

A Case Study of Virtual Anatomy Museum: Facilitating Student Engagement and Self-paced Learning through an Interactive Platform

Hui-Yin Yow

Abstract—Due to the COVID-19 pandemic, digitalization of teaching and learning has been forced to be in place for effective remote and online education. Most learning platforms offer teacher-centered pedagogy and limited opportunities for self-paced learning. This project used Gather.Town, which is an online proximity-based video-conferencing platform with an ability to allow student interactions and self-paced learning. This case study aimed to evaluate Year 1 pharmacy students' experiences and perceptions in learning through the virtual anatomy museum visit. The virtual anatomy museum was developed via Gather.Town and introduced to Year 1 pharmacy students from Taylor's University, Malaysia enrolled in Human Anatomy and Physiology module in the August 2021 semester. Student experiences and feedback were collected using a self-administered questionnaire by using universal sampling. A total of 61 pharmacy students participated with a response rate of 93.9%. The majority of the students (82.0%) actively participated during the virtual visit. More than half of the students (52.5%) enjoyed the self-guided visit at their own pace and this was significantly associated with their pre-university education. The majority of students enjoyed (93.4%) and felt motivated (77.0%) during the virtual visit. From students' qualitative responses, they found that the virtual museum provides a real-world environment with a self-paced learning mode, which helped them understand better in anatomy lectures. This study highlighted the implementation of virtual anatomy visit with Gather.Town platform that enhanced the students' visit experience in terms of their engagement with self-paced learning. It could be used as an alternative platform for students in visit-based learning.

Index Terms—Distance-learning, self-paced learning, student engagement, synchronous video-conferencing.

I. INTRODUCTION

Digitalization of teaching and learning has gained prominent interests among educators, particularly in higher education [1], [2]. Digitalized learning involves the integration of technology to convert the lecture content into digital forms, such as video recording, audio and videoconferencing. Due to the COVID-19 pandemic, digitalization of teaching and learning has been forced to be in place for effective distance and online education [3]. This learning trend brings new opportunities for learners and educators to embrace digital learning. However, it also poses challenges for both learners and educators, particularly for visit- and practical-based subjects in Health and Medical

Sciences to create an interactive synchronous environment for learning [4].

Human anatomy museum visit is part of learning activities in the Human Anatomy and Physiology course, which is one of the core modules for Year 1 pharmacy students. A visit was conducted in week 3 of the semester to expose the students to the anatomical arrangements of various human body systems and cultivate their interests in learning fundamental knowledge on human anatomy and physiology that is essential in a pharmacy study. Physical visit to the anatomy museum was unfeasible due to the closure of the university during COVID-19 pandemic and alternatively it had to be conducted virtually.

There are a variety of digital learning platforms available to conduct virtual museum visit to the students remotely in a synchronous or asynchronous approach. Learners are participated and engaged at the same time with the educators during synchronous sessions, such as synchronous videoconferencing, whereas asynchronous session enable self-paced visit at the time of choice of learners, such as recorded video, 360-degree learning tour or expedition [5]. Unlike other virtual museums, the virtual anatomy museum visit has to be conducted in a synchronous approach due to the ethical perspectives of the anatomical specimens. However, most of these learning platforms offer a static mode of delivery, which is predominantly presented with teacher-centered pedagogy and one-size-fits-all approach. This learning delivery has implicit issues to engage and interact with students, as well as providing personalized self-paced learning during the visit [5], [6]. With the limited opportunities for self-paced learning, it can be a significant issue for Year 1 students who are new to the program and may experience isolation during synchronous sessions. Traditionally, formal face-to-face anatomy museum visit provides opportunities for students to interact with educator and peers, which would be more beneficial and motivated for learning. Therefore, an appropriate approach that can cater for both learners' and educators' needs is required to create an interactive and self-paced learning environment during the virtual anatomy museum visit.

Student engagement entails a series of conceptual commitments, teaching methods and learning behaviors expected from students [7]. A conducive learning environment is an important framework to actively engage students from diverse backgrounds in learning, which is the backbone of constructivist learning approach [8]. In addition, dynamic peer learning has been demonstrated to facilitate deeper learning among higher education students [9]. A sense of belonging is relatively critical for first-year students and

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positively associated with their academic achievement, learning experiences and successful life in their tertiary education [10]. The online learning environment has imposed a barrier for isolated learners and induced a feeling of isolation, particularly when there is lacking students' engagement and support [6]. Recent studies evidenced several challenges encountered by students in their online learning activities during the COVID-19 pandemic. These include limited interactions with students and lecturers, lack of learning motivation, technical issue related to internet connection and device compatibility [11]-[14]. These problems can eventually affect students' retention and success throughout the semester.

This project used Gather.town, which is an online platform that provides proximity-based videoconferencing with an ability to allow the students to move freely in a 2-dimensional space, interact with the shared documents and exhibition posters, as well as interact with educators and peers. Hence, it has a well-established structure for the educators to create the learning spaces for students' engagement and interactions (lecturer-student and peer-to-peer interactions) in a synchronous session and at the same time tailor the learning based on students' needs. Up to date, there is very limited literature on its use for a museum visit. It was primarily used for conferences [15], [16], with some degree of application in practical-based learning [17] or classroom-based learning [18], [19]. Therefore, this case study aimed to evaluate Year 1 pharmacy students' experiences and perceptions of learning in terms of engagement, motivation, interactions, self-paced learning and sense of belonging during the virtual visit, as well as to provide an insight into factors that affecting the learning experiences and to compare the students' performance in reflective writing with the previous cohort. The following research questions were addressed:

- 1) What is the students' engagement, motivation, interactions, self-paced learning and sense of belonging during the virtual anatomy museum visit?
- 2) What do students enjoy the most about the visit?
- 3) What are the student factors affecting the learning experiences during the virtual visit?
- 4) How do students perform in the reflective report after a virtual visit compared to those from the previous cohort who attended the physical visit?

The remainder of this article is organized as follows. Section II discusses the models and theories of constructivist learning. Research methods are presented in Section III. Results, discussion and conclusion are included in Section IV, V and VI, respectively.

II. MODELS AND THEORIES OF CONSTRUCTIVIST LEARNING

Constructivism learning theory was entrenched and advanced by several education theorists, including John Dewey, Jean Piaget, Lev Vygotsky and Jerome Bruner [20]. Constructivism involves cognitive development and deeper understanding via active learning and thus constructs new knowledge based on the learner's prior experience [20]. Vygotsky described the learning process as the Zone of Proximal Development, which is a space between what a learner can do without guidance and what a learner can do

with guidance [21]. The educators provide an environment in which the learners can construct their own understanding during the learning process. Murphy [22] summarized that constructivist learning is a complex interactive process between educators and learners, where educators serve as facilitators or coaches, the learning activities and environments are provided to encourage metacognition, self-analysis, self-awareness and self-reflection, lastly, the learner plays a central role in mediating the learning process. On the other hand, Murphy [22] also pointed out that exploration is a preferred method to encourage learners to pursue their knowledge independently in achieving their learning goals.

Parallel to the digitalization of teaching and learning, Koohang [23] introduced an advanced model with constructivism learning theory in blended learning environments. This model comprises three elements: (i) the design of learning activities (including collaboration, real-world examples, self-reflection and social negotiation); (ii) learning assessment (including instructor assessment, peer assessment and self-assessment); and (iii) instructor's role (e.g., coaching, guiding, mentoring, assessing and providing feedback) [23]. This model was further adapted by Koohang *et al.* [24] by including all essential elements of constructivism and enhanced categorization for the elements in designing learning activities in the e-Learning environment. The adapted new model comprises two elements: the learning design and learning assessment [24].

III. RESEARCH METHODS

A. Project Approach and Design

This virtual visit was developed based on a combination of constructivist and humanist learning theories [25]. It was a virtual anatomy museum presented in a 2-dimensional space with a gamification framework (Fig. 1).

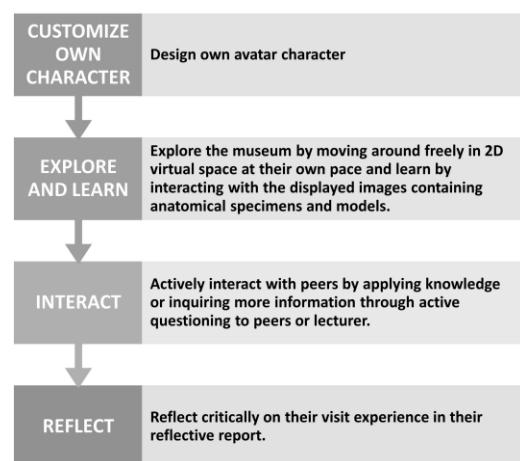


Fig. 1. Framework for virtual anatomy museum.

The pedagogy used in this virtual museum was adopted in Gather.Town platform to enhance students' visit experiences with gamification framework and promote active learning of students. In order to explore the students' experiences and perception, this study employed a case study approach using self-administered questionnaire to collect the data among Year 1 pharmacy students. Universal sampling was applied

to obtain responses from all Year 1 students after attending the virtual anatomy visit. A complete response was considered when all required questions were answered until the last page of the questionnaire. Otherwise, the response was categorized as an 'incomplete response'. All incomplete responses were excluded.

B. Questionnaire

The questionnaire, with a total of 18 items, consisted of two domains and was developed based on study objectives. The first domain of this questionnaire presented 3 items to compile the demographic information of the respondents (on gender, pre-university education and previous learning experience). The second domain (15 items) was to assess students' learning experiences and perceptions in terms of enjoyment, engagement, motivation, satisfaction, sense of belonging, interactions with peers and educators (item 1 – 13), as well as qualitative questions on their comments and suggestions (item 14 and 15). Respondents were requested to rate their learning experience based on Likert scale: 1 (Strong disagree), 2 (Disagree), 3 (Neutral), 4 (Agree) and 5 (Strongly agree). The questionnaire was validated by a panel of experts on content validity and clarity. It was a pre-test with 10 students to ensure the simplicity of language used and assess the comprehension of the questions. Feedback and comments were taken into consideration to incorporate into the final questionnaire following the pilot study.

C. Implementation and Data Collection

The virtual anatomy museum was developed via Gather.Town and introduced to a cohort of 65 Year 1 students enrolled in the Bachelor of Pharmacy (Honours) program, Taylor's University, Malaysia within the Human Anatomy and Physiology module in the August 2021 semester. The layout of the virtual anatomy museum is depicted in Fig. 2. The photos of anatomical specimens and models were displayed as posters in two exhibition halls.



Fig. 2. The layout of the virtual anatomy museum.

The cohort was divided into 3 groups of 21 or 22 students (due to the capacity of the free account which allowed up to 25 concurrent users). The 2-hour visit was conducted in Week 3 of the semester in three separate sessions on 6th September, 8th September and 9th September 2021, with 30 mins of briefing prior to the visit and followed by 90 mins virtual visit. Each session was opened to assigned students with a link and unique password to ensure restricted access to other students. A brief introduction was provided for the

students, in terms of their roles, tasks, rules of virtual visit and the features of Gather.Town platform. During the virtual visit, it was accompanied by an educator and a 'live' museum tour was provided by the educator. Students had a choice to follow the live virtual tour or explore the museum at their own pace. They had the freedom to interact with the exhibited anatomy specimens or models (in posters) based on their interests and needs, as well as interact with their peers and educator via chat, emoji and microphone.

After the virtual visit, students' experiences and feedback were collected by using a self-administered questionnaire. In addition, students were required to critically reflect on their visit experience in their reflective reports and this report was assessed as part of their assessment tasks in the module. The reflective report (with a total weightage of 10%) was graded by the educator based on three components in the marking rubric: self-inquiry (3%), ability in self-assessment (3%) and self-reflection (4%).

D. Data Analysis

Quantitative data were expressed as mean \pm standard deviation (SD) and analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0 (IBM Corporation, Armonk, New York, U.S.). Mann Whitney test was used to determine the difference of mean score in Likert scale between two variables, whereas the Kruskal-Wallis test was used if there were more than two variables. Chi-squared (χ^2) test or Fisher's exact test (when the frequency of respondents was less than 5 for any category) was performed respectively to determine the association between categorical groups. The p value < 0.05 was considered statistically significant. The analysis of qualitative data started with compiling into a Microsoft Excel spreadsheet, and subsequently, the key points were marked with a series of codes, which are extracted from the text. The codes were grouped into similar themes.

IV. RESULTS

A. Characteristics of Respondents and Responses

A total of 63 Year 1 pharmacy students successfully attended the virtual museum visit, where two students had technical issues accessing the learning platform. The response rate was 93.85%. There were no incomplete responses and no exclusion involved. The demographic profile of respondents is shown in Table I. The respondents comprised the majority of females (77.0%), new to this learning platform (95.1%), with pre-university education of the Unified Examination Certificate (UEC) (32.8%), Foundation (29.5%) and A-levels (16.4%).

The responses to each item in the questionnaire are tabulated in Table II.

The majority of the students (82.0%) claimed that they actively participated during the virtual visit. However, only 29.5% of students were more comfortable participating in this virtual platform. Students also moderately agreed that they could interact effectively with both lecturer (62.3%) and peers (47.5%) by using microphone (47.5%), chat (54.1%) and emoji (31.2%) throughout the visit. Gender,

pre-university education and previous learning experience with the learning platform were not significantly associated with the mean score in students' engagement and interactions ($p > 0.05$).

	Malaysian Higher School Certificate	3 (4.9)
	SACE International	2 (3.3)
New to the learning platform	Yes	58 (95.1)
	No	3 (4.9)

TABLE I: CHARACTERISTICS OF STUDY RESPONDENTS (N = 61)

Characteristic	n (%)	
Gender	Female	47 (77.0)
	Male	14 (23.0)
Pre-university education	Unified Examination Certificate	20 (32.8)
	Foundation	18 (29.5)
	A-levels	10 (16.4)
	Monash University Foundation Year	6 (9.8)

Interestingly, 52.5% of students enjoyed the self-guided visit at their own pace and more than two-thirds (70.5%) did not feel like an outsider during the virtual visit. Further analysis revealed that those from A-levels pre-university education significantly enjoyed self-guided learning compared to those who were from UEC and foundation pre-university pathways ($p = 0.016$; Table III).

TABLE II: STUDENTS' RESPONSES ON LEARNING EXPERIENCE AND PERCEPTION (N = 61)

Item	*Responses, n (%)					Mean ±SD
	1	2	3	4	5	
1. I enjoyed this session.	0(0)	1 (1.6)	3 (4.9)	25 (41.0)	32 (52.5)	4.4 ±0.7
2. I actively participated during this session.	1 (1.6)	1 (1.6)	9 (14.8)	32 (52.5)	18 (29.5)	4.1 ±0.8
3. I did not feel motivated during this session.	19 (31.2)	28 (45.9)	6 (9.8)	5 (8.2)	3 (4.9)	2.1 ±1.1
4. I did not find this session useful.	28 (45.9)	26 (42.6)	3 (4.9)	2 (3.3)	2 (3.3)	1.8 ±0.9
5. I am satisfied with the delivery of this session.	0 (0)	3 (4.9)	4 (6.6)	33 (54.1)	21 (34.4)	4.2 ±0.8
6. The technology used during this session has helped me to participate in this session.	1 (1.6)	1 (1.6)	5 (8.2)	30 (48.2)	24 (39.3)	4.2 ±0.9
7. I am more comfortable to participate in virtual platform.	3 (4.9)	13 (21.3)	27 (44.3)	11 (18.0)	7 (11.5)	3.1 ±1.0
8. I enjoyed the self-guided visit at my own pace.	0 (0)	9 (14.8)	20 (32.8)	24 (39.3)	8 (13.1)	3.5 ±0.9
9. I felt like an outsider during this session.	18 (29.5)	25 (41.0)	11 (18.0)	7 (11.5)	0(0)	2.1 ±1.0
10. I could interact effectively with my lecturer in this session.	0 (0)	3 (4.9)	20 (32.8)	28 (45.9)	10 (16.4)	3.7 ±0.8
11. I could interact effectively with my classmates in this session.	2 (3.3)	1 (1.6)	29 (47.5)	23 (37.7)	6 (9.8)	3.5 ±0.8
12. I wish to have more similar learning approach in my future study.	2 (3.3)	2 (3.3)	13 (21.3)	26 (42.6)	18 (29.5)	3.9 ±1.0
13. Which methods you have used to interact with others during this visit?						
Microphone				29 (47.5)		
Chat				33 (54.1)		
Emoji				19 (31.2)		

*1, Strongly disagree; 2, Disagree; 3, Neutral; 4, Agree; 5, Strongly agree; SD, Standard Deviation.

TABLE III: DISTRIBUTION OF STUDENT RESPONSES BASED ON THEIR PRE-UNIVERSITY EDUCATION (N = 54)

Item	Mean score ±SD				Statistical analysis*
	UEC(n=20)	F(n=18)	A-level(n=10)	MUFY(n=6)	
1. I enjoyed this session.	4.3±0.9	4.6 ±0.5	4.4 ±0.5	4.5 ±0.6	$\chi^2(3) = 0.784, p = 0.853$
2. I actively participated during this session.	3.9 ±0.9	4.4 ±0.6	3.9 ±0.7	4.3 ±0.8	$\chi^2(3) = 5.964, p = 0.113$
3. I did not feel motivated during this session.	2.5 ±1.0	2.1 ±1.4	2.0 ±1.2	1.5 ±0.6	$\chi^2(3) = 5.963, p = 0.113$
4. I did not find this session useful.	2.2 ±1.1	1.6 ±1.0	1.6 ±0.5	1.3 ±0.5	$\chi^2(3) = 7.197, p = 0.066$
5. I am satisfied with the delivery of this session.	3.9 ±0.8	4.4 ±0.6	4.2 ±0.9	4.7 ±0.5	$\chi^2(3) = 7.907, p = 0.048$
6. The technology used during this session has helped me to participate in this session.	3.9 ±1.1	4.6 ±0.6	4.3 ±0.5	4.0 ±0.9	$\chi^2(3) = 7.087, p = 0.069$
7. I am more comfortable to participate in virtual platform.	3.1 ±0.9	3.1 ±1.0	2.9 ±1.1	2.8 ±1.3	$\chi^2(3) = 0.689, p = 0.876$
8. I enjoyed the self-guided visit at my own pace.	3.2 ±0.9	3.3 ±0.9	4.3 ±0.8	3.8 ±0.8	$\chi^2(3) = 10.391, p = 0.016$
9. I felt like an outsider during this session.	2.4 ±1.0	2.0 ±1.0	1.9 ±0.9	2.3 ±0.8	$\chi^2(3) = 2.451, p = 0.484$
10. I could interact effectively with my lecturer in this session.	3.5 ±0.6	4.0 ±0.9	3.8 ±0.8	4.0 ±0.9	$\chi^2(3) = 4.681, p = 0.197$
11. I could interact effectively with my classmates in this session.	3.5 ±0.8	3.6 ±0.8	3.7 ±1.1	3.7 ±0.8	$\chi^2(3) = 1.926, p = 0.588$
12. I wish to have more similar learning approach in my future study.	3.9 ±1.3	3.9 ±0.8	3.9 ±0.6	4.3 ±0.5	$\chi^2(3) = 1.498, p = 0.683$

*Kruskal-Wallis test, significance level at $p < 0.05$. UEC, Unified Examination Certificate; F, Foundation; MUFY, Monash University Foundation Year; SD, Standard deviation

In terms of visit experience, most students (93.4%) enjoyed the virtual visit and 77.1% disagreed with the

statement they did not feel motivated during the session. In terms of the usefulness of the virtual visit, 88.5% of students perceived that the technology used had helped them to participate in this session and denied that this session was not useful. Generally, 88.5% were satisfied with the delivery of this learning platform. The satisfaction of delivery method was significantly associated with students' pre-university education, where students from UEC demonstrated significantly less satisfaction levels compared to those who were from Foundation, A-levels and Monash University Foundation Year (MUFY) ($p = 0.048$, Table III). More than two-thirds (72.1%) wished to have a more similar learning approach in their future learning. The mean score of preference to have a more similar learning approach was significantly higher in those who were new to this learning platform (4.00 ± 0.90) compared to those who used it before (2.33 ± 1.16) ($p = 0.013$).

B. Students' Qualitative Feedback

This study also investigated the elements enjoyed by the students during this virtual visit via an open-ended question. Based on the thematic analysis of the students' responses, there were three emerging themes related to students' enjoyments: learning experience (62.1%), learning environment (36.2%) and learning platform (1.7%) (Table IV).

TABLE IV: THEMATIC ANALYSIS OF STUDENTS' ENJOYMENT DURING VIRTUAL VISIT

Theme	Definition	Total number of coded responses (n)	Percentage of coded responses (%)
Learning experience	Any interaction of students with the exhibited posters, peers, and lecturer, or experience in learning. Probable feelings and	36	62.1
Learning environment	thoughts on the virtual learning environment during the visit. Probable feelings and	21	36.2
Learning platform	thoughts on the online portal used for virtual visit.	1	1.7

In terms of the learning experience, almost half of them ($n = 30$, 49.2%) enjoyed the visit where they were able to explore and interact with the posters on the real anatomical specimens. Students also highlighted that this was a different and new learning experience from classroom learning and they were able to learn new things through this virtual visit. A minority of students enjoyed the virtual tour guided by the educator ($n = 3$, 4.9%). The examples of feedback noted by some students were as follows:

"Getting to see the anatomy of human from every angle makes it easier for me to understand them"

"to be able to explore the lab virtually with the cute avatar while learning and experiencing something new!"

For the learning environment, some students ($n = 9$, 14.8%) loved the fun and interactive learning environment and noted that:

"I enjoyed this method of virtual learning because it feels

as if I am playing a game but actually I am learning new things."

"I enjoyed the fact that there was a fun and interactive alternative to visitations despite the limitations of the pandemic."

"I did enjoy this kind of teaching method as it was so fun!"

On the other hand, some of them ($n = 6$, 9.8%) felt that they were inside a real museum:

"I can really feel myself inside the museum although it's a virtual session. The part enjoy the most is the thorax part as i can see the real bones of ribcage and have a view of the real structure of heart. It is quite amazing and my first time experience!"

"I feel like being in a real museum."

Whereas some respondents noted that they enjoyed the self-paced learning ($n = 2$, 3.3%) and highlighted that they were able to visit the exhibited poster freely without any view obstructions ($n = 3$, 4.9%):

"I'm able to visit and go through the posters at my own pace, also it is so interesting to look at the pictures."

"I did not need to worry about obstructing someone's view or someone obstructing my view when seeing the photos and models."

Even though some students commented that they had a fun time during the visit, they preferred to have a physical visit rather than a virtual visit to the anatomy museum and requested to have a longer time for the museum visit.

C. Students' Reflective Report

For the reflective report assessment, students who attended the virtual visit achieved a mean score of $2.4 \pm 0.3\%$ in self-inquiry (out of a total 3%), $2.4 \pm 0.3\%$ in self-assessment (out of a total 3%) and $2.9 \pm 0.5\%$ in self-reflection (out of a total 4%), which added up to a total mean score of $7.7 \pm 0.8\%$. These scores were also significantly higher compared to the previous cohort that attended physical session ($p < 0.05$) (Table V).

TABLE V: COMPARISON OF MEAN SCORE OF REFLECTION REPORTS BETWEEN PHYSICAL AND VIRTUAL VISIT

Component	Physical Visit ($n = 61$)	Virtual Visit ($n = 63$)	Statistical analysis*
Self-Inquiry	2.2 ± 0.3	2.4 ± 0.3	$Z = 4.276,$ $p < 0.0001$
Self-Assessment	1.2 ± 0.4	2.4 ± 0.3	$Z = 6.504,$ $p < 0.0001$
Self-Reflection	2.6 ± 0.6	2.9 ± 0.5	$Z = 3.094,$ $p = 0.002$
Total	6.8 ± 1.0	7.7 ± 0.8	$Z = 5.114,$ $p < 0.0001$

Data were expressed as means \pm standard deviation. The total score of the reflective report was 10%. *Mann-Whitney U Test, significance level at $p < 0.05$.

V. DISCUSSION

This project used a learner-centered learning approach, where the students were being self-guided and responsible for their own learning during the virtual visit. This approach was anchored on the needs and interests of the students. The use of a digital platform allowed the educators to create a self-paced learning environment for students engagement and interactions (lecturer-student and peer-to-peer interactions) in a synchronous session. By interacting with the posters of anatomical specimens or models, it allowed students to construct their own understanding and knowledge of anatomy of the human body through active questioning and exploration on the displayed anatomical specimens and models. This also led to the building of new knowledge via active students' engagement in learning. This is further confirmed by the qualitative feedback obtained from students in this case study. In addition, this study also revealed that students participated actively and interacted with their peers and educators throughout the virtual visit.

According to Maslow's Hierarchy of Needs, the basic needs of an individual must be satisfied before the higher needs of self-esteem and self-actualization (personal growth) become operative [26]. Thus, students need the freedom to learn in the right conditions to achieve higher levels of development. With the application of Gather.Town platform, students could explore the virtual museum freely to learn based on their interests and needs by exploring the displayed anatomical specimens at their own pace. They were given choices and responsibility for their own learning. The responses from the students supported that this online platform provides personalized and self-paced learning. Self-paced learning is reported to be beneficial in improving students' performance, particularly memory performance [27]. Human anatomy is an extensive and difficult subject which forms the fundamental for all medical and health sciences students in understanding the functions of human body, the mechanism of biological processes and the pathogenesis of diseases. Therefore, it is important to stimulate students' interest and independent learning in this subject in order to ensure life-long learning among the students. In terms of students' performance, this study noticed that students performed better in their reflective report writing compared to those from the previous cohort who attended the physical visit. Since this was a one-time visit, the assessment of memory performance is not designated in this case study.

This study revealed that Gather.Town online platform increased the sense of belonging of Year 1 pharmacy students, which might be closely related to positive students' engagement in terms of active participation and interactions during the virtual visit. Student engagement increases students' satisfaction and motivation to learn, which eventually reduces the sense of isolation, and improves overall performance in online learning [28]. With the sense of belonging, it can effectively generate the desire for students to actively engage and participate in the subsequent learning activities.

Previous studies reported on several factors affecting learners' learning experience and satisfaction in their e-Learning activities including learner factors (e.g. attitude,

self-efficacy in using the internet), nature of the subject (e.g. flexibility and quality) and technology issues (e.g. internet quality and technology quality) [1], [29]. In this study, the learner's gender and educational background (pre-university education and previous learning experience) were investigated on the impact of these factors on students' learning experience. Gender was found to be not significantly associated with the students' engagement in this study and this rejected the alternative research hypothesis of this factor. This finding is contradicted by the finding reported by Peters *et al.* [30], where gender significantly impacts the level of engagement in asynchronous online learning. This discrepancy might be attributed to the method of delivery and the nature of the learning activity.

Interestingly, this study revealed that students' enjoyment of self-paced learning and satisfaction of the learning delivery method was significantly associated with their pre-university education. Pre-university education is a connecting bridge between school and university. It prepares the students for tertiary education, which is the pathway into professional life. In Malaysia, there are various pre-university programs offered by both government and private education institutions [31]. Matriculation and Malaysian Higher School Certificate (also known as 'Sijil Tinggi Persekolahan Malaysia (STPM)' in Malay) are the pre-university courses provided by the Malaysia government. Whereas, private sectors offer international orientated courses, such as A-levels (from the United Kingdom), South Australian Certificate of Education (SACE) International (previously known as the South Australian Matriculation (SAM) program), Monash University Foundation Year (MUFY), as well as local foundation courses, such as Foundation in Science [31]. Unified Examination Certificate (UEC) is another recognized pre-university education which is offered by Chinese Independent Schools in Malaysia [32]. Teaching methods implicit an impact on students' learning style and behavior, particularly in independent learning [31]. This explains the findings from this case study, in which diverse students' background influences their preference for learning delivery method. Although some schools might be still dominant with the 'spoon-feeding' metaphor, this teaching method is gradually transformed into 'self-feeding' in order to ensure effective learning among 21st century students [33]. This is evidenced by the findings from this case study, where more than half of respondents enjoyed their self-paced learning during the virtual visit. This indicates the sign of education transformation into a 'self-feeding' trend.

John Dewey [34] articulated his concept on how we think and indicated that "we do not learn from experience. We learn from reflecting on experience". Reflective learning involves the process of examining own thoughts, beliefs and assumptions on an issue of concern, which is triggered by an experience [35]. It is recognized as a student-centered approach to engage students in active learning [35]. In this case study, students were required to reflect critically on their visit experience in their reflective report as an assessment component. This implied their personal growth and development, particularly in their interpersonal skills. The three-stage model of reflection proposed by Scanlon & Chernomas [36], involves awareness, critical analysis and a

new perspective. Three main skills were assessed in this case study: self-inquiry to create awareness, self-assessment to critically analyze own experience for learning and self-reflection to build new perspectives on prior experience. Students from this cohort scored better compared to the previous cohort who attended the physical museum visit. This might be credited to the interactive platform which further enhanced students' engagement and active learning during the virtual visit, as well as the longer duration of the museum visit (90 mins) compared to a physical session (30 mins). Student engagement increases students' motivation to learn and improves overall performance in online learning [28]. However, this virtual museum is always not a replacement for the physical anatomy museum if a face-to-face visit is feasible without any limitations. Based on students' qualitative feedback, they highlighted that physical visit remains their preference. This is also supported by the students' responses, where the majority were less comfortable participating in virtual platform.

Gamification is widely integrated into higher education in order to enhance the learning experience of students by increasing their engagement and motivation [37]. Gather.Town online platform provided some gamification elements for this virtual visit, where the students were able to customize their own avatar character and move freely in a 2-dimensional space, interact with the shared documents and exhibition posters, as well as interact with educators and peers. Undoubtedly, this gamification framework and interactive learning process further enhanced the virtual visit experiences with a high level of students' motivation and engagement, particularly in the current cohort of students who were from Generation Z. Qualitative responses from the students highlighted their positive comments on the gamification feature in this learning platform.

This virtual visit provided scalability to accommodate a large number of students with a longer duration of the visit. Traditionally, there are always time and space limits for the students to spend in a face-to-face anatomy museum visit. During the physical visits, each session can accommodate only 5 students with not more than 30 minutes visit. With this online interactive platform, it provided an opportunity for the students to have longer visit time together with up to 24 peers at the same time, where they could interact with educators and peers and also explore the specimens and models in their own personalized self-paced learning in a fun and interactive 2-dimensional space. Unlike other learning platforms that offer a static mode of delivery, this platform facilitates student-centered learning. Owing to the experimental approach, this case study was limited to the feature of a free account (only 25 concurrent users), yet it can be scaled up a larger number of users (up to 500 concurrent users with payment). The feedback obtained from students indicate that students wish to have a longer visit duration although a 90 mins visit was allocated. With the availability of Gather.Town, the duration of the visit can be easily extended based on the students' needs.

Even though this platform supports personalized students' learning, the anatomical specimens and models can only be presented as two-dimensional images. Hence it is only applicable for those courses which aim to provide exposure

for students' learning experience. It is neither an option to fully substitute the real anatomy museum nor comparable to those three-dimensional models presented in another platforms such as virtual reality applications and 360-degree videos, which serve as a more precise representation of the original models or specimens [38]. However, it provides an emergency alternative for students to enhance their learning experience. It is always beneficial as a supplementary learning platform for the students in anatomy learning.

On the other hand, it is important to take note of those two students who experienced access issues into Gather.Town online platform, which might be related to the incompatibility of the device used. Based on students' feedback, there were some minor glitches for the displayed images, such as difficulty in zooming in the images and a longer time taken for the image to display. Similarly, technical issues were also reported in other studies [15], [17]. Nevertheless, these issues were able to be resolved by refreshing the webpage. In addition, internet connectivity is always a challenge to conduct synchronous online learning activities. During the virtual visit, there was a student who encountered a low-bandwidth issue and the images could not be displayed after clicking on the exhibited posters. This indicates that good internet connectivity is required for a better experience in this online platform. A similar suggestion was proposed by McClure & William [17] based on their experiences in conducting practical-based learning.

According to the findings from this study, it can be construed that Gather.Town provides a constructive learning environment, where the learners tend to be active and able to interact with peers and educators during the virtual classroom setting. Nevertheless, a notable limitation lies in this case study design, where all parameters were measured only for one learning activity of the studied subject. This research method may not fully capture the impact of other factors on students' learning experiences, such as students' variables (learning style and learning capability), different e-Learning activities and the nature of the studied subject. The research design limits the applicability of the learning platform in the future. To address these concerns, future research should be considered by incorporating more learning activities in an entire module with multi-methods and longitudinal study designs. This would provide a process-orientated perspective of this learning platform.

VI. CONCLUSION

This case study highlighted the introduction of a virtual anatomy visit with Gather.Town platform created an interactive, synchronous and effective virtual anatomy museum visit for the students. It enhanced students' visit experience in terms of their engagement, motivation, sense of belonging and interactions with their lecturer and peers during the virtual visit with self-paced learning. In addition, it also improved the reflective thinking among the students. Based on the students' learning experience, this online platform supported personalized students' learning and enhanced first-year learning experience, as well as encouraged interactions between peers and educators and fostered the life-long learning among the students. It could be

potentially used as an alternative platform for students in visit-based learning.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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