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Undergraduate Dental Student's Perceptions of the Effectiveness of Gamified Biochemistry Module

(Persepsi Pelajar Prasiswazah Jurusan Pergigian terhadap Keberkesanan Pembelajaran Biokimia Secara Gamifikasi)

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ABSTRACT

Gamified learning activities in higher education has gained significant interest in recent years. Despite less evidence on the effectiveness, gamification of basic science subjects is suggested to benefit both educators and students compared to the conventional learning method. This cross-sectional study investigated the perception of 52 dental undergraduate students in the School of Dental Sciences, Universiti Sains Malaysia towards gamification in learning, towards the effectiveness of a biochemistry gamified teaching module, and assess the association between the effectiveness of the module and positive gamified learning outcomes. Overall, students perceived gamification to improve their understanding of topics and eased the learning process, encouraged them to participate in the discussion, and further stimulated their learning capacity through an appropriate variety of methods used. They also have positive perception towards the effectiveness of the module. A significant association was recorded between an effectively designed module and the learning environment's stimulation. In conclusion, students viewed gamification as having a positive effect on their learning progress and interpersonal skills. This study adds evidence that gamified modules are well-received by 21st-century students in delivering the course content and have huge potential for application in higher education.

Key Words: Gamification, Biochemistry, Higher Education, Attitude, Perceptions

ABSTRAK

Gamifikasi pembelajaran di institusi pengajian tinggi telah mendapat perhatian sejak beberapa tahun kebelakangan ini. Walaupun kurang bukti terhadap keberkesanannya, gamifikasi mata pelajaran sains asas dicadangkan dapat memberi lebih manfaat kepada pendidik dan pelajar berbanding kaedah pembelajaran konvensional. Kajian tinjauan ini mengenalpasti persepsi 52 pelajar Sarjana Muda Pergigian di Pusat Pengajian Sains Pergigian, Universiti Sains Malaysia terhadap gamifikasi dalam pembelajaran, module gamifikasi pembelajaran, dan menguji kaitan antara keberkesanan modul dan hasil pembelajaran positif. Secara keseluruhan, pelajar bersetuju gamifikasi meningkatkan pemahaman mengenai topik dan memudahkan proses pembelajaran, mendorong pelajar untuk mengambil bahagian dalam perbincangan, dan meningkatkan keupayaan mereka untuk belajar melalui pelbagai kaedah yang sesuai digunakan. Pelajar juga mempunyai persepsi yang positif terhadap keberkesanan modul. Perancangan modul yang baik didapati mempunyai kaitan yang signifikan dengan stimulasi persekitaran pembelajaran. Kesimpulannya, pelajar menunjukkan persepsi yang positif terhadap gamifikasi, serta sumbangannya kepada kemajuan pembelajaran dan kemahiran interpersonal mereka. Kajian ini menyumbangkan bukti bahawa modul gamifikasi diterima baik oleh pelajar-pelajar abad ke-21 dalam menyampaikan kandungan kursus dan memiliki potensi besar untuk aplikasi pengajaran di institusi pengajian tinggi.

Kata Kunci: *Gamifikasi, Biokimia, Pengajian Tinggi, Sikap, Persepsi*

INTRODUCTION

Teaching and learning in a higher institution have become an extremely challenging task for educators in recent years. For some reason, the conventional method of lecturing and discussing fundamental subjects can no longer be conducted the way it used to be for the past ten years. Nowadays, the world moves drastically, making it unsuitable for education to develop using the traditional teaching delivery method (Taylor et al. 2002). A majority of students enrolled in higher education today were born between 1995 to

2000, known as generation Z. This generation, also known as the digital natives, are well equipped with extraordinary technical ability, learning preferences and ways of thinking, as they were born into technology and grew up with hypertext, social media and computer games. It further indicates the higher necessities for this generation to learn and adapt to a new education system uniquely different from the former generation (Bourgonjon et al. 2009; Prensky 2011; Tapscott 1999). Hence, imminent efforts and research have been carried out on finding efficient strategies to improve current teaching methodologies in universities and higher institutions.

With the booming of the Internet of Things (IoT) and the 4th Industrial Revolution, gamification was introduced in different sectors to increase human engagement in learning experiences. The word "gamification" was introduced by Nick Pelling, a game designer, in 2002 and rose gradually in searches by 1,000,000 per month, indicating the increasing popularities (Furdu et al. 2017). Briefly, gamification can be defined as adopting game design features in a non-gaming environment, including mechanics, aesthetics and game thinking for the potential advantages and level experiences (Deterding et al. 2011; Kapp 2012).

Gamification has been widely used in various fields within society, such as entertainment industries, health promotion, marketing of products, team building strategies, motivational support and e-commerce. Similar objectives and technological approach are shared among educators worldwide, as gamification exhibits substantial potential benefits to increase student engagement. Although there is no definite year indicating the discovery and application of gamification in education, gamification in education was introduced a year later, suggesting its significant role in improving the education delivery system (Ramirez & Squirez 2003).

Challenges were encountered in biochemistry pedagogy in health courses (including dental, medical, pharmacy, nutrition and nursing) as it requires a high order of abstract thinking (Chang & Wei 2016; Silva & Batista 2003). Gamification is suggested to be applied during Problem-Based Learning (PBL) and Quest-Based Learning (QBL) (Ružic & Dumancic 2015) to classroom-based teaching as well as integration with e-learning (Chang & Wei 2016). Another method is learning by doing, in which student can use their knowledge and practice the skills to meet the objective (Villagrasa et al. 2014).

The majority of the published study of gamification in learning focused on the definition, concepts, and gamification elements. A high number of published studies also mentioned the importance of designing and implementing gamification techniques in higher educational institutions (Dicheva et al. 2015). However, there is still a lack of data gathered on evaluating the effectiveness of gamification in education, especially on student engagement (Gapp & Fisher 2012). Meanwhile, a study conducted on gamified learning involving one of the compulsory subjects among first-year dental undergraduates in Saudi Arabia showed fair students' satisfaction with the game aspects. The students also demonstrated low interest in using gamification for the future learning process (El Tantawi et al. 2018). It is suggested that further investigation will need to be directed on longitudinal evaluation, perceptions, and the impact of gamified learning, as well as long-term interventions and meta-analysis to aid in a better understanding of gamified learning towards student engagement and academic progress (Zainuddin et al. 2020).

From the existing data gathered on gamified learning in higher education, it appears vital to evaluate the effectiveness of gamified learning among undergraduate students in higher educations, particularly for science subjects such as biochemistry. Hence, the data gathered from this study may provide further evidence to revise or improve the application of gamification in the enhancement of both teaching delivery and students' learning activities. The objectives of this study are:

1. To investigate student's perception towards gamification of learning of biochemistry subjects
2. To evaluate student engagement using gamified learning in biochemistry subjects
3. To assess the association between the effectiveness of teaching and learning module and positive gamified learning outcomes

CONCEPTUAL FRAMEWORK

Before implementing gamified session for biochemistry-related topics, a learning module was constructed, consisting of objectives and learning outcomes. The gamified learning was conducted by incorporating game mechanics and components in small group discussion (SGD) activities, such as challenges, badges, level point, and experience point. All beneficial factors of the gamified lesson, including student engagement, attention span, metacognitive potential, and motivation and interest, were evaluated throughout the session. In this study, questionnaires were used to assess the perceptions and engagement of the students with gamified lesson after the completion of five SGD sessions. Meanwhile, the results from the final examination were analysed to assess the effectiveness of gamified session, which is comparable with another study on the effectiveness of gamification for learning activities (Silva & Batista 2003). Briefly, this conceptual research framework investigates the

effectiveness of gamified learning using students' engagements and scores in assessment. The assumption is that a combination of suitable learning outcome and a practical gamified learning session will result in positive perceptions, engagement and learning outcome. A summary of the conceptual framework that was used for this study is presented in Figure 1.

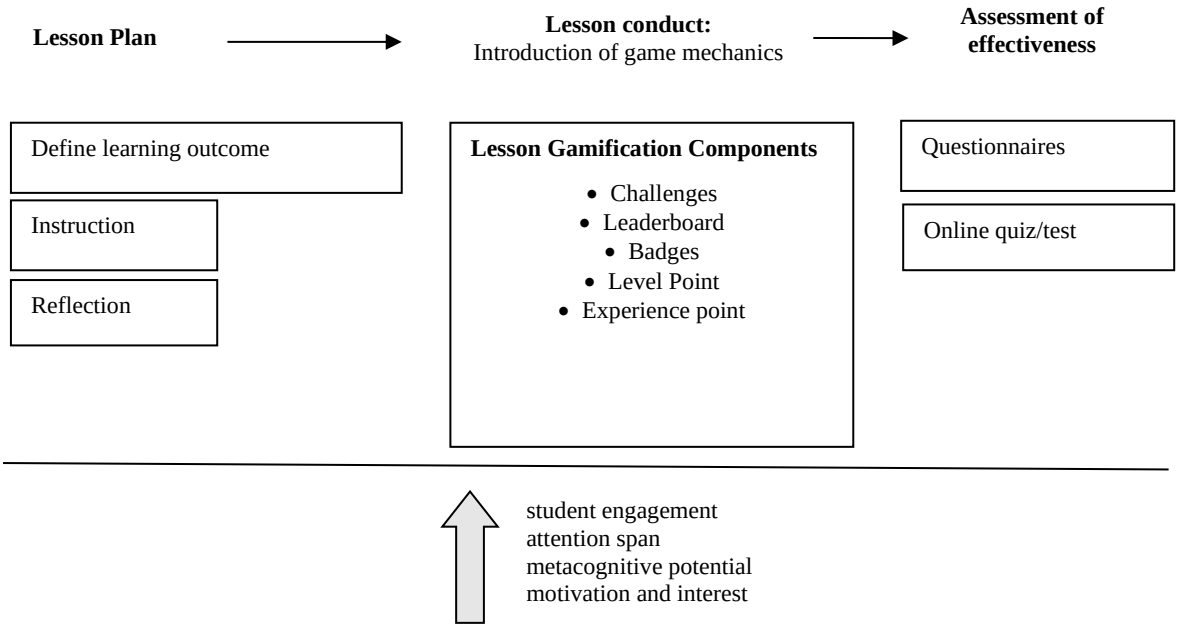

FIGURE 1. Conceptual framework of gamified biochemistry learning.

In this study, gamification was conducted during SGD sessions for Cell, Tissue and Basic Pharmacology topic for students of Doctor of Dental Surgery (DDS) programme in Universiti Sains Malaysia (USM). The course covers biochemistry, physiology, genetics and molecular biology, and the basic concept of pharmacology. Students are obligated to attend all lectures, seminars, practical and e-learning sessions to ensure students fulfilled the cognitive domain that has been set by the Dental Deans' Caucus of Malaysia. A total of three learning domains are introduced to ensure the competency of dental graduates. The domains include cognitive (knowledge-based), kinesthetic and soft skills. In the domain of knowledge, students must have the ability to relate basic structure and functions of the human body at the organ, tissue, cellular and molecular levels to the practice of dentistry (Malaysian Dental Council 2013).

Basic sciences are introduced to first-year dental undergraduates during Phase I. The students must learn anatomy, physiology and histology of the human body, including craniofacial system and oral biology, in three different courses. Meanwhile, a subject is allocated for primary abnormalities in the dental and craniofacial structures, including specialised functions such as swallowing and speech disorders. Reinforcement of Phase I is done during the second year of the DDS programme. The process is conducted in spiral concept up to the second phase; in the third, fourth and fifth year of the DDS programme. This study was designed to investigate gamified learning outcomes among first-year dental undergraduates in USM to ensure that the students have strong fundamental knowledge in Phase I before proceeding to Phase II of the DDS programme.

This study is the first to introduce gamification techniques in teaching and learning basic sciences subject in School of Dental Sciences, USM. Gamification was introduced in the metabolism topic to replace the conventional way of conducting small group discussion, which failed to stimulate active participation from students. Gamification is totally different from game-based learning. Gamification turns the whole learning environment into games; meanwhile, game-based learning only adopts games as part of the learning process. As of now, more and more subjects in universities have begun to practice game-based learning as part of educational strategies.

In game-based learning, students involved in the activity is compulsory, and completion of the challenges will be regarded as active participation. In comparison to game-based learning, complete gamification of the learning module will allow students

to make mistakes, encourage them to keep trying and reduce the fears of failure among students. Eventually, the students have a better learning experience via gamified learning (Al-Azawi et al. 2016). Therefore, this paper has focused on assessing the perceptions and the engagement of the students towards gamified learning.

METHODOLOGY

RESEARCH DESIGN AND PARTICIPANTS

This study is a cross-sectional survey. Cross-sectional survey design is used in this study to collect data from a population at one specific point in time (Creswell 2002). This study has obtained ethical approval from the Human Research and Ethics Committee, Universiti Sains Malaysia review board (Ref: USM/JEPeM/19120883). All participants were informed of the objectives of the study and assurance of confidentiality. Given the subject vulnerability, it was clear to the participants that withdrawal or decline to take part in the study would not affect their marks and credit for any part of the study course. Furthermore, none of the lecturers involved in teaching the subject had access to the feedback and responses. Only the principal investigator who did not directly involve in assessing the students was in charge of data analysis.

The present cross-sectional study was carried out among first-year dental undergraduates (2019/2020 academic session) of the School of Dental Sciences, USM between January to December 2020. Students were invited to participate in this study as they enrolled for the GNT103 course and attended the SGD sessions. Students who were not willing to participate after being informed of the objectives of the study were excluded. Apart from that, second, third, fourth and final year dental undergraduates in the School of Dental Sciences, USM, and students from other courses in Health Campus, USM, were excluded from this study. The sample size was calculated using the Krejcie & Morgan (1970) table. The total number of first-year dental undergraduates for the 2019/2020 academic session was 60, and by considering 20% of dropout, the minimum number of respondents needed was set to 48.

The demographic background of the respondents, which includes gender, age, entry qualification into USM and type of enrolment, is shown in Table 1. A total of 52 students voluntarily took part in the present study, with the response rate recorded at 86.7% (52/60). The data showed that the majority of respondents who took part in this study are female students, who constitute about 75% of the total respondents, as the number of female undergraduates students are generally higher in the School of Dental Sciences. No significant association was found between gender and gaming experience, which is in line with other studies in New Zealand, Australia and the USA, which include analysis on the gender of respondents (Mariño et al. 2006; Slapar et al. 2018). The mean age of the respondents is 22 years. Meanwhile, 48.1% of the total respondents came from the pre-university program; they are entering the transition phase from pre-university programme to bachelor's degree. At this age, the students are more likely to appreciate the game elements (El Tantawi et al. 2018).

TABLE 1. Demographic data of the respondents.

Variables	Percentage (n=52)
Gender	
Male	25% (13)
Female	75% (39)
Age	
19	3.8% (2)
20	76.9% (40)
21	17.3% (9)
22	1.9% (1)
Entry Qualification	
Asasi	48.1% (25)
STPM	7.7% (4)
A-Level	3.8% (2)
Matriculation	32.7% (17)
International Baccalaureate	1.9% (1)
Others	5.8% (3)

The gaming experience applies in this study refers to any games, either computer games, video games, game board, or even physical games and sports. Table 4 showed the last gaming session the students had had before. Fifty per cent of the respondents recorded last gaming session less than a month. However, 13.5% of respondents reported no experience in gaming session before. It might be due to less exposure to the gamification setting because the total time spent on gamified sessions in this study was only five hours, and students never had any experience in gamified learning before.

Further analysis also showed no significant relation between gaming experience and understanding of gamified learning. The present study recorded one respondent who did not understand the concept of gamified learning, even though brief information had been given prior to the study. There is a possibility that the student was unsure of the difference between gamification and games. However, his/her response to the item was acceptable, considering it to be a non-significant outlier (Cheong et al. 2014). Likewise, as mentioned in another study, the extended hours' students being exposed to gamification environment will increase the positive outcome and understanding (Ortiz et al. 2016).

TABLE 4. Last gaming session

Variables	Percentage (n= 52)	
	Yes	No
Online or offline gaming experience before	86.5% (45)	13.5% (7)
Understanding of gamified learning	98.1% (51)	1.9% (1)

Last gaming session	Percentage of agree (n=52)
Never	13.5% (7)
More than 1 year ago	9.6% (5)
Less than 1 year ago	26.9% (14)
Less than 1 month ago	21.15% (11)
Less than 1 week ago	21.15% (11)
Less than 1 hour ago	7.7% (4)

DATA COLLECTION METHOD

The questionnaire applied in the present study was modified from the established Module Experience Questionnaire (MEQ), which was developed by Lucas, Gibbs, Hughes, Jones and Wisker (1997). MEQ was modified from the Course Experience Questionnaire developed by Ramsden (1991). MEQ was widely used in the United Kingdom to explore the effects of module size on students' approaches. The questionnaire was modified in several steps, which include i) understanding constructs, ii) rearrangement and refinement of the questions, iii) selection of appropriate statistical model, iv) conduct of the preliminary study, and v) consult from the experts for feedback and comments (Juhari et al. 2020).

A preliminary study was conducted with nine participants from year four dental undergraduates who were students from the excluded group. A demonstration on the gamified lesson was carried out to give a brief experience of the gamified lesson to the pilot test group, followed by question refinement and validation. From the pilot study, ambiguous question was either removed or paraphrased. Time taken to complete the questionnaires and level of difficulty was also assessed. The reliability of the questionnaires was further tested using Cronbach's Alpha to assess the internal consistency between questions in each part. The result is shown in Table 2 and showing that each factor had a high index of reliability (Taber 2018).

TABLE 2. Cronbach' Alpha for each construct.

Aspect	Number of Items	Cronbach's Alpha
Perceptions	18	0.756
Effectiveness	8	0.886

The questionnaire consisting of 20 close-ended questions, and three open-ended questions were divided into three parts. The first part consists of four demographic questions regarding respondents' gender, age, entry qualification, and enrolment type. The second part includes six questions regarding perception towards gamification in learning. The third part focused on the effectiveness of learning, which further subdivided into three sections: the effectiveness of the teaching and learning module, gamified learning experience, and general feedback. The third part mainly used five points Likert scale (1: Strongly Disagree; 2: Disagree; 3: Not Sure; 4: Agree; 5: Strongly Agree), and the last section include three open-ended questions to identify any potential issues related to the gamified module. The respondents were also given the opportunity to speak out for the improvement of the gamified module during SGD sessions.

After completion of all five SGD sessions, participants were invited to complete the self-explained questionnaire. Following their consent and approval to participate in this study, the questionnaire was distributed via Whatsapp and e-mail the link to Google forms. Brief information about the purpose and the expected outcomes were given to the respondents prior to the process in the form of a video. Should the participants change their mind or wished to withdraw at any time during the study period, they were allowed to do so. The questionnaires were prepared in Malay and English languages so that the non-native Malay speaker (international students) were able to complete and understand the questions. The survey took about 5 to 10 minutes to be completed. The records of this study were kept private and confidential, and access to the document was only given to authorised personnel who directly involved in the study.

DATA ANALYSIS METHOD

This quantitative study uses statistical analysis to analyse the data. Descriptive statistics were used to summarise the demographic characteristics of subjects. Categorical data were presented as percentage (frequency). Data were analysed by univariate analysis, with a significance level accepted at $p < 0.05$. The association data was determined using Fisher's Exact test to analyse the relationship among variables. The result was analysed using Microsoft Excel and IBM Statistical Package for Social Sciences (SPSS) version 27.

FINDINGS AND DISCUSSION

PERCEPTIONS TOWARDS GAMIFICATION IN LEARNING

Generally, the respondents displayed positive perceptions towards gamified lesson, as shown in Table 3. The majority of the respondents agree that they were interested in gamification in learning and feels excited. However, the respondents admit that gamification may also bring negative feeling such as anxiety, confusion and fear. This finding is supported by finding of another study which mentioned that most of the negative emotion, as experienced by competitive students, are mainly caused by the introduction of the game elements such as leaderboard, token and badges (Alabbasi 2017; Hanus & Fox 2015; Haaranen et al. 2014). The educators should also be cautious in offering a reward as it could negatively impact students' motivation and engagement in a lesson, which will eventually affect the students' exam score (Hanus & Fox 2015).

TABLE 3. Perceptions towards gamification in learning

	Perceptions	Percentage of agreement (n= 52)
Feeling towards gamification in learning	Anticipation (Interest)	75.0% (39)
	Excited	73.1% (38)
	Trust	25.0% (13)
	Anxious	19.2% (10)
	Confuse	7.7% (4)
	Fear	9.6% (5)
	Not interested	0.0% (0)
Expectation(s) from gamification in learning	Allow me to improve my current understanding of topic/subjects	86.5% (45)
	It will allow me to enjoy the learning process	84.6% (44)
	It will motivate me to learn and solve problems effectively	80.8% (42)
	Help me to interact with peers and share important information	78.8% (41)
	Allow me to demonstrate how much I know (grasp of knowledge)	75.0% (39)
	Help me to compare learning progress against other students	63.5% (33)
	Help me to identify the learning gap and areas for improvement	63.5% (33)
	Others (Personal reason)	1.90% (1)
The main reason to play games	For mental challenges and I.Q. test	78.7% (37)
	To kill time (relieve boredom)	63.8% (30)
	To learn new skills and gain experience	59.6% (28)
	For self-gratitude (to enjoy the rewards and points gained for completion of the task)	53.2% (25)
	To increase interaction with others (make friends)	51.1% (24)
	To compete with others (compare progress with peers)	44.7% (21)
	To practice different learning languages	36.2% (17)
	For physical challenges (e.g., table tennis, basketball, volleyball and others)	36.2% (17)

On top of that, the students had high expectation that gamified learning would allow them to improve current understanding of a topic while enjoying the learning process. The expectation could be achieved if there is an engagement with the gamified learning as the students are prone to memorise the knowledge and establish the understanding (Gee 2003). In this study, students made full use of the gamified session to compare their knowledge with their friends, and it helped them to improve the knowledge that they lack. This could be a good solution to assist with students' understanding of subject, as basic science educators usually advise their students to just memorising the facts and figures without realising the high necessities of understanding the basic concept, which is particularly important in biochemistry subject (Dewi & Primayana 2019).

Meanwhile, 80.8% believe that gamified lessons will motivate them to learn and solve problems effectively, which can be achieved via effective feedback. The type of feedback that is preferable by the students exists in the form of goals which can be achieved through the inclusion of game elements such as the leaderboard, point systems and badges. The most popular reasons for the respondents to play games were for mental challenges and I.Q. Test (78.7%), to kill time (63.8%), and learn new skills and experience (59.6%). These data further indicated that the students are highly motivated to improve their self-developmental growth and have a good perception that games could be one of the modes of learning new knowledge. Apart from that, half of the students were interested in playing games to increase interactions with peers. This finding is in line with a similar study which suggested that active interaction with other online players can be evidence of the students' desire to socialise and remain connected (Cheong et al. 2014).

PERCEPTION TOWARDS EFFECTIVENESS OF GAMIFIED LEARNING MODULE IN BIOCHEMISTRY SUBJECTS

Teaching effectiveness can be explained as the extent to which the teacher promotes student achievement (McKeachie 1979). Meanwhile, student engagement can be assessed from the class attendance and a properly designed grading system (Beran & Violato 2010). The effectiveness of teaching may as well be measured by monitoring students' engagement in the learning process, by gathering their feedbacks and responses towards the learning module. A module consists of enclose and well-defined learning experience, clear and consistent learning outcomes, as well as competency level using both formative and summative assessment (Ruffi 2015). A learning module is compulsory in designing a well-structured course in teaching, as it will serve as a guidance in delivering the content effectively.

A good learning module could help students to self-evaluate their performance and understanding in regards the knowledge and skills in the learned subjects. Within this study, the students were given an opportunity to evaluate on the effectiveness of biochemistry learning module, as shown in Table 5. As much as 96.1% of respondents positively agreed that the biochemistry module was effectively designed and 94.2% positively agree that they had clear learning outcomes. A well organised module helps the students to increase their knowledge on relevant topics (90.4%) as the students can maximise the use of learning module by having a clear picture about a topic before the class was conducted (Mahajan & Singh 2017).

Next, the present study evaluated on the effectiveness of gamified module in learning biochemistry, as shown in Table 6. The most striking finding was reflected by the highest percentage of students who agreed that gamified learning experience encouraged them to participate in a discussion (92.3%). Also, 86.5% of the participants agreed that the gamified sessions had stimulated their interest in biochemistry subject, as compared to a study that was conducted among 51 undergraduates of I.T. studies, which recorded poor satisfaction among students, with only 45% of positive responses (Cheong et al. 2014). On top of that, over 90% of the respondents agreed that gamified learning experience created a stimulating learning environment for students through appropriate variety of method.

The data gathered from this study are in line with findings of similar research in education. Gamification is associated with increased learner experience, engagement and participation with a system (Fitz-Walter et al. 2011; Denny 2013; Goehle 2013; Lee & Hammer 2011; Yüksel 2016). The game-based factors, such as a fast return system and clear goals, represent the significant benefit of applying gamification to education sectors (Urh et al. 2015). Learners are postulated to experience excitement from the gamification process, stimulating their motivation, keeping up their retention time, and developing their metacognitive potentials. Apart from that, gamification encourages the learners to explore, take chances and experience failure in a fun environment with the low-cost benefit of development (Kapp 2012; Sobocinski 2017; Thiebes et al. 2014). The gamification technique also encourages compassion and builds teamwork skills (Lin et al. 2018).

Nevertheless, a systemic literature search on gamified science learning among developing countries is still lacking, especially among the ASEAN countries. A study revealed that the low level of effectiveness of gamification in developing countries is due to lack of basic I.T. knowledge among students, lack of interest to gamify the learning process by the educators and

shortage of technical support (Ofosu-Ampong, K. 2020).

ASSOCIATION BETWEEN EFFECTIVENESS OF TEACHING AND LEARNING MODULE AND POSITIVE GAMIFIED LEARNING OUTCOMES

The present study further analysed the potential association between an effectively designed learning module, with positive gamified learning outcomes. The data demonstrated significant associations between attributes of the learning module (effectively designed and had clear learning outcomes) and positive gamified learning outcomes (stimulation of interest, stimulation of learning environment, as well as encouraging students to participate in a discussion) during gamified learning ($p<0.05$), as shown in Table 7.

TABLE 5. Effectiveness of teaching and learning module

Gamified Learning Module	Percentage (n= 52)		
	Agree (Likert scale 1 and 2)	Neutral	Disagree (Likert scale 4 and 5)
Effectively designed	96.1% (50)	3.9% (2)	0% (0)
Had clear learning outcomes	94.2% (49)	5.2% (3)	0% (0)
Increase knowledge on relevant topics	90.4% (47)	9.6% (5)	0% (0)
Well organised	88.5% (46)	11.5% (6)	0% (0)

*Likert scale of 1: Strongly disagree; 2: Disagree; 3: Not sure; 4: Agree; 5: Strongly agree

TABLE 6. Effectiveness gamified learning experience

Gamified Learning Module	Percentage (n= 52)		
	Agree (Likert scale 1 & 2)	Neutral	Disagree (Likert scale 4 & 5)
Encouraged students to participate in a discussion	92.3% (48)	7.7% (4)	0% (0)
Stimulate learning environment	90.4% (47)	9.6% (5)	0% (0)
Used appropriate variety method	90.4% (47)	9.6% (5)	0% (0)
Stimulate interest	86.5% (45)	13.5% (7)	0% (0)

*Likert scale of 1: Strongly disagree; 2: Disagree; 3: Not sure; 4: Agree; 5: Strongly agree

TABLE 7. Association between effectiveness of teaching and learning module and positive gamified learning outcomes

Gamified learning experiences / Learning module	Percentage of agree (n= 52) Stimulate interest	p-value*
Effectively designed	90% (45)	0.016
Had clear learning outcomes	91.8% (45)	0.002
Gamified learning experiences / Learning module	**Percentage of agree (n= 52) Stimulate learning environment**	**p-value***
Effectively designed	94.0% (47)	0.008
Had clear learning outcomes	93.9% (46)	0.022
Gamified learning experiences / Learning module	**Percentage of agree (n= 52) Encouraged students to participate in a discussion**	**p-value***
Effectively designed	96.0% (48)	0.005
Had clear learning outcomes	95.9% (47)	0.013

* Fisher's exact test

The methodology of game development in education especially subject-based curriculum is still lacking (Zin et al. 2009). However, the present study has identified few important issues in gamification that need to be taken into consideration to provide a better learning experience for the students. First, clear and detailed instructions must be given prior to each challenge. If necessary, a short briefing session may be conducted to serve the purpose. Second, the time allocated for the gamified lesson can be extended to a minimum of two hour per session, to allow for a thorough discussion between the educators and students on the subject. Third, in future implementations, it is advisable for the educators to carefully select the facilities to conduct the gamified session, with a proper seating or designated space for activities to stimulate an active participation from the undergraduates. The educators also should be very cautious on the introduction of reward system, particularly if the risk outweigh the benefit. The primary objective in gamified learning is to fulfil the learning outcomes by engaging student's active role during the lesson. Therefore, the content delivery should not be focusing on rewards, penalty and personal achievement in the class, as the rewards system was known to reduce intrinsic motivation especially among students who already established learning engagement (Hanus & Fox 2015).

CONCLUSION

This study determined the perception of dental undergraduate students towards gamification in learning, the effectiveness of a gamified teaching module, and assess the association between the effectiveness of the module and positive gamified learning outcomes. Results show that students demonstrated positive perception towards gamification in learning, whereby they perceived gamification to improve their understanding of topics and eased the learning process, encouraged them to participate in the discussion, and further stimulated their learning capacity through an appropriate variety of methods used. They also have positive perception towards the effectiveness of the module. A positive students' perceptions on learning process may act as an indicator of good engagement during the learning process. A significant association was recorded between an effectively designed module and the learning environment's stimulation, which suggests that a properly designed gamified module significantly increase students' engagement in biochemistry learning. In conclusion, students viewed gamification as having a positive effect on their learning progress and interpersonal skills. This study adds evidence that gamified modules are well-received by 21st-century students in delivering the course content and have huge potential for application in higher education. However, although this study has provided very useful evidence in supporting gamification of basic science lesson in higher education, it also possesses certain limitations. Due to time constraint and challenges in fitting the session along with the students' packed academic schedule, this research was conducted within a short period of time, resulting in limited amount of data collected and analysed from the sampling group. This study was also conducted in a small target population as the first-year dental undergraduates in USM that only consist of 59 students, thus representing a small sample size. Several questions remain unanswered at present, particularly whether the same module is applicable for other subjects in USM, or perhaps involving similar subjects among other undergraduates in different universities, in Asia. Future studies on the current research topic are therefore recommended to develop a full picture on the effectiveness of the applied method, involving educators and respondents from different educational background, geographical locations, academic subjects and undergraduate programme.

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