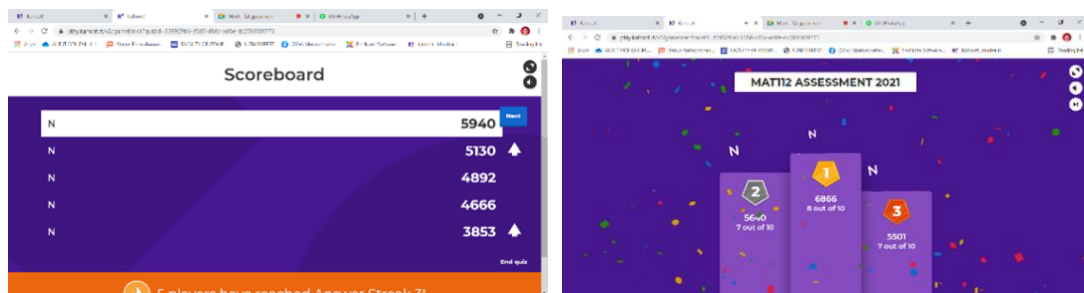(a)   (b)

Figure 17. Students' (a) score and (b) rank

Lecturer could obtain a report from Kahoot consist of the performance at individual level (Figure 18). Analysis of the results could be made holistically to see how many questions students have answered and who has completed the Kahoot gamified assessment.

Figure 18. Students' individual performance in Kahoot

Users' Experience on Creative Online Assignments
After the students experienced in using the creative online assignment in their study, the students were asked on their feedback from two aspects: (1) Is it a fun experience with the creative online assignment? (2) Do you have a better learning experience by using the creative online assignment? The Table 1 summarizes the students' feedback in using the three platforms on creative online assignments.

Table 1
Students' Feedback on the Creative Online Assignments

Online Platform	Students' Feedback on aspect (1): Is it a fun experience with the creative online assignment?	Students' Feedback on aspect (2): Do you have a better learning experience by using the creative online assignment?
Quizizz	• Yes, it is fun. I like it. • Game in the mode of competition and score is always fun. • The game is fun because it has funny quotes while waiting for next question.	• Yes. • I think fast and act fast in a game. • I remember the lesson better. • I can play many times. This way, I can remember the topic.
IXL Learning	• Yes, I like it. • I love learning with many examples and feel confident to answer question. • The IXL is fun because it always drilled and motivated me to do more exercises.	• Yes, of course. • We can remember the lesson better. • We can repeat the questions and build up our confident level. • I can remember the lesson by learning with examples.
Kahoot	• Yes, I love it as it is fun. • The scoring game makes me more excited.	• Although the question is difficult, but I can answer it

• I enjoy it as it is a visualized and unique type of quiz. • I feel more excited, fun, and less sleepy while playing Kahoot.	well because Kahoot features are great. • I act fast and think fast when I play a game. • Consist of suspenseful music and instant scoreboards to keep us engaged in competition lively. • Can measure my level of understanding.

Findings of the Study

Quizizz is a game-based learning approach. Based on students' feedback, we found that students like to play games. They felt that Quizizz was an interesting assignment as they can learn while having fun. By integrating technology in virtual learning environment, this approach could maximize the students' enjoyment and engagement in learning mathematics. Based on students' feedback, the game-based assignment can help them to remember better on the lesson. When a game is incorporated with scoring and timing, they strive to do better to gain a higher score. Furthermore, students will not be penalized for answering wrongly and the score in the game does not contribute to the percentage of course assessment. Therefore, they felt safe in this learning platform while assessing their learning progress. The students were excited to complete the assignment even though it is a non-graded assignment. Hence, Quizizz is an online assignment in the form of game-based learning that provides an enjoyable learning environment for students to learn mathematics. This finding is similar to Ishak et al. (2021) in which it supported game-based learning for the subjects in science, technology, engineering and mathematics.

From students' feedback on using web-based learning in IXL Learning platform, it is found that they love to learn by practicing with many examples. They gave the opinion that exercises in IXL Learning was an interesting assignment as they can learn and develop their solving skill in the topic given by the lecturer. This learning approach has incorporated technology in online learning environment. It benefited students as this approach has increased students' interest in mastering mathematics.

The web-based assignment has many repeated similar exercises on each topic. Students felt that this assignment can help them to remember well by practicing more questions in a subtopic. This web-based learning provides score and time for each student complete the assignment. The students are motivated to do better to get a better score. Score or point is one of the basic elements in gamification that promotes motivation in learning process. Many studies reported that recent learning management system or web-based learning platform that applied gamification element improve engagement and motivation in the learning process (Swacha, 2014). The students' feedback in using IXL Learning in mathematics in this study is aligned with the finding.

Since the score in the exercises in IXL Learning does not contribute to course assessment score, the students were happy to complete the assignment even though it is a non-graded assignment. Due to the attractive learning features of IXL Learning, it has shown that IXL is an online platform for assignment with learning element that benefited both students and educators. Students are provided with a less stressful and enjoyable learning

environment to learn mathematics while lecturer can monitor their students' performance easily through this online platform.

In this study, Kahoot was applied as a gamified graded assignment. Student's marks were taken and recorded in the course assessment marks. Based on students' feedback, youths generally like to play games. Therefore, they felt that Kahoot was interesting as it has the element of game in learning. Having technology integrated in online distance learning environment, the use of Kahoot digital application as a game-based learning approach was found to be successful in fostering a culture of lifelong learning among students in line with the goals of 21st century learning.

As reported in Wardani & Saputro (2021), many challenges and obstacles occurred during online distance learning. The challenges are such as unstable internet connection, insufficient time in submitting assignment or high amount of assignment given during online learning. However, the implementation of creative online assignments in this study have shown positive impact for students in learning mathematics and indirectly tackling some of the issues faced in online distance learning. Based on lecturers' experience and students' feedback in this study, the features of the creative online assignment that benefit the students in learning mathematics are summarized in Table 2.

Table 2

The Beneficial Features of the Creative Online Assignment in Learning Mathematics

Assignment in Online Platform	Features	Benefit to students
Quizizz	1. Attractive interface with game-based learning element 2. Individual score is given for each game 3. Allow repeated attempt for each game	1. Increase students' enjoyment in learning 2. Avoid dull classes 3. Student can get feedback from the scores given immediately 4. Encourage repeated practice
IXL Learning	1. Well-organized web interface 2. Many examples are provided with step-by-step solutions 3. Exclusive report is given on each student's score, time spent doing the assignment, number of questions practiced each day	1. Student can learn from guided examples and later apply the same concept to answer different questions 2. Encourage active learning, practicing by doing repeated similar questions 3. Promote self-regulated learning
Kahoot	1. Colorful interface with competition element included 2. It is an interactive learning tool 3. Suspenseful music and instant scoreboards during the online session	1. Encourage active thinking with assignment content that emphasizes the attention, retention, and purpose of student's learning 2. Increase students' participation in online class, avoid absenteeism 3. Keep students engage in learning through game-based learning

Mathematics is an important knowledge that can improve the personal quality and the academic performance of a student. Mathematics education plays a role in educating

students to be a logical person. Therefore, it is important to encourage students to master the mathematics knowledge. Mathematics is a subject that needs thorough understanding and frequent practice. Hence, assignments play an important role for students to enhance their learning after each topic is learned (Latif & Miles, 2020). Some challenges frequently faced in conducting classes in online distance learning include dull classes due to static learning styles, students' loss of attention due to long hours on screen, students are difficult to maintain high motivation due to non-conducive learning environment. As reported in Attali & Arieli-Attali (2015), introducing fun game-like features into traditional learning activities could promote user engagement and make the learning more attractive to students. As a result, this study has shown that implementing creative online assignments with the interesting features could benefit students in terms of motivation and engagement, as summarized in Table 2. The attractive features could be a motivation for students to have independent learning and hence improve their learning mathematics in online class. This is in line with the study from Amelia et al (2020) where it is reported that learning motivation is a factor in contributing to the success in learning mathematics.

Conclusion

In this study, we found that students enjoyed the learning when the edutainment method was adopted in the learning process. The term of the enjoyment has been evaluated based on the feedback given by the students. Moreover, another finding that has been discovered is about the student participation during the class hours. The participation from students was encouraging and it indirectly reduced the absenteeism issue. The implemented creative online assignments as discussed in this study has increased students' engagement and indirectly increased their confident level in learning mathematics. In other words, the approach has successfully created a conducive teaching and learning environment. As a conclusion, deployment an appropriate method and teaching tool can produce a healthy relationship and engagement between the lecturer and the students during the class hours. Literally, the positive vibe during the class hours was maintain until the end of the semester. The creative online assignments for mathematics courses that were implemented in this study have shown that technology has embedded in education. It is aligned with the concept of education for the future, namely Education 4.0 and Education 5.0. The flexible and active learning strategy with the use of technology has indeed changed the way of learning in this 21st century. Beginning the year of 2022, we are moving from COVID-19 pandemic to endemic. However, many studies have shown that online learning would inevitably be a way of learning in 21st century. Therefore, although this study was conducted during COVID-19 pandemic, the findings of this study can still serve as a reference for other educators to provide a purposeful and interesting online learning experience to students in higher education as well as other level of studies. As a future work, this study can be extended to include quantitative approach of survey study in evaluating students' acceptance of these creative online assignments in the post COVID-19 learning environment.

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References

Amelia, R., Kadarisma, G., Fitriani, N., & Ahmadi, Y. (2020). The effect of online mathematics learning on junior high school mathematic resilience during covid-19 pandemic. *Journal of Physics: Conference Series*, 1657(1), 012011.

Attali, Y., & Arieli-Attali, M. (2015). Gamification in assessment: Do points affect test performance?. *Computers & Education*, *83*, 57-63.

Basar, Z. M., Mansor, A. N., Jamaludin, K. A., & Alias, B. S. (2021). The Effectiveness and Challenges of Online Learning for Secondary School Students–A Case Study. *Asian Journal of University Education*, 17(3), 119-129.

Chow, S. H., Ng, S. F., & Mat, S. C. (2007). An investigation on e-learning readiness of engineering students. *Journal of the Institution of Engineers Malaysia*, 68(4), 56-64.

Darmawan, F. A., & Jainuddin, J. (2021). Augmented Reality-based Mathematics Worksheet for Online Learning During Covid-19 Pandemic. *Indonesian Journal of Educational Studies*, 23(2), 81-90.

Eren, O., & Henderson, D. J. (2008). The impact of homework on student achievement. *The Econometrics Journal*, 11(2), 326-348.

Hamid, N. H. A., & Kamarudin, N. (2021). Assessing Students' Mathematics Achievement and Mathematical Creativity using Mathematical Creative Approach: A Quasi-Experimental Research. *Asian Journal of University Education*, 17(2), 100-112.

Hong, Y. H., Teh, B. H., & Soh, C. H. (2014). Acceptance of smart phone by younger consumers in Malaysia. *Asian Social Science*, 10(6), 34.

Ilmadi, I., Zarista, R. H., Aden, A., & Sastro, G. (2020). The Effectiveness of Online Learning for Mathematics Students during the Covid-19 Pandemic. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 4(2), 1273-1282.

Ishak, S. A., Din, R., & Hasran, U. A. (2021). Defining Digital Game-Based Learning for Science, Technology, Engineering, and Mathematics: A New Perspective on Design and Developmental Research. *Journal of medical Internet research*, *23*(2), e20537.

Karadimitriou, K. (2016). The Impact of Collaborative Graded Home Assignments on the Performance of University Students. *International Online Journal of Educational Sciences*, 8(2), 62-70.

Kersaint, G. (2007). Toward technology integration in mathematics education: A technology-integration course planning assignment. *Contemporary Issues in Technology and Teacher Education*, 7(4), 256-278.

Latif, E., & Miles, S. (2020). The impact of assignments and quizzes on exam grades: A difference-in-difference approach. *Journal of Statistics Education*, 28(3), 289-294.

Mothar, N. M. M., Hassan, M. B. A., Hassan, M. S. B. H., & Osman, M. N. (2013). The importance of smartphone's usage among Malaysian undergraduates. *IOSR Journal of Humanities and Social Science*, 14(3), 112-118.

Mulenga, E. M., & Marban, J. M. (2020). Prospective teachers' online learning mathematics activities in the age of COVID-19: A cluster analysis approach. *EURASIA Journal of Mathematics, Science and Technology Education*, 16(9), em1872.

Muthuprasad, T., Aiswarya, S., Aditya, K. S., & Jha, G. K. (2021). Students' perception and preference for online education in India during COVID-19 pandemic. *Social Sciences & Humanities Open*, 3(1), 100101.

Ng, S. F., Ismail, A., & Tukiman, N. (2021). Students' perception on using teaching video in online learning during COVID-19 pandemic. *Journal of Creative Practices in Language Learning and Teaching (CPLT)*, 9(1), 10-19.

Osman, M. A., Talib, A. Z., Sanusi, Z. A., Shiang-Yen, T., & Alwi, A. S. (2012). A study of the trend of smartphone and its usage behavior in Malaysia. *International Journal of New Computer Architectures and their Applications (IJNCAA)*, 2(1), 274-285.

Reese, B. C. (2013). Educational use of smart phone technology: A survey of mobile phone application use by undergraduate university students. *Program: electronic library and information systems*, 47(4), 424-436.

Rehfeldt, R. A., Walker, B., Garcia, Y., Lovett, S., & Filipiak, S. (2010). A point contingency for homework submission in the graduate school classroom. *Journal of Applied Behavior Analysis*, 43(3), 499-502.

Rosario, P., Nunez, J. C., Vallejo, G., Cunha, J., Nunes, T., Mourao, R., & Pinto, R. (2015). Does homework design matter? The role of homework's purpose in student mathematics achievement. *Contemporary Educational Psychology*, 43, 10-24.

Samat, M. F., Awang, N. A., Hussin, S. N. A., & Nawi, F. A. M. (2020). Online Distance Learning amidst COVID-19 Pandemic among University Students: A Practicality of Partial Least Squares Structural Equation Modelling Approach. *Asian Journal of University Education*, 16(3), 220-233.

Swacha, J. (2014). An architecture of a gamified learning management system. *International Conference on Web-Based Learning*, Springer, 195-203.

Taleb, Z., & Sohrabi, A. (2012). Learning on the move: the use of mobile technology to support learning for university students. *Procedia-Social and Behavioral Sciences*, 69, 1102-1109.

Tukiman, N., Khalid, A. K., Onn, M., Ng, S. F., & Amran, M. A. M. (2020). Online Learning Challenges and Students' Preference on Mode of Learning during COVID-19 Pandemic. *International Journal of Advanced Research in Education and Society*, 2(3), 72-79.

Wardani, E. R., & Saputro, D. R. S. (2021). Online Mathematics Learning during the Covid-19 Pandemic. *Journal of Physics: Conference Series*, 1808(1), 012044.

White, J., & Mills, D. J. (2014). Examining attitudes towards and usage of smartphone technology among Japanese university students studying EFL. *CALL-EJ*, 15(2), 1-15.

Yahya, N. A., Said, J. M., & Yusof, A. M. (2021). Students' self-regulated learning in open and distance learning for Mathematics course. *EDUCATUM Journal of Science, Mathematics and Technology*, 8(1), 1-5.