Enhancing First Year Fundamental Engineering Subject Understandings through Game Based Cooperative Learning

Chris Jonathan Tang[1], Dzeti Farhah Mohshim[1,*], Sia Chee Wee[1]

[1] Petroleum Engineering Department, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, Perak, Malaysia

ARTICLE INFO	ABSTRACT
	The recent COVID-19 pandemic has brought about a need for rapid changes to the existing education system to ensure continuous fulfilment of human capital development needs amidst the challenges of social distancing. Thus, game-based cooperative learning carried out via an online environment is proposed for implementation to ensure students stay engaged in the newly created study atmosphere. For this study, online game-based learning is implemented on a group of final year Petroleum Engineering students taking Production Chemistry and Flow Assurance in a private government-linked Malaysian university. Students' feedback was obtained to analyse the effectiveness of the implemented study upon completion of the semester. The survey questions were grouped into 6 themes, namely Relevance, Reflective Thinking, Interactivity, Tutor Support, Peer Support, and Interpretation. Overall, the implementation was a success indicated by student satisfaction at 88.3% by the first class with room for improvement in the area of peer support. The maximum score of 5 was rated as the mode for 92% of the 24 survey questions while the mean ranged from 4.0 to 4.7. The standard deviation was also found to range from 0.45 to 1.11, showing a relatively collective agreement on the successful implementation of game-based learning.

1. Introduction

Game-based learning (GBL) is defined as utilizing games, be it digital or non-digital to deliver knowledge. The introduction and integration of GBL revolves around improving student interest, commitment and engagement with their study matter in such a way they are freely committed to pursue excellence on their own accord. It was reported that students were likelier to remain

---

* *Corresponding author.*
E-mail address: dzetifarhah.mohshim@utp.edu.my

committed to their educational materials when technology was involved [1]. It was also mentioned that traditional educational systems are facing difficulties in sustaining student interest, thus enforcing the need for GBL in pursuit of student progress [2]. Game-based learning is not an entirely new subject matter as it has proven track record of improving information retention with a flexible system that enables students to craft and individualize their training pattern. However, the reason why game-based learning was not executed at an institutional scale was because there was no pressing need for a change in the traditional system. Now, with the increasing concerns over the risk exposure to the COVID-19 coronavirus, it has never been more paramount to look into the feasibility of a large-scale change with the introduction of game-based learning as part of a hybrid educational environment.

2. Literature Review
2.1 Game-Based Learning Mechanisms

Game-based learning can be divided into 3 distinct frameworks – gamified learning, gamification in higher education and game-based learning in higher education [3]. Gamified learning and game-based learning in higher education revolves around the practical use of games themselves in teaching and learning. From their studies, several findings from the implementation of gamified learning could be derived, including the use of awards and penalties to draw students to produce exemplary results and deter them from violating academic requirements respectively, especially in an environment where educators are not able to fully monitor their presence as compared to the traditional approach of a physical class. Attendance during the award presentation day was also found to be significantly higher, indicating student interest and motivation towards the opportunity of winning an award. Once gamified learning was introduced, the efficacy of the games in achieving course outcomes had to be evaluated, and this was conducted via in-game student performance, knowledge tests and user feedback, expectations, thoughts, and continuous participation. It was derived that poor game mechanics often resulted in failure to achieve learning objectives. Hence, improvements and details to these elements could effectively increase student interest and engagement, therefore ultimately achieving the intended objective of self-initiated pursuit of student academic excellence. It should also be noted that the design of the game itself should be aligned with the course schedule throughout the semester as studies have shown that some students may stop utilising the system upon completion of the entire quest. It was mentioned that learning contents which are not tailored to the requirements of the students are of no educational value at all [4]. An example of this learning pathway could require students to pass a short assessment in order to unlock subsequent more advanced chapters. These assessments would also contribute to their final coursework marks.

On the other hand, gamification in higher education makes use of game elements like Moodle and Anki to increase student motivation. It was also suggested that tasks such as drag and drop, MCQ and finding the odd one out in various range of levels to engage students and track their learning behaviour and performance [5]. It was found that gamification promoted individualism rather than collaborative efforts amongst students [3]. This is not always true however, depending on the form of gaming element that is designed. Team-based gaming may create a more relaxed environment where students are able to answer collaboratively. It was also found that team-based games support peer or small group learning, where team members offer timely feedback to one another in ways that are beneficial to the cause [1]. It was found that a virtual 3D social environment for competing, collaborating and receiving task feedback resulted in elevated student interest and was largely received by the student community with positive performance. Selecting the form of teaching method is highly dependent on the nature of the course itself and also the country of implementation

as it would be more effective for example a reading subject if its material was presented in a physical form, making it more accurate, comprehensive and easier to read on paper than on a computer screen. This is supported by a simple explanation that printed materials may want to be kept for easier comparison or referral. Moreover, certain countries may face larger challenges in terms of educator readiness for online implementation and technology availability among many other external factors that may ultimately affect the choice of teaching platform. Although there was no significant difference in final scores found between students with and without gaming elements incorporated in their course module, students in the gamified course were found to enjoy the learning process and were motivated to work harder, with deeper perceived learning, increased work quality, and improved behavioral and cognitive user engagement [1,3,4]. With the increase in student motivation, the trial group whose learning is incorporated with GBL can be expected to observe an increase in student average GPA and reduce failure rate as compared to a traditional class [3,6].

A study introduced a GBL environment where the learning process is divided into the concept-learning stage and the task stage [4]. The first stage would involve students learning fundamentals and theories pertaining to the course by investigating the game environment, followed by a two-tier test for assessment of student understanding. These tasks are left to the freedom of students to complete on their own schedule, highlighting the flexibility offered to students to individualize their own learning pattern. Consequently, the game is able to draw a diagnosis on the level of knowledge retention and provide appropriate feedback for student improvement. Their study looked into the impact of GBL on the learning achievements of the test group, their mathematics anxiety and the difference in student behavioural pattern. Since there was no distinct difference in the achievements of both the experimental group and the control group, this could be an indication that using GBL was on par in terms of teaching effectiveness as compared to a traditional classroom, except with the flexibility of location and time. A study also stressed on the benefits of online learning in terms of time and knowledge management [2]. It was also found that students who took time to read the feedback given by the game had significant learning effectiveness as compared to those who did not spend much time to study the feedback, indicating that these long-time reading students successfully learnt the course concept, retained them and required less frequent review of class content [4]. They could also accurately select correct answers with less frequent application of trial-and-error method in addition to improved prior knowledge before continuing onto the subsequent chapters. Figure 1 depicts the feedback mechanism used in the gaming environment.
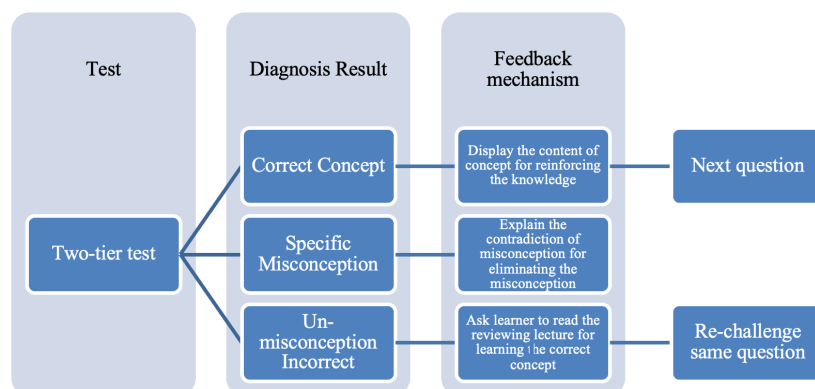

Fig. 1. Two-tier test [4]

A study made use of an integrated e-learning platform, one that allowed students access to resources including online applications, tools and information at any time to support e-learning [2].

This platform was in line with their aim to create a self-learning environment for students which allow constant student-teacher interaction and knowledge sharing relevant to their course outcomes. In order to create a satisfactory online learning environment, student survey indicated and stressed the importance of online course quality, integrated online platform functionality and user-friendly interface. System administrators should constantly ensure availability of platform functions while making it easy for use as this can allow students to create a comfort zone within the platform, thus making the online environment more approachable.

With the availability of such an integrated platform, educators are able to conveniently conduct interactive learning, including discussions and Q&As in the community forum. Students are also allowed to freely add relevant information and evaluate the teachers and the teaching system itself through the platform. Some other features include the bulletin board system, multimedia recording system and virtual classroom system. A study mentioned the use of Blackboard learning system, a similar integrated online platform that offers communication tools such as a bulletin board and chat room while allowing for glossaries, references, self-tests, quizzes and assignment submission [7]. Through such a wholesome system, both the educator and the learner are able to track their progress and improve quality of teaching.

2.2 Advantages of Game-Based Learning

The main advantage of game-based learning is that it affords students the chance to make mistakes without penalizing them; gives them opportunities to amend their mistakes and revisit class content, an empathy that traditional learning systems often do not consider. Students often show reduced percentage of error in answers with repeated quizzes as opposed to a single quiz given at one point of time throughout the course. Since students are able to freely practice in a relaxed atmosphere and in the absence of judgement, they reportedly learnt and reviewed their materials more effectively, thus reducing student reluctance towards academic commitment [1]. It was also reported that lower levels of mathematics anxiety were observed in GBL as students had higher learning frequency with appropriate and effective learning content, thereby reducing stress associated with the fear of solving mathematical problems [4]. Physical examinations often left no room for students especially those with disparate learning patterns to make mistakes, often leaving them with poor results in the rigid learning system. Moreover, in a traditional system, delivery of a large amount of complex knowledge in a constricted period of time may result in only partial retention. Hence, with the introduction of GBL, smaller amounts of information can be quizzed more frequently and can be more easily recalled. With the introduction of game-based learning, it is hope that more individualized concepts can be incorporated in such a way that students are able to connect the dots between course contents and real-life application. The best learning method gives sufficient time to learners to learn the concepts, equipped with appropriate feedback mechanism [4]. This gives students the opportunity to identify their misconceptions and reinforce their fundamentals that translates to improved learning effectiveness.

Moreover, in the usage of an online platform to deliver teaching materials, for certain allocated tasks, students are given little to no support in completing the said assignment [8]. As a result, they were stimulated to search for related online resources to deepen their understanding of the subject matter and subsequently answer the assigned questions. Consequently, it is hoped that through this way of teaching, students are not constrained by the line of thoughts of a boxed-in traditional classroom but are given the freedom to answer the questions to their own personal creativity, thus reducing the chances for plagiarism amongst peers. Characteristics of an online game-based learning system could include:

- Leading role of the teacher, who provides all relevant data and shares their screen so as to ensure that all students have access to the same set of information.
- Centralization of all student comments and questions via the online chat and answered live by the teacher.
- Organization of the game in periods with enough time between subsequent periods to allow students to reflect on the decisions they take and discuss them with other group members.
- Decentralized communication among students via social platforms such as WhatsApp, Facebook, Skype, or any other device for chatting with their classmates.
- Use of a learning management system such as Moodle to allow students to communicate their decisions/actions in the game to the teacher.

2.3 Possible Disadvantages of Game-Based Learning

Of course, it would be unrealistic to state that GBL is fool proof. Interactions between the educator and a large class can be less personal [6,7], and may reduce the ability of the educator to detect weaker students that require specialized attention and assistance; made worse should students be shy to speak up about their difficulties. Furthermore, students may be less inclined to be prepared prior to the learning session, seeing as to how the environment is a relaxed one that can help them advance their practical capabilities Hence, the ultimate goal is to come up with a strategy that enables students to learn in a dynamic environment that can be easily managed by educators as well. This translates to the need for constant feedback from students on the effectiveness of GBL in achieving their course objectives. Large investment of efforts is naturally needed to deliver the importance of student feedback in an online learning environment to students, especially as it would be difficult to ensure complete student participation in this type of survey in a distant learning environment. It was also mentioned that the successful implementation of an online learning tool largely depends on student acceptance and usage of the technology [7]. Some strategies that may be adopted to encourage student acceptance include:

- Explaining the importance of the assigned task, allowing them to link it to their everyday life.
- Defining the course objective, allowing them to understand what it takes to attain their desired goals.
- Giving relevant advice, especially with regards to time management.
- Supplying preliminary exercises that can allow students to practice and subsequently build their confidence and boost their motivation.

A study made use of Bauman's layered-learning model, one that introduces contemporary education, which in this case is GBL without entirely obsoleting traditional information transfer via scholarly reviews and educator-student interaction in a situated and multimodal approach [1]. This hybrid form of teaching and learning does not function to replace the teaching approach of a traditional classroom, but rather increase accessibility to digital content.

3. Methodology

This case study is taken from a group of Final Year Petroleum Engineering students who took Production Chemistry and Flow Assurance in a Malaysian university. This module was carried out fully online throughout a 12-week semester duration, with a total of 10 chapters to cover. Assessments for this module included two tests, two quizzes and one assignment, with tutorial classes as well as two adjunct lectures, of all which were carried out via the university's online learning platform.

3.1 Assignments

During the first lecture, students were asked to complete their first group assignment by constructing a mind map of the delivered topic. With the students being able to complete their assigned task successfully and with many of them making use of creative editing software, the general feedback was positive and encouraging, indicating the activity was not impossible to complete online. Furthermore, this task enabled the assigned group members to familiarize themselves with each other, therefore making it easier in weeks to come for group work over the internet.

During the middle of the semester, the students were given an assignment on which they had to select a flow assurance issue from the list provided and design a question based on the chosen topic. This question had to be comprehensive as well as holistic as to be able to gauge the audience understanding on the subject matter, and the students had to come up with their own model answer themselves. For the implementation of this assignment, the list was made available online, of which only limited slots were available for each topic. Only 4 groups could select each topic – Wax, Organic & Inorganic Scales, Asphaltene, Emulsion and Sand Production. Once the quota was filled, the topic would not be available for selection. This method of selection was fair and there were no critical issues nor discrepancies brought up on the method of selection. The challenge for this assignment was that these topics were yet to be covered at that point of the semester and will only be taught in the subsequent weeks. As so, information on the subject matter was not provided and this opened up an opportunity for the students to get creative with their questions and answers. Students largely showed deep interest in the subject matter, with some going as far as to look into empirical and simulation scientific papers to come up with better technical questions and answers. Overall, the assignment encouraged student self-learning. Through the assignment, they were able to widen their scope of knowledge and better understand the lecture contents that were delivered subsequently.

3.2 Tools for Lecture
3.2.1 Mentimeter

During the first lecture itself, 88.3% of the attending students indicated they were very satisfied with the session, with the remaining being somewhat satisfied and none being unsatisfied. Thus, it can be concluded that that were not many issues with the usage of the online platform for teaching and learning. Moreover, during the first class, Mentimeter, an online application as shown in Figure 2 was used for getting student response in order to estimate the level of understanding of the students by the end of the first class. More commonly said words would be displayed in a bigger font size by the application. Overall, the students showed profound understanding and general positive feedback by the first class as recorded in Mentimeter with regards to the usage of various online learning tools for teaching.

Fig. 2. Student response on Mentimeter.

3.2.2 Online glossary

Since this subject consisted largely of reading materials as well as definitions, the lecturer introduced a glossary on the online platform. Students could edit and add onto this glossary whenever new terms were introduced with the idea of sharing of information amongst peers platform wide. However, students showed lack of use of this function and required the lecturer to reiterate the availability of this function for them to add onto this glossary, indicating more encouraging response only when prompted. This idea may require a further look into the structure of implementation as it can be beneficial in the long run for lecturers to be able to gauge the accuracy of the information provided by the students and therefore tailor the course structure accordingly to fit the needs of the students.

3.3 Quiz

Moreover, a pre-class quiz was conducted on the third week of the semester on a chapter that was familiar to the students as it had been touched on in their previous semester. With a good number of them being able to score full marks for the short activity, this indicated that students had reviewed their past online lecture materials. The advantage of the online learning platform is that students could trace back their notes to their previous semesters, giving them access to information anytime and anywhere. Two quizzes were also carried out throughout the semester, where students were given 15 minutes to complete the assessment. The quizzes consisted of defining phrases, matching words, selecting correct statements as well as true or false questions. The quiz was designed to incorporate elements which were familiar to students i.e., word matching in hopes of increasing student commitment and reducing stress whilst completing their assessments, commonly associated with the largely traditional MCQ or essay questions. Largely, no issues were reported during the execution as students were given a flexible span of 2 hours to complete the quiz anytime within the time frame.

3.4 Tutorial

For their tutorial classes, the students were divided into ten groups, with two groups attending each tutorial session as shown in table 1. That meant having five different tutorials occurring simultaneously during the assigned time slot. Each tutorial group was assigned one tutorial question to discuss, answer and complete. However, they were encouraged to answer other tutorial questions as well and refer to their classmates in the other tutorial session for the correct answers. Overall, the sessions which were conducted thrice throughout the semester were smooth and students showed proactiveness in answering the questions prior to the tutorial session and discussing them within their groups as well as inter-group. As a result, the overall class had a good grasp of the tutorial content and only referred to the tutors during the session for correct answers and further elaborations. For the design of the tutorial questions, students showed excellent answering skills when the questions were covered in the prior lecture sessions. As the lecturer had shown the steps to getting the answers and the theory behind it, students showed little to no complications in answering similar pattern of questions, and even going further as to making use of Microsoft Excel for computing answers which required iterations. These Microsoft Excel files later on came in handy during their assessments as the formulas were readily completed in the program for use. Students faced uncertainties mostly when answering questions which were not covered during the lecture

sessions. They however showed efforts to look for information online before seeking further clarification.

Table 1
Tutorial group demarcation

Tutorial Session	Question	Groups
1	1	A and F
2	2	B and G
3	3	C and H
4	4	D and I
5	5	E and J

3.5 Adjunct Lectures

To increase the relevancy of students to the industry and increase their marketability, adjunct lectures were conducted to familiarize students with industrial operations, namely on Technology Enablement for Assuring Flow from Pores to Point-of-Sales and Production Systems. Students were less shy to ask questions using the chat box and the 'raise hand' functions. The presenter incorporated a Kahoot game as part of the lecture to increase student interest. With the ability to conduct the session over an online platform, the presenters were able to easily access and demonstrate the usage of state-of-the-art software. Relatively less technical issues were encountered as compared to traditional lectures as applications or information are displayed directly from its original source. With the ease of accessibility, students can join adjunct lectures on their own accord as well as to replay the lecture which had been recorded whenever they needed to recap.

3.6 Final Examinations

For their final examination, the traditional format of examination was replaced with an online 24-hour Extended Assignment that encouraged the usage of the expanse of information available. The questions asked were largely open-ended and commonly required cross-referencing across the modules taught. As so, students were able to correlate their various subjects. The assignment tested their fundamentals and was able to link their taught theories to industrial application. It should however be taken into account the level of understanding of students when designing the exam questions, bearing in mind the objectives and scope of the course module.

4. Findings and Discussions

At the end of the semester, a survey using the university's online education platform was conducted to obtain student feedback on the teaching and learning method. 24 questions were put forward to the students, out of which were categorised into the themes of Relevance, Reflective Thinking, Interactivity, Tutor Support, Peer Support, and Interpretation. Students were to rate their feedback from a scale of 1 to 5 (1-Poor, 5-Excellent). Out of the 71 students who participated in the survey, 37 are Malays, 7 are Chinese, 17 are Indians and the rest are international students, while out of the 71, 59 are males while 12 are females.
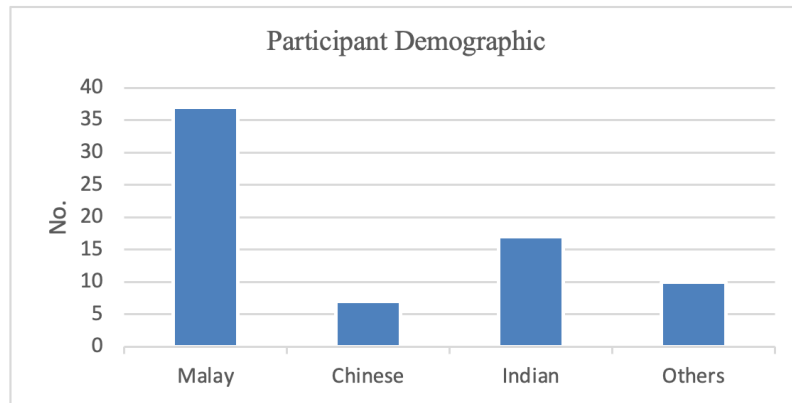
Fig. 3. Participant demographic

Table 2
Survey questions

| Theme	Survey Questions	Score		
		Mode	Mean	Standard Deviation
Relevance	My learning focuses on issues that interest me.	5	4.49	0.67
	What I learn is important for my professional practice.	5	4.72	0.45
	I learn how to improve my professional practice.	5	4.46	0.73
	What I learn connects well with my professional practice.	5	4.59	0.55
Reflective Thinking	I think critically about how I learn.	4	4.35	0.70
	I think critically about my own ideas.	5	4.45	0.63
	I think critically about other students' ideas.	5	4.27	0.83
	I think critically about ideas in the readings.	5	4.42	0.67
Interactivity	I explain my ideas to other students.	5	4.23	0.85
	I ask other students to explain their ideas.	5	4.31	0.84
	Other students ask me to explain my ideas.	5	4.13	1.07
	Other students respond to my ideas.	5	4.21	0.95
Tutor Support	The tutor stimulates my thinking.	5	4.39	0.80
	The tutor encourages me to participate.	5	4.48	0.71
	The tutor models good discourse.	5	4.41	0.79
	The tutor models critical self-reflection.	5	4.41	0.80
Peer Support	Other students encourage my participation.	5	4.04	1.02
	Other students praise my contribution.	4	4.03	0.96
	Other students value my contribution.	5	4.08	0.98
	Other students empathise with my struggle to learn.	5	3.96	1.11
Interpretation	I make good sense of other students' messages.	5	4.25	0.84
	Other students make good sense of my messages.	5	4.27	0.79
	I make good sense of the tutor's messages.	5	4.31	0.79
	The tutor makes good sense of my messages.	5	4.39	0.75
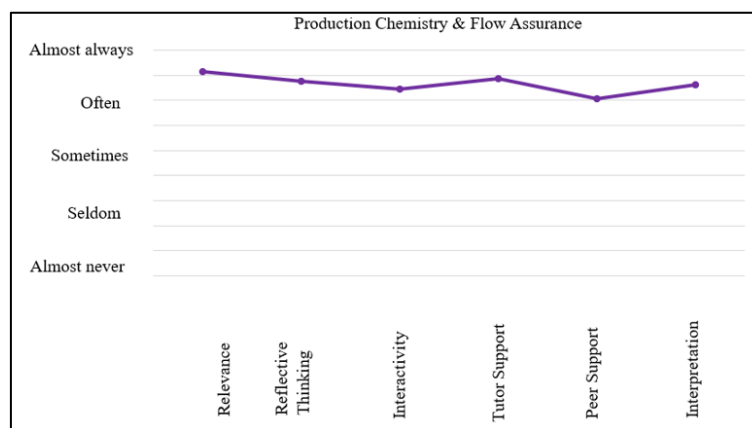
Fig. 4. Course survey

Based on Figure 4, students found that the course content throughout the semester was often touched on to almost always in terms of relevance, reflective thinking, interactivity, tutor support and interpretation. However, lower frequency was observed for peer support. This could have been due to the functionality of an online class as opposed to a traditional classroom, where students are free to approach their peers physically in the latter one, making it easier and quicker for support. In an online environment, students may be more reserved to message their peers as they may find it more difficult to explain through text messaging.
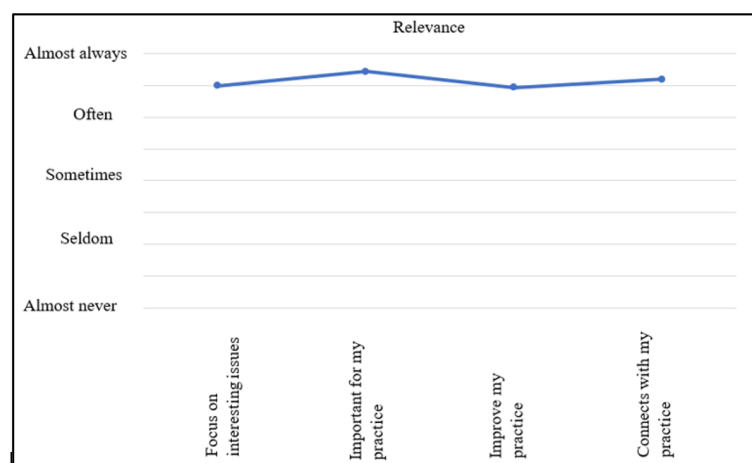
Fig. 5. Survey on relevance

Based on Figure 5 on the theme of Relevance, student feedback were more inclined to almost always on the questions asked. Students found the course content to be important for their professional practice and they were able to connect the relevance of the information provided to their practice as well. Slightly lower frequency was observed for interesting issues and for practice improvement. Due to the relatively new environment, educators are continuously improving their course content to ensure students stay engaged throughout the online session. As so, educators may face challenges in selecting interesting topics and increasing student efficiency and information absorption.
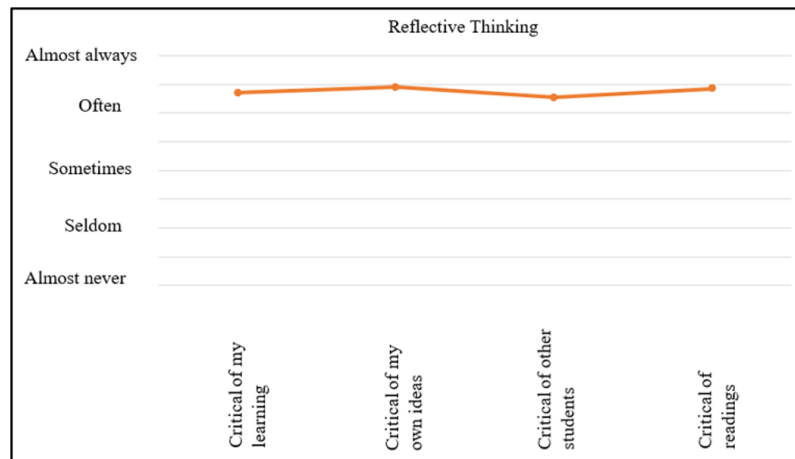
Fig. 6. Survey on reflective thinking

Based on Figure 6, student feedback found that students' thinking were critical of their own learning, ideas as well as readings. This shows encouraging independency of students to critically analyse the information delivered to them. A slight shortfall is observed for critical thinking of other students' ideas as the online environment may create a slight challenge for students to listen and gauge their peers' ideas and learn from them. However, with additional efforts from students to create a virtual discussion and knowledge sharing on their own initiatives, we can hope to see thinning down of the communication barrier in the near future.
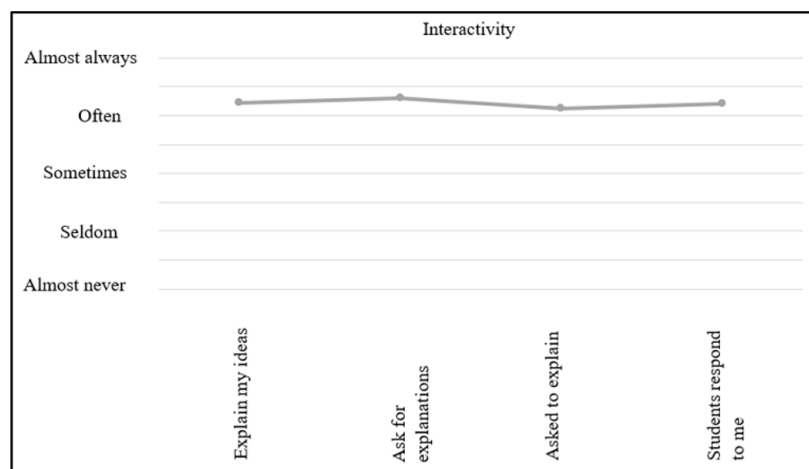
Fig. 7. Survey on interactivity

Based on Figure 7, frequency of student interactivity were relatively constant for students explaining their ideas to others, asking for explanations and peers responding to their ideas. This again reiterated student independency in approaching the necessary people for assistance. However, the frequency of this is more inclined towards often rather than almost always. A slight drop is seen in frequency of students being asked to explain. This situation may be seen more commonly during tutorial classes and a distributed few during lectures. As so, more teacher-student interaction may be needed, where students are asked to take on the role of the teacher in explaining a portion of the lecture.
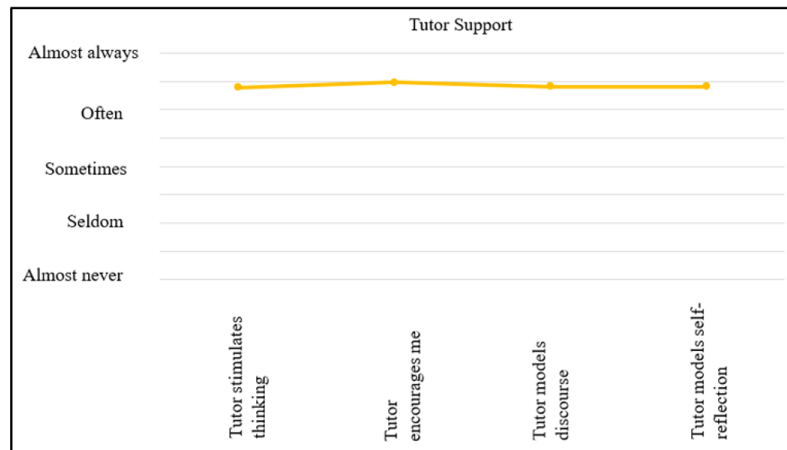
Fig. 8. Survey on tutor support

For feedback on tutor support shown in Figure 8, student response were relatively constant for all questions, indicating positive feedback for tutor-student relation. The tutorial sessions were effective in stimulating student thinking and the tutor was able to encourage students' participation in the classes, therefore ensuring all students were able to achieve the objective of the sessions in answering the tutorial questions assigned to them.
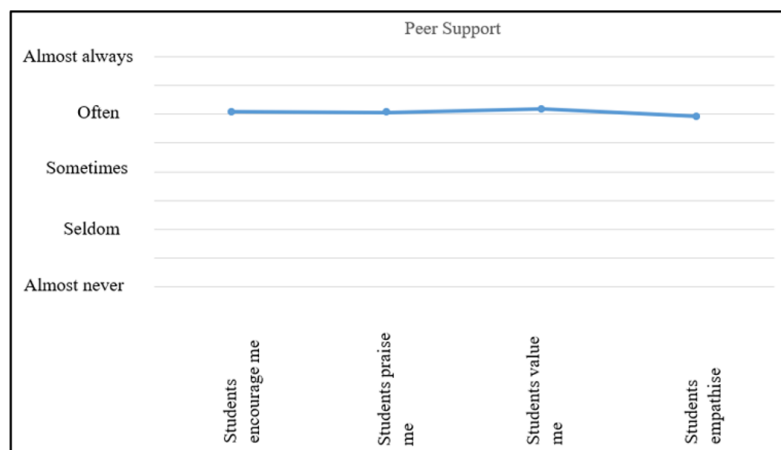

Fig. 9. Survey on peer support

Among all the other themes, feedback on peer support shown in figure 9 was relatively the lowest. Additional activities that can stimulate group interaction would be needed to initiate more student encouragement, peer feedback and empathy amongst peers. Furthermore, students who find themselves struggling with the new environment should maintain a two-way communication with both the educator and their peers so that they can help each other in this remote learning environment. During sessions amongst peers, students should also be encouraged to give each other praise or constructive criticism so that students may understand their pain points and find methods to address them accordingly. Peers may also empathise with their classmates when they are willing to share their issues, therefore creating an ecosystem of offering help to one another. The weaker students can then improve while the better students can reiterate and reinforce their understanding on the subject matter.
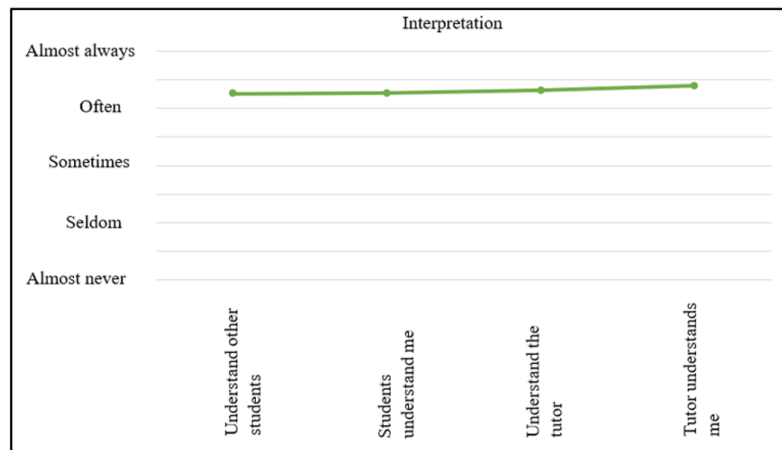
Fig. 10. Survey on interpretation

Lastly, on the theme of interpretation shown in figure 10, students showed minimal problems in understanding the subject. They were able to understand both their peers' and tutors' messages. It can be inferred that students showed a relatively uniform level of knowledge acceptance as they were able to possess similar degree of understanding both amongst their peers and with the tutors. As such, GBL can be seen to bridge the gap in understanding between students possessing different learning patterns.

5. Conclusion

Based on the feedback obtained, there were no critical issues with the implementation of a fully virtual experience, indicated by student satisfaction at 88.3% by the first class. The maximum score of 5 was rated as the mode for 92% of the 24 survey questions while the mean ranged from 3.96 to 4.72. The standard deviation ranged from 0.45 to 1.11, indicating a unified agreement on the implementation of GBL. Online tools like Mentimeter were able to maintain student engagement albeit the pandemic necessitating a shift from the traditional classroom, thus achieving the objective of improving and sustaining student interest. Although a success, there still leaves room for improvement in the sector of peer support as shown by the lowest mean score of 4.0 and largest standard deviation of 1.11.

References

[1]	Felszeghy, Szabolcs, Sanna Pasonen-Seppänen, Ali Koskela, Petteri Nieminen, Kai Härkönen, Kaisa MA Paldanius, Sami Gabbouj et al. "Using online game-based platforms to improve student performance and engagement in histology teaching." *BMC medical education* 19 (2019): 1-11.

[2]	Aixia, Ding, and Dan Wang. "Factors influencing learner attitudes toward e-learning and development of e-learning environment based on the integrated e-learning platform." *International Journal of e-Education, e-Business, e-Management and e-Learning* 1, no. 3 (2011): 264.

[3]	Subhash, Sujit, and Elizabeth A. Cudney. "Gamified learning in higher education: A systematic review of the literature." *Computers in human behavior* 87 (2018): 192-206.

[4]	Yang, Kai-Hsiang, and Bou-Chuan Lu. "Towards the successful game-based learning: Detection and feedback to misconceptions is the key." *Computers & Education* 160 (2021): 104033.

[5]	Priyaadharshini, M., R. Dakshina, and S. Sandhya. "Learning analytics: Game-based learning for programming course in higher education." *Procedia Computer Science* 172 (2020): 468-472.

[6]	Abou El-Seoud, M. Samir, Islam ATF Taj-Eddin, Naglaa Seddiek, Mahmoud M. El-Khouly, and Ann Nosseir. "E-learning and students' motivation: A research study on the effect of e-learning on higher education." *International Journal of Emerging Technologies in Learning (Online)* 9, no. 4 (2014): 20.

[7]   Kattoua, Tagreed, Musa Al-Lozi, and Ala'aldin Alrowwad. "A review of literature on E-learning systems in higher education." *International Journal of Business Management and Economic Research* 7, no. 5 (2016): 754-762.

[8]   Benta, Dan, Gabriela Bologa, and Ioan Dzitac. "E-learning platforms in higher education. Case study." *Procedia Computer Science* 31 (2014): 1170-1176.