TECHNOLOGY-ASSISTED LEARNING: HONING STUDENTS' AFFECTIVE OUTCOMES

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TECHNOLOGY-ASSISTED LEARNING: HONING STUDENTS' AFFECTIVE OUTCOMES

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Editorial: Technology-assisted learning: Honing students' affective outcomes

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Editorial on the Research Topic
Technology-assisted learning: Honing students' affective outcomes

When this Research Topic was first conceived, we were focusing on a couple of cross-institutional projects which had made substantial use of information technology (IT) to facilitate students' learning and achievement of affective outcomes. The projects started well before the world was ravaged by COVID-19, with the activities conducted in the calm of pre-pandemic times. As we progressed to receive submissions, the world was learning to live with COVID-19, catapulting educational institutions at various levels around the globe into the fast-track on eLearning or virtual teaching and learning (VTL) adoption. Interestingly, at this stage of finalizing our Topic, we noted that the lessons learned—before being rushed by the pandemic and pushed to respond to the "new normal"—have remained apt and appropriate in current times. This realization has armed us with confidence to continue to rely on technologies to assist and continue student learning, and to prepare ourselves and our students to be "disruption-ready" in the emerging era.

Another important realization on our Topic is that despite our initial aim to address the gap in the literature concerning the use of IT to help students achieve attitudinal outcomes, the predominant focus has still been on using VTL to enhance students' attainment of knowledge and skills outcomes. Yet again, useful insights have been gained to help advance our VTL deployment for affective outcomes.

From the selection of papers published under our Research Topic, we noted that using IT to exemplify gamification to engage students in active learning has been gaining popularity with both teachers and students. We have had a good number of papers on games, which have been used to supplement classroom teaching, or entice students to learn outside the curriculum, including in relation to the United Nations' Sustainable Development Goals (UNSDGs). Access records kept by Frontiers in Education confirm that readers of our papers are

also keen on topics about IT with games to drive VTL. Of the 10 published papers, eight were from Hong Kong, one from the Philippines, and the other from the USA, covering a good spectrum of using technologies to help students learn/achieve outcomes, for emotional support, and for gauging the reception of proctored online examinations.

Within our Research Topic, Cheung and Ng's paper attracted the largest number of readers as it showed their success in arousing students' intrinsic and extrinsic motivation with a combination of gamification and traditional methods to enhance their subject knowledge learning, in this case, in Physical Education. Lu et al. used gamified augmented reality (AR) to help their students learn Chemistry, a fundamental science subject. Their AR app proved to be useful in terms of enhancing students' awareness, learning, understanding, and engagement in Chemistry. Lam and Tse explored gamification in Hong Kong's primary and secondary classrooms. They confirmed that gamification was already popular at these levels, with teachers believing that "the game is a powerful way to engage students".

In terms of coupling IT and games for attitudinal outcomes, Marcial et al. brought scenarios to life by using AR and mobile devices to create a learning trail on the responsible use of social media at a university in the Philippines. This advanced form of situated learning stimulated students' interest and awareness as the scenarios were relevant and engaging. Lau used a similar technology-assisted learning trail to engage his research students in academic integrity and ethics scenarios. Of the six fundamental values of academic integrity defined by the International Center for Academic Integrity (ICAI), Lau noted that *honesty* and *respect* might be the most familiar values to his students. Interestingly, his study also highlighted his students' emphasis on *empathy* and *mindfulness*, two attributes not defined by ICAI. Both Leung et al. and Lau et al. reported on the same project that used an online competitive game to help students develop cross-cultural skills by working in virtual teams to learn about the UNSDGs. Leung et al. used pre-post questionnaires to gauge whether the online game had helped students develop global perspectives. The findings supported those of prior research on how gamified eLearning platforms could contribute to the development of students' global perspectives. Lau et al. analyzed the chat histories of students from the top-5 and bottom-5 teams of two consecutive eTournaments (online competitions). The results provided evidence that high performing teams took a different gaming approach from the low performing ones in such areas as team building and game strategy deployment. The authors shared valuable insights on building cross-cultural virtual teams, a critical and essential endeavor in our interconnected world today.

The other three papers reviewed IT in education from various perspectives. Chan et al. explored the relationship between performance and enjoyment in game-based learning. With various statistical analyses performed, they aimed to continue their study to shed light on improvement of intended learning outcomes in the Asian tertiary education context. Alessio and Messinger studied faculty members and students' perceptions of academic integrity with technology-assisted proctoring in online testing in a US university. They found that both groups had similar perceptions of the importance of academic integrity and ease of cheating in online tests, but differed regarding proctoring software's effectiveness in deterring cheating, and concerns about privacy, anxiety, stress and how to uphold academic integrity. Lee deployed eLearning to provide emotional support for her students in difficult times, and shared some useful practices to facilitate the teaching of healthy lifestyles to students.

As stated at the beginning, the studies and research selected for our Research Topic were not targeted at coping with the urgent and poignant challenges posed to education due to COVID-19. Yet from the outcomes achieved by the students involved and the conclusions drawn by the various authors, we are encouraged to seek further ways to employ VTL to effect better learning experiences for our students during both regular and more challenging times.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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How Online Teams with Diverse Backgrounds Worked to Excel: Findings from an International eTournament

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A tide of changes with technological advances at its center has allowed more efficient and productive synchronous and asynchronous collaborations among dispersed individuals across the globe in recent years. Working effectively in virtual teams of individuals with diverse backgrounds is thus critical for students to succeed in the 21st century. However, relevant training for international collaboration is lacking in the higher education system. The research team examined data from a project aimed to heighten students' multidisciplinary and multicultural competencies via a team-based, international eTournament organized in 2019 and enhanced and repeated in early 2020 featuring the 17 Sustainable Development Goals (SDGs) of the United Nations. Students were teamed up according to a mechanism, to ensure diversity in each virtual team and mimic the real practice in many workplaces. A two-stage "strategize-play" approach was deployed with activities carried out entirely online. Team members first got to know each other, built up their teams and formulated their strategies for the next stage. In the second stage, the virtual teams competed with one other on a gamified learning platform called PaGamO by answering questions related to the SDGs. About 240 students (2019) and 420 students (2020) participated. Various sets of quantitative and qualitative data were collected, including student chat histories, focus group interviews, data analytics from PaGamO recording how the students progressed in the game, as well as the pre- and post-game surveys. This article focuses on the chat histories of students from the top-5 and bottom-5 teams of the 2019 and 2020 eTournaments. The results provide evidence that the high performing teams took a different gaming approach from the low performing teams in such areas as team building and game strategy deployment.

Keywords: challenge-based learning, gamification, multi-cultural, multi-disciplinary, online learning, online team

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INTRODUCTION

"Wicked problems" in the 21st century, referred by Ritchey (2013) as characterized by "sets of complex, interacting issues evolving in a dynamic social context" (p.2) with reference to the "10 criteria" set by Rittle and Webber (1973), are unavoidable to mankind. From extreme weather to unequal opportunities in education, these wicked problems require the orchestrated efforts of

peoples across disciplines and boundaries to tackle, and those efforts can be facilitated with modern technology. For instance, despite the bounds of local social distancing measures and international travel bans during the recent COVID-19 pandemic, many people still carried on communicating, working and studying with others through the Internet.

Since 2016, the authors of this article have been aware that the trend of "working from home" via remote collaboration has resulted in multidisciplinary, multicultural, technology-supported work-teams becoming a norm in global businesses. However, it appears that the impact of this norm in work practices on teaching and learning at universities are not yet widespread (Gibson, 2012). Thus, there is a need to help students develop online teamwork skills, particularly when they do not have the luxury of picking their own teammates and have to work closely with unfamiliar members of diverse backgrounds.

Online game-based learning can be adopted to help students develop such skills in terms of communication, collaboration, critical thinking and motivation. Bakan and Bakan (2018) observed that participants in a game-based learning environment could work collaboratively to achieve the goals set by the game and created a space where they can explain, discuss, and listen to each other (p.17); Herodotou (2010) suggested that the virtual space created by online games could be a platform for diverse social relationships. Cicchino (2015) suggested that game-based learning for problem-solving could facilitate students' critical thinking. In terms of motivation, Herodotou (2010) also commented that attending to similar game aims could bring players together and could motivate them to work collaboratively for longer period of time.

The "Developing Multidisciplinary and Multicultural Competences through Gamification and Challenge-Based Collaborative Learning Project" (or "CCGame Project") is thus launched, which is a technology-facilitated teaching and learning related project led by Hong Kong Baptist University (HKBU) in collaboration with three other local universities in Hong Kong and an overseas university from Australia. The project team consists of about 20 teaching and learning professionals and academics from various disciplines. The CCGame Project, which was run from July 2017 to June 2020, aimed to enhance university students' readiness and capabilities to address the common global issues or challenges through its "CC" spirit–Cross-cultural, Cross-disciplinary; Challenge-based, Collaborative–put in a gamified approach. Participating teachers teamed up to address the pressing need for equipping university students with the abilities to tackle global challenges in academically and culturally diverse teams, leveraging a set of virtual environments for collaboration across long distances (Cagiltay et al., 2015).

The project team adopted the 17 Sustainable Development Goals of the United Nations (SDGs; https://sustainabledevelopment.un.org/sdgs) as the theme of collaborative tasks and challenges for students since these universal goals: 1) motivate global interest; 2) require cross-disciplinary efforts and 3) have an urgent need to be fulfilled. The cross-cultural element of the project was created for the teams by recruiting student participants worldwide and fostering cultural diversity in each online team. The project team had implemented an array of online teaching and learning activities to stimulate students' curiosity and desire to learn (Shroff, 2010), assist people in forming self-organizing and self-directing international teams for solving real-world problems, and nurture students' competences for addressing global challenges.

One of the project's signature activities was the "United Nations SDG International eTournament," the first of its kind in the world featuring the SDGs. Two runs of the eTournament were organized in February 2019 and January 2020 respectively. Ordinary team-based competitions allow participants to form teams by themselves with friends or someone they know. In contrast, team formation was determined by the project team according to students' home countries/regions and academic disciplines. This practice of team formation promoted diversity on each team (Schmucker, 2017). Also, the fact that team members did not know each other beforehand and had to get acquainted efficiently and successfully to compete in the eTournament simulated people working on international teams in real-world scenarios (Jackson and Joshi, 2011). Furthermore, many teams included members of different time zones, challenging students' ability to manage their time and work/study schedules effectively.

Various sets of quantitative and qualitative data were collected, including student chat histories, focus group interviews, data analytics drawn from PaGamO recording how the students progressed in the game, as well as the pre- and post-game surveys. This analysis reported here focused on the chat histories of students from the top-5 and bottom-5 teams of the 2019 and 2020 eTournaments.

MATERIALS AND METHODS

Background of the eTournament

The eTournament was organized with the following three objectives. The students participated voluntarily in the eTournament through open recruitment.

1. To enhance students' SDG awareness, through the gamified, challenge-based setting on a gaming platform known as PaGamO (http://www.pagamo.org);
2. To facilitate collaborative learning, by providing opportunities for students from different parts of the world, who do not know each other before the eTournament, learn to work together online to complete specific tasks.
3. To enhance students' intercultural competence, enabling students to learn about the different cultures and background of their teammates.

A two-stage "strategize-play" approach was adopted in the eTournament. Being entirely online, the students, upon entering the first stage of the eTournament, were asked to communicate with their teammates from different cultural and academic backgrounds, via one of the approved messaging tools for building their virtual teams and discussing the game strategies to be deployed. Then, in the second stage, the teams competed

with each other by answering SDG-related questions on the gaming platform known as PaGamO, a mature and unique learning platform designed to engage students in virtual competition for acquiring knowledge of a specific topic.

The first-ever entirely online, SDG-based eTournament was conducted in 2019 (4 days for Stage 1; 4 days for Stage 2), which drew together 243 students from 24 home countries/regions. In terms of levels of study, the percentages of the participants studying for sub-degrees, bachelor's degrees, master's degrees and doctoral degrees were 4.9, 77.8, 13.2, and 4.1% respectively.

Regarding the collaboration platform for the eTournament, various platforms including the Challenge Platform developed by Curtin University (https://challenge.curtin.edu.au/Home/about) were test-drove and evaluated. The Moodle LMS, being handy in terms of administration (already used by the University leading the project) and discussion history extraction, was selected and deployed as the only approved messaging tool in the 2019 run for communication, team building and strategizing. Concise, structured materials on understanding culture, teamwork and conflict management were also provided on Moodle for collaborative skills training.

Building on the success of the 2019 run, the CCGame Project team brought back the eTournament in January 2020, with a longer duration (5 days for Stage 1; 7 days for Stage 2) and a number of advancements based on the internal review and feedback from the first run participants. While Moodle was again deployed for collaborative skills training, instant messaging platforms–Skype, WeChat or WhatsApp–were also allowed for teams' use. That was referred by students' feedback as more responsive than Moodle. More importantly, an additional activity was added in Stage 2, in which an SDG was assigned to each team and they were invited to allocate at least 40 min for a synchronous online audio chat, to exchange and share each member's own experience and knowledge about the assigned SDG, for a bonus score (provided that the team submitted the recording of the chat). The response of the 2020 eTournament was significantly greater than 2019–416 students from 42 home countries/regions enrolled (171% of the 2019 run in terms of the number of students; 175% in terms of the number of home regions). The percentages of the 2020 participants studying for sub-degrees, bachelor's degrees, master's degrees and doctoral degrees were 5.8, 68.3, 21.4, and 4.5% respectively.

Methodology

Our research question of this study is: How could a diverse team function effectively to reach a common goal in a virtual environment?

The focus of this study was on the chat histories of the top-5 and bottom-5 competing teams of 2019 and 2020. Team selection in this study was based on the rationale that any difference between the top and low performing teams should be significant enough to derive meaningful findings. Less or more teams drawn from the eTournaments for the study would either provide insufficient data for analysis or dilute any meaningful results. 10% was selected as the threshold, resulting in picking the top-5 and bottom-5 of both eTournaments as there were 55 teams at the beginning of the 2019 eTournament.

In 2019, the top-5 and bottom-5 teams consisted of 46 students with team size ranging from four to five members. In 2020, there were a total of 50 students in the top-5 and bottom-5 teams, with the same team size range. The chat histories of the selected teams were analyzed through the text mining results from the Education University of Hong Kong's Bilingual Text Mining System (TMS; http://analytics.ied.edu.hk/tms). A core function of the TMS is to mine relevant text data by checking the occurrence frequencies of certain keywords in student chat histories against a predefined framework composed of three different categories of attributes, namely Collaboration, Personal Learning and Problem Solving adopted from the Curtin Learning Futures: Attributes for Curtin Ready Learners (**Table 1**) (Gibson et al., 2018).

It is noteworthy that some of the attributes in **Table 1** seem to be ambiguous in terms of their allocation to more than one category. For example, "taking appropriate action to solve the problem" in Collaboration and "planning and executing" in Problem Solving might be evidenced by a similar set of evidence. There is rarely an exclusive 1:1 relationship of a single bit of "completely determinant" evidence when building an inference based on a measurement—if the observation is the only evidence submitted, then it might be insufficient to make a judgment, or a set of evidence might indicate more than one category. Mislevy et al. (2003) commented that it is the preponderance as well as a "web of evidence" as a whole that constitute an assertion that particular observations form an evidence-based picture of an underlying construct being measured:

> "In educational assessment, we observe what students say, do, or make in a few particular circumstances and attempt to infer what they know, can do, or have accomplished more generally. A web of inference connects the two. Some connections depend on theories and experience concerning the targeted knowledge in the domain, how it is acquired, and the circumstances under which people bring their knowledge to bear. Other connections may depend on statistical models and probability-based reasoning. Still others concern the elements and processes involved in test construction, administration, scoring, and reporting." (cf. abstract)

To develop the keyword framework, the Latent Dirichlet Allocation (LDA) function of the TMS was first used (number of topics = 3) to create a first draft version of the framework. The words of this draft were then manually sorted into the three categories (Collaboration, Personal Learning and Problem Solving) and further examined with related words and their synonyms manually added, with reference to the student chat histories, thesaurus lookups to make the framework as comprehensive as possible. For example, the keyword framework was checked by other team members who had not been involved in its creation. Full details of the

TABLE 1 | The 3 categories of attributes extracted from the Curtin Learning Futures for the keyword framework.

Curtin learning futures: Attributes for curtin ready learners	
Collaboration (Roschelle and Teasley, 1995)	Establishing and maintaining shared understanding
	Taking appropriate action to solve the problem
	Establishing and maintaining team organization
Personal Learning (Friedrichs and Gibson, 2003)	Sharing experience
	Examining diverse concepts
	Articulating, applying and building understanding
	Communicating new powers and creations
Problem Solving (Mayer and Wittrock, 1996)	Exploring and understanding
	Representing and formulating
	Planning and executing
	Monitoring and reflecting

keyword composition of the framework are included in the **Appendix**.

With the framework created, four text mining exercises were then conducted respectively for the top-5 and bottom-5 teams of both runs of the eTournament with the TMS. The keyword frequencies in the chat histories of different student teams were recorded and grouped under their respective category of attributes. This allowed the project team to understand the focus of discussion among the top-5 and bottom-5 teams during the eTournament, and thus the gaming approaches adopted by them. The keyword frequencies of the 3 categories would indicate the proportion of time students spent on different topics of discussion, from team building to SDGs and cross-cultural and cross-disciplinary awareness, and to strategy deployment. The research team could follow the flow of discussion of the high performing and low performing teams by monitoring the keyword frequencies against the framework, so as to keep track of the progress of different teams in the eTournament.

RESULTS

Observations of the four text mining exercises uncovered different discussion patterns of the top-5 and bottom-5 competing teams, in both of the eTournaments. **Figure 1** shows the occurrence frequencies of keywords appeared in their chat histories which fall under the attributes of Collaboration, Personal Learning and Problem Solving.

Data of the top-5 teams of 2019 and 2020 eTournaments showed that the team members spent most of their discussions on Problem Solving, followed by Personal Learning, with Collaboration last. The occurrence frequencies of keywords related to Problem Solving appeared in the chat histories of the top-5 teams were 63.7 and 62.2% more than Collaboration in the 2019 and 2020 games respectively. On the contrary, for the bottom-5 teams of both years, the keyword occurrences among student discussions showed that these low performing teams mainly focused their discussion on Collaboration, followed by Personal Learning and then Problem Solving. Keyword frequencies related to Problem Solving among the bottom-5 teams were only 31.9 and 55.9% of those under Collaboration for the 2019 and 2020 eTournaments. This reverse sequence of emphasis in student discussions of the top-5 and bottom-5 teams was recorded in both years, showing that the pattern or approaches taken by the high and low performing teams of both eTournaments were almost identical (**Figure 2**).

In addition, for both runs of the eTournament, the frequencies of keyword occurrence under all the 3 categories of attributes were much higher among the top-5 teams than the bottom-5

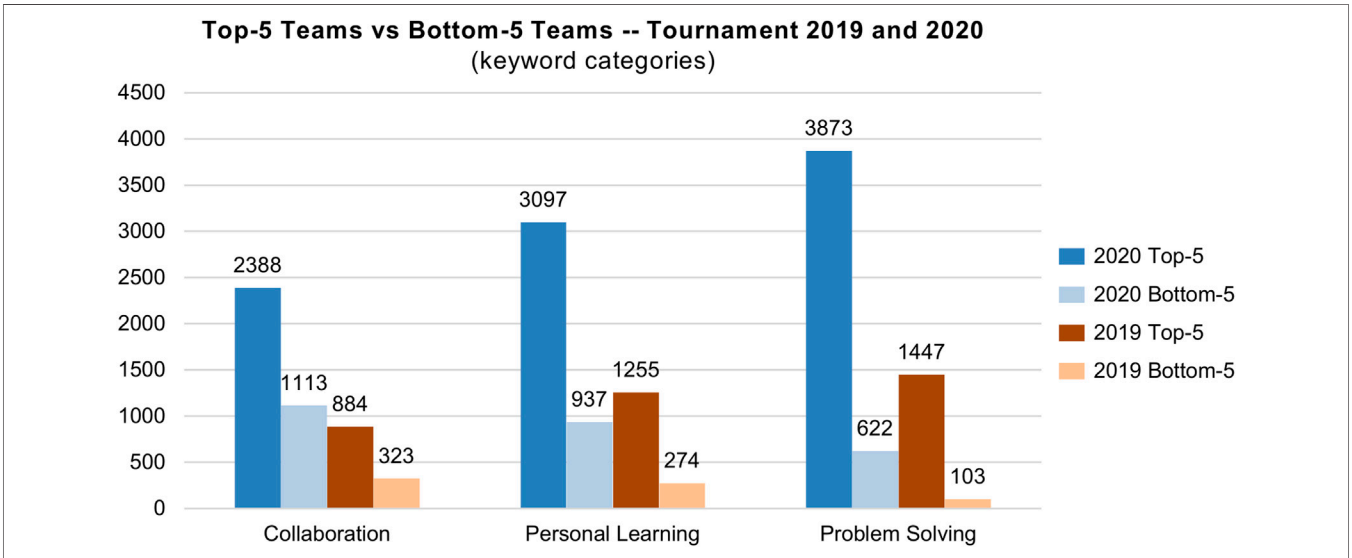

FIGURE 1 | Keyword frequencies of the top-5 and bottom-5 teams of the 2019 and 2020 eTournaments.

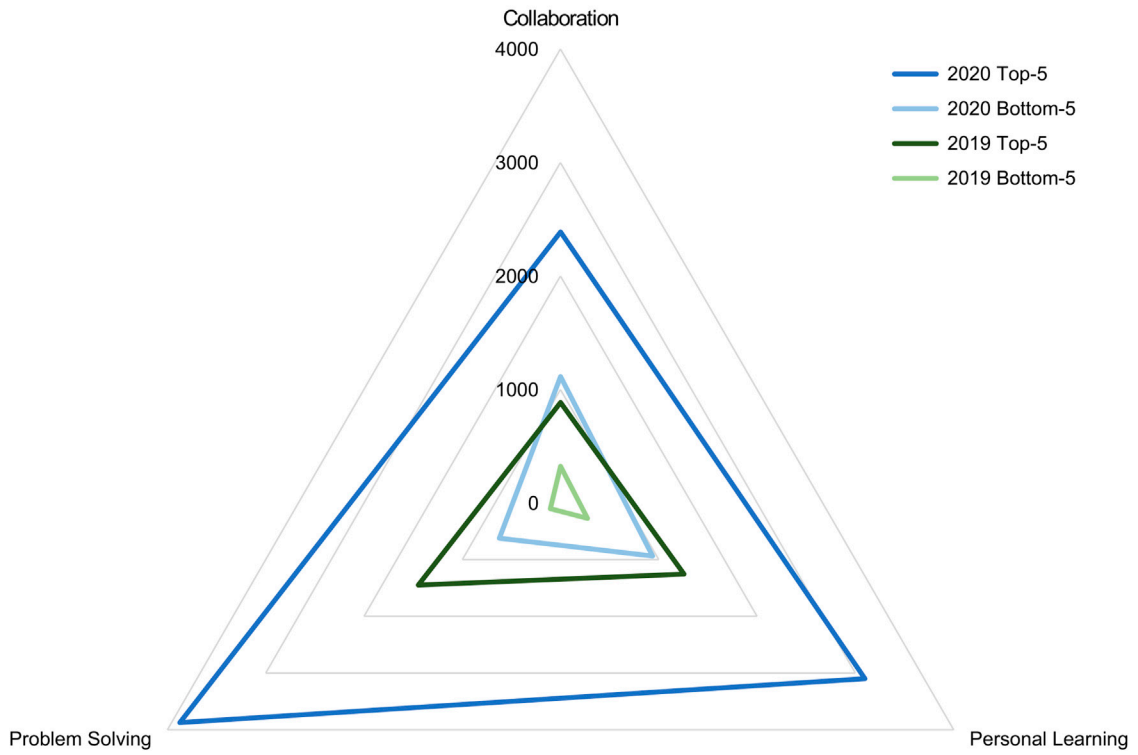

FIGURE 2 | Performance trends of the top-5 and bottom-5 teams of both eTournaments.

teams, indicating the possibility that more discussion and word production took place. The total keyword occurrence frequencies of the 3 categories of attributes among the top-5 teams were 3.5 times of the bottom five teams in the 2020 eTournament. The top-5 teams of 2019 recorded a total keyword frequency of more than 5 times of the bottom-5 teams.

Among the three categories of attributes, keywords related to Problem Solving took up more than 40% of the discussions by the top-5 teams of both eTournaments, leaving only 35.0 and 33.1% for Personal Learning and the remaining 24.7 and 25.5% for Collaboration in 2019 and 2020 respectively (**Table 2**). For the bottom-5 teams of both years, Collaboration occupied more than 40% of their discussion, with Personal Learning showing similar figures of 39.1 and 35.1%, and the remaining 14.7 and 23.3% of the discussion spent on Problem Solving in 2019 and 2020 respectively. It was noteworthy that across the four groups of competing teams, the differences for keyword occurrence of Personal Learning were not significant, all of them spent around 30–40% of their discussion on this topic.

DISCUSSION

The reverse pattern of discussion between the top-5 teams and bottom-5 teams for both runs of the eTournaments showed totally different approaches taken by the high and low performing teams in the SDG-themed games. Throughout both stages of the eTournament–team forming and playing the game–students could communicate or chat with other team members via messaging tools. The keyword frequencies of the 3 categories of attributes revealed differences in the flow or focus of student discussion. The occurrence of Collaboration keywords in student chat histories showed evidence of building up their virtual teams, choosing team leaders, and trying to establish a mutual understanding among themselves (Cross et al., 2008). Keywords related to Personal Learning showed that students seemed to understand some cross-cultural and cross-disciplinary differences among the team members, but this learning process was mostly done individually (Fiedler and Väljataga, 2011). Lastly, keywords of Problem Solving

TABLE 2 | Distribution of keyword occurrence across the three categories of attributes in student chat histories of the 2019 and 2020 eTournaments.

Category	Top-5			Bottom-5		
	2020 (%)	2019 (%)	% Change	2020 (%)	2019 (%)	% Change
Collaboration	25.5	24.7	0.9	41.7	46.1	−4.5
Personal learning	33.1	35.0	−1.9	35.1	39.1	−4.1
Problem solving	41.4	40.4	1.0	23.3	14.7	8.6

indicated that student efforts to solve the SDG-themed challenges involved deploying game-related strategies.

The significantly higher frequencies of Problem Solving keyword occurrences among the top-5 teams compared to the bottom-5 teams in both eTournaments indicate that members of high performing teams put considerably more efforts solving the SDG-related questions in the second stage, by working with their diverse teammates. This focused discussion also indicates that the high performing teams had, to a relatively larger extent than the low performing teams, been able to move past team formation to work productively with one another by contributing their knowledge and experience toward solving the SDG problems (Yeager and Nafukho, 2012). In other words, the top-5 teams were harnessing the benefits of having members of different backgrounds to help them tackle the complex challenges by pulling together their diverse expertise (Horwitz and Horwitz, 2007). Thus, the top-5 teams appeared to come up with more strategies to deal with the challenges in the game. In contrast, the chat histories of the bottom-5 teams of both 2019 and 2020 indicate that they put most of their discussion efforts on Collaboration which was expected to be completed during the first stage of the eTournament, which may indicate that the teams stayed focused on forming their teams most of the time throughout the game. With relatively weaker bonds and less mutual understanding among the team members resulting from poor team building skills and lack of competent leaders, the bottom-5 teams seemed to find it difficult in solving the SDG-related questions which required a diverse knowledge and skill set (Magnus and Joseph, 2015).

The similar distributional pattern of discussion between the top-5 and bottom-5 teams of 2019 and 2020 as shown in the performance trend graphs of **Figure 2** also reaffirms that the top-5 teams were able to get through the phases of discussion from team building (Collaboration), to their awareness of SDGs, cross-cultural and cross-disciplinary differences (Personal Learning), and lastly, to strategy deployment (Problem Solving) along the timeline of the eTournament. With better communication and teamwork skills, and competent leadership, members of the high performing teams were more likely to work toward the same goal more efficiently by taking advantage of their wide range of cultural and disciplinary skills and knowledge. The top-5 teams were able to meld their cultural differences to a certain extent, and embrace the universal values, in the eTournament which focused on the global SDG issues. Students of the high performing teams were no longer culturally centered, but moved beyond to respect others' culture (Babalola and Marques, 2013). The top-5 teams seemed to have won the eTournament by working productively with their diverse teammates toward the common goal (Babalola and Marques, 2013).

In contrast, for the bottom-5 teams where there were loose ties between the members, students with different cultural and academic backgrounds, were less committed and motivated to work together and contribute effectively (Bawa, 2017). Since the challenges of the eTournaments were about the 17 SDGs which were global issues affecting different parts of the world, simply focusing on one's own culture and certain field of knowledge would not get the competing teams far enough to win the game. Not only did the bottom-5 teams find it hard to form a productive team and then move to create effective gaming strategies with an effective division of labor, but the low performing team members also worked relatively individually while solving the SDG problems with their more limited exposure and knowledge (Salas et al., 2008). Failure to embrace diversity may have derailed the process of the low performing teams in pulling together the expertise of their members, leading to poor results in the eTournaments–a pattern found in both years.

The different gaming approaches adopted by the high performing and low performing teams as seen in their open text chat data seems to have determined their competitiveness gap in the virtual world of PaGamO where diversity and universal values were a determinant of success. Team capacity to move beyond forming to performing is needed in the real world, especially when the world is getting more interconnected and challenges are much more complex than ever before. Students should be well-prepared by putting them into diverse teams where they could learn how to develop and sharpen their teamwork, communication and leadership skills so as to survive in this digital era, which comes with a brand new set of opportunities and challenges (Darbellay, 2015).

Lastly, the similar percentage frequencies of Personal Learning keywords in the chat histories indicate that members across all competing teams were able to learn individually. However, focusing on one's Personal Learning was not the most critical factor of success in the eTournaments, which required group work of individuals with cross-cultural and cross-disciplinary backgrounds. The eTournaments required each participating student to contribute proactively in a diverse team with his/her expertise and disciplinary knowledge, to complement the contributions of other members. This is the underlying value of adopting the 17 SDGs in the eTournament, since students could only win the game if they embrace the global values and put them into practice by working together. The CC-spirit always prevailed in the eTournament and was a critical element in differentiating the high performing and low performing teams.

In addition to the keyword frequencies, qualitative inspections of the chat histories data were completed to compare the teamwork of the high and low performing teams. **Table 3** shows the lines of histories having the word "answer" collected from the bottom- and top-5 teams in the 2020 eTournament. "Answer" was selected since it was categorized as Problem Solving and the keyword frequency of "answer" and its related keywords was 14.7% of all the Problem Solving keywords collected from the top-5 teams in contrast to just 10.3% of those collected from the bottom-5 teams. There were only 10 occurrences of "answer" in the bottom-5 teams (all are listed in **Table 3**), with most of them talking about the general gameplay of PaGamO. In contrast, there were 309 occurrences of "answer" in the 2020 top-5 teams, and examples of Problem Solving by working as a team ("planning and executing"), such as updating the teammates the answers of questions, and a more even division of labor compared to the low performing teams.

Table 4 shows the lines of histories having the word "land(s)" collected from the bottom- and top-5 teams in the 2020 eTournament. The word also categorized as Problem Solving was selected as that provided further contrast—the keyword frequency of "land" and its related keywords was 13.5% of all

TABLE 3 | Lines of chat histories with the keyword "answer" appeared in the 2020 bottom- and top-5 teams.

Bottom-5 teams: 10 occurrences		
	… energy recovers fast	answer attack ic ill baatar maro select maro
	score check welcome guide bu moodle correct	answers difficulty weightings added land tiles end stage
	actually difficult keep log questions correct	answers game allow copy paste yeah started nice
	2 character money also obtained getting correct	answer passive money generation reems better
	check actually like quiz want something game	answer question first questions like age empire war
	teams compete pagamo gamified learning platform	answering questions related 17 SDG
	everytime wants occupy place damage related	answer speed one get money upgrade
	awarded a larger amount of money for	answering the question. s. Thus, I feel that
	Thus, I feel you can	answer questions and find member
	However, 1 thing note is	answer questions requires energy as well
Top-5 teams: 309 occurrences—only examples shown		
Planning and executing (Sharing answers)	I forgot letter, but	answer "Climate change"
	checked last years winners. I think	answering a lot questions will let us
	I mostly playing SDG 3 and sharing	answer. And <name> and <name> sharing answer
	I have some	answers for sdg 1,2,3 normal. For some I know
	remember put correct	answers google sheet,

Note: Function words which are irrelevant to the analysis were removed from the lines above.

TABLE 4 | Lines of chat histories with the keyword "land(s)" appeared in the 2020 bottom- and top-5 teams.

Bottom-5 teams: 13 occurrences		
Planning and executing (Strategy)	game energy use action like attack training	land divided different tiers upgrade hp increase
	seems energy important enough energy u spam	land get land even high goes amir
	example bataar maro effectively acquire	land got high attack life respectively 1 stage 2 star
	hahaha btw ideas happens take person	land logged back attacking 1 left haha dunno actual
	speed one get money upgrade	land occupied sure whether money shared clarify goal
	first open trial account try attack train	land ofc content trial account sdg better look
	haven't done sure taking person	land team 24 hope attack back next time log
	correct answers difficulty weightings added	land tiles end stage 2 land upgrades terrains monsters
	difficulty weightings added land tiles end stage 2	land upgrades terrains monsters end stage 2 3 bonus
Monitoring and reflecting (Reporting status)	surrounded someone giant	lands lol tried friends far working think
	yeah	land came back yesterday wake late
	sorry late reply main	land china know cannot receive message immediately
	btw add name mistakenly respawn	lands gone hahaha sad idiot lol btw energy
Top-5 teams: 440 occurrences—only examples shown		
Planning and executing (Strategy)	Student_3, yea build a	land bridge and more contact with the big guy
	is more worth it to get more	lands, and place eggs if anyone is going
	Student_2, Fight together and take as much	land as possible,
	we can start expore our neigboring blue	land as well.
	Recomendation for attacking: Attack all unowned	land first. Then once there is no longer
	So far I can see <name>	land as well, which is not far away
	Haha, just fight her weak	lands
	Just to ensure we have	lands to left even if we lose some.
	once there is no longer any unowned	land, we attack the enemy's weaker lands.
	You should take over the inner	lands which belongs to your enemy
	<name> may just focus on getting others'	land while other teammates attack others+protect our
Monitoring and reflecting (Reporting status; encouraging teammates)	Wow, <name> has 70	lands already
	He took my 8	land and I took 2 back .. energy is getting
	One guy beside me just got all	lands from another guy
	a new "neighbor" of mine invaded my	lands, guys mind territories new neighbor
	ask you how you got so much	land
	Student_3, I saw you have more	land .. good going
	really amazing!! still trying to get more	land, guys really amazing

Note: Function words which are irrelevant to the analysis were removed from the lines above.

the Problem Solving keywords collected from the 2020 top-5 teams compared to only 6.1% of those collected from the bottom-5 teams. There were 13 occurrences of "land(s)" in the bottom-5 teams, with 8 of them related to "planning and executing" (strategy) and the remaining showing "monitoring and reflecting" (report of status). On the other hand, there were 440 occurrences of "answer" in the

2020 top-5 teams, with examples of "planning and executing" (strategy; some even showed updates to strategies as per the actual game situation), "monitoring and reflecting" (report of status and encouragements of teammates on achievements), could be seen. These seem to provide further evidence of effective teamwork among the high-performing teams.

This study is limited by the duration for the eTournament, which was extended to 11 days in the 2020 run, but still seemed to be short for observing and collecting evidence of online teamwork. More prolonged activities and studies (e.g., inviting the teams to plan and implement an initiative related to the SDGs for say, 6 months) could be carried out in the future for more comprehensive observations and analyses.

Secondly, while the text mining with a keyword framework of words allocated into categories helped in providing some insights of various aspects of online teamwork, there is a strong possibility that the keywords collected in the actual context of the eTournaments, may not convey all of the potential implications, due to the complexity of natural language. Text mining with the facilitation of natural language understanding is a promising future direction of research.

CONCLUSION

The world is getting more interconnected than ever before, and challenges are becoming more complex. The 21st century has brought us not only the technology for collaborating with anyone, anywhere but also global, complex issues. Hence, it is important to help students develop online teamwork skills, particularly when they are required to work online with unfamiliar peoples of diverse backgrounds.

As a project highlight of the CCGame Project, the eTournaments improve upon existing pedagogical practice through gamified global digital learning challenges. The game-based challenge was effective to arouse students' curiosity and desire to learn by making central the solving of SDG-related problems to win the eTournament as a team goal for a team with cross-disciplinary and cross-cultural members.

The technological advancements coming along in the digital era have made it easier to pull together talents from different parts of the world to solve global challenges of common concern. The different gaming approaches adopted by the high performing and low performing teams in this study showed that students on digital teams had a much higher chance of problem-solving success when they were able to embrace and leverage the diversity among themselves. Members of a successful diverse team were able to harness the benefits of the presence of a wide range of exposure, knowledge and skills available in the team to effectively tackle the global challenges of the 21st century. Simply working alone and focusing only on one's personal learning or capabilities will not get an individual far enough in his/her career and personal development. Team leadership that unleashes the potential of diverse teammates, including effective division of labor, is crucial to the success of a diverse team. Educators could provide more activities on team building, conflict management and cultural differences, to facilitate students to leverage teamwork via online means.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Committee, Hong Kong Baptist University. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

ML, RV, and LM developed the manuscript with the support and advice from all other authors. The literature review was conducted by ML and LM. All authors contributed to the design and implementation of the research.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

APPENDIX

Keyword framework created for this study.

Category	Keywords and synonyms
Collaboration	lead/leader/leadership/leaderships/squad/squads form/forms/formed/formation/group/groups/grouped/member/members/role/roles/team/teams/teamwork email/emails/e-mail/e-mails/facebook/fb/id/instagram/ig/line/mail/messenger/moodle/phone/skype/snapchat/snap/ telegram/tg/wechat/whatsapp call/called/calls/chat/chats/chatted/contact/contacts/contacted/discuss/discusses/discussed/discussion/discussions/ join/joins/joined/meet/meets/met/message/messaged/messages/share/shares/shared/speak/speaks/spoke/spoken/talk/ talks/talked aim/aimed/aims/hope/hopes/hoped/intend/intends/intended/intention/intentions/mission/missions/objective/objectives/ target/targets aid/aids/advice/advices/advise/advises/advised/guide/guides/guided/guidance/guidances/recommend/recommends/ recommended/recommendation/recommendations assist/assists/assisted/assistance/contribute/contributes/contribution/contributions/help/helps/helped/support/supports/ supported/division of labor/division of labor anticipate/anticipates/anticipated/altogether/expect/expects/expected/expectation/friend/friends/hope/hopes/look forward/looking forward/together/wish/wishes agree/agrees/agreed/disagree/disagrees/disagreed
Personal learning	idea/ideas/game/games/method/methods/purpose/purposes/rule/rules/strategy/strategies/strategize/strategizes/ strategized/strategise/strategises/strategised/suggest/suggests/suggested/suggestion/suggestions choice/choices/choose/chooses/chose/chosen/conclude/concludes/concluded/conclusion/conclusions/decide/decides/ decided/decision/decisions/option/options/pick/picks/picked/picking/select/selects/selected/selection different/difference/differences build/builds/built/brainstorm/brainstorms/brainstormed/brainstorming/create/creates/created/feel/feels/felt/guess/ guesses/guessed/mean/make/makes/made/plan/plans/planned/planning/think/thinks/thought/thoughts believe/believes/belief/believed/know/knew/known/knows/knowledge/facts/fact/learn/learned/learnt/learns/learning important/key/main/major/principle/principles attempt/attempts/attempted/check/checks/checked/try/tries/tried begins/begin/begun/start/starts/started confirm/confirms/confirmed/confirmation/confirmations/certain defense/defences/defense/defenses/defend/defended/protection/protect/protects/protected experience/experiences/experienced/interest/interests/interested/interesting
Problem solving	action/actions/attack/attacks/attacked/expand/expands/expanded/expansion/invade/invades/invaded/invasion/spam/ spams/spammed/ energy/occupy/occupies/occupied/play/plays/played/upgrade/upgrades/upgraded/loss/losses/lose/loses/lost acquire/acquires/acquired/assault/assaults/assaulted/capture/captures/captured/train/trains/trained/ complete/completes/completed/end/ended/ends/final/finalized/finalized/finalize/finalize/finish/finished/finishes/score/ scores/scored/rank/ranked answer/answers/answered/correct/incorrect/mistake/mistakes/reply/replied/replies/response/responses/respond/ responded/right/wrong/ attainable/achievable/doable/feasible/possible/practicable/work/works/worked/workable unattainable/unachievable/undoable//infeasible/impossible/impracticable/unworkable content/contents/detail/details/info/information/ dig/dug/digging/explore/explored/explores/find/finds/found/google/googled/search/searches/searched/searching/ yahoo/bing ground/land/lands/multiplier/multipliers/penalty/penalties/sea/seas/terrain/terrains/territory/territories/tile/tiles/wealth days/hour/hours/hp/limit/limits/limited/minute/minutes/months/period/range/seconds/time/times/weeks recover/recovers/recovered/recovery/win/won/fail/failed advantage/advantages/disadvantage/disadvantages/aggressive/conservative sdg/sustainable development goals/goal/goals

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The Design of a Gamified Responsible Use of Social Media

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Social media is part of almost everyone's daily life. Its networking facilities redefines the way people connect and interact with each other. However, social media is reported being misused in different ways, especially the millennials. There is a need to elevate the teens' level of empowerment on the responsible use of social media. Other technological innovations like augmented reality (AR) and digital gamification provides pedagogical benefits. Digital gamification in the classroom is a teaching strategy that translates content and delivery into a game using digital technology. On the other hand, AR is an emerging technology to enlarge real-life situations in multimedia. Research shows both technologies increase interactivity well as attention span among the learners. Additionally, these technologies, including social media, are among the many useful tools in teaching twenty first century learners once correctly used. With this, a game-based mobile application was developed to advocate responsible use of social media among teens. The learning content was gamified in augmented reality to provide an innovative teaching and learning way at Silliman University. This paper describes the gamification design of the learning trail on the topic of responsible use of social media. Specifically, it presents the publishing process of the augmented reality mobile application about responsible use of social media. Kuhlmann's 3C Model (Challenge, Choices, Consequences) was utilized to formulate the learning content. It also demonstrates the design phases, game mechanics, and the general evaluation of the learning application. Four challenges were developed. These are (a) be familiar with security and privacy policies, (b) do not express concerns about others, even if you think you are anonymous, (c) respond to digital offenders, (d) do not tell the world about an upcoming vacation. These challenges were translated into graphics and animations. The animated material was compiled, programmed, and published to a server of the mobile application. The gamified learning trail on responsible use of social media is accessible through QR codes leading to the augmented reality interface. The design was validated and found to be relevant and engaging.

Keywords: gamification, ICT in education, whole-person education, augmented realitiy, e-learning

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INTRODUCTION AND LITERATURE REVIEW

Technological advancement is rapidly increasing, which affects humanity. It affects how people think and interact and how people live and decide. Among the emerging of today's technological innovations that redefine online activities is social media. Social media usage is rising. An ∼3.6 billion people were using social media globally in 2020 and are projected to

rise to almost 4.41 billion in 2025 (Clement, 2020). Likewise, the GlobalWebIndex's flagship report on social media in 2019 stated that 98% of consumers had used a social media network in the past month; being an internet user means being a social media user (GlobalWebIndex., 2019). It also reported that 63% of people feel most comfortable sharing and talking about messaging apps. It also reported that 60% of internet users said they had watched a video on Facebook, Twitter, Snapchat, or Instagram in the past month.

Interestingly, the Philippines ranked first in terms of user engagement. An average time per day spent is 4 h and 1 min, twice the amount of time spent by U.S. users (Clement, 2020). These global reports illustrate how social media changes how people communicate and how information is shared. It can also be asserted how people, especially the Filipinos on how engaged they are and how they use social media. Webster's dictionary defines social media as "forms of electronic communication through which users create online communities to share information, ideas, personal messages, and other content."

Studies have shown the pedagogical benefits of social media in learning and education. Social media applications "support the acquisition, access, manipulation, processing, retrieval, presentation, and visualization of information within a teaching/learning space [White et al., 2014]." Sheldon (2015) summarized the benefits of social media education surrounding student-centeredness, interactivity, customization, collaboration, access, engagement, creativity, and support system, among others. Social media applications encompass wikis, blogs, microblogs, online groups, forums, podcasts, video-sharing, web mashups, virtual worlds, community sharing, social repositories, social tagging, bookmarking, and many more.

Gamification is defined as "the process of adding games or game-like elements to something so as to encourage participation" [Merriam-Webster. (n.d).]. "Gamification is using game-based mechanics, aesthetics, and game-thinking to engage people, motivate action, promote learning, and solve problems" (Kapp et al., 2013). Fuchs et al. (2014) rethinks gamification as the "permeation of economic, political, and social contexts by game-elements such as awards, rule structures, and interfaces that are inspired by video games." Gamification involves three general principles: mechanics, dynamics, and emotions (Robson et al., 2015). Further, gamification is a teaching strategy that generally translates content and delivery into a game in the form of "points, badges, and leaderboards as incentives and motivations to be productive" (Fuchs et al., 2014). There are two general types of gamification in education. These are structural and content gamification with the primary intention to achieve learning outcomes through content, stimulate action, influence behavior, and drive innovation (Kapp et al., 2013). Among the popular frameworks in assessing gamification's effectiveness in teaching and learning includes the Kapp Framework, Csikszentmihalyi's Flow Framework, and Student Intrinsic Motivation for Persistence in Learning Environments Matrix (Bell, 2018). Studies show that gamified content are more lifelike when applied with augmented reality.

Augmented reality (AR) is defined as "a wide spectrum of technologies that project computer-generated materials, such as text, images, and video, onto users' perceptions of the real world" (Chi-Yin Yuen et al., 2011). It is depicted as "enhancement of the real world by computer-generated content which is tied to specific locations or activities" (Krämer, 2017). Wu et al. (2013) asserts that instructional approaches in AR must emphasize the roles, tasks, and locations. Forms of AR include marker-based, markerless, projection-based, and superimposition-based [Profiletree.com. (a)., 2020], which generally comprises displays, input devices, tracking, and computers (Carmigniani and Furht, 2011). Augmented reality in the classroom is usually coupled with mobile technology because it is low cost and easy to integrate appropriate to the course and education type. Gu and Duh (2011) concluded that mobile-based AR in education must emphasize performance, portability, and extendibility. Among the most common technology in augmented reality application is QR (Quick Response) code.

This paper describes the gamification design of a learning trail on the topic of responsible use of social media. Specifically, it presents the publishing process of the augmented reality mobile application about responsible use of social media.

BACKGROUND OF THE PROJECT

The Project

The project is about gamifying teaching delivery about the topic "responsible use of social media." The game is mobile-based that runs in both iOS and Android operating systems. It is a learning trail. The project is one of the research's deliverables, "Integrating Augmented Reality and Gamification in Silliman: An International Partnership to Improve Student's 21st-Century Skills." The research is funded by the United Board for Christian Higher Education, a non-governmental organization that is "committed to education that develops the whole person—intellectually, spiritually, and ethically." The project is also in partnership with the Centre for Holistic Teaching and Learning, Hong Kong Baptist University.

The Learning Goal and Outcomes

The game is an innovative integration of maximizing digital technology into teaching instruction in a fun, enjoyable, exciting, and entertaining way among the students at Silliman University. It comes into two-interrelated general goals. First, it aims to educate students about responsible use of social media. Specifically, the game allows students to think critically and decide the best action of becoming a responsible social media user. Likewise, the game presented a checklist of dos and don'ts in social media utilization. The game's second goal is to orient students, especially the freshmen, about the university library system. Specifically, the game offers showcase four (4) locations and services in the library. At the end of the game, players are expected to understand better becoming responsible digital netizens. Likewise, players are also expected to familiarize some of the library services of the University.

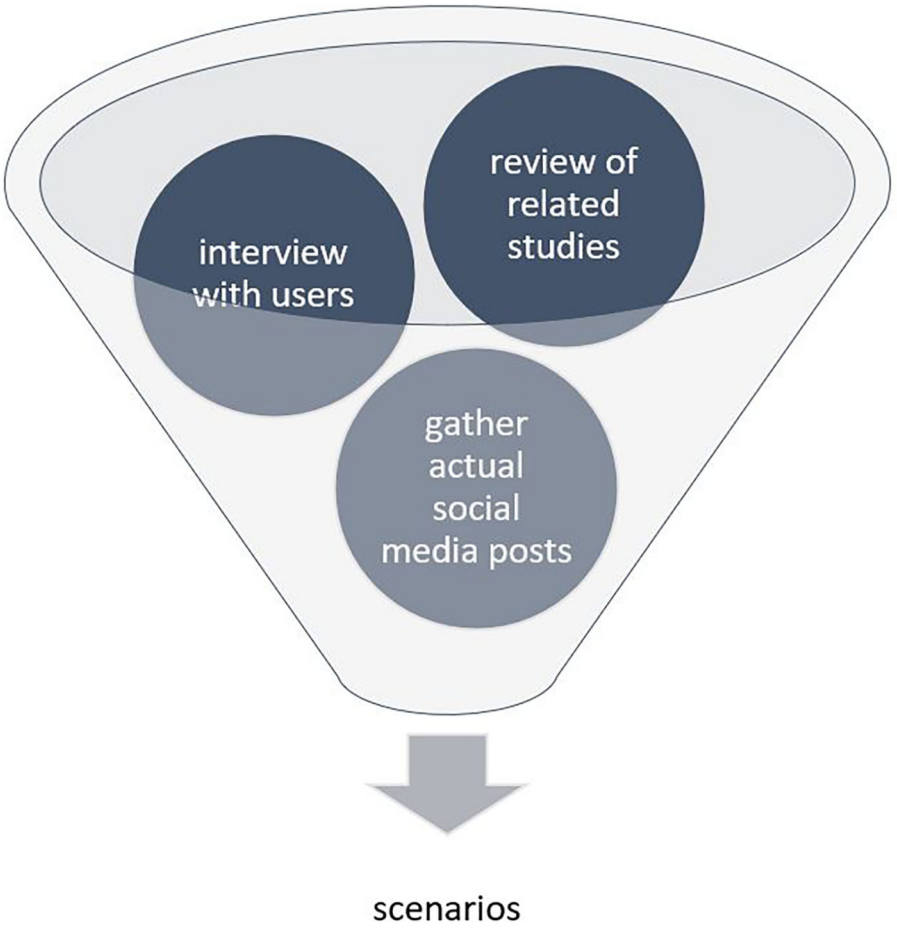

FIGURE 1 | Scenario Analysis.

Why "Responsible Use of Social Media?"

While social media provides vast educational opportunities, technology is among the many risk sources to everyone, especially the millennials. Studies show that teenagers are more engaged in social media. In a Statistica survey of 13–17 years old, 16% of teens admitted checking their social feeds nearly constantly. Another 27% do so on an hourly basis (Richter, 2018).

"Young digital citizens in the Asia Pacific region experienced a multitude of risks posed by ICT such as cyberbullying, fake news, spamming, internet or technology addiction, health and wellness issues, identity theft, fraud and scams, pornography, and online sex trafficking." (UNESCO, 2018) In a survey of about 1,500 young people ages 16–24 [Royal Society for Public Health. (n.d)., 2019], 91% of 16–24-year-olds use the internet for social networking, 7 out of 10 young people report experiencing cyber-bullying through social media, 37% of young people report being cyber-bullied on a high-frequency basis, young people are twice as likely to be bullied on Facebook than on any other social network. Approximately 5% of young people around the world suffer from social media addiction. In another survey among 1,000 kids age 13–17 in 2018 (Common Sense Media., 2018), 57% of all teens agree that using social media often distracts them when they should be doing homework. The study also revealed that teens do not value face-to-face communication with friends as much as they used to do. Further, some of the destructive effects of social media on children and teenagers include hate speech, social distrust, cyberbullying, identity theft, cyber-stalking, explicit or violent imagery, sharing too much, online grooming, emotional implications, and lack of interpersonal skills (Techno Crazed., 2014).

The #StatusofMind report by RSPH and the Young Health Movement (YHM) listed the 14 health and well-being-related issues of social media. These are awareness and understanding of other people's health experiences, access to expert health information you know you can trust, emotional support, anxiety, depression, loneliness, sleep, self-expression, self-identity, body image, real-world relationships, community building, bullying, and FOMO (Fear of Missing Out) [Royal Society for Public Health. (n.d)., 2019].

There is a need to give attention to this emerging issue among the youth. Likewise, every educator's job is to guide and educate the youth about the risk of too much engagement with social media. There is a need to deepen our advocacy on digital

FIGURE 2 | Kuhlmann's 3C Model (Challenge, Choices, Consequences).

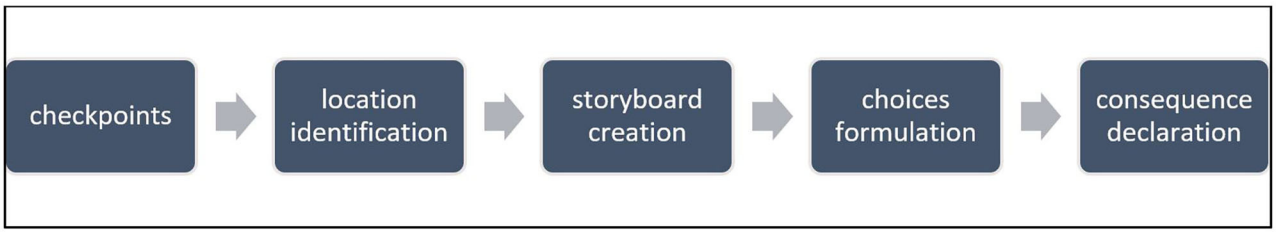

FIGURE 3 | Designing Challenges, Choices, and Consequences.

citizenship and social media's responsible use before these youth will be obsessed. Their health and well-being will be affected.

THE INSTRUCTIONAL DESIGN

The topic "responsible use of social media" discusses the subjects Empowerment Technologies in senior high school, Computer Ethics, and other degree-based computer fundamental courses at tertiary level. A micro-learning approach was utilized in designing the learning content, which emphasizes precise tips in becoming a responsible user of social media.

The ADDIE model was utilized in the conduct of the overall instructional design. These processes include: Analysis, Design, Develop, Implement, and Evaluate.

The Analysis Phase

During the analysis phase, the team is guided with the principles of the Forrester Problem Analysis Method—problem definition, evidence, impacts, causes, and recommendations (Gonsenhauser, 2017). Specifically, an intensive review of related studies was conducted about digital citizenship, netiquette, and responsible use of social media. Ten 18-years old students were interviewed about their knowledge, attitude, and practices toward social media. The team also checked several online groups, online forums, and online fan pages on Facebook, Twitter, and other independent blogs. The team checked on the actual postings that are perceived as fake, unwanted, offensive, and unbecoming. News and other press releases in local and foreign periodicals about the reckless use of social media were also reviewed. For example, posted on PhilStar.com, "NBI summons Mocha for fake news" (Cayabyab, 2020). This process is illustrated in **Figure 1**.

The Design Phase

Scenarios, also known as checkpoints, were identified. Each checkpoint consisted of a situation, options to select, and aftereffect, based on Kuhlmann's 3C Model (Challenge, Choices, Consequences), shown in **Figure 2**. The 3C model is an interactive scenario-building where "each scenario consists of a challenge, some choices, and then consequences of those choices" (Kuhlmann, 2009). It aims to challenge the learner's understanding or assumptions. The model shows choices for the learner's decision making. In every decision made, a consequence is provided for feedbacking and guidance.

TABLE 1 | Scenario 1.

Checkpoint 1	Be familiar with security and privacy policies
Location	Ground floor, Entrance, Main Library
Challenge	Max meets Marah at the main entrance of the main library. Marah told Max to create a Facebook account as one of the requirements in the Social Networking Class. So, Max created an account. If you were Marah, what advice would you give to Max being a first-time user of Facebook?
Choices	Consequences
1. Be selective with friend requests. If you do not know the account or the person, do not accept their request. It could be a fake account. Likewise, do not add to your network your parents too. They will monitor you.	1. Being selective to friends' requests is one of the responsible uses of social media. Do not add fake accounts. You should be aware that what you posted will stay forever. Do not post anything that you do not want your future employers to see something negative. However, do not block your parents. Research suggests that parents should follow their children online. This ensures oversight in case there are an issue and a "check and balance" of content.
2. Set up your security answers. Use the default password given by the school personnel.	2. No! Always use a strong password. The longer it is with a combination of numbers, letters, and special characters, the more secure it will be. Passwords must be unique and must be different from your other social media accounts. An additional measure is to password protect your device.
3. For easy recognition, reveal your information like residential address, financial details, phone number. The more details and information you post, the easier it is to have your identity known.	3. Be extra careful about what you posted and share. Do not reveal sensitive personal information such as a home address, bank account details, phone number. The more details and information you post, the easier it is to have your identity stolen and taken.
4. Become familiar and conversant with the privacy policies of the social media channels you use and customize your privacy settings to control who sees what.	4. This is excellent advice! Read thoroughly the privacy policies of the social media channels you use and customize your privacy settings to control who sees what. Be selective to friend's requests, but do not block your parents, siblings, and family members. Be accountable. Always remember that there is no such instance or thing as 100% private online. Use social media meaningfully to showcase your aptitude.

TABLE 2 | Scenario 2.

Checkpoint 2	Do not express concerns about others, even if you think you are anonymous
Location	2nd Floor, CyberLibrary, Main Library
Challenge	Max is browsing his new Facebook account. He saw a public post of his best friend Giorjoe, a freshman student, complaining about their class's particular requirement, and vented frustrations about the teacher's favoritism. Max remembered that he felt the same feelings when he was enrolled during the said teacher last year. Max failed in this class too. If you were Max, what should you do to help Giorjoe immediately?
Choices	Consequences
1. Chat with Giorjoe privately and ask him for a meet-up to discuss the matter.	1. You are a responsible social media user. Use social media as a means to interconnect and communicate effectively and efficiently. Social media is not a platform to complain, protest, criticize, or vent your frustrations. Be a source of useful and relevant information. Do not gossip! Always remember to THINK about what you are going to post. T—is it Truthful, H—does it Help? I—does it Inspire? N—is it Nice or Necessary? K—is it Kind?
2. Comment on Giorjoe's post and express your concerns by telling Giorjoe about what you went through.	2. That is not a responsible method of using social media. Do not use social media to complain, protest, or criticize. Do not use social media platforms to vent your frustrations. Do not use social media to express your concerns about others, even if you think you are anonymous. Always remember to THINK about what you are going to post. T—is it Truthful, H—does it Help? I—does it Inspire? N—is it Nice or Necessary? K—is it Kind?
3. Share and forward the post to your friends without commenting.	3. That is not a responsible technique of using social media. Be wary of oversharing; remember that digital footprints stay forever. Be a source of useful and relevant information. Your friends and networks do not need to know every emotion you or your special friends have. For sure, you do not want to be an accessory to any crime. Ask yourself about these questions before sharing: Is the post TRUE or a rumor? Is the post HELPFUL or harmful? Is the post NEEDED or irrelevant?
4. Create a group chat with Giorjoe and your classmates and ask them to share their experiences with the teacher.	4. That is not a responsible mode of using social media. While it is true that group chat is a great way to engage with your friends on a personal and intimate level, you should ask yourself as the creator of the group: Is the post HELPFUL or harmful? Is the post INFORMATIONAL or gossip? Is the post KIND or harsh? As the saying by Frank Clark: "Gossip need not be false to be evil—there is a lot of truth that should not be passed around."

In the responsible use of social media AR Trail, challenges are presented into a set of questions for the players to learn about a particular situation, dilemma, or problem. Likewise, choices are presented as guided decisions for the players to consider critically. Lastly, the consequences are reinforcement, recommendations, and suggestions for the outcomes.

TABLE 3 | Scenario 3.

Checkpoint 3	Respond to Digital Offenders
Location	2nd floor, Makerspace, Main Library
Challenge	Around 9 p.m., Max is in the maker space editing a video blog that he took in the computer laboratory yesterday. While editing, he found out that he accidentally captured a student who put one computer tablet inside the bag, then walked out of the laboratory. Unfortunately, the face is not clear in the video. Based on the body structure and color of the shirt, Max suspected that it was Alan, his classmate, last semester. If you were Max, what would you do?
Choices	Consequences
1. Just delete the video, continue editing the vlog. Remain silent and be neutral.	1. Do not ignore situations like this. You can be a responsible netizen to make our world a better place. As a student, you are expected to be helpful in your little way. One of the responsibilities that come with digital citizenship highlights the need to respond to digital offenders to help solve the offense.
2. Contact the laboratory personnel about what you captured for them to investigate. Email the file to them.	2. Good Job! You are a responsible social media user. One of the responsibilities of digital citizenship highlights the need to respond to digital offenders that can help the offense. Nevertheless, it does not entail investigating on your own. It merely requires that you report the offender to concerned offices or, if necessary, to the proper legal authorities.
3. Send a private message to Alan and verify from him if it was him in the video.	3. Do not message him. As a responsible netizen, be more sensitive. You may be misinterpreted if you confront via instant-messaging. One of the responsibilities of digital citizenship highlights the need to respond to digital offenders that can help the offense. However, it does not entail investigating on your own. Understand your limitations.
4. Post the video on your FB with the caption, "Do you know this culprit?"	4. You are not a responsible social media user. Do not post videos that are "disruptive, threatening, profane, abusive, harassing, embarrassing, tortuous, defamatory, obscene, libelous, or is an invasion of another's privacy." It will not help the situation. It may worsen the situation. After all, you only captured a few seconds of the situation. You did not know the real story.

TABLE 4 | Scenario 4.

Checkpoint 4	Do not tell the world about the upcoming Vacation
Location	3rd floor, Fiction Nook, Main Library
Challenge	While Max is reading a fiction book, he receives an SMS message from his Dad, informing him that they will have a family tour in Paris. It is going to be the first time for Max to travel internationally. Which of these acts is a good idea for becoming a responsible social media user?
Choices	Consequences
1. Max tweeted, "so excited! All of us, including my Nanny, will be seeing the Eiffel Tower on November 15, 2021. Goodbye house and see you on Christmas Day."	1. It is not wrong to share excitement online. However, do not reveal the details of your upcoming vacation on social media. Do not tell the world that your house is empty. Your home is susceptible to break-ins and damages. You have to wait until you return home before you post and share your travel memories.
2. Max posted a captured photo of their airline ticket and passport, showing his family's personal information.	2. It is not wrong to share your excitement online. However, posting a picture of your boarding pass might lead to cybercrimes such as identity theft, duplicate credit cards, account numbers were stolen, and even passwords. If you cannot help yourself by posting your ticket, avoid disclosing sensitive information, especially the bar code, by making it blurry from your picture.
3. Max conducted research and read some travel tips online, including negative testimonies about the tourist spots. He downloaded it and forwarded it to his parents.	3. Good Job! You are a responsible millennial. The internet is a powerful tool to gain information about places, geography, travel tips, etc. Online testimonies, blogs, forums, and groups are among the venues that you can filter relevant information. It is discouraged to shout out to the world that your house will be empty. Likewise, it is also not advisable to post your airline ticket and passport, showing any sensitive information. Posting a picture of your boarding pass or passport might harm you and your family. Let us all be careful about identity theft, duplicate credit cards, account numbers were stolen, and even passwords.

Figure 3 depicts the process of designing challenges, choices, and consequences. The team came up with four checkpoints. These are: (a) familiarizing security and privacy policies, (b) not expressing concerns about others, even if you think you are anonymous, (c) responding to digital offenders, and (d) not telling the world about an upcoming vacation. The Robert B. & Meta J. Silliman Main Library was chosen as the location of the trail. The library was chosen as the game's path, being the primary resource center of relevant and updated information and research. Four specific locations of the library were chosen with the assistance of the University Librarian. Storyboards were formulated, ensuring the application of cognitive, affective, and psychomotor domains in the intended outcomes. Services of the location of the library were also depicted in the scene.

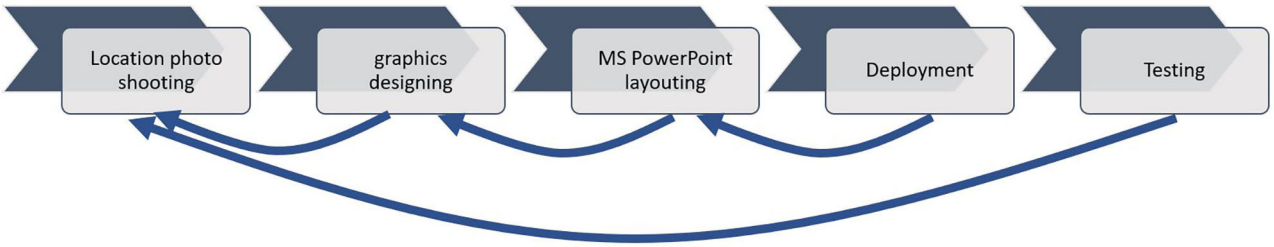

FIGURE 4 | Prototyping.

FIGURE 5 | User Interface for every checkpoint.

FIGURE 6 | User Interface of the Choices.

Formulation of choices was conducted. Choices are guided decisions for the player's consideration. In the responsible use of social media AR Trail app, there are at least three choices in each scenario. Guided decisions are based on related studies, articles, interviews conducted, among others. See **Tables 1–4** for the final version of the four scenarios.

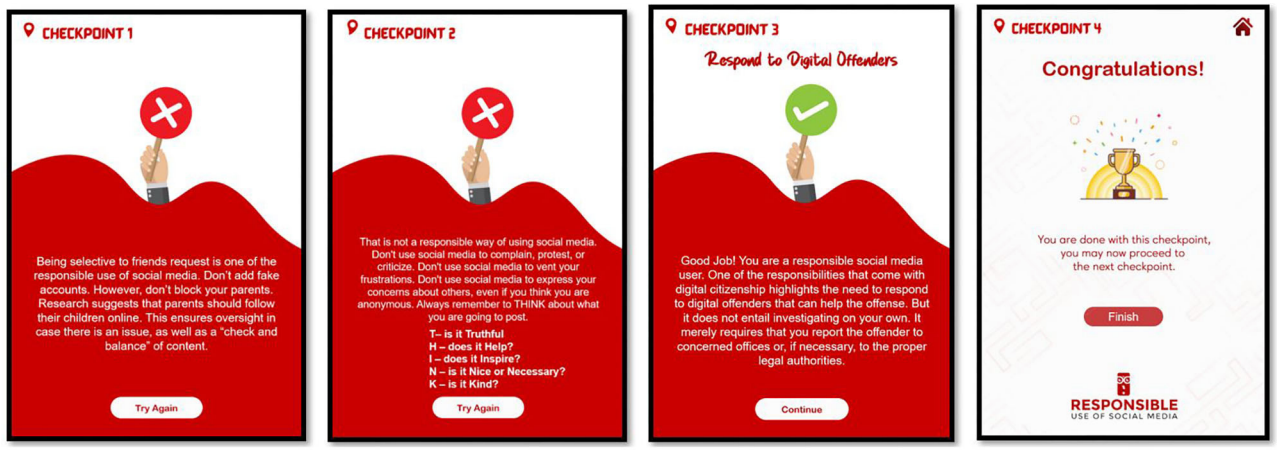

FIGURE 7 | The interface of a wrong and correct choice with the consequence.

The Development Stage

The team designed the prototype with an emphasis on user-interface and its friendliness, as illustrated in **Figure 4**. Photo shooting in the identified location was done with consideration of the data privacy of the persons involved in the photos. Other particular considerations during the prototyping development are the presence of the University's branding and user-friendliness. User-friendliness was made sure by following the templates of the mobile AR Trail app, which was developed by the Centre for Holistic Teaching and Learning, Hong Kong Baptist University (CHTL-HKBU). At least five iterations and versions of the design were created before deploying the application to the server. The CHTL-HKBU also hosts the server of the application.

The user interface was designed to be easy for the students and teachers to use and understand. Shown in **Figure 5** are sample screenshots showing the user interface for every checkpoint. In contrast, **Figure 6** are sample screenshots showing the user interface of the choices of every checkpoint. Sample screenshots of the interface of the wrong and correct responses are shown in **Figure 7**. The following were the considerations in doing the design interface:

1. Youthful and vibrant—when designing, specifically for college students, one must consider how to get the students' attention during an activity. Nowadays, student's participation depends on the content of their activities. If the content is youthful and vibrant, students tend to be very participative compared to a dull and plain-looking activity.
2. Applying Silliman's Identity—applying Silliman's identity to represent the University partaking in the said project. By using the official color of Silliman University, which is red, we were able to design a user interface that reflects the culture of Silliman University, thus, allowing students to spark devotion for their University, leading to more participation in doing the activity.
3. Easy-to-identify—To ensure that the design will impact the students' learnings, the design must be easy-to-identified. Some of the things are the characters being used and their expressions, the well-laid contents, and the story's flow.
4. Easy-to-use—considering the purpose of the project to provide students learning how to be a responsible social media user, using complicated design will only confuse the students and even the teachers. To contribute to the students' overall learning, we designed a system that is easy to navigate with the content making sure that even first-time users, players, will use the system well.
5. Originality—the essential part of designing the interface is all about one's originality. The more unique it is, the more it will spark curiosity in its users.

QR codes were generated for each checkpoint. These codes were printed and posted in the strategic areas of the identified location. Further, the team also did User-testing. The responsible use of social media AR Trail was also tested by ten students who were taking up the "Empowerment Technologies" subject. An orientation among the testers was provided inside a computer laboratory before the players were immersed in the actual location. Revisions were made based on the comments and suggestions of the testers.

The Implementation Stage

The responsible use of social media AR Trail was integrated into the subjects "Empowerment Technologies," "Educational Technology," and "Whole Person Education." A 4-day pilot utilization of the app was conducted among seven classes, with 280 students. The students performed the actual trail on four different locations in the library. A short briefing was conducted before the start of the actual game. The Informed Consent that is embedded in the application was also emphasized during the orientation.

The Evaluation Stage

Integrated into the game is a survey that is aimed to measure the overall player's experience. The questionnaire is composed of

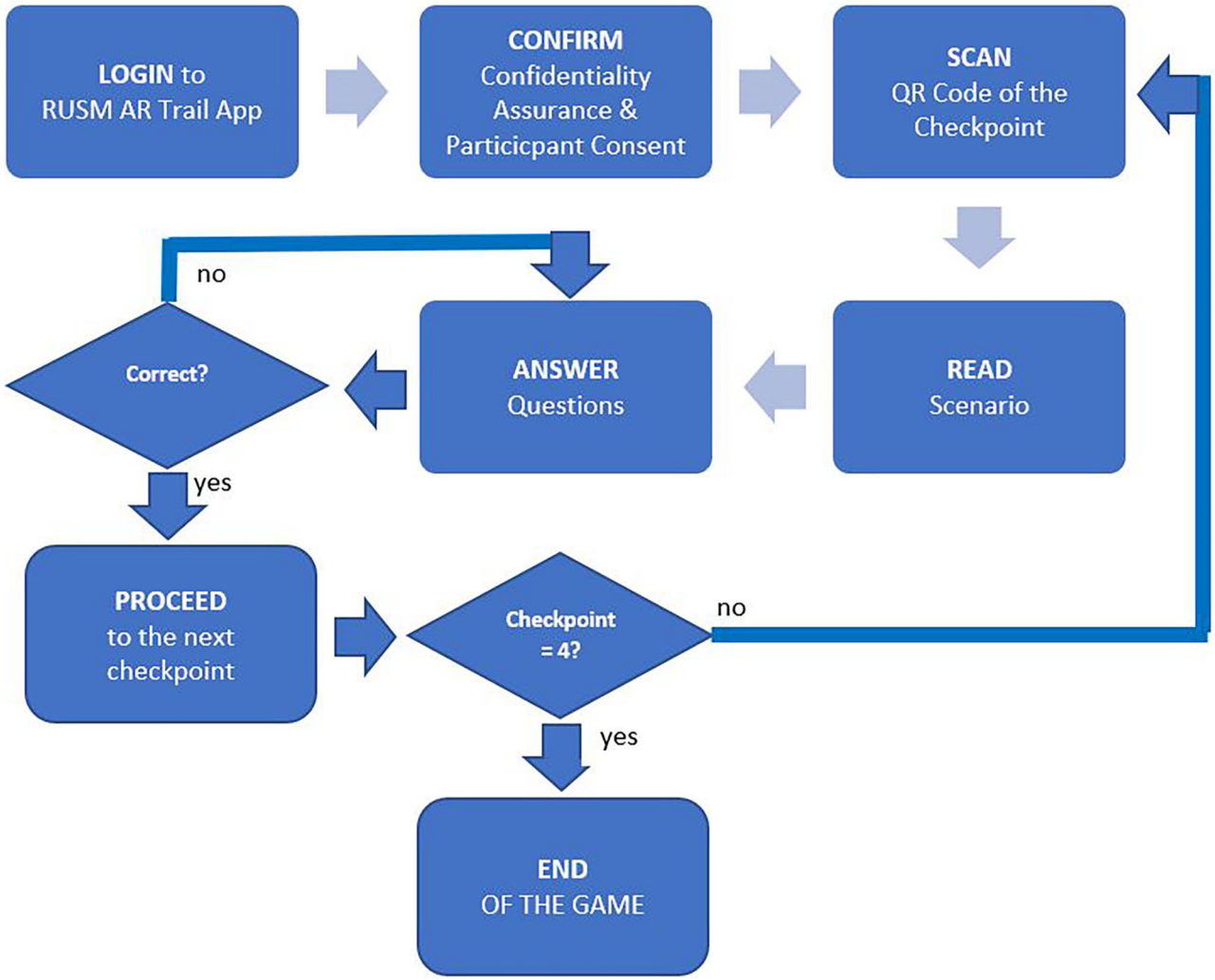

FIGURE 8 | Game Flowchart.

TABLE 5 | RUSM AR trail game mechanics.

Game mechanics	Description
Challenge	At the shortest time, the player must answer the four challenges about the responsible use of social media correctly
Reward	Each trail is translated into questions where players need to answer correctly to move on to the next location.
Competition	Several players can play the game at one time. A player who answered correctly at the shortest time will be declared the winner.
User engagement	The game can be played using a Smartphone, either iOS or Android applications. The payer needs to install the game. QR codes are utilized to interact with the game. The players need to follow the trail.

eight (8) statements. These are (a) I find this App easy to use, (b) My interaction with this App is clear and understandable., (c) This App makes learning responsible use of social media more interesting., (d) Working with this App is fun., (e) The WiFi connection is stable., (f) I learned a lot from the trail., (g) I would like my teachers to integrate apps like this in my classes., and (h) It is easy to accomplish the task mentally and physically using this app. Respondent-players were asked to respond using the 5 -point Likert Scales: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree.

A short processing activity through a focused group discussion was conducted a week after the game's actual use.

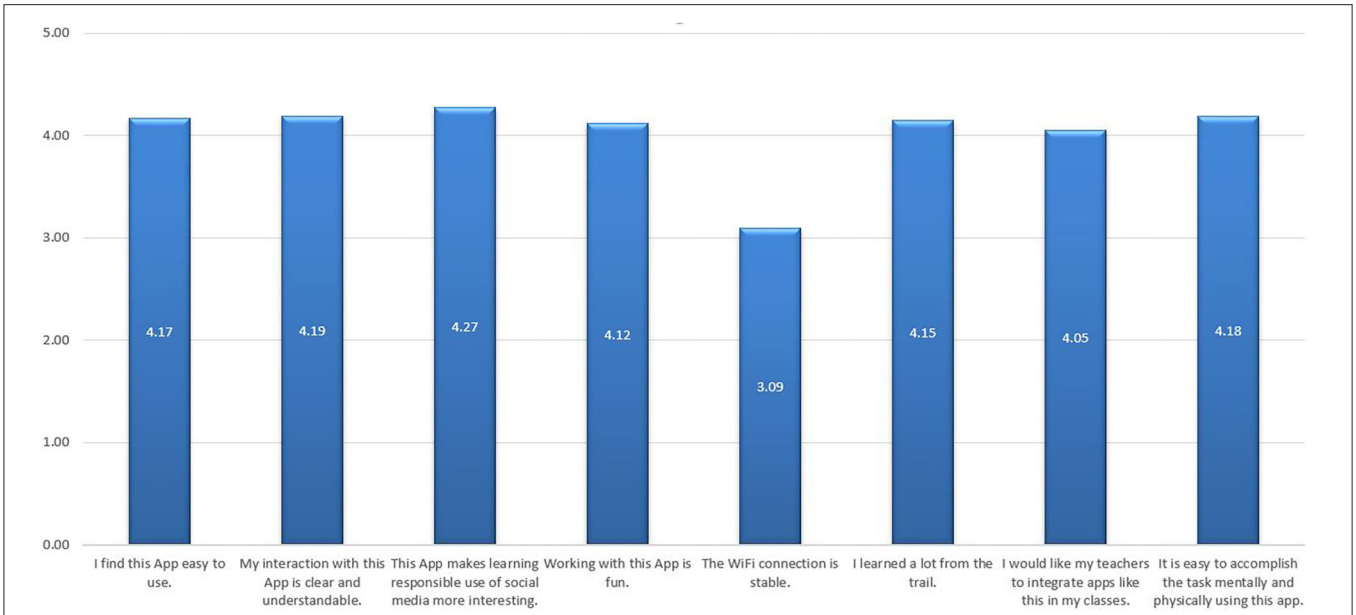

FIGURE 9 | Survey Evaluation.

It was aimed to capture qualitative evaluations that were not captured in the evaluation survey. The processing of the student's learning was conducted in the respective classrooms. A student in every class was asked to recite and share their experiences and lessons learned during the trail. Similarly, the 9 teachers who were part of the project team also evaluated and reflected the entire project implementation.

THE GAME MECHANICS

The game's goal is to get the correct answer to all the questions about becoming responsible for social media in the shortest time possible. Before the player can start the game, they have to confirm the confidentiality assurance and participant consent. Players need to scan the QR code of each location to view the augmented scenarios of each checkpoint. To follow the trail, the players should get the correct answer per challenge of the checkpoint. Otherwise, the player cannot proceed to the next checkpoint. There are four checkpoints, and each checkpoint is placed in different locations in the University Library. **Figure 8** is the flowchart of the game.

Four challenges were developed that emphasize (a) familiarity with security and privacy policies, (b) expressing concerns about others, even if you think you are anonymous, (c) responding to digital offenders, (d) telling the world about an upcoming vacation. These challenges were translated into graphics and animations. The animated material was compiled, programmed, and published to a server of the mobile application. The gamified learning trail on responsible use of social media is accessible through QR codes leading to the augmented reality interface. The design was validated and found to be relevant and engaging.

Table 5 is the summary of the description of the responsible use of social media AR Trail game mechanics.

THE GAME EVALUATION RESULTS

The overall mean of the evaluation is 4.03, described as "agreed." It implies that the game has elements that encourage student participation. It may also mean that the game has engaging factors that allow students to learn (Kapp et al., 2013). As shown in **Figure 9**, the student-respondents strongly agreed ($\overline{x} = 4.27$) that the app makes learning responsible use of social media more interesting. The respondents agreed that their interaction with the app is clear and understandable ($\overline{x} = 4.19$). The application is easy to accomplish the task mentally and physically ($\overline{x} = 4.18$). The app is easy to use ($\overline{x} = 4.17$) and the students had fun while playing ($\overline{x} = 4.12$). Most importantly, the students agreed ($\overline{x} = 4.15$) that they learned a lot about the AR trail. The students also agreed ($\overline{x} = 4.05$) to the statement, "I would like my teachers to integrate apps like this in my classes." This result implies that the AR and gamification as teaching strategies in the classroom are perceived positively and accepted. Expectedly, the Wi-Fi connection does not meet the expected stability to efficiently run the game app ($\overline{x} = 4.05$). The result also denotes that the project team successfully integrated well-designed game mechanics and dynamics (Robson et al., 2015). Likewise, the result signifies that the team successfully translated responsible use of social media content and delivery into a game that motivates students to learn (Fuchs et al., 2014).

Further, all seven students who shared during the focused-group discussions said they enjoyed a lot the whole experience and suggested continuing this activity in future classes. Moreover, all teachers said that the activity provided a new and innovative

way of learning and teaching at Silliman University. They said that the activity is responsive to the University's strategic trust in people, programs, and partnerships. The teachers also believed that the activity promoted multicultural knowledge-sharing and transfer. A teacher said

> *"Being involved in the project made me realize that latest trends in teaching pedagogy that is coupled with technology is really the "in thing" for the kind of learners that we have right now. So, for us teachers to harness our students' 21st century skills, we should also be open-minded to adapt and use the latest trends like augmented reality and gamification in our respective classrooms."*

CONCLUSION AND RECOMMENDATION

A gamified content of the topic "responsible use of social media" was successfully designed and well-developed. The Responsible Use of Social Media-AR Trail offers a highly satisfactory experience among the student-players as well as the teachers. The application comprises features that motivate students to learn in a fun and interactive way. The gamified application offers positive pedagogical benefits among the learners and students.

In general, the study impacted both the students and teachers. The study provided a new and innovative way of learning responsive to the demand of 21st-century learning. Likewise, it provided an opportunity for the teachers to be immersed in a technology-oriented teaching strategy. The study allowed the teachers to translate a topic into scenarios and challenges for critical thinking.

Designing an instructional augmented reality trail game must be carefully designed. A game application must be able to respond to the intended learning outcomes of the subject. Game designers and developers must possess a certain level of understanding of the content. Prototyping is a critical process to ensure that instructional components and game aspects are intertwined cohesively. It is recommended to add more scenarios that will depict situations depicting digital citizenships and whole-person education. Moreover, a thorough study should be conducted to quantify the application's learnings, skills, and achievements.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Centre for Holistic Teaching and Learning, Hong Kong Baptist University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Application of the Educational Game to Enhance Student Learning

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The purpose of this study is to investigate the use of an educational game to enhance student learning effectiveness. This study consisted of 56 college students majoring in physical education and recreation management (32 men, 24 women, age M = 21 years, SD = 1.72). Students used the educational computer game "PaGamO" to study the motor learning and development course. Students received rewards based on their individual and group "PaGamO" scores. Regression analysis indicated that "PaGamO" score was a significant ($p < 0.01$) predictor of multiple choice (MC) score in the final examination, there was a medium positive correlation ($\beta = 0.354$). The R^2 suggests that 12.6% of MC score was explained by "PaGamO" score. Quantitative and qualitative mixed-method approach was used to gain insights into students' perceptions and experiences of the educational game. The top three statements of a modified questionnaire from Riemer and Schrader (2015) are: (1) "*In my opinion, the use of 'PaGamO' enables me to better prepare for the final examination*" (*M = 5.04, SD = 1.41*), (2) "*In my opinion, the use of 'PaGamO' enables me to understand learning contents*" (*M = 4.8, SD = 1.19*), (3) "*In my opinion, the use of 'PaGamO' allows me to apply knowledge*" (*M = 4.75, SD = 1.08*). The top three motives to play "PaGamO" were "fun," "self-learning," and "want to get a higher grade in the final examination." By using gamification as a tool for learning and studying, students did find "PaGamO" effective for their learning experience. Both intrinsic and extrinsic participation motives are reasons why students play "PaGamO." Furthermore, due to its convenience, using mobile devices to play "PaGamO" is more popular than using computers and tablet devices. In conclusion, the combination of gamification and traditional learning methods can enhance students' learning outcomes.

Keywords: educational game, learning, self-determinated motivation, intrinsic motivation, perceptions

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INTRODUCTION

Gamification in education has become the focus of attention in recent years. While "gamification is the practice of using game design elements, game mechanics and game thinking in non-game activities to motivate participants" (Al-Azawi et al., 2016, p. 133), educational gamification is a teaching method that requires learners to participate in competitions according to preset rules (Fitzgerald, 1997). It has been an interdisciplinary and prevalent tool for educators to utilize in teaching in the past few years (Robson et al., 2016). In view of the rapid development of technology, learners may expect teachers/lecturers to employ this tool in lessons/lectures (Rondon et al., 2013). In the field of education, researchers have been eager to find new strategies to enrich students'

learning experiences, especially in this technology-driven world in which educational games are one of them (Minovic et al., 2012a).

Effectiveness of Educational Games

A systematic literature review had been conducted by Calderón and Ruiz (2015) who found that 53 educational games research literature had adopted different methods to assess the effectiveness of diverse educational games in the period between November 2013 and April 2015, compared to 18 and 20 games used in health and wellness, and the professional learning and training domain, respectively. They also reported that 60% of these 53 studies examined the effectiveness of using educational games in higher education setting, compared to only 40% in primary or secondary school settings, indicating that teachers in higher education are more likely to combine educational games with traditional teaching methods into students' learning experiences—a sign of creativity of embracing the new strategy to enrich students' learning experience.

Gamification has become popular in education in recent years. Its advantages include, but not limited to, giving students the opportunity to experience learning in a multi-sensory, active and experimental environment. Specifically, learners can use these educational games for experimental learning to develop their decision-making and problem-solving skills in a dynamic learning environment (Adachi and Willoughby, 2013). In addition, students can receive feedback/results immediately to get answers, instead of receiving delayed feedback from traditional assessment methods (e.g., tests and examinations). Moreover, some educational gamification may help to reduce limitations, including time and place, as portable devices can enable students to study and/or learn anytime and anywhere. These user-friendly tools can make difficult subjects easier to understand and memorize (Hanus and Fox, 2015). In other words, with the use of educational games, the learning process is considered to be more interesting (Calliari, 1991), motivating (Sun-Lin and Chiou, 2019), achieving knowledge retention (Gros, 2007), increasing attention (Prensky, 2003), and can even enhance peer communication and social skills (Liao et al., 2011).

Although extensive research supports the use of educational games to help improve students' learning experience, it has been found that young students are more likely to be inattentive (Wickens, 1974), and the use of educational games, among the many other solutions, to alleviate the issue may become helpful. Research shows that students' attitudes toward learning, class attendance and mood were more positive when compared to primarily using traditional methods of teaching and learning (Vernon and Blake, 1993). It is believed that in the learning process, when students have the opportunity to participate in decision-making, they are more likely to enjoy learning because they regard "learning" as "playing" (Zapalska et al., 2012). Even though as children grow older, their attention and concentration may correspondingly increase (Wickens, 1974), it is important to ensure that students' learning motivation can remain at a high level. In other words, by using educational games during lectures or teaching, students will be required to focus on the teaching content in order to successfully complete the tasks in the game, whilst their learning motivation may remain high due to the inclusion of game elements in the learning process.

However, the advantages of using gamification in education does not necessarily mean it would receive overwhelming advocacy, as it had produced some mixed results (Hanus and Fox, 2015). Whitton (2007) even documented that their participants did not find educational games motivating or interesting, elucidating that since individuals normally play games for entertainment purposes, the deployment of gamification in educational environments/settings may not produce the same motivational effect. If individuals have the option of either playing educational or casual games, they are more likely to choose the latter (Karakus et al., 2008), because they may perceive educational games to be dreary (Kinzie and Joseph, 2008). Furthermore, participating in educational games may even have detrimental effects. According to Dominguez et al. (2013), the utilization of education games was associated with a decline in academic performance.

While the fun side of gamification has counterbalancing effect to learning motivation is not yet known, an educational game is fun and/or motivating, and ultimately effective for learning, will highly depend on learners' personal differences and learning preferences. It is therefore essential to investigate factors affecting the effectiveness of educational games to enhance student learning.

When May Educational Games Be Played?

The effectiveness of educational games is undoubtedly significant to scholars, but it is equally important to consider how to make the best use of these games. Most educational games are played on computers during classes, but not many are played on mobile and tablet devices. This may limit the usage of these educational games outside of traditional classroom. As a result, students may not be able to take the full benefit of these games. It is worth noting that learning and studying can take place outside the classroom, thus the availability of these portable tools could meet the needs of the students. It is believed that an educational game that enables students to "play" and study conveniently and effectively may be more beneficial for students, particularly in this fast-evolving modern society where individuals spend a vast majority of time on their mobile phones. A study conducted by Hanson et al. (2010) found that college students spend approximately 20 hours on their mobile phones per week, for example, when they are traveling and waiting. The high usage of mobile phones may indicate that if educational games are also available on mobile phones, other than on computers, the opportunity to learn outside of the classroom would increase as individuals may use the educational games applications more often due to their convenience. Thus, the educational game which is available on mobile devices was one of the criteria in the current study.

Introduction of Educational Game: "PaGamO"

"PaGamO" is an online gamification learning platform for individuals to learn and compete with each other by participating in a game. Individuals are required to answer questions correctly in the game to successfully build, occupy and conquer territories. It is believed that with such a popular and unique method of motivating students to learn, students would be more motivated and entertained in the learning process. In addition, "PaGamO" provides information for teachers to monitor the learning progress of a large group of students, as shown in the statistics of completion rate and percentage-correctness rates.

With the increasing popularity of "PaGamO," the game is now widely used for different purposes, including but not limited to, language learning, license examinations and other professional training. With over 500,000 players and over US $6 million being invested into the game (Business Next, 2015), we may wish to understand the factors behind its quick success ever since its start-up, and more prominently, its effectiveness for learning.

One of the advantages of the "PaGamO" is that it can be accessed via computer, mobile phone and tablet applications. Students can not only review their knowledge prior to their academic tests/examinations, they can also use educational games as study tools in their spare time. If these mobile educational games are developed and used appropriately, they may help enhance students' learning motivation and change their perceptions of learning, i.e., learning can be fun and interesting. In this rapidly changing world, traditional education system may not be as effective as before, hence researchers are very eager to explore alternative learning strategies (Minovic et al., 2012b).

Thus, the principal researcher decided to use the educational game, i.e., the "PaGamO," in the current study. For students in the current study, other assessments (such as quizzes and tests) that were conducted in class accounted for a larger proportion of their final grades. The principal researcher decided that the "PaGamO" assessment scores would contribute to only 5% of the final grade, so students could try this educational game as a study tool and/or as a supplement to the learning materials in the lectures. After the selection of the educational game, the next step was to design the appropriate instructional strategies according to the theory of enhancing students' learning.

Educational Games and Motivation

In order to let educational game developers understand how to motivate and encourage individuals to use educational games, it is important to first understand the reasons behind the popularity of recreational games. According to the Interactive Software Federation of Europe (2016), individuals from the Great Britain, France, Germany and Spain spent more than 6 hours every week playing video games, and their gaming activity further increased in 2017 (Interactive Software Federation of Europe, 2016, 2017). Those players are believed to play games for enjoyment without any pressure from outside in participation. Precisely, players are attracted to those games while no one else "force" them or encourage them to play. One explanation is that playing games is intrinsically satisfying for them, as players can experience a sense of enjoyment and fun (Malone and Lepper, 1987). For some, they are willing to pay an absurd amount of money to participate in these video games. Scholars from the education sector are very interested in studying the sources of motivation that lead individuals to spend time and money on these entertainments. It would be fascinating to see if educational games, like popular recreational video games, can enhance motivation for learners. As such, the Self-Determination Theory (SDT; Deci and Ryan, 2004), a widely used theory in motivation, is adopted to aid the discussion in this study. It will also be appropriate to use theoretical reasoning to elucidate the sources of motivation to participate in recreational gamification.

Self-Determination Theory

Motivation is defined as a decisive psychological process that can stimulate human behavior and guide our behavior to specific situations (Reeve et al., 2004). Self-Determination Theory (SDT; Deci and Ryan, 2004) meticulously explains about the sources of motivation in some specific situations, in this context, it is to play educational games. This theory comprises of three different types of motivation, namely "intrinsic motivation," "extrinsic motivation," and "amotivation." "Intrinsic motivation" refers to internal feelings, such as enjoyment, pleasure or interest, which drive the individuals to participate in a particular activity. For example, a game player may play a recreational game because he enjoys it. Conversely, "extrinsic motivation" consists of external rewards or outside pressure that encourage or push individuals to behave in a certain way. For example, a player may play a game because he wants to win a medal. The behavior is merely directed by the external reward rather than intrinsic feelings. It is worth noting that over-reliance on extrinsic rewards can weaken the existing intrinsic motivation because individuals are likely to focus on the extrinsic reward as a source of motivation (Lepper and Henderlong, 2000). Finally, "amotivation" indicates that individuals are not motivated at all to complete a particular activity. In the educational context, individuals may not be psychologically driven to participate in certain educational activities, for example, to play educational games, because they are simply not motivated.

It is believed that the adherence to a particular activity will be longer if we engage with intrinsic motivation (Ryan et al., 1997). Intrinsic motivation can be enhanced when three basic psychological needs are met, namely "autonomy," "competence" and "relatedness." How the three needs are relevant to the current study will be discussed in detail in later part of this paper. It is suggested that when one of them is achieved, it is likely to increase a sense of intrinsic motivation in oneself. If three of the needs are all satisfied, the level of motivation may be further enhanced (Deci and Ryan, 2004). However, it is worth noting that the three basic psychological needs may offset each other and can be an impediment of one or another needs. Specifically, one of the needs can be fulfilled at the expense of the others, or two needs can be met through the same task (Ryan and Deci, 2000). For example, collaboration in a group may yield a sense of relatedness, but at the expense of one's need for autonomy because other group members may not approve certain decisions, therefore freedom can be limited. On the other

hand, two psychological needs (relatedness and competence) can be satisfied when a group has successfully mastered a particular task together. It is therefore recommended that when teachers are supporting one of the psychological needs, they should be wary of not thwarting the other needs (Van Roy and Zaman, 2017).

Need for Autonomy

In education, "autonomy" refers to the absence of external pressure to force the learners to act or behave in a certain way during the learning process. Individuals would have freedom of choosing whether or not they will take certain actions, and when those actions are being taken. For example, if individuals can choose when to exercise during the week, instead of having a fixed schedule of running on every Monday, Wednesday, and Friday, they are more likely to enjoy exercising because they would enjoy a sense of autonomy. In the educational context, when students are being put in situation where it is controlling, such as having very strict parents and teachers, the level of autonomous motivation is likely to descend (Rigby and Ryan, 2011). Moderate level of choice and freedom have been found to be fundamental toward autonomous motivation (Deterding, 2015). However, Rigby and Ryan (2011) believed that individuals can still have a sense of autonomy even when only one single option is provided. For example, if students are being instructed to write an essay on a particular topic, and if that topic aligns with their interest or strength, that will allow the students to have a sense of volition.

With regard to the current study, the authors believe that a sense of autonomy was achieved through the freedom of: (1) choosing when to play the game, rather than forcing them to play in class, and (2) choosing whether to use the "PaGamO" as a study tool or not. Although some may argue that students' sense of autonomy may diminish as the "PaGamO" scores would contribute only 5% to the students' final academic grade, the researchers believe that the small fraction would not negatively affect students' sense of autonomy. On the contrary, this could encourage students to participate in the game, and students could possibly become more intrinsically motivated once they have explored the interesting and motivating side of the game.

Need for Relatedness

The need for relatedness can be achieved when individuals feel that they belong to a particular group (Deci and Ryan, 2004). When humans have the opportunity to share experiences, the positive feelings will be strengthened and fostered (Rigby and Ryan, 2011). Although students may be involved in school settings where they can become competitive, they all share a common goal—to achieve academic success. If teamwork is encouraged, it would enable students to share their knowledge and experiences, resulting in stronger bonds, higher sense of relatedness and motivation to complete a common task together (Carr and Walton, 2014). The benign competition against other groups would perhaps drive students to improve as a group to fulfill a sense of relatedness and competence.

In the current study, 4–5 students formed a team. The "PaGamO" also allowed students to send messages among themselves to discuss their team tactics and share their academic knowledge. Taking the advantage of using social features, the students were encouraged to work together to complete the "missions"—to facilitate interaction among them and lead to better assessment grades (De-Marcos et al., 2016).

Need for Competence

The "need for competence" refers to the feeling of being able to successfully master a particular task/activity (Deci and Ryan, 2004). Students who experience a sense of competence are more likely to persist in the face of challenges, and have better academic results than those who are incompetent (Rigby and Ryan, 2011). However, it is not just a matter of making the activities/tasks easy to accomplish, so that students can experience a sense of mastery. Teachers should ensure that the tasks are being set at an "appropriately difficult level" where they are challenging, yet attainable (Peng et al., 2012), as students may feel bored if they can do the task effortlessly, or may become anxious if it is too difficult (Csikszentmohalyi, 1990).

In the current study, with over 50 students in the sample, it is not feasible to ensure that the difficulty of the questions is challenging yet attainable for every student. Therefore, the researchers included a set of easy, medium and hard questions in the "PaGamO" sessions, with a large proportion being at medium level. Students were also encouraged to seek advice from the principal researcher if they would perceive the questions to be too challenging, i.e., tutorial sessions. Thus, students would feel more comfortable and competent when they thoroughly understand the content, and would be able to master the "hard" questions.

Ways to Enhance Intrinsic Motivation

One of the factors that Malone and Lepper (1987) mentioned to increase intrinsic motivation is curiosity. If learners are curious and have a desire for knowledge, they are more likely to pay more attention to the new information in order to integrate into their existing knowledge. Curiosity is induced when there is a gap between our perceived discrepancies or conflicts from our personal expectations and knowledge (Loewenstein, 1994). As human beings, we are curious about our surroundings and the world in order to make sense of the things that we are not certain and/or could not explain. On the other hand, as Garris et al. (2002) argued, whether an individual is motivated to learn can be determined by the complexity of the information. For example, if the information is considered to be slightly discrepant/easy, the learner may simply disregard the message. On the contrary, if the new information has a high level of discrepancy compared with our existing knowledge, or if the content is too difficult, it may confuse the learner, and he/she may lose motivation or interest to learn the new knowledge. In this sense, it should be taken into consideration when designing the questions for students in educational games. The questions should be set at a level where students can feel challenged, yet attainable.

In addition, many children and adolescents do not participate in outdoor sports or physical activities, but they play computer and video games in their spare time (Mumtaz, 2001), so educators are interested in combining educational content with educational games to enhance students' intrinsic motivation for learning

(Prensky, 2001). Prensky has provided some suggestions to keep players intrinsically challenged: (1) to ensure that individuals feel challenged, and experience a sense of mystery and control while playing; (2) when designing the game, ensure that the level of difficulty of the game should neither be too easy nor too difficult, otherwise both may affect the player's motivation; (3) the player's score should be provided to the player so that he/she can track the progress while pursuing the goal; and (4) the purpose of playing the game must be relevant and meaningful to the player—gaining specific knowledge from participating in the game should provide a purpose for the learner to be adherent to the game. This study has followed each of the aforementioned guidelines with an aim to enhance intrinsic motivation in learning.

Objective

This study uses a combination of gamification and traditional learning methods, while implementing the elements of self-determination theory to design the instructional strategies to motivate students. The aim is to study whether the use of educational game "PaGamO" could enhance students' learning ability and understand students' perceptions of educational games.

MATERIALS AND METHODS

Participants

The participants consisted of 56 college students (32 men, 24 women, *M*age = 21 years, *SD* = 1.72) majoring in physical education and recreation management and taking the motor learning and development course. Each group consisted of 4–5 students; a total of 12 groups were formed. In addition, a total of five students, who had achieved low, medium, and high scores (score range from 19 to 94 out of 100 points) in the tasks using "PaGamO," had participated in focus-group interviews, further enabling the researchers to collect students' opinions on "PaGamO" in exhaustive detail. According to Morgan (1988), a small focus-group encourages participants to make more contributions.

Procedure

Since the educational game "PaGamO" was newly introduced to the researchers in this study, a meeting was held with the Senior Project Officer (SPO) of the University's Centre for Holistic Teaching and Learning in order to gain a thorough understanding on how the educational game functions. SPO provided clear instructions and recommendations to ensure that the game could run and be managed smoothly and effectively.

Then, the principal researcher/lecturer of the course designed a list of 100 multiple-choice (MC) questions based on the course materials. Afterward, the researchers checked the quality and the accuracy of the questions and answers. They also discussed the difficulty of the questions and ensured that the questions were comprised of different levels, namely simple, medium, and difficult. After successfully uploading the questions to the "PaGamO" system, the SPO and researchers introduced the game instructions to students in detail. Technical support was also provided to ensure that all students could download and install the "PaGamO" game effectively.

In order to increase the sense of competitiveness while playing the game, 4–5 students formed their own team. A total of 12 teams were eventually formed. Teams and individuals with the highest scores at the end of the study would be awarded. Meanwhile, the principal researcher would send weekly reminder to students to participate in the game. Upon completion of each section, students would receive individual and team scores.

Students played the "PaGamO" game in four sections according to the theme of the module. As the principal researcher decided to encourage and increase the motivation among the students, the latter were informed that 20 of the 100 questions in "PaGamO" would be included in the final examination. In addition, the final "PaGamO" score would contribute 5% to the students' final grade. Students were given 7–10 days to complete the questions (the length of the completion time depended upon the number of questions in different sections). All tasks of the four sections were required to be completed within 5 weeks. The principal researcher also encouraged students to collaborate with their team-mates and/or search for answers in handouts and textbooks, that aimed to stimulate their critical thinking and make it easier for them to absorb what they have learned.

Data Collection and Analysis

A mixed-method approach was used to thoroughly assess the effectiveness of "PaGamO." The current study extracted primary data via the use of questionnaires and was supplemented by interview in which feedback and answers were thematically analyzed.

Quantitative Method

Students' perceptions and opinions of "PaGamO" were evoked immediately after the completion of their final examination through a questionnaire which consisted of two sections. Questions on Section 1 were modified from the questionnaire of Riemer and Schrader (2015) entitled "Students' attitudes, perceptions and intentions to learn with different types of serious games." For example, the question "*I would like to use serious games regularly for learning*" was changed to "*I would like to use 'PaGamO' regularly for learning.*" The reason for changing the wording was to ensure that students were indicating their level of agreement or disagreement based on the "PaGamO," instead of general educational games. Questions on Section 2 specifically focused on "PaGamO," such as "*Would you like the game 'PaGamO' to be played in other courses?*" and "*What are your motives to play 'PaGamO'?*"

Qualitative Method

To help answer the research question (In what ways the application of the educational game to enhance student learning?), a group of students were subsequently invited as members of a focus-group to elaborate their thoughts on "PaGamO." In the questionnaire, a student strongly agreed to the statement *"I would like to use 'PaGamO' regularly for learning."* In order to understand the reasons behind this response, the breadth and depth of the information was gathered

through exhaustive interviews with the students. For example, the students elaborated and insisted, "*'PaGamO' can help me revise for the final exam for this module*". This extensive information enabled researchers to better understand this circumstance.

Prior to the interviews, trust and rapport were built in order that participants would provide truthful and exhaustive data for precise and valid analysis (Hodge et al., 2014). In addition, the researchers also ensured that the questions in the interview guide were open-ended and non-leading (Patton, 2002). Semi-structured interviews lasted 30 minutes on average. The audio recording was used to assist the note-taking in order to ensure the accuracy of the latter. After that, the transcript of the interview was translated back to back to confirm accuracy.

Some of the literatures identified by Boyle et al. (2016) have examined the effectiveness of educational games on learning using randomized control trial (RCT) and quasi-experimental design. However, as the students participated in this study were taking a university course, and they were assessed as a whole class, it would not be feasible to allocate them into experimental and control groups. Furthermore, it would be meaningless to conduct a pre-test as our participants would have limited knowledge in the motor development and learning topics.

RESULTS AND DISCUSSION

Students' "PaGamO" Score and Examination Score

There were 48.3% of the students completed a total of four sections of the game, and eight of them scored above 80 points out of 100. The final examination consisted of three parts, namely, MC questions (20%), fill in the blanks (20%), and long questions (60%). A statistical analysis was conducted to examine whether there was relationship between the educational game "PaGamO" score and the final examination score. The quantitative data was supported by qualitative findings received from focus-group interviews.

A simple regression was conducted to examine the relationship between the "PaGamO" ("PaGamO" score) and the MC and final examination scores. Regression analysis indicated that "PaGamO" score was a significant ($p < 0.01$) predictor of MC score in the final examination. A medium positive correlation ($\beta = 0.354$) was found. The R^2 suggests that 12.6% of MC score was explained by "PaGamO" score. For the final examination score, the "PaGamO" score was not a predictor ($p = 0.065$). The R^2 suggests that only 6.3% of final examination score was explained by "PaGamO" score. One possible explanation was that the format of the question in "PaGamO" was MC questions, while there were other questions in different formats in the final examination. Therefore, it could be more challenging if students were unable to transfer and apply their knowledge from one format to another while answering the questions. Also, they had never seen the long questions before the final examination, unlike the questions in MC which primarily were included in the "PaGamO" game.

Some students had a low "PaGamO" score, but had a high MC 20 mark on the final examination were observed. We assumed that students tended to use their existing knowledge to conduct self-tests rather than searching for answers directly using their lecture notes. These assumptions are supported by students in the focus group:

> *"At the beginning, I don't use notes because I want to see how much I know, but for the questions that I did wrongly, probably when I was wrong twice, I would use the notes in the third time. Because if you get the notes out at the beginning, you won't remember the answer (for the final exam), but when you are wrong, you will know what you have done wrong."*—Student A.

> *"When I played it the first time, I did not revise for it, I based on my memory only and tested myself to see how much I remember. For second time, I did do a bit of revision, because I want to get higher scores."*—Student B.

"PaGamO" could be an effective tool for studying and students seemed to have learnt by adopting the *"trial and error"* strategy to strengthen their memory on the subject. Another reason for scoring the high MC mark was possibly because the students had been informed that 20% of the questions in "PaGamO" would repeat in the MC section in the final examination.

One of the main purposes for using educational games is to provide an alternative learning option for students, with an aim to help them study more effectively in an entertaining manner. A student said, *"I think this app is quite good, because it is a game, it allows me to revise in a relaxing way, unlike how I normally revise which I just try to remember everything" (Student C)*. When nearing the end of the semester, with assignment deadlines and examination periods approaching, it could become a stressful period for students. The quote aforementioned suggests that students perhaps can study effectively "in a relaxing way" rather than simply over-loading their memory. The elements of the game could be new, exciting and challenging for students to learn and study. This method was also welcomed by other students from the same class, *"I can play education game in this subject, I think it's quite special" (Student D)* and *"it's better than keep on revising my notes again and again, PaGamO is a more interesting way to revise, so why not use it." (Student E)*. Hence, the findings support that the educational game can enhance students to study the course materials and could be effective in learning.

Students' Motives to Play "PaGamO"

Motives for participating in the "PaGamO" were mainly intrinsic as suggested in the top 10 motives of the list, i.e., (1) fun, (2) self-learning, (3) want to get a higher grade in the final examination, (4) challenging, (5) want to get a higher score in the game, (6) enjoyment, (7) I can choose when to play, (8) self-achievement, (9) want to win, and (10) the game has high relevance to my learning. The findings are consistent with previous research (Dominguez et al., 2013; Sun-Lin and Chiou, 2019) and they support the gamified design to make learning tasks more interesting and fun, thereby attracting students' attention and motivating them to complete the learning tasks.

In addition, not only were the students driven by both intrinsic and extrinsic motives to play the "PaGamO," there was also the social factor involved. Student A remarked:

> *"The game is simple and it has ranking, that's why it is competitive, it is fun. It is challenging. . . you have to compete with others, so that you have the motivation to play, because you would want to compare with others, if you can see the ranking, the motivation level is higher."*

Herodotou et al. (2014) argued that the theory of self-determination did not well predict individuals' motivations for playing entertainment games. In their research, they found a weak association between basic psychological needs and game playing. The researchers believe that one of the main factors motivating individuals to play casual games is the social interaction between players, who would cooperate and/or compete with each other. In the current study, the view provided by Student A supports the discovery of Herodotou and the research team, suggesting that social interaction and competitiveness are key to game players' participation in the game.

Students' Perceptions of Educational Games

In order to study students' cognitive perception and intention to use the "PaGamO," 15 statements on the 7-point Likert scale were listed and utilized for in-depth analysis. The top five statements are: (1) "*In my opinion, the use of 'PaGamO' enables me to better prepare for the final examination*" (M = 5.04, SD = 1.41), (2) "*In my opinion, the use of 'PaGamO' enables me to understand learning contents*" (M = 4.8, SD = 1.19), (3) "*In my opinion, the use of 'PaGamO' allows me to apply knowledge*" (M = 4.75, SD = 1.08), (4) "*In my opinion, by using 'PaGamO,' I can learn easily*" (M = 4.67, SD = 1.28), and (5) "*In my opinion, using 'PaGamO' enhances my learning performance*" (M = 4.65, SD = 1.35) (see **Table 1**).

Since *"In my opinion, the use of 'PaGamO' enables me to better prepare for the final examination"* was the highest ranked statement, it was deemed essential to ensure that further elaboration was heard from the students. When being asked how "PaGamO" was helpful in their final examination, Student C recalled, *"in 'PaGamO,' when you are wrong, you are more likely to remember it better, and when the questions come up again in the exam, then you won't be wrong again."* Similar responses were also heard from Student D, who said, *"after answering the questions, I can remember it very well."* It was evident that the *"trial-and-error"* approach had helped students memorize the content successfully who subsequently could apply the knowledge in the final examination.

TABLE 1 | Students' perceptions and intentions to use the educational game.

Rank order	Statement	*M*	*SD*
1	In my opinion, the use of PaGamO enables me to better prepare for the final examination	5.04	1.41
2	In my opinion, the use of PaGamO enables me to understand learning contents.	4.80	1.19
3	In my opinion, the use of PaGamO allows me to apply knowledge.	4.75	1.08
4	In my opinion, by using PaGamO, I can learn easily.	4.67	1.28
5	In my opinion, using PaGamO enhances my learning performance.	4.65	1.35

Furthermore, based on the 15 statements of "Students' attitudes, perceptions and intentions to learn with different types of serious games" questionnaire of Riemer and Schrader (2015), three factors were also examined and the findings are as follows: (1) perceived potential to support performance which includes items on beliefs about whether the game promotes specific learning performance, such as the final examination (range = 8–35, M = 23.82, SD = 5.48); (2) perceived potential to support performance which includes items on beliefs about the overall efficiency and effectiveness of academic performance through the use of games (range = 6–35, M = 22.89, SD = 6.27); (3) usage intention, address the intention to use or avoid using serious games for learning (range = 5–35, M = 19.38, SD = 5.38). Moreover, independent t-test results of the three factors show that men and women have similar views on "PaGamO."

However, as mentioned earlier, perceptions of whether "PaGamO" is interesting and motivating largely depend on individual differences and learning preferences. As Student E recalled:

> *"PaGamO" doesn't help that much. . . after I complete it, I won't actually remember what we have answered. . . I don't actually like to use these methods (educational games) to revise. Traditional learning and revision will help me more, it is better to have quizzes in classes than "PaGamO."*

Consistent with previous literature by Whitton (2007), and Chen et al. (2019), the citations above suggest that not all students would find educational gamification fun and motivating. Some students may prefer to use traditional learning and teaching methods as a result of, perhaps, its being a habitual behavior. Furthermore, the game design may also affect students' perceptions of "PaGamO."

> *"PaGamO" is less fun compared to the one I played before, in "PaGamO," you can only upgrade your land or rob other people's lands, but the one that I played before had different subjects, it had some words that come out and you select the right ones, but "PaGamO" only had A, B, C, like exams.*—Student C.

As such, it is important to ensure that the game design is fun enough to keep students engaged. MC questions may appear too similar to the examination in the current study. Although the researcher is convinced that if MC questions can mimic the format of the examination, students may prepare better for the examination. However, Student C's view suggests that when educational gamification is too similar to the formats of the examination, it can become demotivating and tedious. Since it

is not clear which question format is best for students' learning, further research is necessary.

Technological Devices for Playing Educational Games

In relation to the devices used by students to play "PaGamO," it was reported that 42 students used mobile phones, 12 used tablets and 2 used computers. The use of a mobile phone enabled students to play "PaGamO" conveniently, which could increase the frequency of game participation. Student A and C mentioned, respectively, *"I think this game is quite good, because it is portable, you can bring it anywhere (mobile), so when you are free, you can take it out and play the game"* and *"because it is more convenient, you can simply press the app button, and you can play."* The convenience undoubtedly enabled students to learn and/or study more often without having to carry textbooks/lecture materials around. They could simply open the "PaGamO" application on their mobile phones and immediately start playing and studying.

Likewise, despite not many students used computers to play "PaGamO," one student pointed out its convenience, as student B recalled, *"When I open the 'PaGamO' link, I don't normally close it, so when I turn on my computer, I can play the game."* The choice of devices used to play "PaGamO" would depend upon personal preferences and the availability of devices. This game also allowed students to have freedom to decide when to play and on what devices to play.

Average Time Spent on "PaGamO" for Each Session

For each "PaGamO" session, 62.5% of students used "PaGamO" for less than an hour, while 32.7 and 1.8% of them spent between 1 hours and within 2 hours, and between 2 hours and within 3 hours, respectively. Studying can be mentally demanding and dull for students as they would have to maintain high concentration during the process. One of the purposes of using "PaGamO" was to enable students to study while "playing" and make it more interesting rather than boring. Notwithstanding the time spent on "PaGamO" was not considerably long, "PaGamO" can be considered effective and successful in helping students to prepare for their final examination as the average score for MC was 16.12 out of 20 points (SD = 2.99). When asked about how much time was spent on "PaGamO," Student E revealed that "*around 35–40 min, including time spent on viewing notes."* It was sufficient for students to study the key points of the subject within an hour.

Other Key Factors Extracted From Questionnaire Data and Interviews

There were 48.3% of students completed all four sessions of the game. While the researchers have been studying the effectiveness of the game and students responses, adding to the fact that educational games have just been developed and are still in the early stage in higher education, the present full-participation rate is acceptable.

However, the researchers understood that there were still areas for further enhancement in educational game, such as the number of the questions (a few respondents reported that 100 questions were insufficient) and the format of the question (students recommended different formats to be used along with the MC questions). Additionally, when asked if students would like to play "PaGamO" in other modules, 56% said they would welcome this idea, while some mentioned that it would be difficult to play "PaGamO" in two or more subjects simultaneously.

In summary, by using gamification as a tool for learning and studying, students did find "PaGamO" effective for their learning experience. The motives of using "PaGamO" came from both intrinsic and extrinsic motives, with more students toping to play "PaGamO" for "Fun." In addition, the use of mobile phones to play "PaGamO" was indeed more popular than using computers and tablet devices because of its convenience. Furthermore, the combination of gamification and traditional learning methods could enhance students learning.

Recommendations for Further Research

The sample size of the present study was 56. As mentioned earlier, this is an exploratory study which aims to examine the application of educational game on students' learning. Considering the cost of the game accounts, administration time, and manpower, it would not have been appropriate to widely utilize the educational game before assessing its suitability and effectiveness. As the results of the current research are positive, it is expected that a larger sample size can be used in future to investigate students' attitudes, perceptions and willingness to learn.

During the research period, only three courses (computer sciences, music, and physical education) had utilized this educational game as a supplementary tool to integrate into the traditional teaching method in the University. At the same time, different course instructors adopted different approaches to design the questions and the degree of involvement of students was varied. It is suggested that, in future, course instructors of different subjects should discuss and standardize the research procedures, so as to conduct comparative study to facilitate the investigation of the effectiveness of educational games on student learning and students' perceptions on educational games for different disciplines.

Due to the experimental nature of the study, only MC questions were used in the educational game. To avoid the limitation, in future, more formats of questions could be explored, such as using fill-in-the-blanks and short questions. This strategy can help students learn by mimicking real test scenarios under less stressful situations.

It is also feasible that, as researchers in this study introduced the use of educational game prior to students' final examination, future studies may explore the long-term effects of gamification on students' knowledge retention and the applicability of information in other contexts.

CONCLUSION

The results of the current study show that the combination of gamification and traditional learning methods can

enhance students' learning motivation and learning effects. The higher the "PaGamO" score, the higher the MC score is observed. Student learning is also influenced by the content of the game, the format of the question, the instructional strategies, and the motivation for participation. In addition, due to its convenience, playing educational game on mobile devices is more popular than using computers and tablet devices. In conclusion, with the development of educational technology, educational games are becoming more and more popular, and further research is therefore recommended.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

SC: design of the study, data collection, data analysis, and writing of the manuscript. KN: data collection, assist in data analysis, and draft of the manuscript. Both authors contributed to the article and approved the submitted version.

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A Case Study on Research Postgraduate Students' Understanding of Academic Integrity at a Hong Kong University

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This case study aims to understand how research postgraduate (RPg) students at a Hong Kong university perceive academic integrity before and after participating in the Trail of Integrity and Ethics on the general issues of academic misconduct (TIE-General learning trail), which makes use of Augmented Reality (AR) technology and mobile application to help students acquire abstract concepts (Wong et al., 2018). A total of 33 RPg students, who had completed the mandatory courses on research ethics and teaching skills, successfully completed the TIE-General learning trail. The participants were required to demonstrate their levels of understanding of academic integrity and ethics before and after going through the learning trail. Results of the thematic analysis on the participants' responses indicated that the RPg students were generally able to show some understanding of the six fundamental values of academic integrity defined by the International Center for Academic Integrity (ICAI), namely *honesty*, *trust*, *fairness*, *respect*, *responsibility*, and *courage*. Among these six values, the findings suggested that *honesty* and *respect* might be the most familiar values to the participants. However, the other four values seemed to be less familiar to them. On top of the above six values, *empathy* and *mindfulness* were considered as two other important attributes of academic integrity from the participants' perspectives. This article analyses the possible impacts of *empathy* and *mindfulness* on the academic integrity development of university students.

Keywords: academic integrity, research postgraduate, empathy, mindfulness, ICAI's values

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INTRODUCTION

Background

Like their counterparts in other tertiary institutions across the globe, Research postgraduate (RPg) students at the University of Hong Kong (HKU) play various important roles in the University community. In addition to conducting primary research, RPg students often have to render support to different teaching and learning initiatives in the undergraduate programs by grading/marking assignments, invigilating at examinations, running tutorials, demonstrating in laboratories, facilitating other student learning activities in and outside the classroom. To pursue a successful career as qualified researchers or teachers after graduation, RPg students at HKU should not only acquire the necessary research and teaching skills, but also uphold their academic integrity, so that they could work both efficiently and ethically at the workplace.

Academic Integrity

Academic integrity refers to an adherence to a collection of ethical values and behaviors demonstrated by individuals within the academic context (Young et al., 2018). It represents the foundational values and conducts in the daily practice of teaching and learning, research, and other pertinent services in academia (Macfarlane et al., 2014; Young et al., 2018). Thus, individuals should see integrity as a "personal choice" for a "consistent commitment" (Killinger, 2007, p. 12) to comply with the ethical and moral principles in different circumstances.

The word "integrity" borrows from *integer*, a Latin word, which derives meanings of entire, complete, pure, and honest (Kang, 2017). From a psychological point of view, Killinger (2007, p. 12) used wholeness, a psychological state of internal harmony, to describe consistent morality and essences of integrity. In academic context, integrity requires individuals to consistently internalize the sense of wholeness in academic services and works, regardless of circumstances. This expectation is applicable to all stakeholders, including students, teachers, researchers, and administrators, of any academic setting. Furthermore, having a sense of wholeness, an individual will be able to see the full picture of a situation. He/she will consider all the variables or factors involved and make the right choice to contribute, establish and maintain the academic standard in his/her discipline (Killinger, 2007; Busch and Bilgin, 2014).

Proposes of the Study

This is a case study which aims to understand how RPg students at the HKU (one of the research-intense institutions in Hong Kong) perceive academic integrity before and after participating in the *Trail of Integrity and Ethics* on the general issue of academic misconducts (TIE-General). The virtual trail makes use of Augmented Reality (AR) technology and mobile app to help students acquire abstract concepts (Wong et al., 2018).

LITERATURE REVIEW

Fundamental Values of Academic Integrity

When the late Donald McCabe coined "academic integrity" in the 1990s, the term sounded vague due to its abstract and unclear boundaries. To conceptualize the meaning of academic integrity, the International Center for Academic Integrity (ICAI) defines academic integrity as a commitment to the five fundamental values for all academic activities even in the face of difficult situations, namely *honesty*, *trust*, *fairness*, *respect,* and *responsibility* (International Center for Academic Integrity [ICAI], 1999). These values guide all members in an academic community (including learners, teachers, researchers, administrators and sometimes alumni) to understand the principles and expectations of academic integrity.

According to the International Center for Academic Integrity [ICAI] (1999), the first value, *honesty*, is a prerequisite for seeking truth and knowledge. It is suggested that individuals who strongly adhere to facts and truth, as far as they know, are most likely to demonstrate honesty in their behavior. Once honesty is built in as a core value in an individual, it will help develop a climate of trust among the members of a community. The second value, *trust,* will facilitate free exchange of ideas and encourage further credible contributions grounded on the works of others (collaboration). It should be developed in reciprocal ways. When the individuals are willing to cooperate and share information, expectation of fairness and respect follows. *Fairness*, the third value emphasizes on the consistent and fair treatment to all members of a community when they interact with each other. It includes reasonable expectations and transparent procedures. Upholding fairness allows individuals to become role models who are respectable in an academic community. Fishman (2014) emphasizes that *respect* in academic communities is developed mutually, which means it requires individuals to "show respect for oneself as well as others" (p. 9). For oneself, it means to respond to the challenges from others with appreciation or to believe that it is an opportunity for improvements. For others, it means to recognize and value diversity. Lastly, when the above four values are cultivated in an academic community where all members are both respectful and respectable, a collective responsibility will be developed. The fifth value, *responsibility*, refers to the personal active endeavors to safeguard integrity in all academic activities and procedures (including scholarship of teaching and learning). It involves serving as good examples to stand up against academic misconducts, and to refrain from violating any ethical and academic principles.

Failure to embrace these five values will put one's academic career in peril as others would doubt the credibility of his/her works. However, it is easier said than done. A few studies (for example, Carrell et al., 2008; Fernandez, 2019; Moldes et al., 2019) found that peer pressure or influence is one of the most tempting factors leading to academic misconducts, such as plagiarism, cheating in examination, etc., even though some might not have the intention to cheat. Research studies repeatedly found that a student who found a classmate cheating would struggle to stand up to them or report the misconducts to teachers since he/she was afraid of ending their friendships. Carrell et al. (2008, p. 173) also reported an astonishing result that "with one additional cheater, it drives approximately 0.67 to 0.75 additional students to do cheating." Based on their findings, they approximated that the social multiplier for academic cheating could be as high as *three*.

In view of the significant impact of peer pressure on one's academic integrity, the ICAI introduced *courage* as an additional element to the above five values. The second edition of Fundamental Values of Academic Integrity was published in 2014 (Fishman, 2014). This additional element conveys a clear message that we should go beyond "simply believing in the fundamental values" (p. 13). Rather, courage represents our determination and strategies to put values into actions and overcome any fear.

Approaches to Develop Academic Integrity at HKU

Like other institutions in the world, the HKU established a few typical measures to facilitate its staff and students to develop academic integrity. One of the measures adopts a

disciplinary approach by rolling out pertinent rules and policies (such as Plagiarism, Photocopying of Printed Works, Privacy Policy Statement, Policy on Research Integrity, etc.) to regulate academic behaviors/procedures. This approach emphasizes on the fact that an individual who violates any policies on academic integrity should be liable to penalties or other negative consequences, such as a fail grade and disqualification. To a certain extent, this approach works well to discourage students from cheating in tests/examinations, committing plagiarism in coursework, and falsifying data in research (behavioral change). However, Young et al. (2018) argued that in this approach, students tend to pay much attention to avoid adverse consequences, but not to the underlying values and morality of academic honesty. To make sense of the values, there is a need to create opportunities for students to practice on the values, rather than hiding from the watching eyes.

On the other hand, an educational approach is also adopted at HKU. Rather than penalizing an individual for ethics violation, this approach focuses on preventive measures to educate students on how to develop understanding of academic integrity through participation in certain mandatory programs, such as induction seminars and workshops. To further encourage self-learning on academic integrity, all postgraduate students are required to complete the online course of Responsible Conduct of Research under the Collaborative Institutional Training Initiative (CITI) program. This program consists of several discipline specific course web-based courses. Course participants could choose from the five existing research areas, including clinical research, social/behavioral research, science research, humanities, and engineer and architects. The online course covers nine topics of study such as research misconduct, data management, authorship, conflicts of interest, etc. To successfully complete this course, students are required to obtain a score of at least 80% in the quizzes (multiple-choice questions) of each topic. After meeting the above requirements, students are required to sign and submit a declaration form to their affiliated faculty office, to indicate that they understand and agree to follow the University's academic regulations and policies. This educational approach provided students with an opportunity to clarify the rationale of the values, regulations, and policies. Students will become more sensitive to the potential risks and learn the necessary knowledge and skills to avoid any misconducts in their academic activities. However, there is one major limitation in this approach. Only knowing the correct answers to questions or ethical values will not lead a person to act ethically at all times. There could be some cognitive changes after taking those online courses but still no guarantee for any attitudinal or affective change.

Braunschweiger and Goodman (2007) analyzed the CITI program evaluation data when it reached 600,000 participants from more than 715 institutions in 2007. They found that the program generally allowed learners to respond to the materials in ways that "transcend mere compliance" (p. 861), because the course design is based on the framework in which critical thinking is a fundamental skill to moral reasoning. However, they argued that "the current thrust toward the (online) training is misguided" (p. 863), because the CITI program had been considered as a tool to *train* the skills (cognitive changes), rather than to develop learners' conceptual foundations to support their briefs and practices (attitudinal change).

Proactive Approach to Nurture Students' Integrity in Higher Education

Targeting on the attitudinal or affective change, Tan and So (2015); Bealle (2017), and Young et al. (2018) argued for a more proactive approach to put students in various real-life scenarios or ethical dilemmas in which they have to make ethical decisions, argue for their choices, and reflect on the experience. Rather than figuring out the "correct" or "model" answers in the scenarios, this approach focuses on the real/virtual experience reinforcing students' abilities to interpret situations, analyze any possible consequences, and justify their choices (for practical solutions rather than the ideal options). Students also have the opportunities to reflect on their experience, as a second-time exposure to the same situation, organize and consolidate their thoughts to better prepare themselves for any similar encounters in the future. To ensure an effective learning process, O'Connell (2016) suggested that teachers should guide students to discuss those scenarios with their peers step-by-step.

Furthermore, numerous interesting examples (by making use of positive peer influence) are suggested for this developmental approach around the world. For example, in an Australian university, Deborah Richards et al. (2016) piloted a project with an idea of using student ambassadors to promote academic integrity; in a Canadian university, Lucia Zivcakova et al. (2012) studied the impact of residential student leaders on academic integrity of others. The above studies tried to reinforce the fact that peers play crucial roles in influencing students' perceptions of academic dishonesty (McCabe and Trevino, 1993).

Pedagogical Innovation: Learning Trails of Integrity and Ethics

Learning Trails of Integrity and Ethics are thoughtful mobile learning activities developed in a government-fund teaching and learning research project led by Hong Kong Baptist University, which collaborated with The Chinese University of Hong Kong (CUHK), The Education University of Hong Kong (EdUHK) and The Hong Kong Polytechnic University (PolyU). In consideration of the increasing difficulties of observing academic integrity in curriculum with the advent of informative technology (IT), the project aims to explore various ways to make use of Augmented Reality (AR) technology to combat the issue of academic misconducts worsened by IT advancements (Wong et al., 2018). Eleven AR learning trails were developed with various focuses on the general concepts of academic integrity (the TIE-General version focuses on data falsification, citation, and proper use of library resources), ethics education for professional disciplines (such as humanities, science, business, language, social sciences, etc.), and student personal growth programs (such as service-learning, residential life tutor training, etc.). See a few screenshots of the TIE-General learning trail in **Figure 1**.

In general, the pedagogical design elements include a repository of relevant scenarios (putting student in real-life situations), bite size teaching materials (displaying key concepts

FIGURE 1 | Screenshots of the TIE-general learning trail (Scenarios of Citation and Library Resources).

in short videos), interactive problem-solving process (giving explicit feedback on players' choices), pre-trail surveys (triggering mental preparation), and post-activity reflection (reinforcing learning). Since the first launch of the AR learning trail in 2014, this pedagogical design has been adopted in different academic programs and co-curricular activities of the four participating institutions. Participation in the trials has become a graduation requirement for both undergraduate and postgraduate students in these universities. As of 2020, over 9,000 students have participated in the learning trails on their own campuses.

It is suggested that the AR learning trail represents a typical example of developmental approach to nurture and develop students' academic integrity. This case study aims to understand how the HKU RPg students perceive academic integrity. Thus, the TIE-General, one of the learning trail versions that focuses on the general concepts, was chosen as the learning activity in this study.

METHOD AND METHODOLOGY

Method Approach, Sampling and Methods

This is a case study, which adopts a qualitative approach (Merriam, 1998). It aims to understand how the HKU RPg students perceive academic integrity against the six fundamental

values put forward by ICAI. It targeted to study the RPg students who (1) finished the University's mandatory research ethics course, (2) completed the University's mandatory teaching training course, Certificate in Teaching and Learning in Higher Education course (CTLHE course), between February and May 2020, and (3) enrolled to a PhD/MPhil program for at least one semester. The above selective criteria were to ensure that all the participants are familiar with ethics in research and teaching duties, as well as the relevant policies adopted by the University.

Invitation emails indicating these three requirements were sent to all the CTLHE course participants who completed the course in the above period. A total of 41 students agreed to participate in the study and 33 of them completed all the three checkpoints (for data falsification, citation, and proper use of library resources) in the TIE-General learning trail and submitted both pre-trail survey and post-activity survey of reflection. Finally, 33 valid matched samples were collected. There were 14 males (42.4%) and 19 females (57.6%) in the group of participants. The 33 samples indicated their study majors spread across seven disciplines, including Architecture (1), Arts (8), Education (3), Engineering (4), Science (3), Social Sciences (5), Medicine (9). The samples skewed a bit to the disciplines of Arts and Medicine.

In view of the needs of social distancing during the COVID-19 pandemic in 2020, the University decided to cancel all unnecessary student activities on campus and replace all face-to-face teaching and learning activities with online teaching. Thus, the "checkpoints visiting" part of the TIE-General learning trail activity was canceled. Rather than visiting the checkpoints with peers, participants could join the learning trail over the internet at their own pace. In the original design of the learning trail, the scenario of ethical dilemmas at each checkpoint is triggered by the GPS locator of the mobile devices of the participants when they are only meters away from the checkpoints. However, in the modified virtual learning trail of this study, QR codes were used to trigger the specific scenarios. This change might have minor impacts on the user experience, but the deliveries of information and scenarios were the same.

Once the students confirmed their participation, they would receive a set of instructions including guidelines to download and operate the mobile application. They were also assigned with a unique set of login ID and password which allowed them to access the mobile application. Students were allowed to complete this 30-min virtual learning trial by themselves within 2 weeks' time.

Data Collections and Analysis

At the beginning of the learning trail, participants had to complete a pre-trail survey in which they needed to explain academic integrity according to their understanding with about 100 words. After that, in each of the three following scenarios, participants would interact with the mobile application and receive bite-size videos or reading materials. Participants could go back anytime for changing their choices and study other possible consequences and explanations from the application. After completing all the three scenarios, participants would receive three checkpoint codes. When a declaration of "I must not cheat" came up by putting those codes in correct order participants could then unlock the final challenge of the Trail. The final task included six survey questions on the user experience of the App (see **Table 1**) and post-trail reflection, which requires participants to explain their refreshed and enhanced understanding of academic integrity in 100 words.

The qualitative data collected before and after participating in the virtual learning trail was analyzed by a flexible thematic analysis method, which employs a hybrid approach of two main methods of reasoning: a top-down deductive process and a bottom-up inductive process (Swain, 2018). In this study, the top-down deductive process produced a set of priori codes with reference to the six fundamental values of academic integrity from the literature. The bottom-up inductive process resulted in two posteriori codes (empathy and mindfulness) from an examination of the students' responses. The results of descriptive statistics were summarized in **Figure 2**. It is believed that those posteriori codes would be helpful for educators or researchers to explore, expand or elaborate the ICAI's fundamental values from RPg student's perspective.

RESULTS AND DISCUSSION

Overall Comparison of Individual Student's Responses Before and After Learning Trail

Based on the descriptive statistics results (**Figure 2**), among the 33 participants, it was found that 25 (75%) and 19 (57%) individual responses mentioned the values of *honesty* and *respect* respectively in the pre-trail survey, while 28 (84%) and 25 (75%) individual responses mentioned these two values in the post-trail survey. It seemed to suggest that students' understanding of these two values (*honesty* and *respect*) might be strengthened in the learning trail. However, regarding the other four values (*trust*, *fairness*, *responsibility*, and *courage*), in both pre-trail survey and post-activity reflection, the number of students' responses remained low and a drop is identified. This might be due to the limited coverage of the three scenarios in the learning trail. The topics adopted in the scenarios (data falsification, citation, and proper use of library resources) seemed to be apparently relevant to *honesty* and *respect* than the other four ICAI's fundamental values. These scenarios seemed to create a condition driving the participants to re-construct their understanding based on the two apparent values. For instance, increasing student responses regarding the theme of honesty associated with the data falsification scenario. To name a few:

> "No fabrication. . ."
> "Do not change data for the perfect results."
> "Do not try to manipulate data."
> ". . . academic integrity is to avoid falsification. . ."
> ". . . stating data and methods honestly and not intentionally ignoring data in order to deliver expected research results."
> ". . . data must not be selectively skewed for the sake of one's personal academic benefit (i.e., must be given proper variables to prevent fabrication and falsification)."

TABLE 1 | Post-trail survey results.

Post-trail survey questions	SA	A	N	D	SD	Mean
1. I find the AR Trails App easy to use.	11	21	1	0	0	4.3
2. My interaction with the AR Trails App is clear and understandable.	10	22	0	1	0	4.2
3. The AR Trails App makes learning academic integrity and ethics more interesting.	12	18	3	0	0	4.3
4. Working with the AR Trails App is fun.	6	17	9	1	0	3.8
5. The WiFi connection is stable.	17	13	2	1	0	4.4
6. My overall usage experience with this learning trail is good.	9	21	3	0	0	4.2

SA, Strongly Agree (5); A, Agree (4); N, Neutral (3); D, Disagree (2); SD, Strongly Disagree (1).

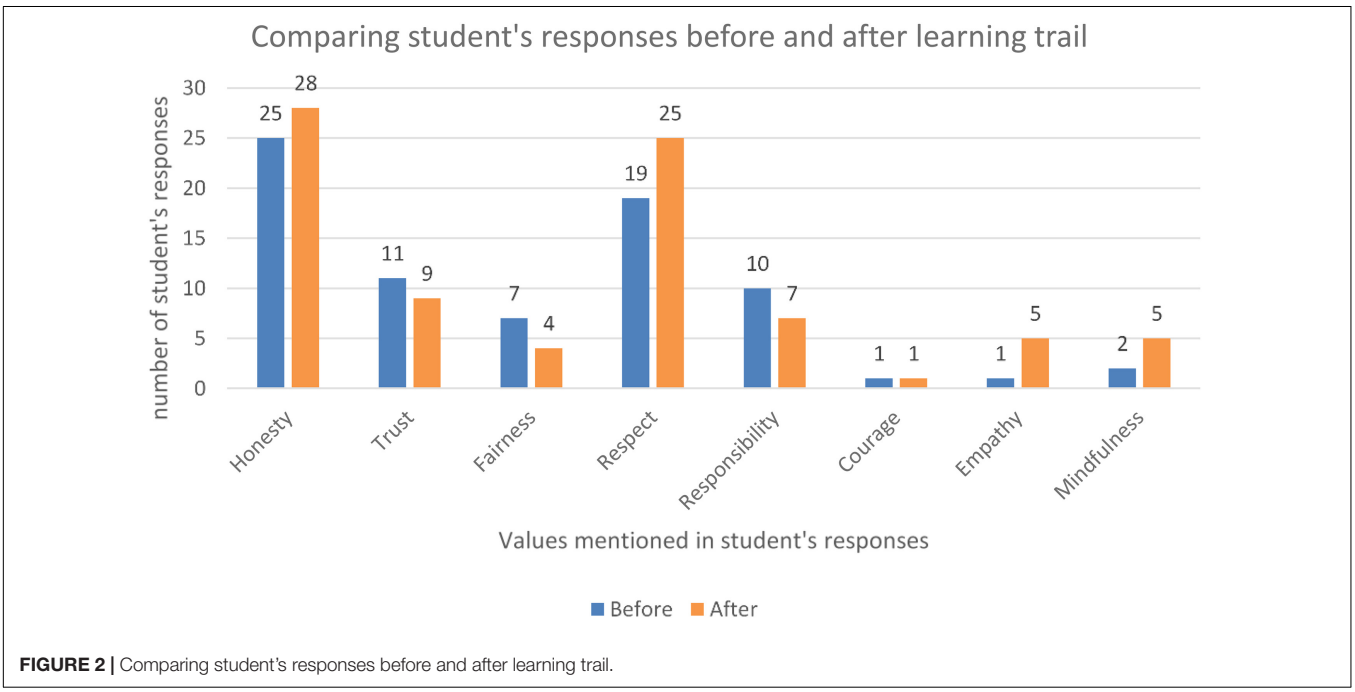

FIGURE 2 | Comparing student's responses before and after learning trail.

Whereas, most of the student responses regarding the theme of responsibility extensively associated with the citation scenario. See below selected examples:

"... acknowledge the contributions of other people."
"... recognize others' works in their research."
"... provide credits to third party."
"... cite the proper sources."

There might be a limitation in the scenario design. To minimize the skewed results, it is suggested to incorporate all the six values into the scenarios in a more balanced way, for example, developing a few other scenarios for the TIE-General. Possible scenarios include grading student/peer assignments (fairness), academic collaboration (trust), following ethical procedures (responsibility), reporting peer cheating (courage), etc. That might help to raise the awareness of the six ICAI's values to the participants.

Though **Figure 2** shows a drop in mentions of the other four values (trust, fairness, responsibility and courage), since the sample size was relatively small (n = 33) and the length of writing was limited to 100 words, there is insufficient evidence to conclude whether any significant decrease exists. However, by increasing the sample size (n = 200), it is possible to draw a meaningful conclusion with valid statistical test results then. Besides, increasing the length of writing (e.g., 3–500 words) would also help to enrich the qualitative data.

Thematic Analysis – Students' Perception Before Learning Trail

The results indicated that the overall pre-trail and post-trail student responses covered the ICAI's six fundamental values. In addition to these six values, two other meaningful attributes were identified from the student responses. Before participating in the learning trail, one RPg student used "empathy" to illustrate his/her understanding of academic integrity.

That student perceived "empathy" as the attitude and willingness to put oneself in a situation: how bad is the feeling if someone cheats on me or steals ideas from my works. It is different from the original six fundamental values which mostly emphasize on the positive consequence of upholding academic integrity. The sense of empathy in this

context highlights the imaginary experience of suffering, and the unpleasant consequence on others (the victims). In other words, it goes in line with the following traditional Confucius thought:

> "*Do not do to others what you do not want to be done to you.*"
> – from Lunyu (Analects of Confucius)

It is believed that this new thought helps remind students to think for others, e.g., to imagine the negative consequences that might bring to others, rather than considering their own benefits.

On the other hand, two RPg students also indicated in their pre-trail surveys that "self-awareness" and "conscious(ness)" represented one's self-regulating abilities in a new academic environment without any surveillance from others. The participants tried to relate to the emerging challenges in online assessment (examination) and the extensive use of technologies in academic works during the pandemic in 2020. This finding suggested that an academic should always stay alert in the ever-changing environment where new temptations turn up from time to time. *Mindfulness* (or being mindful in this context) enable the students to suspend any emotional reactions to pause and rethink from a new angle when they find themselves in difficult situations of making ethical decisions. This is another important attribute that students should develop at the early stage of their academic careers.

From the above findings, two new attributes (*empathy* and *mindfulness*) were identified apart from the ICAI's six fundamental values.

Thematic Analysis – Students' Perception After Learning Trail

In the post-trail reflection, apart from the six fundamental values, increasing responses to the others (*empathy* and *mindfulness*) were observed. There was an increase from 3 (pre) to 10 responses (post) as shown in **Figure 2**. More students related their perceptions of academic integrity to these additional attributes. A few students' responses highlighted the needs to take the cultural/educational background of the target audience (such as readers of journal articles) into consideration. This echoed the theme of empathy as participants elaborated on the need for proper citation and references. Besides, some students' responses also revealed the fact of increasing temptations of ethics violation on campus during the current pandemic. While encountering uncertainties (such as noticing peer cheating or misconducts) and other new situations, they identified the need to consult supervisors or seniors if they had no experience or guidelines to follow in handling those situations. These views extended elaboration to *mindfulness*. On one hand, the attribute of *mindfulness* is developed at an individual level which means that a person stays alert to uncertainties in his/her daily work. On the other hand, it induces an individual to engage in discussions with others on those uncertain issues for solutions. Such active engagement among the individuals could help promote *mindfulness in* the learning community.

Results of the Post-survey on User Experience

According to the results in **Table 1**, the participants, in general, agreed that the virtual learning trail made learning academic integrity and ethics more interesting (mean score: 4.3) and that working with the app is fun (mean score: 3.8). They also found the app easy to use (mean score: 4.3) and the instruction was clear and understandable (mean score: 4.2). The learning trail was different from the traditional ethics education (disciplinary and educational approaches), because participants could experience and react to different scenarios enhanced by the AR technology. The trail was well received by the participants because of the flexible blended learning experience brought to them during the activity.

Existing Views on Empathy and Mindfulness in Academic Integrity From the Literature

In this study, some participants argued for the value of *empathy* in academic integrity because they see the need to be considerate to others. For example, one decides to add a citation or footnote not just for acknowledging others' contribution to the ideas, but also for offering the sources of specific cultural knowledge to the readers having different cultural background so that they could identify the sources easily for a better reading experience. While the participants hold positive views on *empathy* in academic integrity, they seemed to overlook the fact that *empathy* could impede ethical decision making. In fact, there is a major concern on the value of *empathy* in making ethical decisions or moral judgments (Coplan and Glodie, 2012).

According to Decety's (2016) definition (2016), *empathy* represents one's capability to interpret others' emotional states. It is characterized as a "vicarious emotion" that a person experiences to reflect on others' emotion (Prinz, 2011). However, it was found that the study on empathy in academic integrity development context was relatively limited. Thus, I chose to draw some literatures from the field of moral judgment or justice to discuss here. In the article, Against Empathy, Prinz (2011) explains the dark side of empathy in moral judgment, such as the "prone to bias" (p. 214), "precondition for approbation" (p. 216), and "easily manipulated" (p. 227), etc., which could lead to unethical and harmful consequences. Prinz (2012) also argued that empathy is potentially an impediment to one's motivation of making ethical decisions or moral judgments, one should not even try to cultivate empathy-based morality. In view of this argument, Hoffman (2012), one of the scholars defending the importance of empathy in moral thought, also admitted that it is necessary to clarify the limits of empathy, even though it has contributed importantly to the justice in the US law system.

While there are critiques of the value of *empathy* in ethical decision-making and morality, there are several studies supporting the needs to address *mindfulness* in the process of academic integrity development.

The term mindfulness, originated from the Pali language word *sati* which means *to remember* as a way of consciousness, represents the "present of mind" (Brown et al., 2007, p. 212).

Brown and colleagues have also defined mindfulness as a "receptive attention to and awareness of present events and experience" (p. 212). In their study, Ruedy and Schweitzer (2010) explored how mindfulness influences students' ethical decision-making and recognized that students with higher levels of mindfulness (self-reported) tended to act ethically, embrace the values, and uphold the professional standards. Recently, Culiberg and Mihelič's (2020) structural equation modeling (SEM) study on the impact of mindfulness on students' response to peers' academic dishonesty also contributes a clear picture of how mindfulness influences students' ethical decisions in a university. Many studies seemed to support the needs to strengthen students' *mindfulness* in developing students' academic integrity, because the causes of academic misconducts, such as self-serving bias (Epley and Caruso, 2004), are "exacerbated by a lack of attention and awareness" (Ruedy and Schweitzer, 2010, p. 73).

IMPLICATIONS ON TEACHING OR PEDAGOGY

Assigning pre-class readings (e.g., assessment policies and cases) and then follow-up with in-class discussion on various scenarios is a very common practice to deliver knowledge and values of academic integrity. This pedagogy has been used in my course for a while, but I have no idea how good or bad did the students engage with the reading materials. However, in this new implementation (using the AR technology), in addition to the above-mentioned user experience survey results, the system could also generate learning analytics reports which allow me to know how long they have spent on reading materials, the tasks or questions, as well as any common misconception or mistake. I could then plan to improve the course design accordingly.

On the other hand, the mobile app will provide immediate feedback or explanation to the learners if they choose the wrong answers. It also saves my time to take an overview of the class performance.

LIMITATIONS

Sampling and Methods

The scale of this case study is relatively small. Due to the restricted sampling requirements (see the sampling section), there were only 33 participants who successfully completed the learning trail and submitted all surveys. Higher reliability could be maintained if hundreds of participants (for example 200) are involved. The participants' responses in the surveys were quite brief as they were required to write 100 words to describe their understanding of academic integrity. The depth and richness of data could be improved if participants could write a short/mini-essay, around 300–500 words or within one A4 page.

The findings in this study were mainly based on student surveys. Due to the suspension of face-to-face classes, focus group discussions and interviews were not implemented. For improving reliability and data triangulation, it is suggested to arrange online focus group discussions in addition to the student surveys to understand their personal views and learning experience in the future.

Implementation

In view of the social distancing requirement in the COVID-19 pandemic, all the face-to-face student activities on campus were replaced with online and virtual ones. The "checkpoints visiting" of the TIE-General learning trail activity was also canceled. Although a QR code scanner was used to replace the GPS locator technology to trigger scenarios, the teaching materials delivery remains the same. There is a major difference in user experience between the original and virtual learning trails. The participants in the virtual trail could join the activity individually at their own pace within two weeks. In the original learning trail, participants will join it with peers at the same time, so they could discuss the materials with each other when they move from one checkpoint to another (around 5 min). Such informal social learning opportunity is missing in the virtual version. Though such peer interaction is very informal, it somehow creates a positive condition to engage participants in discussion and the tasks in the original version. It might be very helpful if a synchronous peer discussion could be arranged for the virtual learning trail.

Scenarios Design

As discussed in earlier sections, the three scenarios of the TIE-General learning trail mainly aligned with the *honesty* and *respect* values. That might create a condition to drive the participants to re-construct their understanding based on the two values. To raise the awareness of the six ICAI's values, it is suggested to find a balanced way to incorporate all the values into the scenarios. Possible additional scenarios include grading student/peer assignments (fairness), academic collaboration (trust), following ethical procedures (responsibility), reporting peer cheating (courage), etc.

CONCLUSION

The participants (33 RPg students) in this case study found the AR learning trial easy to use and believed that it made learning academic integrity more interesting. According to their responses in the pre-trial survey and post-trial reflection, participants were generally able to identify the ICAI's six fundamental values, namely *honesty*, *trust*, *fairness*, *respect*, *responsibility*, and *courage*. Among these six values, the findings suggested that *honesty* and *respect* might be the values most familiar to the participants prior to joining the learning trail. Their understanding of these two values seemed to be strengthened after the activity. However, the other four values seemed to be less familiar to the participants even though they indicated that they understood the University's policies on academic integrity and have completed the mandatory courses on research ethics and basic teaching. Their understanding of these four values remained at a low level after going through the learning trial. It is suggested to develop more scenarios so as to expand the coverage of the learning trail on the six fundamental values and explore alternative means

to facilitate effective peer discussion in the trail. Though the participants had experienced the scenarios, the learning trail was held as an individual activity eventually, since the mandatory measure of social distancing on campus during the pandemic had prohibited "the walk with peers" and any synchronous discussion in person.

On top of the six values, *empathy* and *mindfulness* were identified as the two other important values to develop academic integrity from participants' perspectives. Increasing responses on these two values were identified in the post-trail reflection. Though some participants might perceive *empathy* as an important attribute in developing academic integrity, there is no direct evidence from literature to support this saying. Rather, to borrow insights from other relevant studies on ethical decision making and morality, there is a dark side of *empathy* that could lead individuals to make unethical decisions when encountering uncertainties (Prinz, 2011, 2012), such as observing peer cheating in an examination. Educators should pay extra attention to this students' perception of empathy to avoid any misinterpretation. As suggested, there is a need to delineate the limits of *empathy* in personal decision-making for upholding academic integrity. To prevent students from falling into the traps induced by empathic emotions, a well-developed *mindfulness* might help them to overcome the struggles and make an informed decision in uncertain circumstances.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Research Ethics Committee, The University of Hong Kong. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Supporting Flipped and Gamified Learning With Augmented Reality in Higher Education

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Chemistry education is challenging when many students cannot see the relevance and interest between what they learn at school and their everyday life outside the curriculum. Due to the prevalence of chemicals in real life, students lose interest in those not-so-novel Chemistry problems as they are satisfied with their rudimentary grasp of knowledge. Therefore, it is of paramount importance to draw students' attention to those day-to-day Chemistry concepts, a task in which augmented reality (AR) can be a competent pedagogical facilitator. Despite its popularity due to the development of smart devices, educators are still averse to adopting AR in teaching because of the doubts about its pedagogical effectiveness and difficulties in implementation. This paper will demonstrate an AR app developed by City University of Hong Kong (CityU) for a year four undergraduate Chemistry course under two UGC's project funds and CityU's Teaching Development Grant that aligns with the university's Discovery and Innovation-enriched Curriculum. The learning theories and technology stack of development and deployment will be shared in this paper. The consideration during preparation, production, and publishing will also be documented. A pilot survey about students' perception of the AR showed positive feedback for the AR app in terms of enhancing awareness, learning, understanding, and engagement, which addresses the concerns of retaining students' engagement during teaching and learning real-life Chemistry. We hope that educators who are interested in adopting AR can gain insights from this AR development experience. This research can act as a foundation for further exploration of applying AR in secondary and tertiary Chemistry education.

Keywords: augmented reality, AR, AR learning design, hazardous chemicals, environmental toxicology

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INTRODUCTION

City University of Hong Kong (CityU) is one of the pioneers in the adoption and application of virtual reality (VR) technology in creative art, humanities, and social sciences (Im et al., 2018; Wong et al., 2019). Inspired by the previous design of a smartphone app developed for a CityU MOOC (Ip et al., 2016) and based on the previous development experience of web-based VR field trips (Wong et al., 2019), this AR chemistry software, "Chemicals in our Environment: Friends or Foe," is intended to apply AR technology to strengthen students' understanding of the toxicants and to

ensure the fulfillment of the intended learning outcomes through its gamified environment in a flipped-classroom approach.

Information on microscopic chemistry can be too abstract for students to grasp (Behmke et al., 2019) because of the unobservable behaviors of chemicals and the potential conflicts of learners' daily experience from chemical sciences (Limniou et al., 2008; Bower and Jong, 2020). The chemical composition of products, potential problems of the environmental toxicants, and their fate in the environment can be a formidable task for students to digest. As a result, students become oblivious and lose interest in learning about chemicals in real life. However, an understanding of chemical and scientific ideas is important for dealing with problems of everyday life in a technological society (Childs et al., 2015), so chemistry educators need to convey the importance and relevance of the subject to learners and society (Karukstis and van Hecke, 2003). With high relevance for creative inquiry, teaching, and learning, AR is an emerging technology expected for broad adoption in education (Wu et al., 2013; Johnson et al., 2016) because of its potentiality of improving learner interaction, motivation, and enjoyment (Akçayır and Akçayır, 2017). However, the pace of VR and AR development goes beyond research into the pedagogical application, which results in the insufficient evidence base for educators to determine the "why" or "how" of using VR and AR in learning and teaching (Bower and Jong, 2020). These concerns accentuate the need for further research of VR and AR learning method and tools used in STEM teaching and learning. This paper addresses AR's pedagogical concerns and its effectiveness by documenting the best practice of developing the AR tool and conducting a pilot study.

A Brief Review of Augmented Reality Applications in Teaching and Learning

Augmented reality (AR) is the technology that blends digital information dynamically with real-world environments to engage users by in-time interaction with virtual objects (Azuma, 1997). Milgram et al. (1995) explained that AR and VR are rooted in the same concept but with a different user level of immersion on two sides of the Reality-Virtuality (RV) continuum. One side of the RV continuum, generally regarded as VR, consists entirely of computer-generated or synthetic objects to construct an immersive environment for users. In contrast, AR augments a real-world scene with stimulated cues for users to interact. Guttentag (2010) defined AR as the enhancement of a real-world simulation adopting layers of computer-generated images.

Pence (2010) identified two AR methods, marker-less AR and marker-based AR. The former method suggests mobile devices correspond to virtual information via users' GPS location function. In contrast, the latter means users retrieve virtual details with their mobile devices or tablets by scanning the marked AR code. Cheng and Tsai (2013) categorized AR into image-based AR and location-based AR. In image-based AR, virtual information is obtained through actual picture recognition to conduct mobile learning without any geographical limitation. Location-based AR is designed to facilitate the discovery of augmented information around the target spots by detecting users' location and position.

In light of the recent advancement in computing development, AR is made more affordable for the public and education applications. A myriad of AR research and implementations in education indicate that the recognition of its advantages over traditional classroom teaching and media communication, such as PowerPoint, images, and videos, is gaining momentum (Yung and Khoo-Lattimore, 2019). Sotiriou and Bogner (2008) advocated that the application of AR adds value to science learning by increasing students' experimentation and interest. The relevancy of science can be made more feasible and fruitful with immersive technology (Wang and Hannafin, 2005). Students can more readily understand challenging concepts in science due to AR's remarkable ability to visualize details and hidden information (Yoon et al., 2017). Three-dimensional visualization, supported by AR, can offer a contextual and personal learning experience. This positive learning experience can help learners make sense of phenomena and connect science ideas by applying the new knowledge to the current and other situations (Joe, 2015). Zhang et al. (2014) created a mobile AR app for outdoor astronomical observations and interactive learning. They accorded that mobile devices' portability and free geographical operations were the main success factors. Furthermore, they included data derived from learners' mobile device functions and sensors to engage them in stargazing outdoors. AR implementations for elementary students were also designed with elements like accomplishing missions, storytelling, and mini-games to simulate game-based learning and encourage students to have fun (Squire and Jan, 2007; Chen and Tsai, 2012; Koutromanos and Styliaras, 2015).

The use of AR in school settings has been supported by several researchers as a positive indication for improving learners' self-efficacy (Lin and Chen, 2015), critical thinking (Chao et al., 2016), cognitive load, and motivation (Cheng, 2016). Kurilovas (2016) supported that AR-based systems effectively enhance student satisfaction and motivation compared with traditional teaching. From a systematic review on science, technology, engineering, and mathematics (STEM) learning with AR, Ibáñez and Delgado-Kloos (2018) agreed that the application of AR fits the instructional techniques of the flipped classroom. The flipped classroom is intended to facilitate out-class learning at the preliminary levels so that class time can be used for active learning and discussion. The traditional flipped classroom approach is through multimedia learning content, like the video (Hwang et al., 2015). However, Jensen (2011) suggested that students are more likely distracted in taped learning outside the more structured classroom environment, undermining learners' attention and engagement during the flipped learning. Therefore, the success of flipped learning depends significantly on how the out-class learning activities can encourage students' engagement and exploration (Lo, 2018). Research indicates that AR can enhance learners' motivation by offering immediate feedback and relevant learning content (Tosti et al., 2014). In the study by Chang and Hwang (2018), AR-based flipped learning yielded positive results in

learners' performance by encouraging students to interact and practice more.

Learning Theories and Instructional Design in AR Software

Sommerauer and Müller (2018) summarized the most prevalent learning theories in educational AR design from a cognitive or constructivist perspective.

Cognitivists regard learning as a process to receive, organize, store, and retrieve information in the brain (Sommerauer and Müller, 2018). The effectiveness of one's learning process depends on his processing (Craik and Lockhart, 1972), suggesting that memory will last longer by a more profound process of information, and existing knowledge structure will determine one's attention to perceive, learn and remember (Woolfolk and Hoy, 2006). The cognitive learning theory (CLT) by Sweller (2011) proposed that learners' total cognitive load is limited, so the increase of unfavorable intrinsic and extraneous cognitive load will undermine learners' germane resources for attention and organization of learning materials. Since the intrinsic cognitive load, depending on the complexity of the instructional topic which may not be altered by instructors (van Merriënboer and Sweller, 2005), and the extraneous cognitive load, associating with the presentation of learning materials under the control of instructors, are additive and cannot exceed the capacity of working memory (Fred et al., 2004), instructional designers have to reduce extraneous cognitive load which does not contribute to learning so as to foster an increase of germane load within learners' overall working memory (van Gog et al., 2010). Therefore, the presentation of learning materials has a profound impact on reducing extraneous cognitive load. Sweller and Chandler (1994) recommended integrating correlated textual and visual information to reduce learners' mental efforts to synthesize information, helping them understand complex concepts. The cognitive theory of multimedia learning (CTML) proposed by Mayer (2009), which was partially applied in this research (**Table 1**), made a hypothesis that the works of mind bring more meaningful learning. CTML, based on cognitive science principles of learning, suggests three assumptions, namely: (1) the dual channels, visual and verbal, of human information processing system, (2) the limited processing capacity of each channel, and (3) the active cognitive process for knowledge construction. Therefore, instructional design to reduce irrelevant content, as advocated by CTML, is expected to reduce the extraneous cognitive load of learners and promote effective learning by increasing their germane resources.

Constructivism believes that learning is an active process of knowledge acquisition rather than passive receiving (Kundu et al., 2017). It is usually regarded as learner-centered learning because of its focus on learners' problem-solving strategies through information, resources, and social interaction (Woolfolk and Hoy, 2006). Lave (1991) emphasized that learning shall consist of mastering knowledge and tasks in realistic situations. Abdoli-Sejzi and Bahru (2015) supported that AR allows students to develop new knowledge and understanding via active interactions with the natural and context-rich virtual environments, which is aligned with constructivist ideas of education (Martín-Gutiérrez et al., 2010). Constructivists emphasize the importance of actively engaging students by creating a meaningful context that motivates them to construct knowledge based on their experiences because learning should be imposed by individuals rather than existing independently in the world (Dede, 2008). By applying AR in education to increase attention, satisfaction, and confidence (Khan et al., 2019), educators can help learners achieve a deeper level of engagement for lasting connections within their own knowledge (Kerawalla et al., 2006).

Game-based learning (GBL), widely applied in AR education research, resonates with the constructivist approach. GBL can transfer contextually relevant information in an immersive game environment more readily to real-life applications (Brom et al., 2010). It has been regarded as an effective and engaging method for learners (Eck, 2006) to connect their knowledge tightly with the physical and social worlds (Gee, 2008). Pedagogically, AR GBL can foster an experiential learning environment to convert boring instruction into a more entertaining experience (Lu and Liu, 2015). Learners are motivated to maintain positive learning behaviors (Kiili, 2005) which are positively correlated with deep learning and higher-order thinking (Crocco et al., 2016). We also adopted GBL in our design, which is likely to make learning experiences motivational and fun (Kiili, 2005; Hirumi et al., 2010; Crocco et al., 2016). In the AR Chemistry software, students are required to explore and handle the misplaced elements. Such gaming elements, inside the AR context, are expected to result in a more engaging learning experience to foster organic connections between the learning materials and the real world (Shirazi and Behzadan, 2013).

Principles for mobile learning from Herrington et al. (2009) were also incorporated into our design because of its mobility

TABLE 1 | Partial features adapted from 12 principles of CTML by Mayer (2009).

Principle	Definition	Implementation in the AR app
Spatial contiguity principle	Students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen (P.135)	Cues with guiding texts are prepared on the same screen as activities
Temporal contiguity principle	Students learn better when corresponding words and pictures are presented simultaneously rather than successively (P. 153)	Pictures/videos and narrations are presented simultaneously
Segmenting principle	People learn better when a multimedia message is presented in user-paced segments rather than as a continuous unit (P. 175)	The app is divided into three separate scenarios
Voice principle	People learn better when the narration is spoken in a human voice rather than in a machine voice (P. 242)	Human voice-overs are recorded for videos

and portability for AR learning. The importance of such mobility and portability has been heightened when physical classes are suspended under the COVID-19 pandemic. It is essential to engage students in online lessons or remote learning by allowing access to learning content whenever or wherever at their own pace. The first-hand interaction with the surrounding environment, supported by mobile AR, increases learners' motivation, making learning more situated, personal, and lifelong (Naismith et al., 2004). The portability and convenience of mobile learning are the overriding factors to remedy technologies' affordances and mediate knowledge construction and consumption of knowledge (Herrington et al., 2009). To further facilitate students' independent learning, AR-based flipped learning was adopted to promote positive learning attitudes, better learning performance (Chang and Hwang, 2018), enhancing students' attention (Röhl et al., 2013), and augmenting student engagement (Kobayashi, 2017). Since the AR software in the study is a pre-class activity immersing students in a virtual three-bedroom flat setting, students are engaged to learn about their home environments. The teacher will encourage students to bring the abstract concepts of misplaced toxic chemicals to their real home environments and construct other novel sets of AR scenarios with mishandled chemicals. Students will then form into groups in class to conduct mini-research about the hazardous chemical of their choice and share their findings with their peers to gain further insights and experiences in a reflection and discussion session.

DEVELOPMENT OF AR

There are three AR design stages, which consider factors relating to hardware, software, and content (**Figure 1**). All these factors are inter-related with each other in the AR application.

Preparation

In order to design a comprehensive framework, design elements applied by previous researchers were incorporated into the design after a review of the literature. Those elements have to be based on well-established standards to cover both internal and external communication in and from the AR app for both user and object communication.

After identifying the foundation of learning theories, several AR toolkits were evaluated based on their offered functions and limitation. Although plane detection in ARCore from Google and ARKit from Apple works well to detect vertical and horizontal surfaces, the libraries do not provide backward compatibility before Android version 26 and iOS11, respectively. To cover a wide variety of students' phones, Vuforia was picked because it allows a platform-neutral implementation of the function in general smartphones with cameras. Using Vuforia, we replaced platform-specific plane detection with image recognition, presenting the same idea of displaying the AR apartment model. Unity AR by Unity Technologies, which is the status-quo 3D game development platform, was finally selected because of cross-platform requirement, which is essential for our goal of Bring Your Own Device (BYOD) during online learning, as well as the availability of integration to XCode and Android Studio, which are the most common integrated development environments (IDEs) for iOS and Android. One of the features of Unity 3D is to translate code directly to 2 AR languages for Apple iOS and Google Android. While Blender, an open-source 3D creation suite, was used to optimize the 3D model to enhance the performance of the AR software.

Meetings with the teacher and the subject experts were documented to confirm the AR software flow with relevant virtual objects (chemicals in a domestic setting), presented as layers of computer-generated images for simulation to align with the intended learning outcomes. Four chemicals, namely butane gas canister, formaldehyde, sulfuric acid, and carbon monoxide, together with four complete sets of scenarios, were selected to keep the project manageable while facilitating the learning objectives. Each chemical would be accompanied by a scenario, similar to a hotspot that involved a short static animation delivering its background to students, leading to a mini-game and other learning activities. The static animation and chemical items were drawn manually or modified from Shutterstock's selected graphics, a prepaid licensed footage library. The static images and scenes were processed through Adobe Illustrator. The background information of the household chemical was scripted and voiced over. Based on the design principles and learning theories, these chemicals were hidden and placed wrongly in the AR so that students will have to relocate them to avoid potential hazards through the given cues and hints. Such gaming elements and real-life simulation experiences were expected to engage and encourage students to explore the AR-powered app.

Production

During the production stage, graphic user interface (UI) elements, i.e., icons, buttons, and animation movement, were crafted by Adobe Illustrator and Adobe Photoshop to provide clear indicators to reduce learners' cognitive loads when using the AR software. For typical 3D models, we collected the 3D model references from an open-source 3D model platform, Sketchfab. However, those models could only act as prototypes because of the lack of optimization or the insufficiency of features. By using Blender to reduce polygons, modify details, map, and assign texture materials, those models could yield better performance, in terms of bootstrap time and physical storage volume, in the AR software. While being programmer-agnostic, Unity offers intuitive application programming interfaces (APIs) and a software development kit (SDK) to allow cross-platform mobile development.

Chemical items, interactive and gesture control, AR image recognition, and game logic of the software were programmed during this stage. The entire workflow of the AR app is illustrated below (**Table 2**). Students will begin by exploring the three-bedroom flat with objects surrounded by a thin layer of green illuminating light to prompt students to trigger a scenario to learn about the chemical's background. The 3D apartment model can be zoomed in and out and rotated with two fingers touching the mobile phone or tablet's screen. When a scenario ends, students will be asked to find the misplaced hazardous chemical in the household. Once the

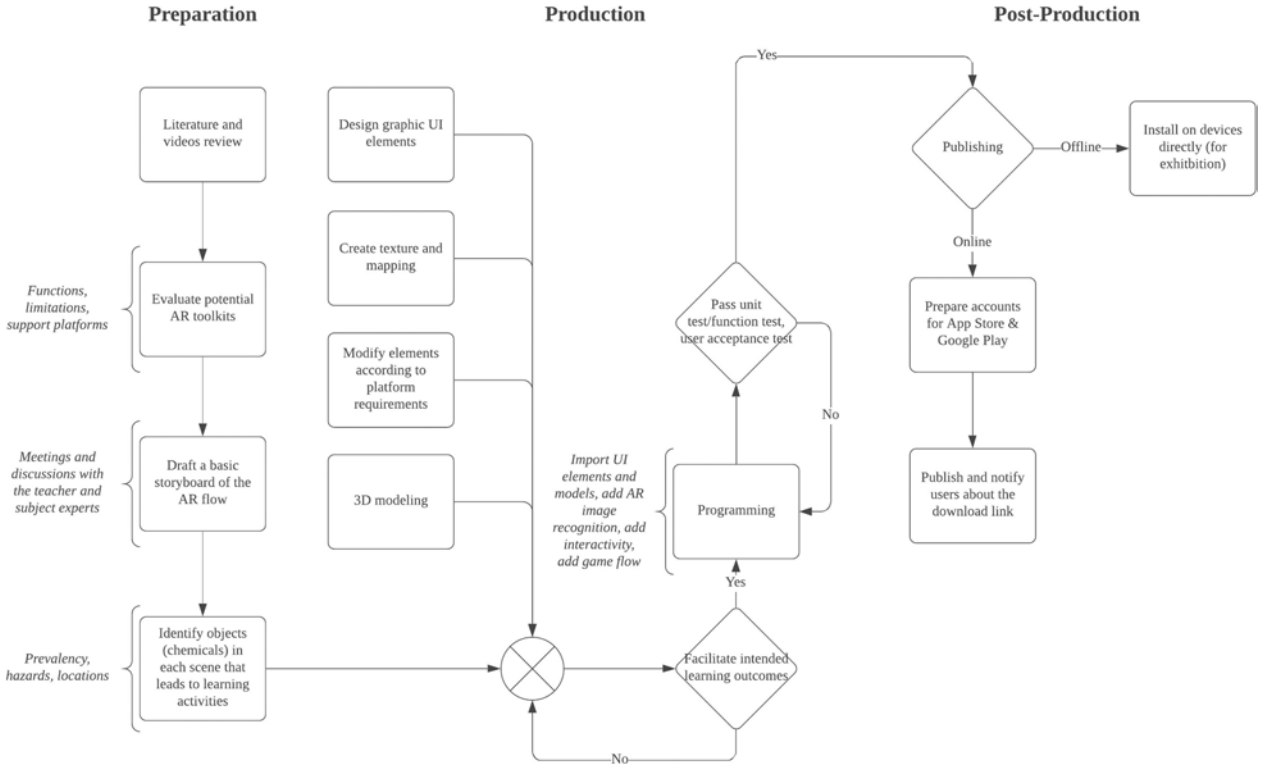


FIGURE 1 | A flowchart for the AR production flow.

chemical is identified, there is another short static animation that explains the chemical's property. Students are then asked to handle the chemical correctly by placing it in an appropriate location, similar to a mini-game. In order to encourage and motivate students to find the hidden chemicals, digital badges indicating success will be awarded if the hazardous chemical can be found in 5 min. If the chemical hunt exceeds the time limit, a highlight of the hidden chemical will be displayed. Besides, informative pages are added to supplement the background knowledge of the chemical after the chemical item is identified in order to facilitate the acquisition of the learning outcomes. The final step in the production was the reiteration based on functional tests, focusing on individual functions, and user acceptance test (UAT), for cosmetic errors or system testing to validate the end-to-end business flow of the AR app.

Post-production

After passing the validation and the tests, the AR app was ready to be published, either publicly or internally. The advantages of online publishing are the ease of installation by end-users through the existing app stores of their platform, as well as broader exposure of the software. However, the registrations and compliances required by the app stores may be complicating for an internal app intended for only a few dozen students in a Chemistry course. Therefore, we chose to publish internally by providing an APK package for the Android platform and an internal link to iOS users. Such an arrangement provided fast iterations of upgrade and bug fixing before the commencement of learning activities.

FLIPPING A CLASS WITH AR SOFTWARE

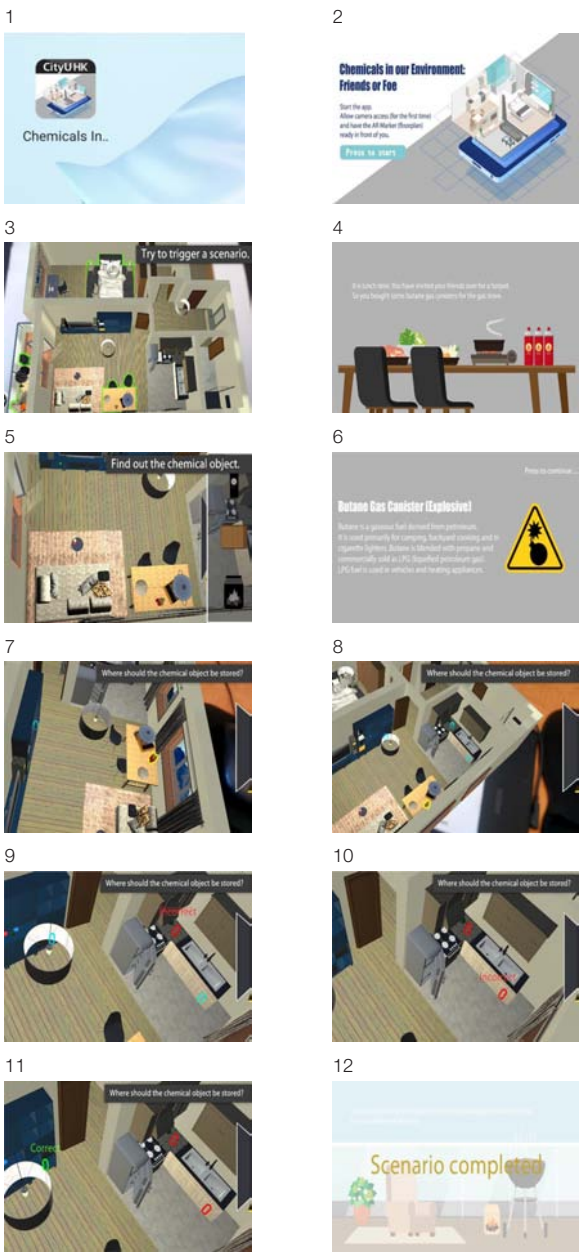
The AR tool is intended to facilitate students' online self-learning. By reading through self-learning materials in the app before classes, students are free to review unfamiliar topics according to their understanding or at their own pace. This pre-class preparation before the online face-to-face session not only allows the teacher to spend class time in a more meaningful way but also strengthens students' comprehension and ensures the fulfillment of the intended learning outcomes. After completing the tasks within the AR software, the teacher will elaborate on the potential hazards in the surrounding environment and ask the learners to form groups to consolidate their knowledge by constructing extra scenes of hazardous chemicals in the household. The exchange of ideas and collaboration is expected to strengthen students' understanding as teams of students are required to conduct a mini-research and presentation.

DATA ANALYSIS AND FINDINGS

This paper adopted quantitative methods to analyze students' feedback on the AR software. A questionnaire taken from

Cai et al. (2014), which had been used to measure students' attitudes toward an AR Chemistry software, was distributed to 46 students of the Chemistry class after using the software. The questionnaire adopts a six-option Likert scale, ranging from "Strongly Disagree" as 1 to "Strongly Agree" as 6 for four constructs about learning attitude (7 questions), satisfaction within the AR software (14 questions), cognitive validity (5 questions) and cognitive accessibility (4 questions). An optional open-ended question asking for students' comments about the AR software was included at the end of the survey. 37 valid responses out of 46 were received within 2 weeks after the learning activities. To evaluate if the adopted questionnaire was appropriate for undergraduate students, we conducted a reliability analysis. The Cronbach's alpha coefficients for each construct and the entire questionnaire are all over 0.8, suggesting the questionnaire's high inner consistency and reliability (**Table 3**). Descriptive statistics for each construct and their correlation were calculated and analyzed below.

TABLE 2 | An example of a complete AR workflow.



Descriptive Analysis of Students' Attitude

The mean score and standard deviation of each construct were summarized in **Table 4**. The average score of each item of the corresponding construct was calculated. Among the four constructs, cognitive accessibility yields the highest score, 4.72, while cognitive validity has the lowest, 4.01. These scores may suggest that students were generally satisfied with the AR software's usability, but they would look for more in-depth chemical knowledge.

From the Learning Attitude construct (**Table 5**), the 3 highest scores items ("I think that learning chemistry is rewarding [4.78]"; "I think that learning things related to chemistry is meaningful [4.76]"; "I think that learning and observing chemistry-related content in addition to that in textbooks is meaningful [4.65]") suggest that most students value the knowledge learned in Chemistry and they prefer a more personal and observable learning experience instead of merely reading Chemistry textbooks. Despite being the lowest score item, the statement "I view learning about the chemicals in an Augmented Reality software as rewarding" still yielded a mean of 4.30. This may indicate that even though the AR software is a rewarding companion to learn about Chemicals, the design or the content can be further improved to bring a more fruitful experience to learners.

Descriptive statistics for the Satisfaction construct in **Table 6** show that students are in favor of the user interface of the software (4.54 in "The color of this software is appropriate, as it is attractive and does not distract me"), the application of science-subject-discipline related AR (4.49 in "I hope that

TABLE 3 | Cronbach's alpha for each construct.

Variable	Number of items	Cronbach's alpha
Learning attitude	7	0.814205
Satisfaction	14	0.952337
Cognitive validity	5	0.868105
Cognitive accessibility	4	0.855043
Overall	30	0.946382

TABLE 4 | Descriptive statistics for the four questionnaire constructs.

Variable	Sample size	Min	Max	Mean	*SD*
Learning attitude	37	1	6	4.5483	0.9153
Satisfaction	37	1	6	4.2915	1.1611
Cognitive validity	37	1	6	4.0108	1.0884
Cognitive accessibility	37	1	6	4.7230	1.0421

TABLE 5 | Descriptive statistics for "learning attitude" construct.

Item	Mean	*SD*
I view learning about the chemicals in an Augmented Reality software as rewarding	4.30	0.8119
I think that learning chemistry is rewarding	4.78	0.7865
I think that learning things related to chemistry is meaningful	4.76	0.7229
I think that learning and observing chemistry-related content in addition to that in textbooks is meaningful	4.65	0.8887
I will actively search for information related to chemistry in books or on the internet	4.49	0.9894
When I come across problems in learning chemistry, I will actively reach out to teachers, classmates, books or the internet for solutions	4.51	0.9609
I think that learning chemistry is important for everyone	4.35	1.1357

TABLE 6 | Descriptive statistics for "satisfaction" construct.

Item	Mean	*SD*
The AR-based learning software is more interesting than previously used learning methods	4.19	0.9079
This game-like learning tool can aid me in discovering new questions	4.27	1.2394
Using AR-based software enables me to view chemistry concepts and chemical substances in a different way	4.38	1.0369
I like learning chemistry using AR	4.19	1.2211
I like game-like learning methods	4.49	1.4068
I hope that other disciplines such as Physics and Biology will apply AR tools to learning as well	4.49	1.1456
I hope to use similar AR tools to learn chemistry in the future if possible	4.27	1.1937
I will recommend the AR learning tool to other classmates	4.32	1.1317
I'm interested in using AR-based learning tools	4.32	1.2031
The content of this software is closely related to the course's "chemical substances," which is a very interesting topic to me	4.24	1.2997
The AR-based learning tool enables me to learn not only on my own but also with my friends and classmates	3.92	1.1150
The design of this software is pleasing and genuine	4.38	1.2099
The color of this software is appropriate, as it is attractive and does not distract me	4.54	0.9005
I think that learning about the chemical substances inside and outside the household using an AR-based learning tool is necessary	4.08	1.1874

TABLE 7 | Descriptive statistics for "cognitive validity" construct.

Item	Mean	*SD*
I believe that AR demonstration renders learning materials more detailed and understandable	4.35	0.8887
I think that using this game-like AR learning tool is very helpful for learning chemistry	4.05	1.0787
This AR learning tool is more effective than any other software I have ever used	3.73	1.1702
Using this AR software enables me to master important knowledge points in an in-depth manner and comprehend the principles I did not understand in the past	3.89	1.1251
The AR learning tool provides abundant space for me to think and try, which aids me in solving problems	4.03	1.1177

other disciplines such as Physics and Biology will apply AR tools to learning as well) and gamified learning environment (4.49 in "I like game-like learning methods"). It is expected science students are keener on the AR experience because many science concepts are relatively abstract and cannot be easily observed or experienced personally. The lowest score item, "The AR-based learning tool enables me to learn not only on my own but also with my friends and classmates (3.92)," is also expected since the AR software was used as a remote learning tool during the physical class suspension. This constraint may hinder the exchange or communication among peers during the use of the software.

Results of students' Cognitive Validity are shown in **Table 7**. The contrast between the highest score item, "I believe that AR demonstration renders learning materials more detailed and understandable (4.35)," and the bottom item, "This AR learning tool is more effective than any other software I have ever used (3.73)," may suggest that students are benefited from the interaction and observation of elements within the AR software. The result met our expectation that the AR learning tool, which integrates the relevant textual and visual information, can reduce the extraneous cognitive load to enhance germane load for a better understanding of the learning materials. Still, the extra setup of AR, which may be novel to students, may, contrarily, pose an unfavorable extraneous load on students hurting AR learning effectiveness.

The Cognitive Accessibility construct (**Table 8**) receives the highest score among all constructs, indicating that students can master the AR at a reasonable time. The lowest score item, "The content of and procedures for this learning activity are clear and understandable to me (4.43)," may suggest that additional instructions shall be given to students to facilitate a better learning experience and lower cognitive load of AR operation, especially when this is a novel learning experience during the online learning mode.

In summary, the above constructs demonstrate overall positive feedback toward learning attitude and the AR software for the Chemistry class. The findings echoed the idea that immersive learning technology, like AR and VR, can help convert some unobservable and abstract concepts in science subjects to interactive learning materials. Consequently, learners can benefit from first-hand interaction to enhance their understanding during the better learning process. Learners are more engaged and motivated to learn with GBL under the flipped classroom context.

The Pearson Correlation coefficient was calculated in **Table 9** to evaluate the correlation between students' learning attitudes and AR software perception. Generally, Learning Attitude

TABLE 8 | Descriptive statistics for "cognitive accessibility" construct.

Item	Mean	*SD*
Operating the AR software is not difficult	4.73	1.0179
Learning to use this AR tool does not cost me a great deal of time and energy	4.92	0.8293
The content of and procedures for this learning activity are clear and understandable to me	4.43	1.2143
I can grasp how to operate AR software within a very short timeframe	4.81	1.0498

TABLE 9 | Pearson correlations between "learning attitude" and "satisfaction," "cognitive validity," "cognitive accessibility".

	Learning attitude	Satisfaction	Cognitive validity	Cognitive accessibility
Learning attitude		0.443	0.412	0.272
		0.006	0.011	0.103
Satisfaction	0.443			
	0.006			
Cognitive validity	0.412			
	0.011			
Cognitive accessibility	0.272			
	0.103			

positively correlates with students' positive feedback toward the AR software, ranging from 0.412 to 0.443, $p < 0.05$, except for the construct Cognitive Accessibility with 0.272, $p = 0.103$. This high *p*-value in Cognitive Accessibility may not necessarily imply its insignificance with Learning Attitude. Still, it may be regarded as an indicator to further consider the variation of learners' technology adeptness and accessibility when carrying out novel learning activities, especially in the context of distant online learning. In summary, the results reflect that students who perceive a higher value in learning Chemistry generally demonstrate greater satisfaction and usefulness toward the AR software of the Chemistry class.

Students' Comments Toward the AR Software

The optional open-ended question asking for students' comments on the AR software at the end of the questionnaire collected 12 valid responses. According to the comments, 11 out of the 12 replies showed a positive appreciation for the AR software, and they thought it was fun and interactive to learn Chemistry via the AR software. The only negative response suggested that more interactions in the AR software were preferable. Two of the answers suggested more content should be added to enrich the learning process. At the same time, 1 student agreed that learning through AR was fun but might be less effective than reading books or searching online for domestic chemicals. Additionally, there were 2 replies concerning the difficulties of the AR operations.

DISCUSSION AND CONCLUSION

The questionnaire results show that students generally had a positive evaluation and satisfaction toward the AR software because it allows easy observation and manipulation of real-world environments or elements. Students appreciated the AR software as a valuable tool in a flipped classroom context, allowing them to better prepare and deeper understand the intended learning outcomes before face-to-face online classes. Based on the findings from the questionnaire and students' comments, students were looking for more content, better control, and a nicer presentation of the AR software in order to enhance their satisfaction with it, thus suggesting possible improvements for future works.

Furthermore, significant positive correlations between Learner Attitude and perception of the AR software were found. Despite the high *p*-value in the construct of Cognitive Accessibility, its score was still within the positive category but may bring an implication for further consideration during the design and introduction of the software to minimize students' overhead to access the AR. This result also aligns with Cai et al. (2014)'s conclusion that promoting learner's initiative toward Chemistry is the cornerstone to enhance learning effectiveness via the AR software. Since this is only the first phase of the project, there are many limitations. The team is working on a content expansion for the AR app to cover a minimum of 10 sets of scenarios in the second phase. Further research can be extended when the AR app is launched publicly to cover more Chemistry classes in Hong Kong after this pilot study. Future research may also include secondary students to investigate the impact of the study.

Possible Improvements for Future Work

The paper's findings have proven great potentials for AR software as a pre-class companion under the context of a flipped classroom. The comments from the students suggest several possible improvements:

- Add more scenes in the AR software. Insufficient content may undermine students' positive perceptions of the AR software.
- Add more gaming elements and interactions. Students showed positive responses to the game-like learning methods, while the limits of interaction among the virtual objects in the AR may reduce their experience in the software. More interactions under the gamified AR environment may allow a better immersive learning experience, which may facilitate effective learning.
- Provide better instructions and training on the use of AR software. Extra instructional videos of the setup and instant response to the difficulties encountered during the setup may help students increase their technological capabilities and access to AR, which may allow them to focus and appreciate more on the content and knowledge in the AR software.

The positive results of the AR software also encourage some possible future research directions:

- Expand the sample size to cover more Chemistry students in secondary schools and universities in Hong Kong to boost the impact of the research.
- Evaluate the effectiveness of the AR software in terms of pre- and post-tests' results. Due to time limitations, this research has not collected any test results before and after using the AR software. Future research can focus on the effectiveness of using this AR software by analyzing users' academic performance.
- Add a control group to compare the effectiveness of the AR software and other learning methods. Even though AR is generally regarded as a powerful tool for 3D structure comprehension and experience, it cannot be considered to be a one-size-fits-all solution for all students with different learning styles. It would be valuable to compare the effectiveness of the AR software and other learning methods.
- Evaluate the user interface and the control of the AR software. Due to the hardware limitations, it is understandable that several students found control within AR unsatisfactory. Future human-computer interaction (HCI) research may shed light on aiding such a negative experience.

Technical Notes

There are overwhelming AR toolkits, either proprietary or open-sourced, available on the market, providing different feature sets under various licenses, which may not be familiar with researchers. Hence, it is necessary to fully evaluate those licenses before publishing, especially when the product is intended to be published publicly. Even though open-sourced toolkits may solve licensing concerns, researchers shall also take whether there are sufficient resources and support of the toolkit, e.g., the completeness of documentation and the presence of a discussion forum, into consideration.

Furthermore, AR applications on smartphones provide a convenient and minimized setup solution to appreciate AR in an educational context. However, the mainstream mobile operating systems' incompatibilities impose a great deal of development overhead for cross-platform programming. Such factors are more significant when there are different specifications among Android smartphones. Researchers are suggested to carry out UAT on various phones with various specifications.

Publishing the AR app to the platform-specific market stores can minimize the technical problems during installation. However, different public publishing requirements and code reviews among platforms require exhaustive effort. Researchers are suggested to evaluate the necessity of publishing the app publicly and make thorough preparations in advance.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the City University of Hong Kong Research Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AL was the principal author of the article and co-investigator of the project, responsible for instructional designs of the AR, and flipped learning and drafting of the article. CW was the project leader who contributed to the article's main ideas and structure. RC was the instructor of the Chemistry class for the AR experiment, provided expertise of the subject and the content of the AR design, and responsible for carrying out the survey in the study. TI was the co-investigator of the project and provided essential cross-departmental coordination during the development and the teaching process. All authors contributed to the article and approved the submitted version.

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Faculty and Student Perceptions of Academic Integrity in Technology-Assisted Learning and Testing

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The recent COVID-19 pandemic presented challenges to faculty (Fac) and students (Stu) to uphold academic integrity when many classes transitioned from traditional to remote. This study compared Fac and Stu perceptions surrounding academic integrity when using technology assisted proctoring in online testing.

Methods: College Fac (N = 150) and Stu (N = 78) completed a survey about perceptions of academic integrity and use of proctoring software for online testing. Wilcoxon rank-sum tests were used to determine if there were differences in the distribution of agreement between students and faculty.

Results: Fac and Stu agreed maintaining academic integrity was a priority (93 vs. 94%), and that it is easier to cheat in online tests (81 vs. 83%). Responses differed on whether online proctoring software was effective at preventing academic dishonesty (23% of Fac vs. 42% of Stu disagreed). 53% of Fac and 70% of Stu perceived that online proctoring was an invasion of privacy. Only 7% of Stu and 49% of Fac perceived importance in having a policy about proctoring online tests, whether cheating in an academic setting is likely associated with cheating in a work setting (78 vs. 51%), and if given a choice, 46% of Fac and only 2% of Stu would choose to use proctoring software. Answers to open-ended questions identified feelings of stress and anxiety by Stu and concerns about privacy by Fac.

Conclusion: Fac and Stu had similar perceptions of the importance of academic integrity and ease of cheating in online tests. They differed in perception of proctoring software's effectiveness in deterring cheating, choosing to give or take a proctored online test, and having a policy in place. Policies on technology-assisted online testing should be developed with faculty and student input to address student concerns of privacy, anxiety, and stress and uphold academic integrity.

Keywords: cheating, online, remote, proctoring, faculty perceptions

INTRODUCTION

A steady growth in technology-assisted learning was recently intensified by the COVID-19-initiated closing of many schools from kindergarten to colleges worldwide. This unexpected pandemic resulted in a rapid move from traditional face to face classroom to online teaching and testing that affected schools everywhere. The transition presented challenges to faculty and students for learning material and upholding academic integrity when assessing learning. This was especially evident in the absence of policies about educational tools including proctoring software associated with online teaching and testing. There is widespread concern that cheating has been made easier by advances in technology which provide a large number of innovative schemes to provide students with unauthorized assistance in ways that are difficult to detect (Newton, 2018; Ison, 2020). There are also growing concerns about the potential that proctoring software may be biased in its flagging of suspicious student identification and test taking behavior, violate one's privacy, and convey a sense of mistrust to test takers (Beck, 2014). Adding to complexity, some self-report studies are inconclusive about whether cheating is actually on the rise (Curtis and Clare, 2017).

Cheating is big business and a growing number of unscrupulous companies have profits estimated to approach $100 billion globally (Clarke and Lancaster, 2013; Newton, 2015, 2018) for providing dishonest services for students that provide answer keys, previously written papers, and even people who are hired to take exams or write papers for fees (Allen and Seaman, 2015; Ison, 2020). With the availability of websites that provide a variety of nefarious services, the challenge of ensuring academic integrity is ever-increasing (Alessio and Wong, 2018). To address academic dishonesty in online tests, companies have developed proctoring software designed to identify test takers, monitor student behavior and detect cheating in online tests. Very few studies have directly observed cheating behavior, nevertheless, faculty are aware of the many ways that students cheat both in traditional and online classes. An indication of potential academic dishonesty may be obtained from indirect evidence. One study reported a grade disparity mean of 17 points and double the amount of allotted time to take the test in students who were not proctored compared with proctored (Alessio et al., 2017). Alessio and Maurer (2018) examined the impact of an institutional decision to provide and support proctoring software to all departments in which online exams were used. Final grades were compared in 29 online courses representing 10 departments that were taught 1 year prior to and 1 year following the campuswide adoption of video proctoring software. Results of this study showed that average course grade point averages were significantly reduced with a 2.2% drop in GPA on a 4-point scale after the adoption of the proctoring software. While this study did not directly detect cheating and only compared final course grades that included test and assignment grades, the lower GPA across most courses following the implementation of proctoring software campus-wide found grade differences due to whether or not tests were proctored.

Not all studies have reported grade disparities when comparing proctored and non-proctored test results. Beck (2014) reported no significant difference between proctored and non-proctored tests using a statistical model to provide R^2 statistics for test scores to predict academic dishonesty. Measures of student characteristics such as major, grade point average, and class rank were used to predict examination scores. When comparing different classes, if no cheating occurs it was expected that the prediction model would have the same explanatory power in both classes, and conversely, if cheating occurred it was expected that the R^2 statistic would be relatively low because a large portion of the variation would be explained by cheating. Beck (2014) reported that only grade point average explained a greater degree of variation for test results in proctored vs. unproctored. This is in contrast to Harmon and Lambrinos (2008) who compared proctored and non-proctored tests results using a similar statistical model and reported R^2 values of 50% in the one proctored exam which was much higher than the 15% R^2 value for the first three unproctored exams. In another study at a medium size Midwestern university, Kennedy et al. (2000) reported that 64% of faculty and 57% of students perceived it would be easier to cheat online compared with face to face classes. They also found that faculty who had experience teaching online tended to lessen their perception about the ease of cheating online. These results differ from a survey of faculty teaching online at a different university, located in the southern part of the United States, where the majority of faculty surveyed did not perceive there was a big difference in cheating between online and in-person (McNabb and Olmstead, 2009). Surveys of faculty and student perceptions of cheating in proctored compared with unproctored seem to be similar whether the test is online or in person (Watson and Sottile, 2010). The critical factor is whether or not the test is monitored.

There is currently a vigorous debate occurring on campuses all over the world about the appropriate use of technology assisted proctoring software in online testing. Concerns about bias and surveillance associated with proctoring software that uses artificial intelligence to monitor and flag suspicious identification and behaviors while a student is taking a test has led some institutions to ban the use of proctoring in online testing (Supiano, 2020). There is also concern about the impact of remote testing on student affect due to feelings of intrusion and the discomfort of being watched by a remote proctor or video that uses artificial intelligence to look for suspicious actions. Kolski and Weible (2018) conducted an exploratory study that observed behaviors associated with anxiety during a virtually proctored online test and interviewed students after taking an online test. They reported higher than expected examples of test anxiety and left to right gazing behavior that could have been flagged as being suspicious behavior by proctoring software. Critics of virtual proctoring often refer to added stress, feelings of intrusion, and implicit bias in the practical work as well as the algorithms used by proctoring software. Test anxiety has been reported to increase in some, but not all students, and interestingly, Stowell and Bennett (2010) reported lower test anxiety in students who took tests online vs. in a traditional classroom environment.

TABLE 1 | Wilcoxon rank sum and *p*-values for Likert scale questions.

Question	Wilcoxon rank-sum test stat W	*P*-value
Q06: How many online tests have you given/taken with proctoring software?	1,805.5	0.0123**
Q11: Maintaining academic integrity is a high priority in my department.	3,439.5	0.6086
Q13: It is easier for students to cheat when taking a test online compared to when students take a test in a traditional classroom.	3,467	0.7643
Q15: Proctoring software in online tests is effective at preventing academic dishonesty.	2,869	0.4991*
Q17: Proctoring software in online tests is an invasion of students' privacy.	1,939.5	0.0355**
Q19: How likely is it that students who cheat in an academic setting are also likely to behave dishonestly in a work setting?	3,964	0.0003**
Q21: How important is it to you that a Department or University policy is in place for proctoring online tests that are given outside of a traditional classroom setting?	3,268.5	0.00001**
Q23: If you had a choice to use proctoring software (Faculty) or take with an exam with online proctoring (student) for an online test, how likely are you to use it?	4,531	< 0.00001**

**Significant difference in responses between faculty and students based on only Fisher Exact test, $p < 0.05$.*
***Significant difference in responses between faculty and students based on both Wilcoxon and Fisher Exact tests.*

There is a need for a balanced approach by academic institutions to the students, faculty, and broader society to assure that all course platforms assign grades that accurately reflect how well students master course material while considering student and faculty perceptions of fairness and support in the testing environment. Rubin (2018) states that technology alone will not solve our academic integrity problems. The debate on how best to address upholding academic integrity in online testing includes using multiple modes of assessment, lowering the stakes of exams, spending extra time with struggling students, and using technological assistance where and when appropriate. Perceptions of both faculty and students about the challenges associated with academic integrity in online learning will eventually lead to ways to prevent academic dishonesty, however, many faculty have found that the process of deterring cheating takes an inordinate amount of time and effort on their part, which sometimes still results in cases of students cheating even after substantial efforts were made to prevent its occurrence (Supiano, 2020). This study compares perceptions of faculty and students on the importance of academic integrity, the use of proctoring software to deter cheating, and level of assurance when giving or taking a test online that uses proctoring software.

MATERIALS AND METHODS

The surveys and experimental design in this study were reviewed and approved by the University's Internal Review Board. The survey included Likert scale questions and open-ended questions that inquired about faculty members' and students' perceptions of academic integrity in online testing (**Supplementary Materials 1, 2**). Survey questions were virtually identical except for one extra question specifically designed for faculty members. A random sample of 500 faculty and 1,000 students were invited to complete the survey which was distributed and submitted anonymously online using Qualtrics ([1]Provo, UT, United States). 150 faculty and 78 students responded and submitted surveys. Not every faculty member and student answered all questions in the survey.

[1]Qualtrics.com

To analyze the difference between the distribution of how students and faculty responded to each of these different questions, a Mann–Whitney–Wilcox test was used. The Wilcoxon rank-sum test is a non-parametric procedure that looks at the location of where answers are at which makes it slightly different from a Chi-Square test for independence. Unlike the Chi-Square test for independence where we need to have at least 80% of the table with expected cell counts of five or more, the Wilcoxon rank-sum test just requires us to have independent responses and data that are at least ordinal. There are some questions that don't have many responses for certain categories, hence the reasoning to go with the Wilcoxon rank-sum test over the Chi-Square test for independence. In the Wilcoxon rank-sum test, we test the following hypotheses:

> H_0: The responses for Faculty and Students have the same location/distribution.
> H_A: The responses for Faculty and Students have differing locations/distributions.

The derivation of the test statistic W is the summation of the ranks for one of the groups minus an adjustment of $m(m + 1)/2$ where m is the sample size of the group with its ranks being summed. Under the above null hypothesis, we would expect the summation of the ranks in both groups to be about the same. If the alternative hypothesis is correct, then there would be a difference in the summation of the ranks for each group. To generate a *p*-value, we assume the null hypothesis and randomly sample many different permutations of the sample for each group. Specifically we combine the ranks from both groups into one hat and randomly sample from that hat for group 1, the rest are considered group 2. This gives us a distribution of potential W's to approximate a *p*-value of our observed W.

Another non-parametric procedure that was applied was the Fisher Exact test. This is the non-parametric cousin to the Chi-Square test for Independence. The test specifically looks at the hypothesis of:

> H_0: the two variables are not associated.
> H_A: the two variables are associated.

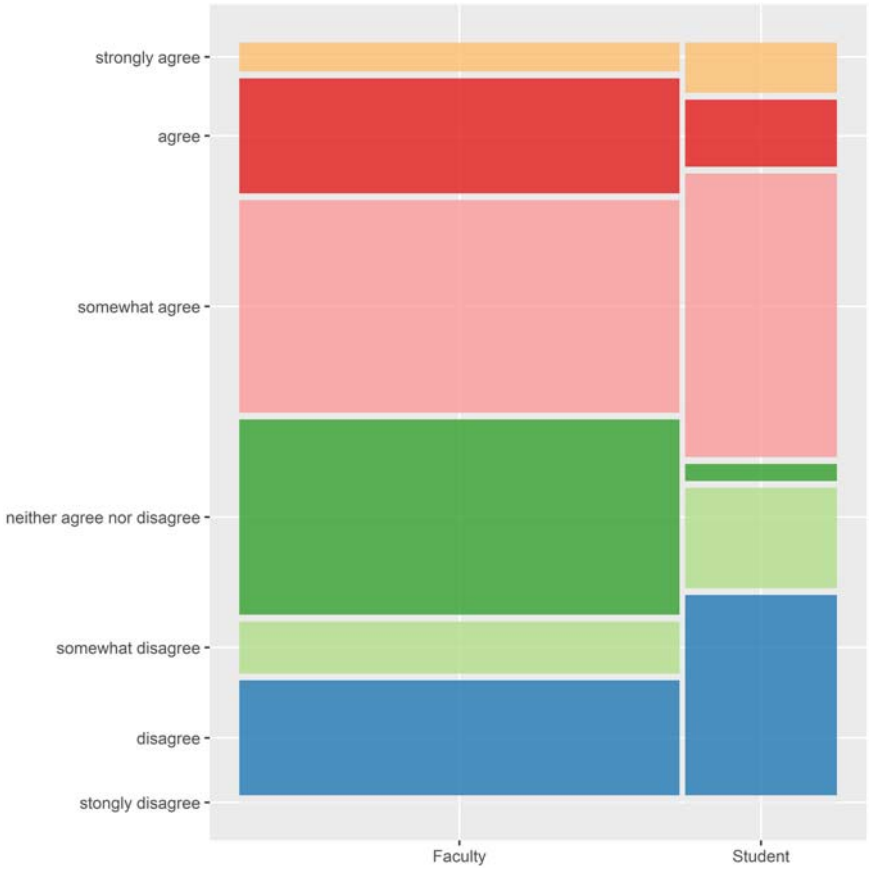

FIGURE 1 | Faculty and student responses to: Proctoring software in online tests is effective at preventing academic dishonesty.

The calculation of the *p*-value gets more complex given the tables being larger than 2 × 2 tables but can still be computed *via* Monte Carlo simulation.

All of the Wilcoxon rank-sum and Fisher Exact tests were done using the statistical software R (R Core Team, 2020). Mosaic plots were constructed with the use of the tidyverse package in R (Wickham et al., 2019). Word clouds were constructed with the help of the wordcloud (Ian Fellows, 2018), tm (Feinerer et al., 2008), SnowballC (Bouchet-Valat, 2020), and RColorBrewer (Neuwirth, 2014).

RESULTS

The survey return rate for faculty was 30% and for students, 8%. The 150 faculty and 78 students who returned the surveys represented departments across five colleges at a large, public university in the Midwest, United States. Not all respondents answered all questions. Fisher Exact test results were run comparing faculty and student answers to the Likert Scale questions. Wilcoxon rank sum and *p*-values for Likert scale questions are shown in **Table 1**. No differences in response between faculty and students occurred for several questions: When asked about their perceptions of their department's priority, 93% of faculty and 94% of students somewhat agreed, agreed or strongly agreed that academic integrity is a high priority in their departments. When asked about perceptions about ease of cheating online, faculty and students somewhat agreed, agreed or strongly agreed to a similar extent that cheating online was easier, 81 and 83%, respectively. The most common reasons shared by faculty and students included access to notes and the internet when unproctored.

Figures displaying differences in Fac and Stu responses are displayed as matrix graphs with the different width representing the larger Fac sample size compared with Stu and colors are representing different levels of agreement or disagreement. The distribution of faculty and student answers to a question about the effectiveness of online proctoring software to prevent academic dishonesty did not differ ($W = 2869$, $p < 0.05$) though there was an association found when a Fisher Exact test was run ($p = 0.0013 < 0.05$) with 23% of faculty disagreeing or somewhat disagreeing compared with 42% of students. On the other hand, 50% of faculty and 55% of students somewhat agreed, agreed, and strongly agreed that online proctoring was effective at preventing academic dishonesty (**Figure 1**).

Fifty three percent of faculty and 70% of students somewhat agreed, agreed or strongly agreed that the use of online proctoring software is an invasion of student privacy (**Figure 2**), a difference

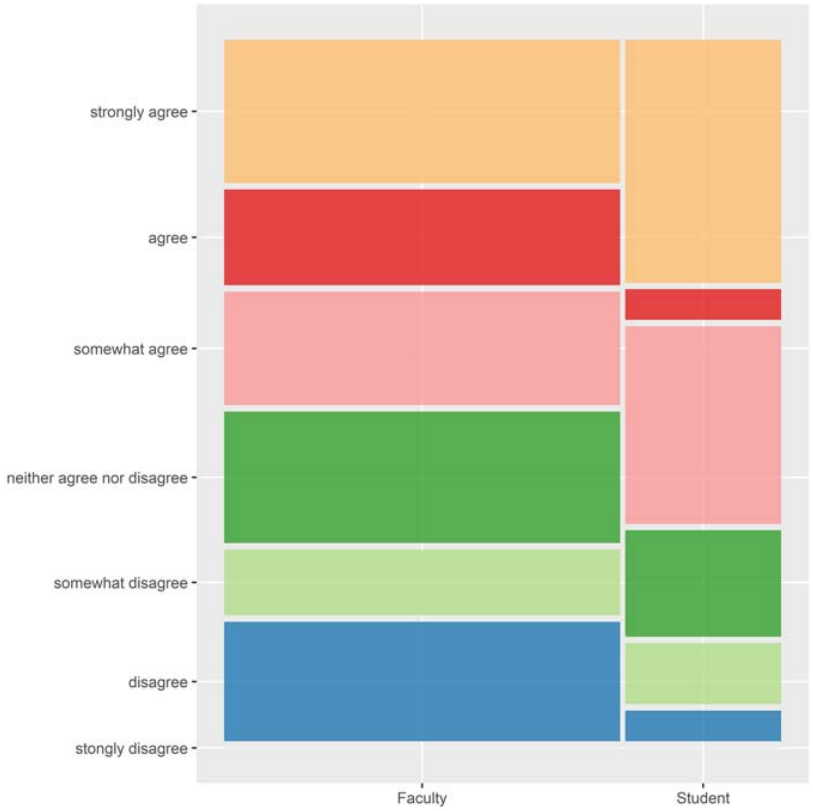

FIGURE 2 | Faculty and student responses to: Proctoring software in online tests is an invasion of student privacy.

($W = 1939$, $p < 0.05$) that included similar themes in descriptive terms by students, such as "watch," "feel," and "room" compared with faculty who more often used terms such as "privacy," "invasion," and "space."

Another difference occurred when 78% of faculty compared with 51% of students somewhat agreed, agreed, or strongly agreed that those who cheat in an academic setting would likely cheat in a work setting ($W = 3964$, $p < 0.05$) (**Figure 3**). There was also significant disagreement ($W = 3268$, $p < 0.05$) in the importance of having a University policy in place for proctoring online tests with 50% of faculty and only 2% of students perceiving it to be very or extremely important (**Figure 4**). If faculty were given a choice to use proctoring software or students given a choice to take an exam with proctoring software, 46% of faculty were somewhat likely, likely or highly likely to choose proctoring software, compared with just 2% of students ($W = 4531$, $p < 0.05$). The wordcloud that emerged from qualitative answers included a high frequency of "stress," "feel," and "comfort" for students (**Figure 5**).

DISCUSSION

While more instructors at every educational level were developing online courses and adding online components to face-to-face courses on an ever-broadening array of topics each semester (Kleinman, 2005), COVID-19 hastened the adoption of online teaching and testing when virtually all schools in countries throughout the world closed or transitioned to technology assisted teaching in 2020 due to the virus. This unexpected pandemic presented challenges to both faculty and students to adjust to a delivery of learning material and assessment of learning in technology assisted online teaching and testing. In the current study, faculty and students were asked to share their perceptions of academic integrity in their departments and their opinions about the effectiveness of proctoring software when taking online tests in deterring cheating and the extent they felt their privacy was impacted as a result of using proctoring software when taking online tests. Perceptions of academic integrity in technology-assisted testing were similar in some items and differed in others when comparing faculty and students' responses. These differences were revealed in both quantitative and open-ended questions.

In a review of the recent debate on proctoring software use, Supiano (2020) explained how some faculty and students are concerned about the negative impact remote proctoring has on students' affect due to feelings of intrusion and anxiety as students sense they are being watched by either a remote proctor or by a video with artificial intelligence monitoring software. Student perceptions in the current study aligned with this concern as only 2% of students indicated they would likely (somewhat-highly) prefer being proctored when taking an online test and used

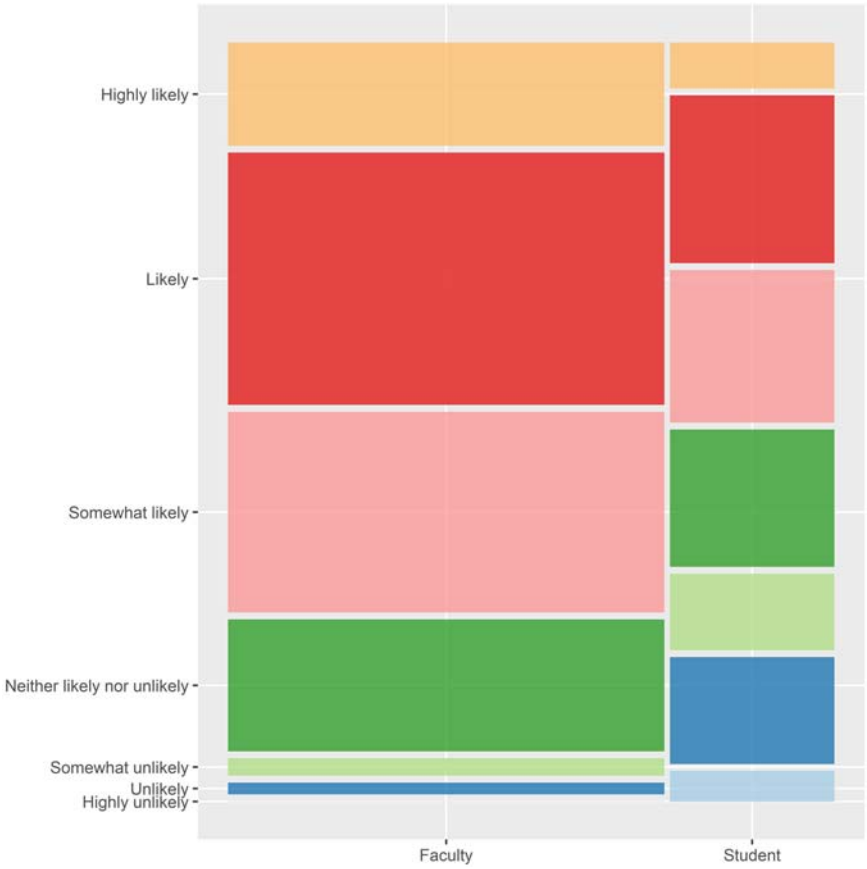

FIGURE 3 | Faculty and student responses to: How likely is it that students who cheat in an academic setting would likely to behave dishonestly in a work setting?

descriptors such as stress, feel, and comfort as reasons. Nearly half of all faculty respondents, on the other hand, indicated they would likely (somewhat-highly) use proctoring software in online exams, although they did acknowledge the invasiveness and privacy concerns of its use.

Some faculty do not relish the role of policing students when they take tests online. Nevertheless, academic integrity is critical to an institution's reputation, as well as the expectation of workplaces and society that college graduates actually master the content and skills assessed in their program of study. Despite efforts to encourage honesty in all types of course assessments, higher education institutions face the same types of scandals and deceit that occur in the workplace and society (Boehm et al., 2009). One of the findings of this current study worth noting is the discrepancy between faculty and student perceptions that those who cheat in an academic setting would likely behave dishonestly in a work setting. While most (78%) faculty agreed (somewhat-strongly) that those who cheat in an academic setting would likely behave dishonestly in a work setting, only about half of the students surveyed felt the same way. A possible explanation is that some students may perceive cheating in college as a means to an end as they face high stakes when competing for admission to selective programs. Once accepted to those programs, cheating behavior may be less likely to occur thereafter. Support for this explanation comes indirectly by a result from Alessio et al. (2018) that significant grade disparities and time used to take unproctored online tests were greater in students who were vying for admission into academic programs with a high grade point average restriction.

Faculty rely on their institution to provide policies and support for academic integrity in a variety of teaching and assessment settings-traditional and remote. In the current study faculty were asked whether or not they perceived their departments prioritized academic integrity. The clear majority of both faculty and students agreed or strongly agreed that their departments prioritized academic integrity. But only half of faculty respondents and hardly any (2%) students perceived having a policy in place as being important. In the absence of policies and educational tools associated with online teaching and testing, faculty are left to decide themselves how to assure that there is an even and just playing field for all students when they are being assessed.

Studies of faculty perceptions of academic dishonesty in online testing have provided mixed results. One survey of 1,967 college faculty and 178 administrators' attitudes about online teaching reported that 60% of faculty believed that academic dishonesty is more common in online vs. traditional face to face courses. On the other hand, 86% of digital learning administrators believed

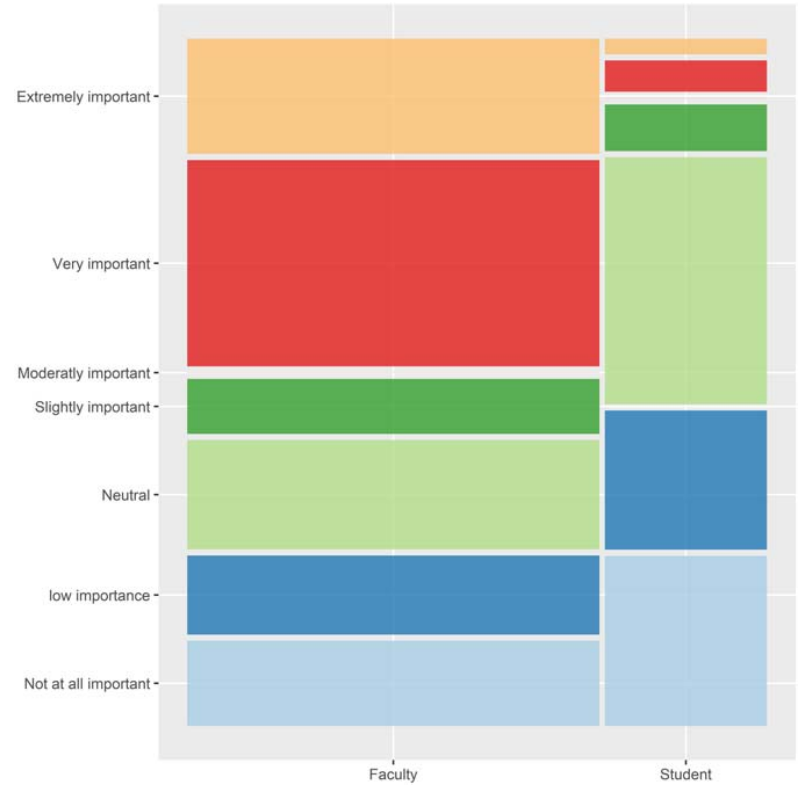

FIGURE 4 | Faculty and student responses to: How important is it to you that a Department or University policy is in place for proctoring online tests that are given outside of a traditional classroom setting?

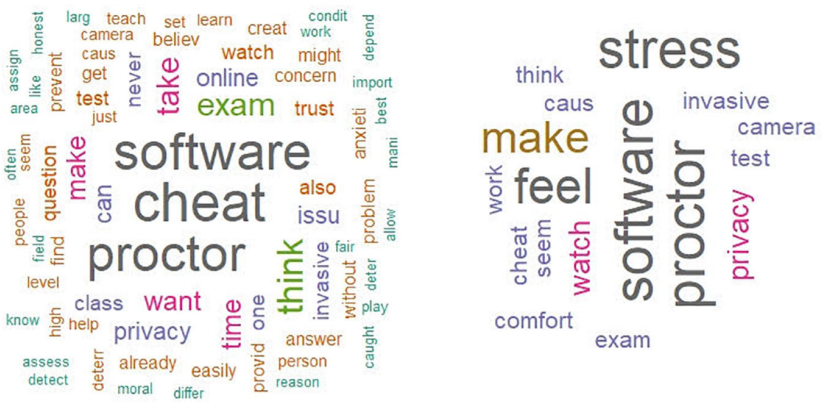

FIGURE 5 | Wordcloud of Faculty (left) and Student (right) comments about the use of proctoring software, with frequency of terms directly proportional to font size.

that academic dishonesty happens in both online and face to face settings equally (Lederman, 2019). The majority of the 303 faculty and 656 students at a midsized public university perceived cheating and plagiarism as greater problems in online classes vs. traditional, face-to-face classes. However, perceptions about cheating online vs. face to face also depended on whether faculty had experience teaching online. The use of proctoring software in online testing has emerged as a hot button topic in higher education as faculty struggle with upholding academic integrity while resenting the role of policing students (Supiano, 2020). Faculty surveyed in this study agree with other reports of faculty being sensitive to the anxiety proctoring software may exacerbate when students take online tests (Kolski and Weible, 2018).

In conclusion, the majority of faculty surveyed in this study perceived that cheating was easier in online compared to face to face testing, that cheating in college may generalize to cheating in a workplace with reasons including student characteristics and their ability to get away with cheating in college. Faculty

supported having policies in place that prioritize academic integrity, especially in online learning and testing, and if given access to proctoring software, would use it. Also, this study found that students agreed with faculty on many matters of academic integrity, except notably their desire to take proctored tests online, whether cheating in class would associate with dishonest behavior in the workplace, and the feelings of stress when taking proctored online exams. Faculty place a higher priority than students on the need for policies to provide guidance on using technology assisted software to proctor online exams. They are sensitive to students' privacy issues and it is clear that an understanding between faculty and student perceptions could help set a tone of responsibility and agreement for how best to assure that proctoring online exams is implemented with fairness and concern for all.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Miami University Institution Review Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

HA created and conducted the survey. JM provided statistical leadership and support for analyzing and interpreting the data. Both authors agree to be accountable for the content of this work.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2021.629220/full#supplementary-material

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ORIGINAL RESEARCH
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Performance Over Enjoyment? Effect of Game-Based Learning on Learning Outcome and Flow Experience

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Competitiveness in serious games and game-based learning contexts, have been suggested to be associated with variations in flow experience pertaining from game experience. Evidence from the game-based learning literature suggested that game-based learning in general enhances learning outcomes, and applicable to learning psychology at the undergraduate level. Yet the magnitude of such effect remains mixed from empirical evidence. The current study examines whether game-based learning, in competitive and non-competitive game format, would lead to differentiated gains on learning outcomes, perceived flow experience from game-based learning, and their interaction. We wish to test whether competitive and non-competitive formats of game-based learning could be characterized with different configurations of game flow experience that encapsulate the game-based learning experience, as well as the extent to which such predominant game flow experience would correlate with observed learning outcomes from featured game-based learning conditions. Effect of game-based learning was tested with an 2 × 2 experimental design. Participating learners (n = 142) were randomly assigned into either one out of four experimental conditions based on a 2 × 2 block design with two independent variables, competitiveness of game-based learning (competitive vs. non-competitive), and format of game-based learning (group vs. individual). Participating Learners in each of the conditions were assessed on learning outcomes related to the subject matters intended for the game-based learning artefacts. Results on learning outcomes revealed a significant main effect of competitiveness of game-based learning was observed, but not for format nor interaction effect. Main effect of format of game-based learning when learning in groups was observed from another two-way ANOVA analysis in a finite set of eGameFlow constructs including feedback, autonomy, goal clarity, and social interaction. Interaction effects between competitiveness of game-based learning and format was observed in autonomy and goal clarity constructs. Results from this study suggested that competitiveness and group format does not necessarily warrant improvement on learning outcomes in the game-based learning context. Main effects on cognitive flow dimensions align with the performance orientation among Asian learners. Further research would shed light on identifying levels of optimal gamified elements while assuring improvement on intended learning outcomes in the Asian tertiary education context.

Keywords: game-based learning, game flow, undergraduate learning, competitive game, social learning

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INTRODUCTION

Background

Learners' engagement in the 21st century is critical with increasing prevalence of blended and remote learning, and one of the popular pathways is to engage learners with game-based learning. Recently, game-based learning has been demonstrated, with comprehensive evidence from education research (Plass et al., 2015) to neuroscience (Howard-Jones and Jay, 2016), to augment learning. Such enhancement on learning has been reviewed and suggested that game-based learning enhances learning performance and outcomes through affective (e.g., enjoyment), cognitive (e.g., cognitive load), and behavioral (e.g., intention to participate in learning) mechanisms (Koivisto and Hamari, 2019; Sailer and Homner, 2019).

In the context of learning of psychology at the undergraduate level, game-based learning has been widely applied and evaluated across various sub-disciplines, including history of psychology (Abramson et al., 2009; Berrenberg and Prosser, 1991), general/introductory psychology (Paul et al., 2006), organizational psychology (Stansbury and Earnest, 2017), and neuropsychology (Goldey and Espinosa, 2020). Most of these attempts employed trivia and board game style for engaging learners with game-based learning toward knowledge mastery.

Though these empirical evaluations examined efficacy of game-based learning in the learning of psychology context, the mechanism for understanding arousal and engagement in game-based learning itself is also a worthwhile venture among researchers in learning and education. The flow theory is deemed a fittingly effective model in understanding how learners engage with game-based learning.

Originated from positive psychology, the flow theory (Nakamura and Csikszentmihalyi, 2014) describes general positive experience in life with absorption from what one does, including the process of gaming or learning, that ultimately contributes to our wellbeing.

Transplanted to the game-based learning context, flow theory has been widely applied for understanding how learning through games approximates flow and peak experience that allow learners to be absorbed in the game-based learning experience and arrive at enhanced learning outcomes thereafter (Kasurinen and Knutas, 2018; Koivisto and Hamari, 2019; Reiners and Wood, 2015; Sweetser and Wyeth, 2005; Terras and Boyle, 2019). Competitive games, in both serious games and game-based learning contexts, have been suggested to be associated with variations in flow experience pertaining from game experience, including challenge (Cairns, 2016), feedback on learning (Chapman and Rich, 2018), as well as autonomy and social relatedness (Sailer et al., 2017).

While recent research on game-based learning and flow theory mainly describe flow in the game-based learning context (Hamari and Koivisto, 2014; Sedig, 2007; Hou, 2015; Shin, 2006) or modeling game flow as a determinant of subsequent learning performance gains (Hamari et al., 2016; Chang et al., 2017; Erhel and Jamet, 2019), the extent to which competitiveness (Kiili, 2005; Nah et al., 2014; De-Marcos et al., 2016; Sailer et al., 2017; Licorish et al., 2018) in game-based learning exert influence on the learning process and subsequent learning performance and outcome remains inconclusive and warrant further explorations.

Conclusions from recent advances in game-based learning literature suggested that the degree to which game-based learning enhances learning outcomes have been generally positive. Yet the magnitude of such effect remains mixed from empirical evidence.

In a recent meta-analysis of game-based learning evaluations on 45 empirical studies, Sailer and Homner (2019) revealed that effect size game-based learning was statistically significant although small and varied with types of learning outcomes. Studies on behavioral learning outcomes such as surgical or spatial skills yielded the lowest mean effect size with Hedge's g of 0.25 while studies on cognitive learning outcomes of game-based learning such as mastery of conceptual and applied knowledge yielded the highest mean effect size with Hedge's g of 0.75 (Sailer and Homner, 2019).

Nonetheless, recent evidence converged to the argument that flow components such as perceived challenge, perceived autonomy, immersion from game experience could be potentially universal determinants toward effective game-based learning.

With a dearth of empirical investigations in flow of game-based learning, particularly in the learning of psychology context, we wish to explore whether game-based learning, apart from achieving its educational goals, would elicit affective outcomes in learners as proposed in the flow theory that precipitate engagement and subsequent enhancement in learning.

Specifically, we wish to address three research questions in the current study:

What is the relationship between learning format (i.e., solitary vs. collaborative game-based learning) and game flow experience?
What is the relationship between competitiveness of game-based learning (i.e., competitive vs. non-competitive game-based learning) on game flow experience?
Is there any interaction effect(s) on game flow experience between learning format and competitiveness?

MATERIALS AND METHODS

Toward providing a comprehensive and transparent disclosure of game-based learning artefacts and procedures adopted in this study, reporting of game-based learning featured in this experiment conforms to the Guideline for Reporting Evidence-based practice Educational interventions and Teaching (GREET) (Phillips et al., 2016):

GREET01: Intervention - Provide a brief description of the educational intervention for all groups involved [e.g., control and comparator(s)]

TABLE 1 | The 2 × 2 factorial design on the competitiveness and format of game-based learning.

Competitiveness/format	Individual-based	Group-based
Competitive (cell game)	Individual-cell game (*N* = 36)	Group-cell game (*N* = 33)
Non-competitive (WISC)	Individual-WISC (*N* = 36)	Group-WISC (*N* = 37)

We conducted a randomized controlled trial to compare effects of game-based learning interventions for learning psychology among undergraduate learners at a university in Hong Kong.

Effect of game-based learning was examined with a 2 × 2 factorial design with two independent variables: competitiveness of game-based learning and format of game-based learning (see **Table 1**).

Competitiveness of game-based learning was manipulated by introducing two game-based learning artefacts for learning about motivation in psychology.

Formats of game-based learning were manipulated with participants randomly assigned to group game-based learning or individual game-based learning. In group game-based learning, learners were assembled physically in a face-to-face small group for engaging in game-based learning activities. In the individual game-based learning condition, learners engaged in game-based learning activities without simultaneous interactions with other learners on the same task.

> GREET02: Theory - Describe the educational theory (ies), concept or approach used in the educational intervention

Affective outcomes derived from game-based learning was assessed with the eGameFlow model, a 42-item 7-level likert scale instrument soliciting game flow experience of learners on eight dimensions: immersion, social interaction, challenge, goal clarity, feedback, concentration, autonomy, and knowledge improvement (Fu et al., 2009). This instrument evaluates educational games by incorporating six elements of flow in immersion, challenge, goal clarity, feedback, concentration, autonomy (Csikszentmihalyi, 2014) with two additional learning artifices in social interaction and knowledge improvement (Sweetser and Wyeth, 2005). The eGameFlow instrument demonstrated good to excellent internal reliability (0.81–0.93), and convergent validity across eight dimension sub-scales as well as criterion validity by correlating eGameFlow scores with a visual-analogue scale on overall enjoyment from game-based learning.

> GREET03: Learning Objectives - Describe the learning objectives for all groups involved in the educational intervention

Game-based learning activities were introduced to determine whether game-based learning improves i) objective knowledge of motivation in psychology, ii) ability to utilize this knowledge in application toward problem solving related to understanding of human motivations, and iii) affective outcomes from game-based learning including immersion, arousal from challenge, and arousal from heightened social interaction during the course of game-based learning.

> GREET04: Evidence-Based Practice (EBP) Content - List the foundation steps of EBP (ask, acquire, appraise, apply, assess) included in the educational intervention

Game-based learning in this study aligns to the evidence-based practice framework with mostly knowledge acquisition about human motivation for future applications in human services, business planning, and engineering designs where applicable.

> GREET05: Materials - Describe the specific educational materials used in the educational intervention. Include materials provided to the learners and those used in the training of educational intervention providers. Indicate where these can be accessed (e.g., online appendix, URL)

Game-Based Learning Artefacts

The "Cell Game" (http://palms.polyu.edu.hk/educational-apps/cell-game/) is a turn-base strategic game-based learning platform that features salient competitive game-based learning activities. In this territory game format, learners compete with each other or in teams to earn points and expand their territories on the leaderboard as reward. Points for gaining or losing territory on the game board in Cell Game were determined by correct response on questions pertaining to the subject content matter.

The WISC-Online platform (https://www.wisc-online.com) features user-built board games for customized development of game-based learning artefact, with a set of non-competitive board game-based learning artefacts developed specifically for this experiment.

The researcher created and collected 166 assessment questions related to the learning module on motivation. Levels of difficulty of assessment questions in this study were based on the Bloom Taxonomy guidelines (Anderson et al., 2001), with items constructed toward assessing basic learning outcomes, such as remembering and understanding, to higher level outcomes, such as applying and analyzing subject content matters on human motivation.

> GREET06: Educational Strategies: Describe the teaching/learning strategies (e.g., tutorials, lectures, online modules) used in the educational intervention.

A set of 6 board games related to theories and concepts of motivation were developed on the WISC-Online platform in the following format: crossword puzzles, "Jeopardy" type Q&A game,

TABLE 2 | Summary table of the selected WISC-Online Games.

Name	Players	questions	types	Difficulties	Details
Crossword	1	8	Spelling	Easy	Spelling puzzle game
Build your knowledge	1	15	Multiple-choice	Easy to medium	Like the win a million TV show
Chakalaka	1	20	Multiple-choice	Easy to medium	Puzzle game
Beekeeper	1–3	15	Multiple-choice	Medium	Roll race game
Baseball	1–2	30	Multiple-choice	Medium to difficult	Using baseball game rules to answer questions
Jeopardy	1–3	20	Multiple-choice	Difficult	A quick answer race for 1–3 learners

snake puzzle game, and turn-based Q&A games. Each game involves 15–30 multiple choice question items pertaining to theories and concepts about human motivation (See **Table 2**). Quiz items in the WISC games were drawn from the assessment questions pool of 166 items about motivation in psychology.

https://www.wisc-online.com/users/blendedlearning/games/33385/crossword
https://www.wisc-online.com/users/blendedlearning/games/33386/build-your-knowledge
https://www.wisc-online.com/users/blendedlearning/games/33388/chakalaka
https://www.wisc-online.com/users/blendedlearning/games/33391/baseball
https://www.wisc-online.com/users/blendedlearning/games/33395/beekeeper
https://www.wisc-online.com/users/blendedlearning/games/33394/jeopardy

Using the same assessment questions pool of 166 items about motivation in psychology for building WISC-Online board games, a turn-base and competitive Q&A game "Cell Game" was deployed for game-based learning:

https://the-cell-game.com/cloud/play/5d9c8b253fa2e8001745f6ca

Apart from the game-based learning platform, a learning module was delivered to the students. Learning artefacts were based on an adaption of an open-source textbook on the psychology topic of motivation (https://courses.lumenlearning.com/wmopen-psychology/chapter/introduction-motivation/). A 23-page chapter of motivation consists of topics of motivation, self-efficacy, and mindset. The average reading time is around 25–30 min. Noted that all the interactive learning content in the original online textbook such as video links and self-assessments were removed.

Learning Outcome assessment. Regarding the learning outcome assessment quiz, a total of 15 questions were randomly selected from the question bank. Participants took the quiz through the Learning Management System by using the tablets after the 45 min session. The post-test was a closed-booked quiz and participants were not allowed to discuss with others during the test.

GREET07 Incentives: Describe any incentives or reimbursements provided to the learners. Participants received credits on research participation towards completing an introductory level psychology course

GREET08 Instructors: For each instructor(s) involved in the educational intervention describe their professional discipline, teaching experience/expertise. Include any specific training related to the educational intervention provided for the instructor(s).

The game-based learning artefact and learning sequence was developed by a team led by an academic with expertize in blended learning, including recognition from university level award and international award such as the Reimagine Education.

GREET09 Delivery: Describe the modes of delivery (e.g., face-to-face, internet or independent study package) of the educational intervention. Include whether the intervention was provided individually or in a group and the ratio of learners to instructors.

Participants were guided to complete a 90-min session including briefing on the learning tasks, traditional learning with handouts on the topic of interest related to motivation, participating in the game-based learning tasks, then undertaking the learning outcomes assessments and survey on game-based learning constructs. **Figure 1** entails the set up of the game-based learning sessions.

GREET10 Environment: Describe the relevant physical learning spaces (e.g., conference, university lecture theatre, hospital ward, community) where the teaching/learning occurred.

Learning sessions were conducted in an innovative classroom with mobile video walls and modular tables for group activities at a comprehensive university in Hong Kong. All participants completed the session face-to-face, with 50% of participants engaged the learning sequence individually while the other 50% of the participants completed the learning sequence in small groups of 3–4 members in each group.

GREET11 Schedule: Describe the scheduling of the educational intervention including the number of sessions, their frequency, timing and duration.

FIGURE 1 | Set up of game-based learning sessions.

> GREET12 Describe the amount of time learners spent in face-to-face contact with instructors and any designated time spent in self-directed learning activities.

A one-off 90-min game-based learning session was administered to all participants between October and November 2019. All participating learners undertook a 90-min session with the following breakdown of activities:

Inform Consent and orientation on session procedures (10-min) (Face-to-Face with game-based learning experimenters).
Experiment Session (Self-Directed learning in group or individual formats).
(45-min).
Exercises/Revision (15-min).
Learning outcomes assessment and study survey (20-min).

> GREET13 Did the educational intervention require specific adaptation for the learners? If yes, please describe the adaptations made for the learner(s) or group(s).

The game-based learning artefacts were specifically developed for the targeted learners. No adaptations were required.

> GREET14 Was the educational intervention modified during the course of the study? If yes, describe the changes (what, why, when, and how).

No modification was made during the experimental period when the game-based learning sessions were administered.

> GREET15 Attendance: Describe the learner attendance, including how this was assessed and by whom. Describe any strategies that were used to facilitate attendance.

This study features a total of 142 participants recruited from a pool of 600 + learners enrolled in an introductory psychology course. Participants enrolled and completing this experimental session earn credits toward fulfilling their research participation requirements in the course. Participation in the learning sequence on "Motivation" was regarded as independent and student-initiated learning on top of the definitive course curriculum. Similarly, learning assessment on "Motivation" unit incorporated in this study was not included in the summative course assessment of where the participants were recruited.

> GREET16 Describe any processes used to determine whether the materials (item 5) and the educational strategies (item 6) used in the educational intervention were delivered as scheduled.

This game-based learning experiment was run over four sessions for all 142 participants. These sessions were administered on the same day with two experimenters giving orientations on the learning tasks and overseeing the experimental sessions. Two additional student helpers assisted in coordinating the learning sessions on logistics and clarification on work flow to participants.

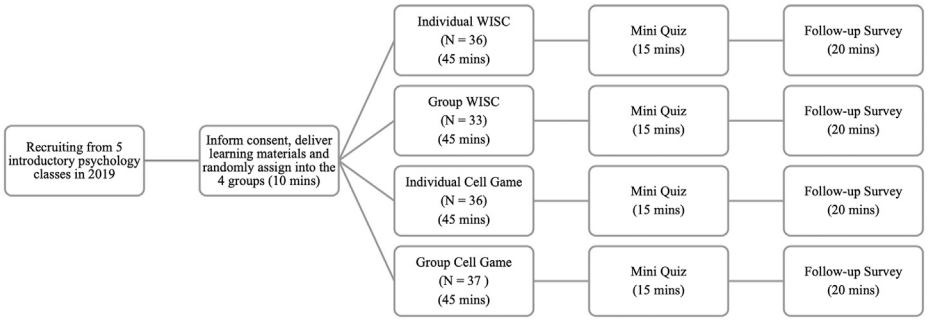

FIGURE 2 | Flow chart of the study procedure.

TABLE 3 | Demographic information of the participants.

Demographic information	*N*	%
Age		
Mean	18.8	
Gender		
Female	68	47.8
Male	74	52.2
Year of study		
First year	114	80.3
Second year	24	16.9
Third year	2	1.4
Fourth year	2	1.4
Disciplines		
Business	77	54.2
Health and Social Sciences	31	21.8
Sciences, Technology and Engineering	25	17.6
Humanities, Design and Hotel Management	4	2.8
Others/not specified	5	3.5

GREET17 Describe the extent to which the number of sessions, their frequency, timing and duration for the educational intervention was delivered as scheduled (item 11).

All learning sessions for this experiment on game-based learning was delivered as scheduled. A detailed flow chart was displayed in **Figure 2**.

Data Analysis

Demographic information including gender, year of the study, and the academic discipline of the participants were described with descriptives about learners' characteristics. To test the hypotheses set out in this study, we performed Two-way ANOVA to examine the main effects and interaction effects between learning format and competitiveness on participants' game flow experience. Participants who did not complete the follow-up questionnaire were excluded from the current analysis.

Research Hypothesis

4. There is significant difference of learning format on game flow experience.
5. There is significant difference of competitiveness on game flow experience.
6. There is interaction effect in game flow experience between learning format and competitiveness.

RESULTS

Demographic Information

Table 3 presented information about the 142 participants enrolled into the study. With a mean age of 18.8 years old, most of the participants (80.3%) were 1st year students. Majority of participants were recruited from the business discipline (54.2%), followed by students from health & social sciences (21.8), and STEM (17.6%). Proportions of male (52.2%) and female (47.8%) participants were evenly distributed.

Two-Way ANOVA on the eGame Flow

A two-way ANOVA was performed to examine the effects of competitiveness game-based learning and learning format on the quiz performance and game flow outcomes. **Table 4** presented the overall results of the Two-way ANOVA. Levene's Test indicated equal variances for all the domains except the Challenge ($F = 2.76$, $p = 0.05$) and Goal Charity ($F = 5.38$, $p = 0.002$).

Simple main effects analysis showed that learning in group reported significantly higher endorsement in Feedback [F (1,138) = 3.98, $p = 0.048$, $\eta^2 = 0.028$], Goal Clarity [F (1,138) = 9.385, $p = 0.003$, $\eta^2 = 0.064$], and Social Interaction [F (1,138) = 23.573, $p = 0.000$, $\eta^2 = 0.146$] than learning individually.

Regarding the test performance, a significance main effect of competitiveness was observed. Participants in the non-competitive game-based learning condition with WISC games attained higher assesement total scores than their counterparts in the competitive game-based learning group [F (1,138) = 35.45, $p = 0.01$, $\eta^2 = 0.06$].

Interaction effects between learning format and competitiveness of game-based learning reached statistical significance for eGameFlow dimensions of Autonomy [F (1,138) = 4.137, $p = 0.044$, $\eta^c = 0.029$] and Goal Clarity [F (1,138) = 6.304, $p = 0.013$, $\eta^2 = 0.044$] (see **Figures 3**, **4**). Other eGameFlow dimensions, including concentration, feedback, challenge, immersion, social interaction, and knowledge

TABLE 4 | Results of two-way ANOVA on learning outcomes and eGame flow.

Dependent Variables	SS	*df*	MS	*F*	*p*	Bonferroni	η^2
Test performance							
Learning format	0.11	*1*	0.11	*0.02*	*0.88*		
Competitiveness	35.45	*1*	35.45	*8.06*	*0.01*	Non-competitive > competitive	*0.06*
Learning format × competitiveness	0.49	*1*	0.49	*0.112*	*0.74*		
Concentration							
Learning format	3.24	1	3.24	3.24	0.07		0.02
Competitiveness	0.48	1	0.48	0.48	0.48		0.00
Learning format × competitiveness	1.05	1	1.05	1.09	0.30		0.01
Feedback							
Learning format	3.94	1	3.94	3.98	0.048	Group > individual	0.03
Competitiveness	0.61	1	0.61	0.61	0.44		0.00
Learning format × competitiveness	0.14	1	0.14	0.15	0.70		0.00
Challenge							
Learning format	3.21	1	3.21	2.43	0.12		0.02
Competitiveness	1.62	1	1.62	1.22	0.27		0.01
Learning format × competitiveness	3.00	1	3.00	2.27	0.13		0.02
Autonomy							
Learning format	4.23	1	4.23	3.68	0.06		0.03
Competitiveness	4.26	1	4.26	3.70	0.06		0.03
Learning format × competitiveness	4.76	1	4.76	4.14	0.04		0.03
Goal clarity							
Learning format	10.81	1	10.81	9.39	0.00	Group > Individual	0.06
Competitiveness	3.28	1	3.28	2.85	0.09		0.02
Learning format × competitiveness	7.26	1	7.26	6.30	0.01		0.04
Immersion							
Learning format	2.55	1	2.55	2.49	0.12		0.02
Competitiveness	3.36	1	3.36	3.28	0.07		0.02
Learning format × competitiveness	0.00	1	0.00	0.00	0.96		0.00
Social interaction							
Learning format	37.84	1	37.84	23.57	0.00	Group > Individual	0.15
Competitiveness	0.25	1	0.25	0.16	0.69		0.00
Learning format × competitiveness	3.50	1	3.50	2.18	0.14		0.02
Knowledge improvement							
Learning format	0.02	1	0.02	0.02	0.90		0.00
Competitiveness	0.48	1	0.48	0.46	0.50		0.00
Learning format × competitiveness	0.14	1	0.14	0.13	0.72		0.00

Italics in this table refers to names of dependent variables being tested.

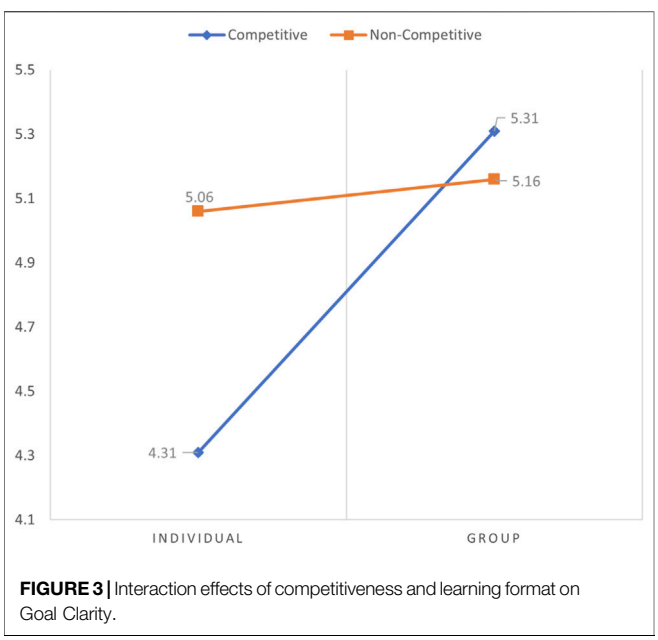

FIGURE 3 | Interaction effects of competitiveness and learning format on Goal Clarity.

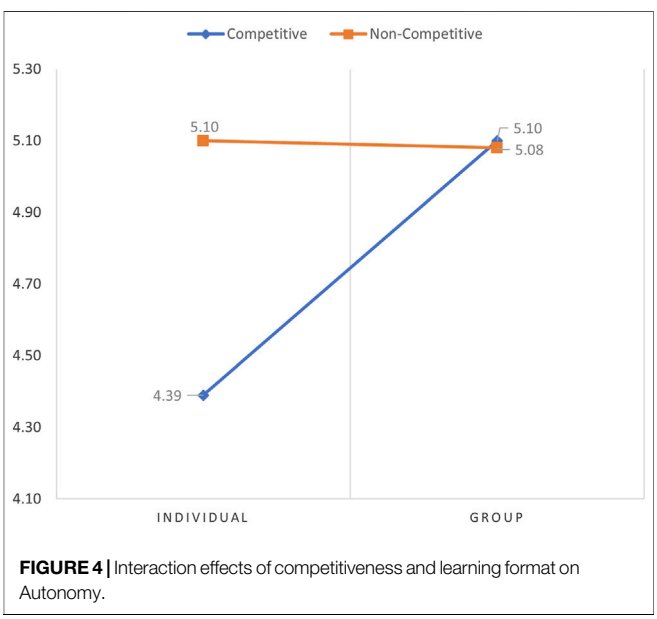

FIGURE 4 | Interaction effects of competitiveness and learning format on Autonomy.

improvement, did not reveal statistically significant interaction effects.

DISCUSSION

Results in this study suggested that game-based learning, when adopting non-competitive games in a group format for learning psychology at the undergraduate level, would likely yield higher enhancement in terms of learning outcome. Learners experienced a heightened level of reported goal clarity and autonomy with non-competitive games when game-based learning was administered individually, rather than in a group format. Heightened flow dimensions observed in the individual rather than the group game format contradicted with previous findings about benefit of ad-hoc group learning in large classes (Tomcho and Foels, 2012). We hypothesized that the observed flow among learners on individual game-based learning was facilitated by the format and nature of learning theoretical concepts related to motivation in the current study. Adopting the cognitive load theory on game-based learning, individual board games introduce minimal extraneous cognitive load on learners when compared with other turn-based competitive games or immersive competitive games (Fisch, 2017).

While some game flow variables significantly affecting learning outcomes, only cognitive dimensions in the featured game flow model in feedback, goal clarity, and social interaction exhibited statistically significant effects. Most of the affective dimensions in the game flow model that align with positive valence and affect, including challenge, and immersion, did not reach statistical significance in the current findings. The sole exception was the significant interaction effect on autonomy, in which perceived autonomy was low in the competitive and territorial Cell Game when administered individually, but matched its non-competitive counterpart in the WISC-Online quiz game condition when learners in Cell Game were in a group competition format. Interaction effects observed in this study do not resonate with previous evidence arguing for equivalence between administering game-based learning in solitary and collaborative modes (Chen et al., 2015; Van Der Meij et al., 2011).

While immersion has been regarded as a major factor in game-based learning toward learners' engagement (Krassmann et al., 2017; Hamari et al., 2016; Cheng et al., 2017), the lack of significant effect observed on immersion in the current study could be attributed to the trivia/quiz game format adopted in this study instead of designing a serious game for learning about motivation. Cheng (Cheng et al., 2017) suggested that though serious games activates immersion, yet immersion does not necessarily warrant learning gain. Indeed, immersion may influence learning indirectly as a prerequisite to game mastery, which subsequently leads to learning gain.

Reported prevalence of emphasizing cognitive dimensions in game flow for game-based learning echoed the dominance of achievement orientations in performance approach and performance avoidance, while undermining mastery goal that associated with affective outcomes and engagement toward intrinsic motivation of learning (Chen and Wong, 2015a, 2015b; Wang and Rao, 2020).

While participants in this study feature predominantly Chinese learners in their adolescence and early adulthood, findings from this study suggest that in application of game-based learning on academic knowledge, design and implementation of game-based learning should consider game flow dimensions that enhances the both cognitive and affective domains in learning experience. Nonetheless, affordances for affective experience from game-based learning (e.g., immersion, concentration, challenge, autonomy) in the context of knowledge-oriented learning may be secondary when compared with use of game-based learning in other types of experiential learning involving more affective components, such as service learning (Giles and Eyler, 1994) and intra-personal development.

For theoretical concept learning featured in this study, these considerations on affective components of game-based learning tend to be undermined by performance-related, cognitive dimensions in game flow such as goal clarity (i.e., how can I benefit from this game on mastering the academic subject matter), feedback (i.e., is this game helping me in identifying my strength and weaknesses mastering or applying the academic subject matter), and social interaction (i.e., is this game-based learning allowing me to solve problems collaboratively through team-based learning).

These performance-centric orientations derived from the current study corroborate with some proposed utility of game-based learning in "performance monitoring" and "social learning" (Westera, 2015). It is also hypothesized to align with the Asian pragmatic orientation toward leveraging game-based learning toward academic achievement (So and Seo, 2018). In addition, performance approach goal orientation in using game-based learning to enhance undergraduate learning, as reflected in corresponding game flow dimensions, offers a stark contrast to K-12 sector counterparts with conventional conception of game-based learning mostly enhancing enjoyment and engagement throughout the learning process (Chang et al., 2017).

LIMITATIONS

Though trivia/quiz format game-based learning has been suggested to be instrumental for enhancing theoretical knowledge mastery (Ranieri et al., 2018), learning related to applications and problem-solving were not examined in the current study with reference to the scope of this proposed study and keeping the experimental session viable for our participating learners. Further studies could introduce learning tasks of different natures toward generalizing the effect of game-based learning in varying learning context.

With focus on flow of game-based learning and subsequent changes on learning performance, the current study did not address the role of other integral psychological mechanisms, such as intrinsic motivation (Hanus and Fox, 2015; Sailer et al., 2017; Chapman and Rich, 2018) and cognitive load (Chang et al., 2017; Fisch, 2017) involved in the translation of

game-based learning to learning enhancement. Further studies incorporating flow, motivation, and cognitive load would allow a comprehensive framework for examining the underlying psychological mechanisms of game-based learning, as well as their relations and reciprocal synergy with each other.

CONCLUSION

Results from this study employing experimental design offer evidence for positive effect of using game-based learning in undergraduate education context. Specifically, non-competitive game-based learning, when performed in groups, was suggested to promote better learning outcomes. Game flow dimensions related to cognitive domains in game-based learning, specifically goal clarity, feedback, and social interaction, has been demonstrated to have interaction effect on learning outcomes, while affective domains in game-based learning were undermined by performance achievement orientation among Asian learners. Affective elements with enjoyment and thrill, as conceptualized in challenge and immersion by the game flow model, may not align well with the prevailing performance orientation in Asian academia context. The use of game-based learning in knowledge-oriented learning in the Asian context could be optimized by focusing on utility of game-based learning toward performance monitoring and social learning.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Hong Kong Polytechnic University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors have contributed equally on data collection, data analysis, and manuscript writing.

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(E-)Learning to Understand and Love Yourself: An Attempt to Teach Healthy Lifestyle in the Midst of Social Unrest

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In the 2012 curriculum reform, an extra year was added to the typical university degree programme in Hong Kong, and this became a good opportunity to provide more structured General Education to students in all major disciplines. Although the mode, units allocation, and actual course content of these GE courses in local universities differ, what they share is a comprehensive coverage across knowledge areas: the arts, the social and natural sciences, and skill sets that students can apply in personal and professional life. The author of this article taught in a Hong Kong university that offers a General Education programme with courses designed and delivered by individual academic departments and supported by relevant administrative units. This article is a reflection on teaching a General Education course in the category of Healthy Lifestyle, open to full-time students of all disciplines, during the fall semester of academic year 2019-2020. During most of the semester, daily life in Hong Kong had been disrupted to different extents, and the emotional landscape across different population groups had been rugged. University students were also affected physically and emotionally during this time, the teaching and learning environment was challenging, and teachers had to create an appropriate teaching and learning experience in view of the external environment and the students' internal emotional needs. This article shares some useful practices in employing e-learning during a time of unrest, to facilitate the teaching of healthy lifestyle to students. The learning outcomes achieved, as seen in some student work, encourage us to seek further ways to employ e-learning for more effective learning experience for new generations of students, especially in the area of affective learning.

Keywords: healthy lifestyle, social unrest, general education, emotional engagement, e-learning platform

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INTRODUCTION: EMOTIONAL EDUCATION IN GENERAL AND SPECIFIC TIMES

After more than 18 months of living with the Covid-19 pandemic, the global world is well aware of the significance of cultivating our resilience to face different life situations. While the medical profession is tasked with the job of creating a medical shield against diseases, we are all responsible for strengthening our emotional competence so that we can adapt to unexpected situations in life. The need for emotional education or training in the school curriculum is not new. Since Daniel Goleman's publicising Emotional Intelligence in his book in 1995, attention to this aspect of human capability has resulted in changes in school curriculum, professional training, and many studies about ways of enhancement as well as impact on the way we lead our lives. University education, for

many being the final step before young adults join the professions, has also been a site which seeks to benefit from incorporating such training to maximize the graduates' intellectual performance and employability. In the same year that Goleman published his *Emotional Intelligence*, McWhirter (1995) described his own psychoeducational groups for university students, to generally facilitate survival in the university, retention rate, and to enhance career exploration. He particularly organised special theme groups such as disabled students and students who suffered from loneliness. These psychoeducational groups contributed positively to students' well-being, and experiences such as these encouraged further exploration into how such training can become part of the regular curriculum.

In the 25 years since Goleman discussed this new intelligence and how to incorporate this in various educational and professional settings, the way of teaching and learning has also undergone huge changes, one of which is the increasing utilisation of e-Learning mechanisms across various levels. E-Learning is hardly a new thing today in most developed communities. Twenty years ago when I joined my university, the orientation programme already contained induction to e-Learning teaching techniques and tools available. During "normal" times, teaching in the university (and in primary and secondary school sectors) is conducted with varying involvement of e-Learning tools, depending on the nature of the disciplines, teachers' professional development, and availability of resources. The discussion about e-Learning is no longer whether it should be adapted, but how best to use it to maximize effectiveness in teaching and learning. Looking at the studies about e-Learning experiences, one issue which is key to the effectiveness of e-Learning immediately jumps out–the e-learners' emotional experience during the process of e-Learning. From a series of interviews with university students, O'Regan (2003) discovered that the perceived dicotomy between cognition and emotion during the learning process was not real, in fact, emotion was "central and essential to the teaching/learning process" (O'Regan 2003, 78). Sun's team did a survey in 2006 with 645 e-Learners in Taiwan, to identify the main factors affecting learner satisfaction in e-Learning experiences. The results showed that among the seven key factors, four had to do with learners' (and instructors') emotions (Sun et al., 2008, 1183).

Some studies about the e-Learning process revealed that learners' emotions in interacting with the mechanism could be a determining factor in the success of the entire learning experience. Two main emotions were identified as expressed by e-learners - pride and shame - in their "human-technology interaction processes" (Juutinen and Saariluoma 2010), therefore in order to increase effectiveness of learning, the e-Learning experience should be designed in a way to increase e-learners' emotion of pride in managing the interaction process. Technophobia was found to be generating "frustration and anxiety" (Juutinen et al., 2011, 104) which caused e-learners to stop or feel reluctant to repeat the experience. Saadé and Kira (2009) came to the same conclusion that emotional factors affected the e-Learning experience, and proposed a design of e-learning systems which featured a consideration of the emotions of the learners. Shen et al. (2009) customised e-Learning material based on emotional responses from learners and found that emotionally aware learning experience had greatly improved learning performance, thus proposed an affective e-Learning model (Shen et al., 2009, 186). Other studies taking into consideration of e-learners' emotions in their interaction with the learning system came up with "emotion sensitive e-learning model" (Nitin et al., 2011, 260) of learning, and "an agent to imitate the human interaction" (Chatzara et al., 2012, 253) in the process of learning, both showing success in enhancing the effectiveness of e-Learning.

With reference to the global trend of attention to emotional well-being, as well as technological development for the education sector, the following is a very specific reflection on a teaching and learning experience set in Hong Kong higher education during a particularly challenging time. During the second half of 2019, Hong Kong experienced a period of social unrest which affected a wide range of daily life practices including teaching and learning activities across all levels. As a result of the social unrest and disruption of regular activities, many young people experienced a range of emotional challenges including shock, incomprehension, helplessness, and depression. The author of this article was teaching undergraduate courses at the time, and had created a very personal teaching and learning experience through a compulsory General Education course, to help student respond to the specific challenges at the time, and to establish a healthy lifestyle in general. This article is a reflective discussion of this teaching and learning experience, with the following aims: to describe university students' need for emotional education, to report how a General Education course can be used to teach self-care skills including emotional intelligence, and finally through the sharing of some students' feedback, to confirm the acute need for emotional well-being among learners in higher education (and beyond).

METHODOLOGY: GENERAL EDUCATION COURSE "HOW ARE YOU, MY FRIEND? UNDERSTANDING AND LOVING YOURSELF"

My university is a medium size liberal arts university which embraces the Whole Person Education ethos. Learning experiences besides the discipline-oriented have always been a core part of its curriculum, and the education reform which changed the university curriculum into 4 years in 2012 was only an additional push factor towards a more structured General Education Programme for all undergraduate students. Healthy Lifestyle is one of the compulsory categories of courses within this programme, containing a range of courses offered by different academic departments pertaining to relevant aspects of daily life. In the most recent call for new courses in Healthy Lifestyle, I proposed a course which provides common knowledge and practical tips about establishing a healthy way of living for young people. The proposal was approved and it was first offered to students in AY 2019-2020, with a quota of 40

places. The medium of instruction was English, there all teaching materials were in English, although students were given a choice to submit their assignments in Chinese if they felt that it would be a more effective way to convey the chosen content.

I gave this General Education course a rather unconventional title: "How Are You, My Friend? Understanding and Loving Yourself". GE is a compulsory requirement for graduation in my university, and despite the many interesting and necessary topics of study available for choice, students' enthusiasm for this group of courses was not always very high. In order to convey the practical orientation of the course, and my user-friendly approach, the title as well as the intended learning outcomes of the course are written in a simple and easy to understand non-academic language. The intended learning outcomes are the ability to:

a. demonstrate self-knowledge in the form of an oral, written, or visual narrative;
b. reflect on the benefits of a healthy lifestyle in relation to personal needs; and
c. identify and use approaches and methods to manage personal problems in lifestyle.

Besides the 2 h × 13 weeks' in-class interaction, students had to complete relevant assignments to complement their learning, as well as demonstrate the achievement of their learning outcomes. In line with the down-to-earth nature of the course, I designed the learning tasks to be practical and self-chosen as much as possible. Each student had to keep a weekly journal throughout the semester, noting any problem area, or inspirations for change in their own lifestyle. I believe that it was only through reviewing their own habits and pattern of behaviour that they could have a basis for initiating a plan for change. Besides, each student should belong to a group and make an oral presentation on one aspect of healthy lifestyle every week. I urged them to identify a common area of concern among the group, and do some research to find practical methods or aids to help everyone make an improvement in addressing one aspect of lifestyle.

The ultimate piece of assignment at the end of the semester was the Personal Resolution Plan (PRP), which included an analysis of their personal lifestyle to identify one area of modification, and a detailed plan to achieve the desired change. I encouraged each student to make this plan just to correct or acquire ONE personal lifestyle issue, and also suggest a way to measure the achievement. It was hoped that students could utilise the skills learned in class, and the information acquired during their group research, to formulate a self-help plan which had to be carried out and evaluated. Adaptation of healthy lifestyle depends on the right attitude, understanding, and approach, no matter what one's career aspirations are. At the beginning of the semester, the rationale of the course and the reasons for the assignments were clearly explained to the students so that they could engage in the learning experience with the correct attitude and a positive mental state–a learning experience that is purely for one's own good. After the first 2 weeks, words about the course were spread and five more students requested to join. The final class size was 45. For a non-major course conducted in English, and with weekly assignments to be submitted, this positive response from students was a strong indication of their identification with the content.

The following reflective discussion is based on interaction with the 45 students of the course, including my observation of their in-class behaviour, and the written assignments submitted by the students via the e-Learning platform. Each student submitted one piece of journal writing (about 300 words) every week for 12 weeks, and finally a portfolio (i.e., Personal Resolution Plan) as a capstone assignment to showcase what they had learned in the semester, as well as to indicate one change desired in their lifestyle. In order to protect students' privacy, no reference of any names or student identity is made in the following discussion, and direct quotations from student work will only be indicated by a "submission number" which was randomly assigned by the e-Learning platform at the point of submission. I have also made translations of student work which was written in Chinese for easy reference here. Since the purpose of this discussion is to show the emotional landscape and behaviour of some Hong Kong university students over the second half of 2019, the voices of these young people are important, and I try my best to refer to their own words.

DISRUPTION AND CONNECTION: E-LEARNING, INTIMACY, AND AFFECT

Unexpectedly, the social and political conditions of Hong Kong at the time of semester 1 (September to December 2019) of academic year 2019-2020 had enhanced the course's relevance to the students' needs than its original planning. Beginning from June 2019, Hong Kong had experienced a series of anti-extradition protests, and many young people including university students were emotionally and psychologically disturbed about the state of affairs. At the beginning of the semester in September 2019, many young people were experiencing stress due to conflicts with their family, anxiety due to disruption of daily routine, frustration about their own roles in the current situation, and a general sense of uncertainty about the future. Although the course was designed as a general education course that covers standard topics related to wellness, and was reviewed and approved well before the summer of 2019, the time of its offering incidentally matched the very specific needs of the students who were struggling to stay healthy both physically and mentally, given the external environment.

The semester started with an air of normality but also a tentative sense of expectation. While we conducted our teaching and learning activities as usual on campus, we were all very much alert to the volatile social situation and its impact on the emotional and psychological well-being of students. At that time, although classes went on as usual, teachers were already reminded to accommodate different student needs: those who did not feel emotionally well enough to attend classes, those who were otherwise engaged, and those who might have problems meeting deadlines for various reasons. Even at the beginning of the semester when face-to-face classes was the official mode of

interaction with students, many teachers had made audio recordings of the lectures and placed them on the e-Learning platform for students to access at their own time, on top of the normal practice of placing all teaching materials such as notes, reference materials and instructions for various learning tasks.

By the end of October 2019, the number of empty chairs in the lecture rooms were quite noticeable, and we spent more and more time communicating with students through email and other means of e-communication. The number of messages we posted on the e-Learning platform message board also significantly increased. Two weeks into November, the University announced suspension of face to face interaction and shifted all teaching and learning activities to the online mode. Immediately class materials had to be re-made to suit this alternative mode of teaching, and communication with the student groups became more frequent as by then non-local students had left the city and gone home, and local students were trying to get used to asking questions about the courses when they did not have the chance to meet with their classmates or the teacher. Accessing the course materials and "learning" when staying in their home was also a new challenge to them in terms of motivation and time management.

Looking back from today's vantage point, after more than 18 months of online classes practiced in many parts of the world, the kind of e-Learning experience we provided in the second half of 2019 was relatively rudimentary. We used the institutionally subscribed e-Learning platform and placed audio-recordings of face-to-face lectures, lecture notes in PowerPoint files with audio clips, and added many other audio-visual materials from external sources to enrich the teaching and learning experience. At the same time, social media platforms were called into service to help us maintain communication with different students–whether they resided locally or had already retreated to their home town. As the disruption to daily life practices escalated, more and more effort was made on maintaining an open communication with students. Visual messages which were not about academic contents were made and posted on the e-Learning platform just to give students some encouragement and dispel the sense of isolation during the extended period of suspension of face-to-face teaching.

HEALTHY LIFESTYLE? THE NEEDS OF HONG KONG UNIVERSITY STUDENTS (IN THEIR OWN VOICES)

In my class, there was a student who identified himself as "the biggest boy in class", and had wanted to lose weight as well as improve general health. After I demonstrated a set of simple physical exercise (which involves arms swinging) in class, he entered this in his weekly journal on October 25, 2019:

> First, I would want to tell you a good news, that my mom started to do the hand-shaking exercise with me. As my mom have to done [*sic*] a small surgery on her eyes, she got to stop all exercises for a month or two, so she is seeking for exercises to do even after the surgery. Then, I tried to persuade my mom to start doing the hand-shaking exercise with me. At first, she thinks that the exercise is quite stupid, but after giving it a try, she found out that the exercise itself is not that easy and she turns out to be a fan of it. I hope both of us can keep up on this exercise and benefits from it. (submission number 1199587882)

This male student was fully aware of his need to lose weight, and was most grateful to have someone offering him advice. But most importantly, what he needed was emotional support–throughout his weekly journals, he reported on his progress, knowing that I cared. This emotional bond between myself as the trusted instructor of the course and individual students was seen in a number of the weekly journals submitted by different students. After discussions on the role of art in helping to maintain wellbeing and build resilience, I received the following entries on November 4, 2019 and November 16, 2019 respectively:

> Art is quite an interesting topic to discuss in a lesson talking about personal health, especially our group presented music therapy afterwards. For psychologist, art and music are two special and important tools to connect themselves with the patients, especially their patients are not good at communicating with others or expressing their feelings. (submission number 1206603631)

> This journal is supposed to be the reflection for week 9 meeting. However, who knows only after one week, Hong Kong changed a lot . . . the place we could study turns into a place I am not familiar with! Full of chaos, this term calls to an early end. . . . Without the sharing from Amy and classmates, I'd say it's less interesting viewing the PPT and materials on my own. However, the information provided for this week really suits my situation these days. The information of this week is about "Resilience" in personal and community levels. (submission number 1215024796)

Such direct expression of their needs was seen quite frequently in the journals. Besides the appreciation of art, and the engagement in making art to build resilience, practices such as mindfulness and meditation were also introduced and experienced in class. The intimate working relationship between myself and the students encouraged them to take our discussion seriously, and spend time to practice what was described in class. Feedback in general was very positive, as seen in this journal entry submitted on November 28, 2019:

> However, the idea of meditating conflicts with my religion. Therefore, I would prefer to call it a relaxing exercise, which allows me to calm down and stop thinking about the worries I have for a moment. . . .I am very glad that I had the opportunity to take this course. Unlike other healthy lifestyle courses, I think

> that this one is really helpful since having a healthy lifestyles involves a lot more than physical exercising. After taking this course, I have really reflected on my current unhealthy lifestyle, and am motivated to start living more healthily by changing my bad habits such as sleeping late, eating unhealthy food, and having negative thoughts. (submission number 1223265287)

The above journal entry had pretty much summed up the common issues this group of university students shared: irregular sleeping hours, unhealthy diet, and emotionally stressed. Despite the fact that it was a mixed class, male and female students who majored in different disciplines had similarly unhealthy habits, and were not taking good care of themselves. They were thus receptive to the topics discussed in the course, and the learning atmosphere was very positive right from the beginning of the semester.

This emotional aspect of the e-Learning experience was impressed on me much more visibly in mid-November 2019 when the University announced an immediate suspension of face-to-face teaching and learning, and moved all teaching activities to the e-platform. Although most of us had been using e-Learning tools to different extents in our teaching for many years, this shift came to be an important turning point, not only because of the abruptness, but also because it was the first time when we were deprived of the kind of interaction that enables us to communicate emotions directly and in the same physical space when teaching. By then non-local students had returned to their hometown, local students stayed at home to access the lectures (if they did) which we conducted either at home or in our own private offices. While the technical tools were well in place, allowing audio-visual communication in real time, and sharing of documents and non-verbal materials, I still felt a reduced "intimacy" - a special and intangible element - in my classes which took away something of what I would like to convey in the class. As mentioned in submission number 1215024796, without "the sharing from Amy and classmates", the viewing of PPT by students on their own was simply not as interesting.

When we went fully online, there were still 3 weeks of classes before the end of the semester. The final examination was cancelled, to be replaced by an alternative e-assessment. I had read 9 weeks of journal entries submitted by the 45 students, as well as having the benefit of meeting them face-to-face in the classroom for 9 weeks. I remember the faces and managed to match these faces with the content of their journal entries. In fact, the weekly journal, which was originally designed as a way for them to keep a record of their lifestyle habits, and possibly helping them to identify their own behavioural pattern, became a "call-for-help" window to reach out to me. These words on the page carried as much affect as if they were spoken by the students, perhaps even more so as the electronic distance had relieved some possible embarrassment. The journal entry below, submitted on November 18, 2019 was a good example of the extent that e-Learning platform can also convey intimate feelings:

> Hong Kong was suffered in these months. I can't believe what was happened at Hong Kong Polytechnique University last night. I felt very uneasy since our universities canceled all the face-to-face classes. I think online learning should be suspended as well. As Hong Kong is in the chaos, I believe there are other things much important than to complete the assignment at this time. I believe the student include me are hard to stay focus on our academics, cause we cannot turn a blind eye to our society and keep working with the assignments. (submission number 1215858002)

This entry represented what many students felt in general during those weeks. Despite the student's comment that there were other more important things to be done, he submitted the weekly journal on time. I believe that the writing, submitted electronically, allowed the student to express his personal feelings in a safe way. The electronic distance between him and myself made the communication both intimate and safe; moreover, we had spent 9 weeks to establish a mutually trusting relationship. Another student also chose to share his emotional experience through this weekly assignment on November 28, 2019:

> Two weeks ago, I was awakened from a dream by my sister, she told me that great-grandmother passed away in the mid-night. I can't contain my tears and didn't know what to do. I was raised by my great-grandmother, me and her had a strong bond between me and her. When I arrived at the hospital, she was laying on the bed, and I knew that it was the last time I saw her face, I can't control my emotion, and felt my emotion became uncontrollable, and it has lasted by a few weeks. I felt heartbroken for not seeing her anymore and felt pretty frustrated for why all the bad things happened to me. At that time, I didn't even talk much to my relatives or friends, I felt like I want to lock myself away from the world. The most importantly, we knew that Hong Kong has been going through a very difficult time, and plus the death of my great-grandmother, I felt so disgusted about the world. (submission number 1223223714)

Personal situations together with what was happening in the wider society became a great weight on some students. The weekly journal was an outlet for them to unburden their emotional baggage, and for some this was also a site for them to record their own attempts to handle the situation. I was very thankful to read the following journal entry from a student who had declared in other journal entries that she had a history of depressive issues:

> Due to the social turmoil of the Extradition Bill, the crisis has sparked various social conflicts, such as large-scale protest and daily riots. The violent scenes often create discomfort and emotions in us. Especially during these two weeks, there have been sieges in the Chinese University and Polytechnic University. As some of my primary and secondary classmates were stuck in there

> and asked for my help, I was very anxious and overwhelmed. This has eventually led to my emotional burnouts. To deal with this emotional breakdown, I have tried to adopt the practice of meditation. During this week, I have been doing meditation for five to 10 min daily at home. . ..After this week's experience of meditation, I have also understood that there are in fact ways to control my emotions, as I usually feel hopeless whenever I am not able to overcome the depression. Therefore, such experience indeed allows me to be more optimistic and less pessimistic about my illness, and I have more confidence that I can defeat negativity in the future. (submission number 1238867635)

The last three topics of my course were: meditative practices in "action", self-care, and loving oneself. After discussing how to establish a healthy lifestyle by working on a number of aspects in the previous weeks, the final 3 weeks were more focused on practical activities that they can engage in to build a healthy lifestyle. I had planned in-class practice of mindfulness, meditation exercises, and writing therapy, unfortunately the class was to meet in the virtual space. Some students did not have stable enough internet connection at home to sustain an extended viewing, and many of them actually took the class in their sitting room where siblings might be working on their assignments or classes. I was aware of their need for these practices as well as the limitations of the virtual class conditions, therefore I made voice-recordings of the lectures and placed them on our e-Learning platform for students' later visit.

When the call to suspend face-to-face classes came, I was worried that communicating with the students entirely in the virtual space would discount our emotional connection. However, the journal submissions of these weeks more than compensated what I could not see or feel in the virtual classrooms. The written words carried each student's emotions, be they worry, frustration, anger, disappointment, sadness, or simply a calm reflection. The following is a journal entry submitted on November 27, 2019:

> I didn't have a class on Monday, plus I was so worried that I hadn't closed my eyes the whole night, so I went out early in the morning. But my sense of powerlessness got heavier. I stayed out until midnight when mother urged me to come home, so I took the overnight minibus home. On the minibus, I received bad news, my good friend was arrested in Yaumatei. When I saw a picture of his being arrested, I was so scared that I could only cried on the minibus. But I recovered and quickly looked for a lawyer for him and informed his family. (*my own translation from Chinese*, submission number 1222836112)

This student had kept a very personal record in the journal entries throughout the semester, referring to her own weight problem, and also her feelings in relation to what was happening in Hong Kong society then. Being the instructor of this course on healthy lifestyle, I was most grateful for her candidness, but also her attempt to use some of the methods discussed in class to help her handle the unexpected circumstances. Another student referred specifically to a topic discussed in class and her own daily life in her journal submitted on November 28, 2019:

> In the power point, the importance and effectiveness of making art are emphasized. It is surprising that resilience is not only focusing on the personal side, but the one in the community is equally important. I am not good at making art other than writing, but I think appreciating can also be a good way to face ourselves. When I read good pieces, listen to songs and look at the lyrics that touch my soul, they speak so much of the feelings that I might not be able to express. (submission number 1222849585)

There are also students who did not make specific references to social incidents, and focused more on general practices in their daily life:

> Knowing yourself is the root of everything. Because if you don't observe yourself, the so-called good habits above are really difficult to develop. In the simplest case, if you haven't observed your own meal, you will never be able to do what is called "eat only seven full meals" [note: she meant 70% full] and lose weight in all likelihood. And if you look at yourself from now on, instead of a year, you will become clearer and more aware of yourself. Many problems will be solved, the most important thing is that you will live more and more calmly and have unprecedented mastery of life. (submission number 1221310387)

PERSONAL RESOLUTIONS TO CHANGE: PLANS SUBMITTED BY THE UNIVERSITY STUDENTS

The Personal Resolution Plan, the final assignment of the semester, was another precious window through which I could view the individual student's mental and emotional world. Each of them identified one particular habit or behaviour that they would like to change in the next few months, and drafted a complete plan to explain and describe the procedures. These self-analyses of their own lives were touching documents to read, especially when so many of them were struggling with the complex social situation and their studies at the same time. I remember two particular students reporting their plans to lose weight, employing the strategies discussed in class, and actually noting the progress since they started quite early in the semester when I talked about dieting and exercise. A number of these Personal Resolution Plans were actually a "final report" of what had been going on since quite early in the semester–a student mentioned her poor diet right after our lecture about diet in week 2—and the weekly journals were small episodes of that resolution

plan. Reading all the 45 PRP was like following the final episodes of these 45 mini-dramas.

The following PRP includes the typical range of concerns students had about their own lifestyle. Although my instruction was to focus on one, she named all the most common issues over daily habits:

> I am going to tune my biological clock back to a healthy and normal condition. As the semester is forced to be finish, all of us do not need to have on-campus meeting again, which means I do not need to wake up so early in the more anymore in this period of time. . . .another factor causing sleep so late is because of the current situation in Hong Kong. Every moment from the news on that day will somehow appear in my mind before I sleep. I understand and feeling so unfortunate for the current situation in Hong Kong so I can only calm myself by listening to music and watching some relaxing video on the internet. (submission number 1230572485)

Diet, sleep and stress were some of the most frequently mentioned aspects that students would like to handle and improve. Some students went a step further, and decided to improve physical fitness:

> In this semester, I have decided to run regularly on weekly basis. Actually, before the UCHL [note: UCHL was part of the course code] lesson. Keep a running habit is one of my dreams. And I had tried to make running a habit, however, there were somethings that pull back from the plan, such as laziness, weather or homework. Therefore, at this time, UCHL requires as to achieve something for writing the personal resolution plan, I think make running a habit can be my plan, and I hope this time I can continues the habit and will not give up easily this time. (submission number 1230716559)

When I described the PRP to the students, I asked them to include the reasons why they would like to make that change in their lifestyle, as well as ways to measure their success in making that change. I did not expect everyone to have made much progress in the course of just one semester–asking them to think about measuring success was simply a reminder that this should be an on-going exercise. Students' suggestions about how they would measure their success seemed to show that my aim was achieved:

> To know the success of achieving my goal, the first thing is to have an improvement in my psychological situation. After doing the record of my daily emotion and obsession, it'll help to notices the factors of causing the unstable of my emotion, and there will have a chance for me to face it and take action to solve it. Second, it'll be the time for me to find and bring back the interest to the things I love. (submission number 1230498989)

It can be seen that the writer was aware of the function of noting down his/her emotional conditions–hoping to identify the "factors" causing these fluctuating emotions. The long-term plan was to address these factors rather than the resulting conditions, and, ultimately recall the interest to things loved. Similarly, the measurements suggested below also reflect an awareness of the long-term process of building up a healthy lifestyle:

> While it comes to physical fitness, this would be considered a success if my weight has decreased by at least 34lbs after half a year of regular exercise. Also, the thickness of my waist should be narrowed down to 38 inches, which is the standard waist circumfix stated by the WHO. As for my sleep habit, the disappearing presence of black patches around my eyes should prove the improving of sleep quality. Since the measurement of success for mental health would be harder to be determined, the goal would be simpler, which is not signs of panic attack or unreasonable tantrums for the coming 6 months. (submission number 1230281922)

For many, the idea that they can and should actively build up a healthy lifestyle had not occurred to them before attending this course. What had been discussed in those few months, as well as the need to develop and personal resolution plan, were wake-up calls for this group of students. It was very encouraging to see that in some of the PRPs, even when students had not completed their plans, they showed positive acceptance of the importance of healthy lifestyle:

> Although I do not finish the plan perfectly, and the result is not significant at all, I still believe it is a successful plan. In this plan, I start to develop a healthy lifestyle, start to change some bad habit, and the plan becomes my habit now. Being aware of a healthy lifestyle, which is the ultimate goal of this personal resolution plan achieves. (submission number 1230480274)
>
> Pilates is for beginners, just like me. I can get a head start in my day with this. Also, I am the most productive I've ever been, and I get most of my work done in the morning now. I always thought that I was a night owl, but now I truly believe that I'm a morning person. I truly understand why my talented friend always wakes up early now after experiencing it. I hope that I can keep this habit in the future. (submission number 1230464827)
>
> In conclusion, I take up courage to change my bad habit and mindset at the same time in order to improve my living standard, which increased my quality of life. Our daily routines are so deeply ingrained that it's sometimes not easy to tell what they even are. In an age of constant distraction, however, it's critical that we don't let our time slip away from us. Focusing on daily habits and what we can do to improve is critical to maintaining satisfaction in all aspects of our lives. (submission number 1223659041)

CONCLUSION: VIRTUAL CONTACT AND AFFECT

At the end of the semester, I received a number of students' emails thanking me for the intimate experience of the course, despite the disruptions outside and especially that of the final 3 weeks of class. They mentioned that the mindfulness exercise and meditation practices were particularly helpful, and even the writing therapy was welcomed. I was genuinely heartened by this experience not only because the disruptions had done little to discount the quality of teaching and learning, but also that it had been an exceptional experiment to highlight the importance of emotions in higher education. In this case, because of the need to rely completely on e-Learning in the last weeks of the semester, I and my students were made to be very much aware of the role emotions had played in our interaction *via* e-Learning tools. And, on top of that, as the content of this course was healthy lifestyle, emotion as an area of knowledge was in the forefront and a large proportion of the narratives produced and exchanged in the course was around emotions, emotional competence and emotional wellness.

The following journal entries are the best support for such claims. For me, these words demonstrated success in learning because the experience touched their hearts as well as their minds:

> But frankly, after taking the Creative Writing courses, I did not pay so much attention to grades. In comparison, I am really more aware of the process and feelings in learning. So grateful to have the luck of taking this course, I gained much more than I imagined. The semester is over, but learning is not. If I have the chance, I will thank you in person. (*my own translation from Chinese*, submission number 1224932595)

> Actually today I would like to thank you for providing these teaching activities and materials. To be frank, when I enrolled this course, I just wanted to have a replacement for my PE lessons as I know that the lessons in this course are taken in lecture halls. I just want to pass the PE credits. The reason is I hate doing exercises. Although I have taken one PE lesson last semester, I treated it as a burden, just like being forced to exercise. However, neither did I know, I have the motivation to improve my health better myself after taking this course. I find that changing my mindset like doing exercises is a burden. (submission number 1225025753)

> Lastly, thank you so much for the help from Dr. Amy Lee, showing understanding and empathize, I hope everyone will be safe all the time. Looking forward to having meetings in the coming future again! (submission number 1223976777)

> The last weekly journal of this semester . . . Firstly, I really want to say I'm so grateful to take this course and meet a friendly and responsible lecturer like you. Even from every single weekly journal, we can see you want to try best to have some connection with us students as well as desire to help us mentally and physically to understand our body and our heart. (submission number 1225055863)

> Time flies, it is the last lecture notes we've studied. Through this semester, I am happy and enjoyable to have the lecture classes. We together learned a lot of things though sharing our own experience, and also to learn from the others. I love this lecture as it always gave me a comfortable zone to comfort and relax by learning how to self-care and understand myself. (submission number 1224873479)

In some studies about improving effectiveness in e-Learning, besides the recognition of user emotions as an essential factor influencing the outcome, other strategies had also been suggested. Paechter and his team discovered that "self-regulated and collaborative learning" (Paechter et al., 2010, 222) was one direction that worked well with e-Learning, while Robertson (2011) suggested that blogging activities could help students and teachers develop "a range of cognitive, social and self-directed learning skills" (Robertson 2011, 1628) which enhanced the overall learning effectiveness. In my unexpected shift to rely heavily on e-Learning to conclude a most unconventional semester, I found truth in these suggestions. The weekly journal and the final Personal Resolution Plan worked together to outline a self-regulated learning direction for each student, and their group presentation on their own chosen topic helped them to identify what was needed and crafted a coherent plant to approach a certain issue. The learning achievement was out of my expectations because this class was open to students of all disciplines, which meant that I had no clear knowledge of their academinc training nor abilities when I started to work with them.

As an experience, this semester offered me the first opportunity to test whether e-Learning and its tools can help us maintain the kind of communication with students that inspires trust, confidence, and togetherness. In the last 3 weeks of the semester, when the social environment of our city was very unstable, and when the emotional landscape of young people was particularly challenged, the e-Learning platform and simple activities I conducted allowed me to maintain a reasonably intimate communication with a class of 45 students from different disciplines and years of study, and moreover to take their pulse concerning their emotional status. I believe this is a strong indication that with careful planning and a genuine intention to establish such a connection, affective education can well be conducted with the assistance of e-Learning.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

The Author Contributions section is mandatory for all articles, including articles by sole authors. If an appropriate statement is not provided on submission, a standard one will be inserted during the production process. The Author Contributions statement must describe the contributions of individual authors referred to by their initials and, in doing so, all authors agree to be accountable for the content of the work. Please see herefor full authorship criteria.

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Promoting Students' Global Perspectives Through a Gamified e-Learning Platform

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With the rapid growth of internationalization in tertiary institutions worldwide, the development of students' global perspectives has attracted the attention of many universities. However, this development is a challenging one due to the complicated nature of global issues and their incompatibility with traditional subject-specific boundaries of classroom teaching. Through two eTournaments organized on a proprietary gamified e-learning platform named "PaGamO," this study examined participating students' learning experience and their change of global perspectives due to their participation in the eTournaments. Data were collected before and after the two eTournaments, and 217 survey responses were considered to be valid and were further analyzed. The findings showed that participating students achieved the satisfaction level of enjoyment (M = 3.62) and their awareness of the United Nations Sustainable Development Goals (SDGs) (M = 3.96) had been improved. In addition, the findings also revealed that 1) students enjoyed and perceived a better understanding of the SDGs in terms of perceptual dimensions like value-oriented and partnership-oriented, rather than the global issues about substantial threats or environmental issues; 2) the "intrapersonal effect" of students had been significantly reduced after the eTournaments; 3) positive significant correlations were found between the level of enjoyment and frequency of question-attempt in relation to the change of cognitive knowledge and interpersonal social interaction. The findings of this study offered some possible insights into students' gameplay experience concerning dimensions of global perspectives and also support the findings of prior research on how gamified e-learning platforms could contribute to the development of students' global perspectives.

Keywords: gamified learning, global perspective, online learning, e-learning, sustainable development goals

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INTRODUCTION

Internationalization in higher education has been accelerating rapidly in the past 40 years (Guo et al., 2021). This "process" (Knight, 2004) increasingly impacts higher education institutions in the world, which facilitates research collaborations, staff and students' mobility, and cultural and economic exchanges (Seeber et al., 2020). While internationalization could be applied to a multi-level organization and sectors, internationalization in higher education could be generally defined as "*the process of integrating an international, intercultural or global dimension into the purpose, functions or delivery of post-secondary education*" (Knight, 2004). The definition of internationalization had been modified several times (Knight, 1994, Knight, 2004; Guo et al.,

2021), and the recent outbreak of COVID-19 has led scholars to believe that the current framework is incompatible (Taşçı, 2021). However, these revised definitions and approaches (e.g., competency approach) remained linked and "*complementary*" (Knight, 2004), reflecting on the dynamic shifts in the "complex world" (Leask, 2015, 27). The reform of definitions may continue as time passes (de Wit and Altbach, 2021), but the core rationale of internationalization emphasizes a sense of relationships between nations, diverse cultures, and global issues at all levels, including institutional, local, national contexts.

From an individual perspective, one of the approaches in describing internationalization is the competency approach, which emphasizes how to develop internationalization in terms of knowledge, skills, and attitudes among students in the globalized world (Knight, 1994). Graduate attributes are a typical example of this approach to link up with the concepts of internationalization and bringing theories into the practices, as the internationalization of curriculum (Leask, 2015, 53). While this approach addresses human growth rather than organizational changes, many institutions use the term "global perspectives" and "international perspectives" explicitly in their websites to represent this as a generic skill for recognizing and respecting the inter-connection of life in a globalized world (Leask, 2015, 55).

Internationalization is frequently viewed from a global perspective rather than as a regional issue (Braskamp, 2009). It is because through understanding the interconnectedness of global issues, students could develop more capacities to address such problems and increase their own competitiveness in the economy (Baildon et al., 2018). It is therefore vital for university education to prepare students to become future leaders with global perspectives, which enable them to address the world's pressing challenges and improve their intercultural social skills.

Although the importance of possessing internationalization through global perspectives had been highlighted by previous works (Warner, 2017; Medora et al., 2020), the term "global perspective" is often considered as an alternative learning outcome of a program rather than an independent learning task (Smith and Yang, 2017) to be achieved by students. Furthermore, most studies conducted about the promotion of global perspectives mainly focused on the teacher-led internationalization activities, such as Education Abroad Program (Hudson and Tomás-Morgan, 2019), video conferencing (Greenwood, Honey, and Clancy, 2016), or university culture (Shephard, Bourk, Mirosa, and Dulgar, 2016), and did not address how students acquired their global perspectives through self-directed learning.

Internationalization can be accomplished through emerging knowledge from cross-cultural contexts into the curriculum (Knight, 1994; Seeber et al., 2020). However, integrating global perspectives as an effective means of internationalization into the formal curriculum had faced some challenging issues. First, global perspectives are often undervalued or incompatible with the traditional subject-specific boundaries of classroom teaching. More boundless learning opportunities should be offered to students to widen their horizons, whereas it may affect the professional recognition of the corresponding degree program (Enonbun, 2010). Second, the selection of global issues is a difficult task—the content should involve the mutual concerns of both developing and developed countries, and an option should be provided to work in a field that crosses all national boundaries, cultures, demographics, and regions (Evans, Ingram, MacDonald, and Weber, 2009). For example, Kopnina (2015) suggested that well-developed countries are more interested in keeping economic growth countries, while their citizen-consumers do not want to scarify themselves for environmental protection, climate change, or other relevant SDGs. Similarly, it is not realistic to ask students from developing countries to talk about "decent work" when they have to face the challenges of survival, like poverty and hunger, every day. It is challenging to integrate the thoughts of students with multidisciplinary and multicultural backgrounds. As a result, despite the importance of possessing global perspectives is highlighted by many researchers, few universities actually dedicate the effort and resources to promote global perspectives on a large scale. Most students could only develop global perspectives themselves through overseas exchange or intercultural interaction at an individual level, without any systematic school coordination (Evans et al., 2009).

Addressing the above concerns, the idea of Internationalization at Home (IaH) was proposed by scholars, which aims to educate students in local learning environments by incorporating international and intercultural components into the formal and informal curricula. This approach, as classified in prior work (Barbosa et al., 2020), is thought to improve "virtual mobility" by providing a technology-assisted environment, an alternate approach for students to collaborate globally, and therefore better promote students' global perspectives. Therefore, this study aims to explore the role of technology-assisted challenge-based learning in promoting students' global perspectives. In this study, a gamified e-learning platform, "PaGamO" was used. It allowed students with multidisciplinary and multicultural backgrounds to work together in teams and compete on a virtual map with their knowledge of the 17 United Nations (UN) Sustainable Development Goals (SDGs). The 17 SDGs were agreed upon by world leaders in 2015 to represent the universal challenges of humans from a global perspective (United Nations, 2015).

LITERATURE REVIEW

Definition and Dimensions of the Global Perspective

Global perspective refers to the nature of a study that is globally oriented, instead of the view that is being confined to the cultural or political preferences and inclinations of the particular country (Hua, 2008). Previous researchers tried to give a detailed description of what global perspectives should cover. Some researchers focused on its significant dimension, emphasizing the range of global topics about which people should be informed, such as universal human values that transcend group identity (e.g., equality, justice, and liberty), and persistent global issues

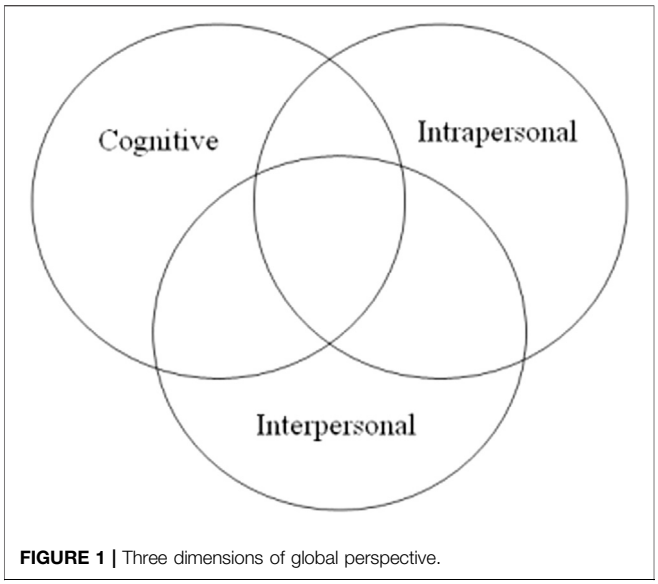

FIGURE 1 | Three dimensions of global perspective.

and problems (e.g., poverty or femininity) (Kniep, 1986). These researchers focused more on knowledge and information, while the development of global perspectives is considered as a cognition process of gaining understanding about different global knowledge, value, and information.

Case (1993) also agreed with the substantial dimension, yet he stepped forward and extended the discussion of global perspectives to "perceptual dimension," which refers to "*various intellectual values, dispositions, and attitudes that distinguish a parochial perspective … from a broad-minded perspective*" (P.320). Case (1993) outlined five main perceptions of developing students' global perspectives, namely, 1) open-mindedness; 2) anticipation of complexity; 3) resistance to stereotyping; 4) inclination to empathize; 5) non-ethnocentrism (thinking one's group is superior to others). Case's idea is further developed into the concept of intercultural competence, which refers to the "*modes of thought, sensitivities, intellectual skills, and explanatory capacities*" (Deardorff, 2009, p.443). In this view, the development of global perspectives is not just cognitive but also involves the psychological and emotional development of dispositions, ethical position, open-mindedness, and multicultural attitude. It thus involves how individuals deal with cultural diversity and how to make sense of the world.

Integrating the substantial and perceptual dimensions of the global perspectives, Braskamp et al., 2014 conceptualized them into three domains: cognitive, intrapersonal, and interpersonal (**Figure 1**).

In Braskamp's view, the cognitive domain is about intercultural knowledge, which includes "*individual knowledge and knowing with greater complexity and taking into account multiple cultural perspectives*" (Braskamp, 2014, p.3). The intrapersonal domain focuses on individual awareness and how they integrate their own personal values and self-identity internally. The interpersonal domain is more about individual attitude and behavior. It is centered on one's willingness to interact with outgroup cultures and their acceptance of others (Braskamp et al., 2014).

Global Learning for Global Perspectives and SDGs

At the university level, students' global perspectives could be developed through global learning. Global learning is the learning process where students with diverse cultural backgrounds make collaborative efforts to tackle and resolve the complicated problems that transcend the national borders (Landorf and Doscher, 2015). And it was recognized as one of the ways to aid institutional internationalization (Ng and Nyland, 2016). Students could develop individual competence through global learning by exploring and considering different points of view.

During the global learning activity, the students would share their own viewpoints as a member of a virtual team, which is known as social presence (Wang, 2009). Also, global learning should help develop global awareness, knowledge of the world's complexity, and interrelatedness. It could also facilitate the students' collaboration since they would acknowledge that they are too complex for any single person, group, discipline, or approach to solve alone.

Although the concept of global perspectives is an individual capacity, its development is not context-independent. There is a need to choose global-awareness issues that the students could explore and integrate different perspectives. In this regard, the 17 SDGs serve as good examples for students to explore their implications.

The 17 SDGs are the core of "The 2030 Agenda for Sustainable Development" of the UN, which serves as a "*blueprint to achieve a better and more sustainable future for all*," instead of the narrow consideration of the particular country. All SDGs require the collaborative actions of all countries—developed and developing—in a global partnership (United Nations, 2015), such as ending poverty, reducing inequality, or tackling climate change. These SDGs had been well noted in previous literature that could be used as an agent to call upon to help contribute to the challenges and goals in internationalization (de Wit and Altbach, 2021).

Through a prolonged discussion in the UN, the 17 SDGs were agreed upon by all world leaders and were adopted at the UN Sustainable Development Summit in September 2015 (United Nations, 2015). The goals are included in **Table 1**.

It is worth noting that learning SDGs in the university setting is a complicated task. It often involves a deep conflict when attaining different SDGs at the same time. For example, Hickel (2019) suggested that continued global industrial growth in SDG 8 may not be reconcilable with ecological sustainability goals (SDG 12–15) due to the global eco-economic decoupling in recent years. Also, economic growth (SDG 8) may worsen the goal of inequality reduction or other sustainability objectives. Thus, the implementation of the SDGs needs to balance conflicting positions and compromise, such as exploring the possibility of ecotourism or global recycling industry, which are generally considered as the typical example of seeking a

balance between economic benefits for resident hosts or consumers' benefits and environmental protection against the additional costs (Alexander and Whitehouse, 2004).

Moreover, the teaching and learning of global perspectives and SDGs is not an easy task. Previous literature showed that most teachers focused on the development of substantial dimensions only. Merryfield, 1998, for example, suggested that most teachers focused on the particular topics of culture and history, such as human rights, the slave trade, or child labor. On the other hand, Kirkwood, 2002 suggested that most teachings about world-mindedness tended to highlight the cultural universals, such as loving families, self-esteem, and personal and cross-cultural appreciation. At the university level, however, the knowledge of people and places is clearly not enough. Although the introductory courses about global perspectives could be the starting point for raising students' awareness of others' perspectives, the lecturer is difficult to help students develop desirable attitudes and sensibilities, such as open-mindedness, tolerance, empathy, or consciousness of their own national orientations, as well as their worldview.

Promoting Global Perspectives Through a Gamified e-Learning Platform

As mentioned before, one of the challenges of promoting global perspectives is that most global issues are extremely complicated because of their cross-disciplinary, cross-cultural, demographical, and regional nature. Moreover, it does not entirely fit the formal curriculum. Teachers could only use the example of global issues for instruction or to encourage students to apply their professional knowledge to tackle global problems. At the same time, students would consider whether the learning content could benefit their academic achievement or professional recognition. Thus, it is difficult to motivate them and build up their awareness of global perspectives outside the official curriculum.

Addressing the above limitations, a gamified e-learning platform was offered as an informal internationalization curriculum for students. The benefits of gamified ICT-enhanced teaching have been frequently reported by different researchers, such as increasing students' motivation and engagement (Koivisto and Hamari, 2019), empowering students with low self-efficacy, and even facilitating the development of critical thinking (Turkay et al., 2014; da Rocha Seixas et al., 2016). Similarly, it is also reported as an effective tool to introduce global perspectives to students beyond the traditional classroom. Previous studies suggested that gamified e-learning platforms are effective in teaching non-subject knowledge, such as leisure reading (Mak et al., 2019), traffic safety (Riaz et al., 2019), or civic engagement (Hassan, 2017). Not only could the gamified e-learning platform motivate students through the peer-pressure or team collaboration, but it also offers external motivation (i.e., points, achievements, or ranking) that makes students more committed to learning and achieve higher levels of flow experience during the gameplay (Mak et al., 2019).

METHODOLOGY

As noted above, the need for global perspectives as one of the research indicators of internationalization had been documented earlier (McCabe, 1994; Leask, 2015), and that the intervention was frequently through formal teacher-led activities to promote students' global perspectives. This research bridges the void by using gamified SDGs content to help students develop global perspectives. As a result, this research investigates the effectiveness of using an eTournament on the gamified e-learning platform "PaGamO" to help students gain global perspectives. It also examined students' perceptions of their gameplay experience. A central question of this study is

To what extent could the gamified e-learning platform help students develop their global perspectives?

To guide the study, the following three research questions are proposed:

RQ1. What are students' perceptions of their gameplay experience and improvement of SDG awareness?
RQ2. How do the students' global perspectives change after the eTournament?
RQ3. What is the correlation between students' gameplay experience and the change of global perspectives in the eTournament?

Research Design

This study adopted a pre-test, post-test quasi-experimental design. A quantitative approach aims to help researchers grasp the pattern of response among the large population (Kendall, 2008). Since this study involved more than two hundred students, the quantitative approach allows us to explore how the gamified e-learning platform works well in the development of students' global perspectives. Second, it allows the researchers to investigate students' feedback from a larger sample size for more generalizable results (Oppenheim, 1992).

The SDGs eTournament

This study involved two eTournaments; they both had a similar design and both aimed to 1) allow students from different parts of the world to learn to work together online (Online Teams) and complete specific tasks, 2) let students learn about the 17 UN Sustainable Development Goals (SDGs) through the game platform, and 3) allow students to learn about the different cultures and background of their teammates (Hong Kong Baptist University, 2020). Two eTournaments were held in the spring of 2019 and spring of 2020, respectively. Both eTournaments had two stages which will be described in the following.

The Gamified Platform

"PaGamO" was used to bridge the gap between informal and formal global perspective learning. PaGamO was developed by a professor from the National Taiwan University, which allows players to learn and compete with each other in an online virtual map by answering preset questions. PaGamO allows teachers to

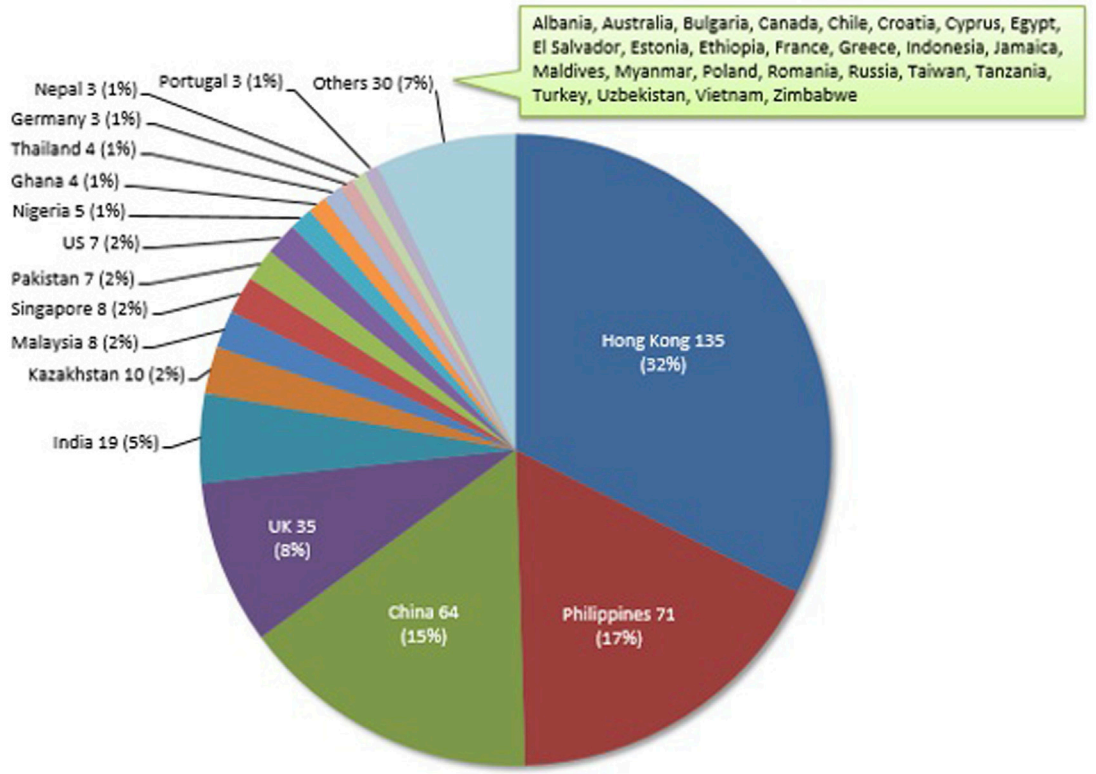

FIGURE 2 | Home region of student participation (second eTournament) (*N* = 416).

prepare their own question bank according to the learning objective (Hong Kong Baptist University, 2020). Also, the PaGamO system provided a convenient way to explore different learning analytic features like the frequency of question attempts for further analysis.

Game Content

The questions about the SDGs are multiple-choice questions (MCQ) which were developed through two approaches. On the one hand, university students from all over the world were invited to submit SDG questions in the 2018 SDG Questions Creation Contest. The expert judges at UNESCO Hong Kong Association reviewed all questions in the contest to ensure their validity of fitting the learning objective of the global perspectives. In the contest, 706 valid SDG-related questions were prepared by 117 university students from 10 institutions in Hong Kong, Australia, India, the Philippines, and Singapore. On the other hand, experts from UNESCO Hong Kong Association were invited to develop the SDG questions so that an SDG questions bank of about 1,400 questions was created.

Preparation Stage

Stage 1 is the preparation stage, where all students were invited to do online discussions in a pre-assigned virtual team so that they could get familiar with each other and work out the strategies for the gameplay. During Stage 1, each team was asked to choose their team leader, PaGamO game characters, and discuss their game strategy for Stage 2.

Game Play Stage

Stage 2 is the gameplay stage, where teams had to compete with each other on the virtual map of PaGamO by answering SDGs questions. The questions were put into a single question pool and were assigned to students randomly in the first eTournament, while in the second eTournament, the questions of each SDG were put into different sets, and the students could choose to answer particular sets of SDG questions.

Sampling

With the involvement of four local partner institutions and 13 international collaborators, this study invited students from universities all over the world. In general, all university students, ranging from sub-degree to doctoral level, are eligible to join the eTournament. Each team consisted of four to five members, and all team members were assigned to each group randomly. To ensure student diversity, no more than two students from the same institution or region would be grouped together in each team.

To minimize the non-response bias among students, two criteria were used in the data filtering process. First, the students would not be counted if their frequency of question attempts (the sum of attack-action and land-training action in PaGamO) was less than ten. Second, the students would be considered as having survey fatigue if they made "straight-line responses" (i.e., giving answers down the same column) over fifteen questions. Previous literature suggested that survey fatigue

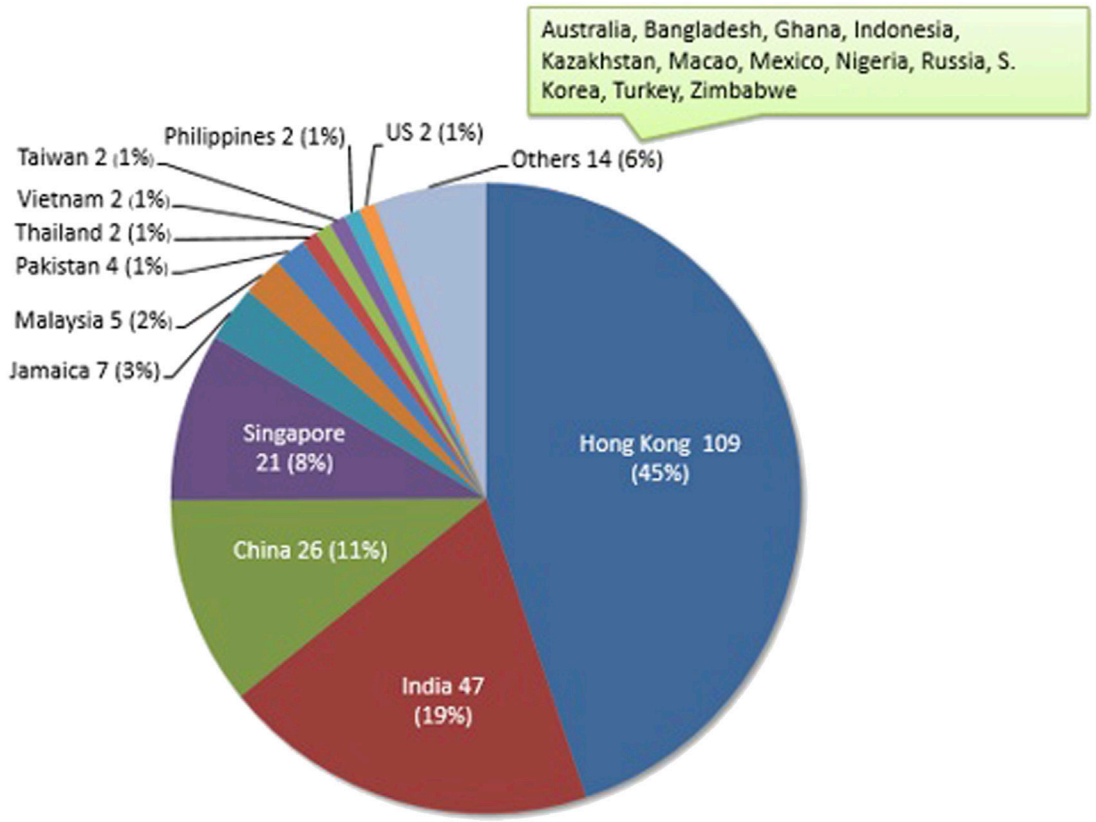

FIGURE 3 | Home region of student participation (first eTournament) (*N* = 243).

would lead to non-response bias and cover the significant findings (Lavrakas, 2008).

Data Collection and Instrument

This study has been approved by the university's Research Ethics Committee. At the first survey, participants volunteered for the study and received their informed consent. Data were collected before and after the eTournament, with 8-day (2019 run) and 16-day (2020 run) gaps between the two surveys. All participating students were invited to fill in the pre-survey while those who finished the final stage of the eTournament were invited to complete the post-survey about their learning experience of global perspectives, level of enjoyment, and perceived improvement of SDG awareness. They would earn some bonus points for the eTournament after completing the survey. Qualtrics, an online survey tool, was used to collect the data. After the eTournament, the question attempts were extracted from PaGamO as part of the learning analytic function.

The global perspectives were measured by a shortened version of the Global Perspective Inventory (GPI), which was developed by Braskamp and his colleagues in 2014. Since the two eTournaments were brief and had no direct effect on individual behavior or life-long social responsibility, the dimension "Social Responsibility" was excluded from the survey.

The shortened version of GPI in this study consists of 22 items, which categorized global perspectives into five dimensions: 1) cognitive knowing, 2) cognitive knowledge, 3) intrapersonal identity, 4) interpersonal affect, and 5) interpersonal social interaction (Braskamp et al., 2014). A 5-point Likert scale was used in the surveys, and students were invited to comment on each statement according to their experience, with one indicating "strongly disagree" and five indicating "strongly agree."

In the survey, the demographic and other self-reported data such as gender, contact email, level of enjoyment, and perceived improvement of SDG awareness were also collected. A descriptive statistical analysis was performed using the data from PaGamO's question attempts.

Data Analysis

First, the Cronbach's alpha of each dimension of GPI was calculated in order to ensure internal consistency. Second, addressing RQ1, the descriptive statistical analysis was conducted on the mean scores of 1) level of enjoyment; 2) perceived improvement of SDG awareness; (3) frequency of question-attempt (including the student's attempt to attack others, expand territory, and train his own land), which explicitly indicated students' experience during the gameplay. Third, the paired-sample *t*-test was conducted to examine whether students' global perspectives had significant changes before and after the eTournament. Lastly, the correlation test was conducted between the global perspectives and students' experience during the gameplay.

TABLE 1 | List of the SDGs.

SDG 1	No Poverty
SDG 2	Zero Hunger
SDG 3	Good Health and Well-being
SDG 4	Quality Education
SDG 5	Gender Equality
SDG 6	Clean Water and Sanitation
SDG 7	Affordable and Clean Energy
SDG 8	Decent Work and Economic Growth
SDG 9	Industry, Innovation, and Infrastructure
SDG 10	Reducing Inequality
SDG 11	Sustainable Cities and Communities
SDG 12	Responsible Consumption and Production
SDG 13	Climate Action
SDG 14	Life Below Water
SDG 15	Life On Land
SDG 16	Peace, Justice, and Strong Institutions
SDG 17	Partnerships for the Goals

FINDINGS

At the start of the two eTournaments, there were a total of 659 students from 46 home regions (see **Figures 2**, **3**).

263 students finished all the stages and filled in both pre- and post-eTournament surveys, and 198 responses remain valid after the data filtering process mentioned above.

The internal reliability of the GPI is first tested. The result is shown in **Table 2**.

In this table, the subscale with Cronbach alpha over 0.7 is generally considered as acceptable (Nunnally, 1978) while 0.5 Cronbach alpha is also legitimate and acceptable with a short scale (Dall'Oglio et al., 2010). Since the Cronbach Alpha in sub-scales "intrapersonal identity" and "interpersonal social interaction" only consist of three and four items, respectively, the GPI in this study is thus considered as reliable for further analysis.

Students' Gameplay Experience in PaGamO

To examine the perceived effectiveness of the eTournaments, this study explored students' feedback on the eTournament through three variables: 1) level of enjoyment in the eTournament; 2) perceived improvement of SDG awareness after the game; and 3) frequency of question-attempt. The result is shown in **Table 3**.

Overall, the students had a moderate level of enjoyment, which gave the mean score of 3.62 for the item "level of enjoyment in the eTournament." By contrast, they gave a higher mean score of 3.75 for the perceived improvement in their SDG awareness after the eTournament.

Regarding the students' autonomy of selecting SDG, the students in the first eTournament (N = 99) were assigned SDG randomly, while the students in the second eTournament (N = 118) were allowed to choose one. An independent samples t-Test was conducted to see if there is any significant difference.

Table 4 shows that students who could freely choose their SDG would have a higher level of enjoyment, increased from 3.09 to 4.06 ($t(215) = -8.17$, $p < 0.05$). Similarly, they reported a higher score (M = 4.40) than students in the first eTournament (M = 2.98) in terms of "perceived improvement about their SDG awareness" ($t(215) = -8.968$, $p < 0.05$)).

To further examine the relation between students' level of enjoyment and the effectiveness of eTournament on different SDGs, this study further examined how the students' scores were distributed differently across 17 SDG in the second eTournament (N = 118).

Figures 4, **5** show that the awareness improvement in SDGs 16 (M = 5.00), 17 (M = 5.00) and 3 (M = 4.71) was most significant and that in SDGs 2 (M = 3.89), 13 (M = 4.00), 4 (M = 4.13) and 8 (M = 4.13) was least significant.

The students enjoyed most in SDG 16 (M = 4.75), 17 (M = 4.40), and 1 (M = 4.33), but the least in 8 (M = 3.75), 9 (M = 3.75) and 11 (M = 3.75).

Before the study, it was assumed the students would enjoy more and perceive more improvement in SDG awareness if they chose to answer the questions related to particular SDG(s) more frequently. However, it is interesting to find that students in some SDGs play the game more frequently but feeling bad, and vice versa. For example, students in SDG 2 (Zero Hunger) reported a higher frequency of question-attempt (M = 207), but they give a lower score in the perceived improvement of SDG awareness (M = 3.89). By contrast, students with SDG 10 (Reduced inequalities) have a relatively high score in the improvement of SDG awareness, whereas there was very few question attempts (M = 94).

Change of Global Perspectives After the eTournament

To examine the change of students' global perspective, a paired-sample t-test on the pre- and post-survey results was conducted. The findings are shown in **Table 5** and **Figure 6**.

As shown in **Table 5**, although the mean score of cognitive knowledge and interpersonal social interaction have been slightly increased after the eTournament, the changes of most sub-scales of global perspectives did not reach the significant level, except "intrapersonal affect." It is surprising to observe that "intrapersonal effect" was reduced from 4.35 to 4.16 after the eTournament, which indicates that the students show less acceptance of others' cultural perspectives and have a lower degree of emotional confidence to manage the intercultural conflict after the eTournament.

On the other hand, to examine the impact of SDG allocation on changes in students' global perspective, an independently sampled t-Test was conducted. The result is shown **Table 6**.

TABLE 2 | Internal reliability of GPI.

	Number of items	Cronbach alpha (pre-survey)	Cronbach alpha (post-survey)
Cognitive knowing	7	0.721	0.732
Cognitive knowledge	5	0.775	0.817
Intrapersonal identity	3	0.607	0.646
Intrapersonal affect	3	0.779	0.726
Interpersonal Social interaction	4	0.537	0.582

Comparing with students of the first eTournament ($M = 0.105$), the mean difference before and after the eTournament has a significant decrease ($M = -0.188$) in terms of "cognitive knowledge" ($t(208) = 3.26$, $p < 0.05$). By contrast, a significant increase in "interpersonal social interaction" among students in the second eTournament (0.144) is observed, while the students' score dropped 0.283 in the first eTournament. Second, both groups of students reported a lower score in "intrapersonal affect" after the eTournament, while the decrease is significantly higher among students in the first eTournament (−0.498) than those in the second eTournament (−0.225) ($t(208) = -4.15$, $p < 0.05$).

TABLE 3 | Level of enjoyment, perceived awareness, and frequency of question attempts.

	Mean	SD
Level of Enjoyment	3.62	0.99
Perceived improvement of UN-SDG awareness	3.75	1.36
Frequency of question attempts	145.0	74.7

Students' Perception, Frequency of Question-Attempt, and Global Perspective

To examine how students' learning experience affects their global perspective, this study conducted a Pearson's correlation test between the "change of students' global perspectives before and after the eTournament" and different variables about students' gameplay. The result is shown in **Table 7**.

This shows that the frequency of question-attempt of students has a significant correlation with the change of students' global perspectives in terms of "cognitive knowledge" ($r = 0.250$, $p < 0.05$), "intrapersonal identity" ($r = 0.167$, $p < 0.05$), "intrapersonal affect" ($r = 0.265$, $p < 0.05$), and "interpersonal social interaction" ($r = 0.211$, $p < 0.05$).

The level of enjoyment is also found to have a significant correlation with "cognitive knowledge" ($r = 0.167$, $p < 0.05$) and "interpersonal social interaction" ($r = 0.177$, $p < 0.05$). However, the "perceived improvement of SDG awareness" has no correlation with all dimensions of global perspective, except "interpersonal social interaction ($r = 0.239$, $p < 0.05$).

The result shows that the students who played PaGamO more frequently could gain more understanding about various cultures and their impact on our global society. They would have a higher degree of engagement with peers from other cultures and develop a higher degree of cultural sensitivity in living in pluralistic settings.

DISCUSSION

The results of the analyses indicate that students' gameplay experience is correlated with the development of students' global perspectives, while the gamified platform also created a desirable context for developing the global perspective. In this section, the robustness of these findings is further discussed in comparison with existing literature.

Students' Gameplay Experience and Perception in Different SDGs

The above findings revealed that the eTournament has basically met its primary objective: to improve students' awareness of different SDGs through the eTournament. However, its change is probably affected by the nature of SDGs.

In the past, Begler (1993) suggested that knowledge inherent in a global perspective could be divided into substantive (Knowledge inherent in a global perspective) and perceptual domains (an array of intellectual values, dispositions, and attitudes). Begler suggested that perceptual domains offered the "lens" through which the substantive domain is viewed, while this study further revealed that these natures would also affect the effectiveness of the gamified learning experience. In **Figure 4**, it is observed that there is less improvement of SDG awareness in the substantive domains (i.e., SDG 2 "Zero hunger" and 13 "Climate Action"). It is probably because the students already had a relatively high awareness about the substantive challenges (i.e., impact greenhouse effect or global warming) through the advertisement of different non-governmental organizations (NGOs) or even popular disaster movies in the cinema. Moreover, people from developing and developed countries may have different concerns and led to different learning outcomes. Murakami et al., 2017, for example, reported that people in developed countries would have a higher environmental awareness of human health, biodiversity, and primary production. On the other hand, the news of famine and hunger, compared with other SDGs, would attract more attention from all over the world (De-Waal, 2017; Banik and Chasukwa, 2019) and raised enough awareness among students before the eTournament.

TABLE 4 | Independent-sampled *t*-test between students in first and second eTournament.

	Mean (first eTournament, *N* = 99)	Mean (second eTournament, *N* = 118)	*p*-Value
Level of Enjoyment	3.09	4.06	0.00
Perceived improvement of SDG awareness	2.98	4.40	0.00
Frequency of question-attempt	114.4	170.7	0.00

TABLE 5 | Paired-sampled *t*-test of Students' Global perspectives in Pre- and Post-survey.

	Mean-difference	t-Value	*p*-Value
Cognitive knowing	–0.06	1.14	0.256
Cognitive knowledge	0.03	–0.98	0.329
Intrapersonal identity	0.00	0.04	0.970
Intrapersonal affect	–0.19	4.22	0.000
Interpersonal social interaction	0.04	0.73	0.456

By contrast, the SDGs about perceptual domains, such as SDG 17 "Partnerships for the Goals" and 16 "Peace, Justice and Strong Institutions," were more complicated to be understood by the general public in daily life. Compared with the environmental issues, which were often portrayed in different disaster and action movies (Keane, 2006), the universal value (i.e., peace or justice) and global partnership may be less attractive to audience or more difficult to form intriguing storylines. Therefore, the students in these SDGs may receive greater shocks and perceived improvement of awareness during the gameplay.

Second, the comparison between the first and second eTournament in *Findings* showed that the students with greater autonomy in selecting their own SDG questions would have a significantly higher level of enjoyment, greater improvement of SDG awareness, and more question-attempt during the gameplay. It indicates that the game designer should pay more attention to the user's autonomy in selecting questions as it could greatly improve the attractiveness of gameplay.

Third, another point of view on students' varying levels of understanding of these SDGs may be related to recent criticisms. The SDGs were recognized as being too complicated, inconsistent, and containing buzzwords without detailed definitions, such as "resilience" and "sustainable" (Liverman, 2018). In addition, in some SDGs, such as SDG 8 "Decent Work and Economic Growth" and SDG 10 "Reducing Inequality," there are certain conflicts such as boosting economic growth for the bottom 40%, without considering the impact on the SDGs relating to the environment and reducing inequality by redistributing the top 1%'s income (Liverman, 2018). This could make it difficult for learners to master these topics.

The Effectiveness of eTournament in Promoting Students' Global Perspective

Regarding the effectiveness of the eTournament on promoting students' global perspective, the result is somewhat surprising. Following the eTournament, students' levels of intrapersonal effect were found to be significantly lower. It is probably because most university students have overestimated their self-openness to other cultures before real multicultural collaboration.

During the eTournament, the students would realize the incompatible views or different working styles of other team members. They have to manage unexpected cultural conflicts or even experience cultural shock during the interaction. Through the discussion process, the student could gain better self-understanding and identify their weakness in intercultural interaction.

In the age of globalization, however, university students should take risks and face challenges before they engage with foreigners as early as possible. It is the only way to enable students to develop advanced social skills and to manage the intercultural conflict through real intercultural interaction experiences, although such intercultural experience may not always be comfortable.

TABLE 6 | Independent-sampled *t*-test of Students' Global perspectives between first and second eTournament.

	Mean-difference before and after tournament (first eTournament, *N* = 99)	Mean-difference before and after tournament (second eTournament, *N* = 111)	t-Value	*p*-Value
Cognitive knowing	0.105	–0.188	3.26	0.00
Cognitive knowledge	–0.059	0.058	–1.56	0.12
Intrapersonal identity	–0.074	0.024	–1.12	0.26
Intrapersonal affect	–0.498	–0.225	–2.85	0.01
Interpersonal social interaction	–0.283	0.144	–4.15	0.00

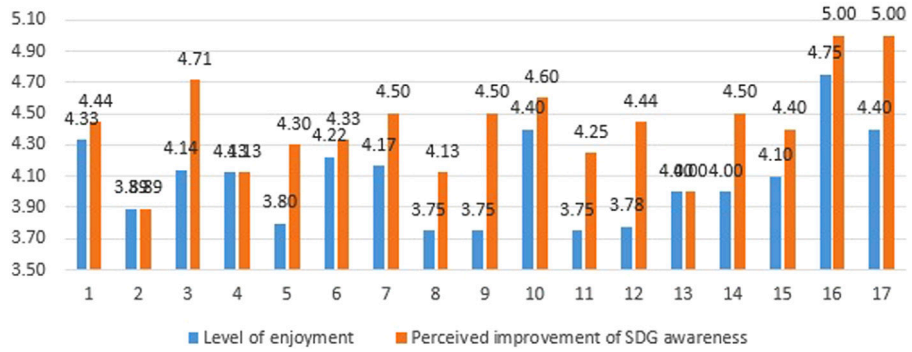

FIGURE 4 | Level of enjoyment and perceived improvement of SDG awareness in 17 SDGs.

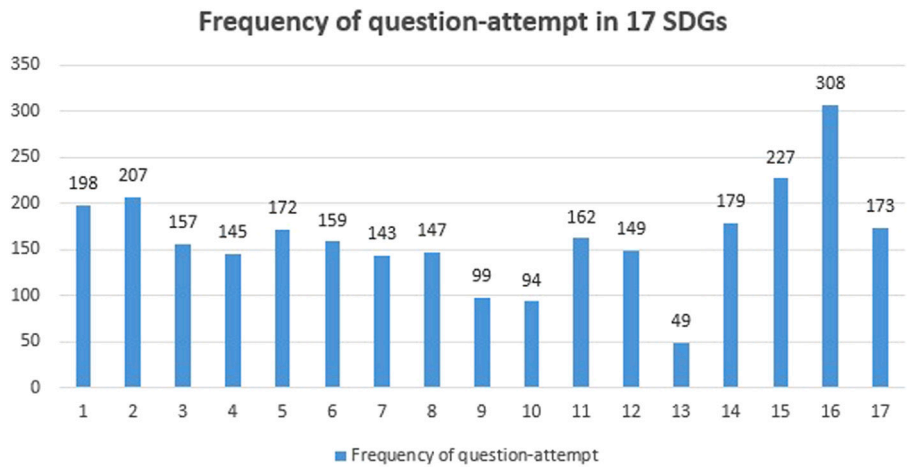

FIGURE 5 | Frequency of question attempts in 17 SDGs.

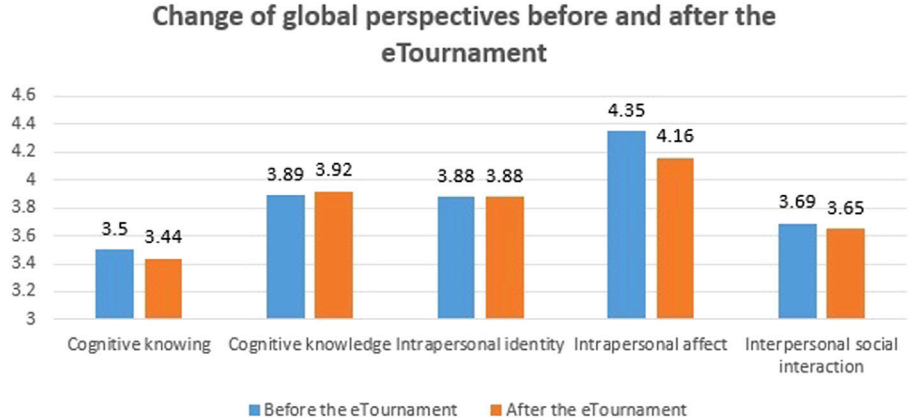

FIGURE 6 | Change of global perspectives before and after the eTournament.

TABLE 7 | Correlation between students' global perspective, level of enjoyment, improved SDG awareness, and frequency of question attempts.

	Level of enjoyment	Perceived improvement of SDG awareness	Frequency of question-attempt
Change of Cognitive knowing	0.002	–0.078	0.095
Change of Cognitive knowledge	0.167*	0.124	0.250*
Change of Intrapersonal identity	0.067	0.079	0.167
Change of Intrapersonal affect	0.199*	0.111	0.265*
Change of Interpersonal social interaction	0.177*	0.239	0.211*

Note (*) p-*value is less than or equal to 0.05.*

Correlation Between the Students' Gameplay Experience and the Global Perspective

The findings show that the eTournament could meet our learning objective, where students could gain more understanding and awareness of various cultures and their impact on our global society through more frequent gameplay. Moreover, the gameplay could also help students build up respect and acceptance to others with multicultural perspectives, as well as a higher level of emotional intelligence and cultural sensitivity for the unknown cultural conflict in the future.

In the eTournament, however, there are some limitations to the game design that we should be aware of. First, the eTournament could not help students to recognize the importance of cultural contexts or judge what the key knowledge or value in different SDGs is. It is also evident in our correlation test in **Table 7**, where no correlation is observed between the "change of cognitive knowledge" and all three variables about students' gameplay experience. It also indicates that the student participants could not develop the perspective-taking ability that concerned other's unique identity after the eTournament. This is due to the fact that the tasks in this eTournament are rather simple and straightforward in the form of MCQ, and the students do not have to deal with complicated tasks during team collaboration.

Moreover, the results show that the perceived improvement of SDG awareness is not necessarily consistent with the students' global perspective. It indicates that the development of students' global perspective and students' awareness about SDG issues should be considered as two non-correlated variables. In other words, a multicultural team with stronger global perspectives would not guarantee a higher level of awareness about SDG. It is quite different from the traditional view that students with stronger global perspectives could have better quality collaboration with intercultural peers, and leads to more successful outcomes (Leinonen et al., 2005). It supports the suggestion of Leinonen and her colleagues that there is a need to investigate students' awareness of collaboration in more detail, including 1) awareness of the collaboration possibility, 2) awareness of the collaboration purpose, and 3) awareness of the collaboration process. It calls for the need to further explore the students' subjective perception and interpretation in the future, which may explain the missing link between multicultural collaboration and the expected learning outcomes, as shown in our study.

CONCLUSION AND THE WAY FORWARD

This study revealed that students' gameplay experience of the eTournament could contribute to their global perspective development. Regarding the impact of eTournament on 17 SDGs, the findings showed that students were satisfied with the level of enjoyment ($M = 3.62$) and perceived improvement of SDG awareness ($M = 3.75$) on average, while it was found to be particularly effective in improving perceptual dimensions of global perspectives in terms of issues about universal values (i.e., SDG 16 "Peace and Justice and Strong Institutions" and structured issues that involved multinational cooperation (e.g., SDG 17 "Partnerships for the Goals" or 3 "Good health and well-being." By contrast, the substantial dimensions (e.g., SDG 2 "Zero Hunger") or environmental issues SDG 13 "Climate Action"), were less likely to receive benefit from eTournament.

At the individual level, the findings showed that students become more aware of the difficulties of intercultural collaboration, such as integrating one's personal values and self-identity into one's personhood. It is reflected in the decrease of "intrapersonal affect" after the eTournament, which indicates that students have re-estimated their level of respect for and acceptance of other cultural perspectives after the eTournament. It is believed that the students' experience in the eTournament could serve as a foundation for their future intercultural interactions towards a more comprehensive global perspective.

This study also examined which elements of gameplay contributed to most of the students' global perspectives development. The findings revealed that the level of students' cognitive knowledge and interpersonal social interaction was positively related to their level of enjoyment and frequency of question attempts. It helps future game designers and course instructors to realize the importance of motivating students' learning through gameplay experience and imposing more enjoyable elements to develop broader perspectives about the world.

From the instructors' point of view, this study gave insights into addressing the students' needs for different global issues. Before advocating the importance of global perspectives, it is better for universities to explore which global perspectives are

better off for their online learning environment and which ones are not. For example, the findings of this study reveal that the students' awareness of SDG 3 "Good health and well-being", 16 "Peace, Justice and Strong Institutions," and 17 "Partnerships for the Goals" received the greatest improvement. The instructors could further explore more possibilities in their development in other game-based learning environments.

Second, as illustrated by the findings, despite most students reporting a satisfactory level of enjoyment and improvement in SDG awareness on average, the correlation is only observed between the change of global perspective, frequency of question-attempt, and level of enjoyment. This implies that game designers or instructors should show more concern about how to optimize the combination of gamified elements and the learning content when promoting students' global perspectives development.

The lack of identification of global perspectives among the participants through a qualitative approach is one of the limitations of this research. Despite the fact that the quantitative results showed students' learning gains and attitudes in this eTournament, there were no in-depth examinations to aid in the analysis of these results. As a result, future studies may concentrate on a different angle of inquiry, such as document reviews and content analysis similar to what McCabe, 1994 proposed, to identify the dimensions among these students' global perspectives. Another drawback of this study was that the research findings suggested that allowing students to self-select SDG question sets in the eTournament may lead to increased motivation on learning the SDGs. Despite the results suggesting this rationale, there has been no further investigation into the exact point of students' shifts in attitude in a more valid manner.

In conclusion, this study reveals the possibility of developing students' global perspectives through a gamified e-learning platform. In the future, global education should begin to move from just an internationalized curriculum in the traditional classroom into the digital platform providing an opportunity to build up more in-depth global perspectives among students with multidisciplinary and multicultural backgrounds.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because they involve the privacy of individuals. Requests to access the datasets should be directed to FL, yickwah@hkbu.edu.hk.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Hong Kong Baptist University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

The first author conducted the literature review and wrote the manuscript with support from all other authors. The second author verified the data and supported the preparation of graphs and figures. The third author assisted with the revisions to the manuscript according to the reviewer's comments. All authors contributed to the design and implementation of the research.

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Gamification in Everyday Classrooms: Observations From Schools in Hong Kong

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Gamification refers to the use of game elements in non-game context to improve user experience and engagement (Deterding et al., 2011a). The potential of games to make learning more engaging has been widely noted by educators and researchers. Many of the applications and research studies in this area focused on non-customizable digital games that are designed for a specific group and a narrow range of subject content. In actual classrooms, however, non-customizable digital games may not be flexible enough to enable teachers to adapt gamification into practice. Hence, teachers sometimes use a mixed set of strategies to flexibly embed game-based mechanics into their teaching. How can different gamification tools be applied in classrooms? Based on classroom observations and teacher interviews from schools from primary to secondary level in Hong Kong, this paper explores the role of gamification in real practice. We frame the discussion based on the following approaches with ranging levels of flexibility: versatile gamification, gamification platform, and rigid gamification. Versatile gamification was seen as more feasible compared with the other two approaches. We also examine how game-based mechanics such as competition, rules, graphics, and achievements are used to enrich classroom interaction. It was found that gamification is already popular in the classroom. Follow up interviews with teachers suggested that game is a powerful way to engage students. Good practices in game-based lesson design and potentials for further development of gamification tools are discussed.

Keywords: game, gamification, classroom observation, student engagement, lesson design

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INTRODUCTION

"Gamification" is often used as an informal umbrella term that refers to the use of game elements in non-game context to improve user experience and engagement (Deterding et al., 2011b). Despite the lack of a precise and commonly agreed definition, gamification has gained much attention from educators and researchers in various types of study, and the number of commercially available game-related systems with an educational purpose have proliferated (Gros, 2007; Bawa, 2020).

It is widely recognized that educational games are effective in motivating students and make learning much more interesting (Bogost, 2007; ZarraonandiaDiaz and AedoRuiz, 2014). While the rapid expansion of video and mobile gaming has made games ubiquitous, developing new educational games or repurposing existing games to educational setting remains a challenge to many due to the cost, time, and expertise required. Can gamification tools be readily applied in classrooms without a heavy upfront investment of resources?

This paper discusses the applications of gamification in classrooms with examples from a 3-years study, in which the research team visited 14 schools in Hong Kong and conducted follow-up teacher interviews. It was found that gamification has been widely adopted in classrooms, and that gamified education can be achieved through varied means that have varied implications on cost, time and expertise. Based on the findings from our classroom observations and interview, we have identified a spectrum of gamification approaches with varying levels of customizability. In the most customizable end of the spectrum, teachers can combine various digital or non-digital resources to create a teaching and learning game as gamification can be achieved by adding game elements in more abstract levels to increase student engagement and motivation (i.e., versatile gamification). A middle-of-the-road approach is the use of game-oriented tools that are more adaptable with a user-friendly interface that enables teachers to create content related to their learning goal (i.e., gamification platform). The least customizable end of the spectrum is the use of ready-built game-oriented teaching and learning tools with specific content to teach a certain topic (i.e., rigid gamification). The advantages and disadvantages of each approach are discussed, and the implications to educators are highlighted.

What Is Gamification?

Gamification has various definitions by different scholars, each with slightly different scope and emphasis. Some authors distinguish between game-based learning and gamification (Khan et al., 2017), while others use the two terms interchangeably. The two definitions of gamification proposed by Kapp (2012) and Deterding et al., 2011a are particularly noteworthy, with the first one focusing on the **purpose** of gamification and the second on its **design**.

Purpose-Oriented Definition of Gamification

Kapp (2012) defines gamification as the use of "game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems". This definition emphasizes the intended use and purpose of gamification (e.g., increase engagement and motivation to do certain tasks), rather than any specific elements of game design (e.g., badges, points, and competition). Kapp's (2012) inclusion of "game thinking" in gamifying everyday activities allows for a broader understanding of gamification in classroom.

Design-Oriented Definition of Gamification

Deterding et al., 2011b elaborate on the design of gaming elements that could be employed to achieve the purpose. A taxonomy of gamification based on the "various levels of abstraction" (p. 12) was proposed. For example, on the most concrete level of game interface design patterns, the presence of common game-related features such as badge, level and leaderboard can be the means to gamify an activity. On more abstract levels, there are game design patterns and mechanics such as utilization of time constraint and limited resources to make the activities more engaging. The game design principles and heuristics further touch on bigger design concepts such as the principle of making the play enduring, making the goals clear and preparing various styles of gaming experiences. On an even more abstract level, game models that can be employed can be associated with fantasy, curiosity or challenges. Lastly, there is the level of game design methods that governs the making process of the gaming design itself, such as using a playtesting method or a playcentric method.

Levels of Abstraction of Game Elements

In brief, there are plenty of gaming elements on different levels of abstraction that may contribute to gamification. Deterding et al., 2011a are also right in indicating that "each of these elements [. . .] taken in isolation, none of them would be readily identified as "gameful" (p. 11). Thus, "'game' is a composite category of multiple necessary conditions" (p. 11). It seems that a good mix of the gaming elements only with an aim to achieve a clear game-related purpose (e.g., increased motivation to participate) is an effective and typical instance of gamification. It is worth noting that while common concrete game elements such as badges, scoring and leaderboard are often used to gamify learning, such elements are not necessary in a gamified lesson, as gamification can occur in a more abstract level by incorporating game design in lesson planning. The cases illustrated in this paper shows how well-designed gaming elements with different levels of abstraction can be applied in classroom setting to engage students and promote learning in the classroom. Both the design (Deterding et al., 2011b) and purpose (Kapp, 2012) of gamification activities are important in conceptualizing gamification in education.

Studies of Gamification in Education

As gamification are increasingly adopted in classrooms, there are numerous empirical studies evaluating the effect of gamification across subjects of study and educational levels (Dichev & Dicheva 2017), as well as extensive discussion on the psychological and theoretical foundation of gamification in different contexts (Krath, Schürmann, and von Korflesch 2021). In a meta-analysis of research conducted on the effect of digital-based gamification using experimental design, Tsai and Tsai (2020) found that students across all educational levels all significantly benefit from game-based science learning. Many recent empirical studies have been done in evaluate the effect of digital game-based learning on learning outcomes across academic subjects such as mathematics (e.g., Deng et al., 2020), physics (Wu et al., 2020), chemistry (Daubenfeld & Zenker 2014) and language learning (e.g., Yang, Lin and Chen 2017). Many of such studies shows that students in the gamification group showed increased attention, positive emotion, or learning motivation compared with the control group, although its effect on academic achievement remains to be debated (Ke et al., 2015). A more recent literature review by Kalogiannakis, Papadakis, and Zourmpakis (2021) also suggested that the use of gamification in education have achieved mixed results with regards to student learning outcome.

Research Gap in Existing Literature

Although the benefit of gamification in motivating student learning is well-established in the literature, many of such research study focused on digital games that are designed for a specific age group and a narrow range of subject content. Hence, such games are not customizable by the teachers, who may be teaching students with characteristics and needs different from the targeted players. For example, the study conducted by Deng et al. (2020) made use of a digital game called Wuzzit Trouble in a Shanghai primary school. The game was developed by the US company BrainQuake to teach basic math concepts and arithmetic operation for third-grade students using a gamified interface. While the student and teacher participants were generally positive about the experience, some teachers commented that the game may not meet the Chinese national curriculum standards and teaching requirements. High quality digital learning games often involve a high cost of development. Although teachers can use those games conveniently off-the-shelf, the lack of customizability of such games entails a tradeoff that some of the games' content may not suit the need of their class. In addition, limitation of the technological equipment was reported as a major obstacle in the adoption of gamification tools (Poultsakis et al., 2021). This leads to the core question to be addressed in this paper: are there other more flexible means of gamification that can be adopted in classrooms to facilitate learning?

METHODS

The present paper looks at gamification in real practice by paying visits to classes in the secondary and primary schools in Hong Kong. The visits were part of a 3-years study supported by the Hong Kong Education Bureau to research on the impact of e-Learning in primary and secondary schools in Hong Kong. Fourteen schools participated in the study, including eight primary, four secondary, two special schools for SEN students. The schools were recruited based on their participation of a government-initiated pioneer project encouraging schools across Hong Kong to adopt eLearning strategies in their teaching. The makeup of the participating schools in term of level of academic achievement is broadly representative of schools in Hong Kong overall.

The full research project is a comprehensive, mixed-method study that aimed at identifying the effectiveness of eLearning using the LEPO (i.e., Learning Environment, Process, and Outcome) framework proposed by Phillips, McNaught and Kennedy (2011). The project employed various research instruments such as collection and comparison of assignment scores, teacher surveys, student surveys as well as classroom observations and interviews with the various stakeholders. The goal of the comprehensive project was to outline the use of technology in teaching and learning in the specific setting and timeframe concerned.

The data relevant to the present paper came from the classroom observations and the follow-up interviews with the teachers conducted between 2016–18. The class observations and the interviews were conducted to observe learning processes, potential challenges and learning outcomes by a professional third-party. A panel of e-learning experts were formed to visit the schools once a year over the 3-year period. Key subjects covered included English, Chinese, Mathematics and/or Liberal Students in secondary schools and English, Chinese, Mathematics and/or General Studies in primary schools. An average of around 30 classroom observations were conducted each year together with the respective follow-up interviews, which were typically conducted shortly after the class was observed. Each classroom observation session lasted roughly between 30 and 45 min and were video-recorded. A structured observation protocol adopted based on Smith et al. (2013) was devised and used by at least two researchers, who marked the protocol independently. Aided by the structured observation protocol, the two observers systematically recorded what the students and teachers were doing in any 5-min time slots. For students, common activities included: listening to teacher, individual thinking/problem solving, working in groups, asking questions etc. For teachers, standard activities included lecturing, real-time writing on board, guiding student work during activie learning task etc. Any discrepancy between the two observers were resolved through discussion. Typically, each classroom has between 20 and 30 students. The teacher interviews were normally conducted on the same day of the classroom observation and lasted between 30 and 40 min. The interviews were audio recorded and then transcribed for later analysis.

The present paper, however, does not comprehensively summarize all the classroom data. Based on the classroom observations, the main purpose of the paper is to find evidence from the data that gamification is in use in the real classroom. Out of all the classroom sessions observed, 13 of them were identified to include substantial elements of gamification. These classroom video recordings and the audio recordings of the relevant teacher interviews formed the empirical basis of this paper. In particular, this paper looks at how different gamification tools can be applied in classrooms to enhance students' learning and attitudinal outcomes? Examples were given to illustrate the many ways of gamification and how they are related to the discussion in the literature. Hence, the purpose of this paper is not to evaluate the effectiveness of the gamification approaches used by the teachers, which has been done by many previous studies, but to identify successful approaches to gamification that can serve as useful references for educators who may develop their lesson plan using similar approaches.

CREATING ENGAGING CLASSROOM ACTIVITIES WITH COMMONPLACE TOOLS

Even though gamification can increase students' learning motivation, there are a number of challenges when it comes to implementing it in classrooms. The complexity of designing an educational game or adopting an existing game for educational use can be a major hinderance for educators. Integrating game elements into existing curriculum require additional effort and expertise from teachers, and the use of

gamification tools can often involve a steep learning curve for teachers and students.

How is gamification being used in the classroom to enhance student engagement? This paper illustrates some examples from our classroom observations in primary and secondary schools. This session discusses some of the effective gamification activities we have observed, with a range of different approaches and digital tools used.

The classroom activities can be broadly categorized into a spectrum of three approaches with varying degree of customizability as shown in **Table 1**.

The gamified activities differ in the type of tools used and the rigidity of the design. "Versatile gamification" refers to a flexible approach of gamification where general purpose, commonplace tools are used to make the learning process more like games; its design can be very versatile, and the user can customize the game flexibly. By contrast, "rigid gamification" refers to single purpose games designed with a narrower set of learning objectives and little room for user customization—often as a part of a publisher-developed interactive content accompanying the textbook. Between the two ends of the spectrum, there is a middle-of-the-road approach that make use of gamification platforms that enable user input of learning content into existing online platforms (e.g., Kahoot! Quizlet) with pre-existing gamified design and interface. The strengths and examples of each gamification approach will be discussed in the sections below.

Using Commonplace Tools to Design Versatile Gamification Learning Experience

Case 1

In a class of Primary five students, the teacher designed a gamified lesson activity using some commonplace, general purpose digital tools. The learning objective was to identify common types of 3D shapes, such as cones and cylinders. Each student was provided with a tablet to take a few pictures of 3D objects they found in the school playground (See **Figure 1**). The students then uploaded the photos they took to the cloud. After the students came back to the classroom, they used a computer to categorize the pictures they took into different types by incorporating the photos into a simple PowerPoint presentation (See **Figure 2**). Students' works were automatically synchronized into the cloud-based learning management platform, and the teacher were able to illustrate the works in class. In another lesson on a related topic, students were asked to create different 3D shapes using the drawing app of tablets. Most students were able to use these commonplace digital tools to complete the tasks.

Implementing a lesson design like the ones described above required much advance planning of the teacher, basic infrastructure (e.g., tablets, stable WiFi) of the school, and technological competency of the students (e.g., using the software). The teacher was able to create an engaging, gamified lesson without the use of specific gamification tools or platforms. Rather, the tools used were all general purpose, commonplace ones such as a tablet for photo taking, cloud-based storage, drawing app, and PowerPoint. By integrating these tools and designing the lesson according to students' ability, the teacher was able to motivate students to complete the learning activity. Although no concrete points or badges were used in this activity, the teacher were able to gamify the learning experience in an abstract level through designing clear goals and time constraints (cf. Deterding et al., 2011a) and create excitement among students by changing the ordinary classroom routine.

The teachers commented in a later interview that students enjoyed viewing the fruit of their own learning (such as the pictures they took). The use of drawing app in for 3D shape also helped to turn abstract shapes into more concrete ones, which was more difficult to accomplish using traditional approach with only pen and paper.

Case 2

Another gamified activity that impressed the research team was in a SEN secondary school. It was a mathematics class and students were told to form into groups of four–five for a shopping role-play game. The teacher gave each student group an envelope with play money and asked the students to visit fast-food websites to plan some shopping for their lunch. The only rule was that they had to make sure they had enough money to pay the food and drink. At the end of the class, they shared what they had "bought", did the calculation in front of the whole class again and explained how much they "paid" (See **Figure 3**).

The researchers in the class observed much excitement and engagement in all the student groups. The students browsed the web pages and did a lot of discussion and calculation to sort out the best way to use their "money". Only very basic technology was needed to make this activity work: just referring students to a real fast-food website. No tailor-made technology was necessary for this activity. It was the addition of the storyline, the inclusion of play money, and the group work setting that made an otherwise common mathematic class on addition and multiplication much more engaging.

Using Gamification Platforms to Create Competition Among Students

Case 3

One commonly used strategy in classroom was to make use of gamification platform to create competition among students to enhance engagement. For example, in a mathematics class of a Primary five classroom we have observed, the teacher made use of Quizlet, an online gamification platform, to make the classroom more fun and engaging. Each student was provided with a tablet in the beginning of the lesson, and the students were randomly divided into groups of three to answer the math questions shown on the tablet. Each group had to answer each multiple-choice question about the area and volumes of certain shapes within a 20-s countdown period. An animated progress of each group was shown in real time on the classroom screen (See **Figure 4**). Each group competed to finish all the questions as quickly and accurately as possible. Some students cheered and jumped up from the chair when their group reached the finish line. After all students have completed the questions, the teacher reviewed students' performance and spent time explaining the questions that were mistaken by a large proportion of students.

In the in-depth interview conducted after class, the teacher said gamification platforms enabled her to set up some questions for students to answer in class. The teacher found that using these

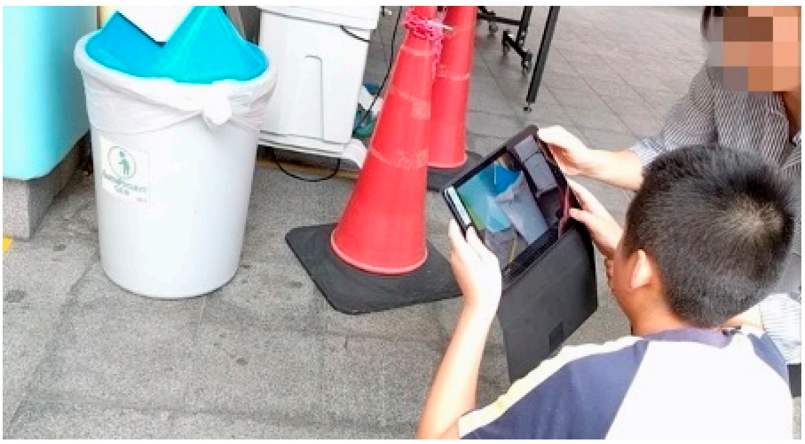

FIGURE 1 | Student took pictures of the shapes observed in school playground, and then incorporated the pictures in a PowerPoint presentation.

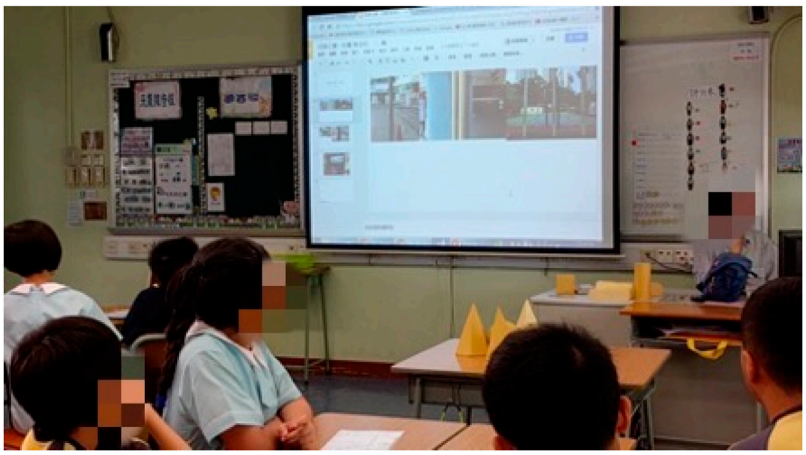

FIGURE 2 | Student took pictures of the shapes observed in school playground, and then incorporated the pictures in a PowerPoint presentation.

platforms helped to make the lesson more interesting to students and create more possibilities for classroom activities. Students felt happy and excited playing games in class using tablets. All the questions were developed by the teachers themselves based on students' level. Since the students' answers can be shown in real time, the teacher can gauge students' understanding of the topic and adjust the lesson accordingly. The gamification platforms have user friendly designs that enabled users to fit in their content easily. The teacher also commented that if tablets are just used as substitute for books, students would not have the same level of engagement—suggesting that the gamified lesson design, rather than the gadget itself, was the decisive factor that motivated student learning.

Using Rigid Gamification Tools to Engage Students Individually

Case 4

In the same Primary five mathematics class, the teacher demonstrated an experimental approach to find out a volume of an object using the water displacement method. The teacher used a real-life container and a jar of water to estimate the volume of an object. Then each student had a chance to try out this approach virtually using their own tablet (See **Figure 5**). Each tablet was pre-loaded with a mini-game designed by the textbook publisher, where students can try their hands on estimating the volume of different objects by doing a virtual experiment. The individual activity lasted for around 10 min. After the students played with the exercise and performed calculations using the tablets, the teacher raised some more challenging questions and invited students to propose new ways to solve them. Students were engaged and were keen on responding to the teacher's questions.

DISCUSSION AND CONCLUSION

Table 2 has a further breakdown of the gaming elements that are associated with the four cases portrayed above. It illustrates game design elements used in the spectrum of different gamification

FIGURE 3 | Students checking up prices in fast food online shop.

FIGURE 4 | Students work in group to compete using Quizlet, with the classroom projector showing each group's progress.

activities, ranging from the more versatile to the more rigid approaches.

Cases 1 and 2 used common technologies such as built-in digital cameras and web browsers and thus did not involve much game interface design patterns as well as mechanics. The gaming elements added to activities were on the more abstract level of rules and game-like psychology. For example, in case 1 the fact that students could go out of the classroom and took pictures everywhere in the school campus broke the everyday routine of a class. The activity aroused curiosity among the students and they enjoyed the adventure involved as they explored the campus hunting for the target shapes. In case 2, game-like psychology was built up by the storyline and the online shopping role-play. The provision of play money further strengthened the students' engagement in the play as it made the story more authentic.

A more sophisticated yet still flexible tool was used in cases 3 with built-in features to achieve gamification, such as an animated scoring board. Each question asked also could have a tight timeframe as the tool kept control of the time. The game-like atmosphere was further strengthened as the teacher introduced new rules and create competition among groups. An even more sophisticated and dedicated tool was used in case 4 to provide the simulations required for students to learn a specific topic. These simulations were topic-specific that the tool was not customizable for teaching other topics. However, it has rich game elements such as attractive aesthetics and animations to engage students. The fact that students may play with it many times to visualize the effect by changing the parameters encouraged students to explore further.

FIGURE 5 | Example of a "virtual experiment" to find out the volume of an object using a tablet.

TABLE 1 | Spectrum of gamification approaches.

	Versatile gamification	*Gamification platform*	*Rigid gamification*
Level of customization	High	Medium	Low
purpose	Can be adapted for a wide range of learning objectives	Flexible range of learning objectives	Single purpose, specific learning objective
Customization of content by teacher	Yes	Yes	No
Design	Very versatile	Flexible with limited format (e.g., multiple choice, short questions)	Rigid
Tool used	Commonplace tools (e.g., camera, calculator)	Gamification platforms (e.g., Kahoot! Quizlet)	Subject specific platforms (e.g., publisher-developed interactive content)
Related examples in the literature	Redesign curriculum content as quest-based game (Kingsley and Grabner-Hagen 2015)	Gamifying lessons using quick quiz software tools (Cheong et al., 2013)	Developing a game to orient new students to library services (Smith and Baker 2011)

TABLE 2 | Game design breakdown in examples.

	Case 1 (Versatile gamification)	*Case 2 (Versatile gamification)*	*Case 3 (Gamification platform)*	*Case 4 (Rigid gamification)*
Game interface design patterns	—	—	Scoring	Trial-and-error
Game design patterns and mechanics	—	—	Time constraint Aesthetic: color	Aesthetic: animation
Game design principles and heuristics	Clear goals	Rules, clear goals	Competition, Rules	Repetition, experimentation, clear goals
Game model	Curiosity, exploration, challenge	Role-play, storyline, challenge	Challenge	Simulation, exploration

Advantages and Disadvantages of Gamification Strategies

There are a few interesting implications based on the findings. For many teachers, versatile gamification can be more feasible and approachable compared with the other two approaches. It is less demanding on the part of the teachers to acquire skills and knowledge to use new computer software. Thus, it is worthwhile for researchers to collect more good strategies that add game elements to common learning resources or activities and then disseminate them to a wide audience of education practitioners.

Nonetheless, there are still many advantages for using gamification platforms and rigid gamification tools. There are ready-made features and content that ordinary learning resources cannot easily achieve, such as the automatic scoring of marks as well as the precise control of time. Game aesthetics is also an important element that enhances engagement. The idea generated from this study is that these activities can be enriched by introducing game elements on the higher levels as well. For example, how about adding a storyline to class exercises apart from merely replying on aesthetics?

Limitation of the Study

The findings of this study are limited by small sample size and scope of the classroom observation. More innovative examples of gamification can be identified from classrooms across other

cultural and educational contexts. Moreover, the effectiveness of gamification strategies was not measured directly in this study, as the current study focuses on the describing learning process more than assessing the learning outcome. Hence, we do not have solid evidence that certain gamification strategies were better or worse than the other in terms of attitudinal or learning outcome. More research is needed to measure the result of various gamification strategies to inform educators about what does and does not work in a specific educational context.

CONCLUSION

Given the rapid development of digital gaming technology, it is a reasonable expectation that future educational games will rise both in sophistication and customizability. Games that are regarded as sophisticated today may be deemed rudimentary in a few years. Games are also likely to become more customizable and easier to develop, as the barrier to acquire the computer programming skills required are lowered over time. Commonly used digital gamification tools in any given time may become obsolete as new technology develops.

Yet the lessons learnt in the cases discussed above will hold true regardless of the level of technological sophistication. Attractive game aesthetic or badges and points are welcomed, though not necessary, features of an engaging gamified lesson. Rather, with some good planning and design on teachers' part, effective gamification can be applied to everyday teaching with remarkable results.

To conclude, gamification is already an approach used in everyday classroom with varied designs and technology. The three types of gamification discussed (versatile gamification, gamification platform, and rigid gamification) are not meant to be exhaustive typology of all possible approaches, but a useful framework for practitioners to consider which approach is best suited to their need. It is hoped that the gamification framework proposed and the examples discussed in this paper will serve as inspiration for educators to integrate game element and design into their lessons. More research would be needed to identify and disseminate good practices of gamification across different educational settings. The good practices should not be defined by the complexity of the technology used but on the learning engagement and learning outcomes generated. In fact, the easier the technology, the easier for it to be adopted by a wider teacher community. More good strategies that lead to engagement and outcomes can be systemically collected and these tips should benefit all types of gamified activities.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Survey and Behavioural Research Ethics Sub-committees, The Chinese University of Hong Kong. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

PL conceived the ideas and key arguments of the article. AT conducted literature review and data analysis. Both authors discussed the results and contributed to the final manuscript.

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