Original Paper

Gamification for Teamwork Skills: Can a Challenge-based Online Tournament Help Students Learn New Knowledge Collaboratively in Teams?

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Abstract

The interest in deploying innovative technologies with gamification to engage student learning in enjoyable style has been growing. This study aimed to investigate whether a purposely designed eTournament with the integration of concepts of gamification and team development could help the participating tertiary education students (N=416) from a variety of backgrounds in terms of culture and discipline to learn to work in teams collaboratively in a challenge-based online game. The qualitative data collected from the top 10 teams' online discussions supported that the thoughtful design of the eTournament did facilitate their development of teamwork skills. In addition, quantitative data collected from two of the Post-game Questionnaire questions indicated that over 79% of the respondents strongly agree or agree that they enjoyed the eTournament in general, and over 84% of respondents strongly agree or agree that they become more aware of the seventeen United Nations Sustainable Development Goals because of the eTournament. Notwithstanding, findings in this study show little evidence in supporting team-playing in PaGamO due to the design of the game regardless of the teamwork skills developed in the early stage of the eTournament. Suggestions to address the limitations of this study are also presented for future improvement.

Keywords

gamification, innovative technologies, multicultural and multidisciplinary, teamwork skills

1. Introduction

With the recent trends of globalization and technology advancement, high level of teamwork skills are commonly required from all graduates to be able to work in a diverse team environment for the workforce in the 21st century. The popularity of adopting digital games not only motivate students to learn in an enjoyable and engaging environment, but they also provide students with the opportunity to learn to work in teams collaboratively (Suh, Wagner, & Liu, 2016). Gamification is the application of game design elements in a non-game context (Deterding, Dixon, Khaled, & Nacke, 2011). The benefits of gamification have attracted the attention of many educators/educational developers in the tertiary education sector to provide learning platforms to learn to work in teams collaboratively. The use of e-tools like Learning Management Systems (LMS) and instant messaging platforms allow virtual team members from different parts of the world to carry out their discussions on given tasks (Powell, Piccoli, & Ives, 2004) online in real-time mode. An eTournament with the adoption of advanced technologies and challenge-based online game was designed in this study with the intention of engaging and motivating student learning to solve current real-world problems (Gibson, 2012) collaboratively in teams which could, in turn, facilitate their teamwork skills. Kiili (2005) suggested that online games could facilitate participants' learning effectiveness, problem-solving skills, and interpersonal interactions. Team, regardless of whether they are face-to-face or virtual, evolve as members learn about each other, resolve conflicts in style and values, and develop trust, cohesion, and shared norms (Bormann, 1990; Tuckman, 1965). Team interactions differ overtime based on a group's stage of development (McGrath, 1991). Virtual team interactions and activities accelerate leading up to interim deadlines (Gersick, 1988). Many studies explained the effectiveness of using gamification to engage and motivate student learning, however, there are few studies to investigate whether integrating the concepts of gamification and team development could help tertiary education students with multicultural and multidisciplinary to learn new knowledge collaboratively in a challenge-based online game platform. The purpose of this study was, therefore, to investigate whether the design of an eTournament with the integration of concepts of gamification and team development could help a number of 416 (N=416) tertiary education students with multicultural and multidisciplinary to develop their teamwork skills through playing a challenge-based online game called PaGamO. All the virtual teams formed in this study had to complete a series of online tasks and training, from strategising to playing by answering questions on the seventeen United Nations Sustainable Development Goals (SDGs) correctly.

Virtual teams, by definition, are teams that are geographically and/or temporally dispersed and are brought together by Information and Communication Technologies (ICTs) to accomplish assigned tasks (Powell et al., 2004). Hence, good use of technology choices are key to developing successful virtual team processes and structure (Maruping & Agarwal, 2004) together with digital games to enhance learning effectiveness, learning motivation, and learning attitudes (Shih, Shih, Shih, Su, & Chuang, 2010).

This study was conducted under a project titled "Developing Multidisciplinary and Multicultural Competences through Gamification and Challenge-based Collaborative learning" ("CCGame Project" in short) which is led by one of the leading liberal arts universities in Hong Kong, in collaboration with three other higher education institutions in Hong Kong as well as a university in Australia. The project is funded by the University Grants Committee of the Hong Kong Special Administrative Region and the leader university, and its aim is to better prepare students to work in multidisciplinary and multicultural teams by deploying gamified learning. The CCGame Project is unique in such a way that the project team adopted a gamified and challenge-based approach with an aim to nurture students' competences to solve global challenges. The seventeen SDGs (https://sustainabledevelopment.un.org/sdgs) proposed by the United Nations were adopted as the theme of collaborative tasks/challenges in this study.

After conducting the first eTournament in early 2019 as a pilot and with reference to the internal review as well as the participant feedback and comments, several enhancements were implemented, and the eTournament was run again in January 2020 by inviting tertiary education students from all over the world. 416 participants from 42 home regions and 37 higher education institutions were recruited and deliberately put into teams of 4-5 by the project team, in which all members were of diverse backgrounds and new to each other. In order to proceed to the different stages of the eTournament, all the virtual teams had to complete a series of online tasks and training in Moodle, from strategising to playing an online game (PaGamO) by answering questions correctly on the seventeen SDGs.

Multiple sources of evidence were used in this descriptive case study (Yin, 1984, p. 23) to interpret the development of virtual teams over a period of 16 days of the eTournament. In this study, qualitative methods such as online chat contents and audio-recorded online discussions were used to allow us to examine events from a holistic perspective as they occurred naturally. These methods are oriented toward discovery and exploration, and lead to the generation of a theory that is thoroughly found from the data (Reichardt & Cook, 1979). The top 10 teams' online discussions collected from their chosen messaging platforms during the eTournament in relation to team building and game strategising (i.e., missions selected; strategies to acquire/attack/upgrade the territory in PaGamO to earn scores etc.) were analysed and the findings were further supplemented with the quantitative data collected from the two selected Post-game questionnaire questions regarding participants' overall impression of the eTournament and their perceived improvement of increasing awareness of SDGs. The four themes categorised from the keyword framework devised for this study are positively coherent with the rationale of designing this eTournament in terms of team building and game strategising. Quantitative results also reviewed that over 79% of the respondents strongly agree or agree that they enjoyed the eTournament in general, and 84% of the respondents strongly agree or agree that they become more aware of the SDGs because of the eTournament. Findings from the qualitative data may offer different views from that of the quantitative one but they should support each other in terms of the study paradigms (Smith & Heshusius, 1986) and such a comparison is useful for establishing validity and reliability (Goetz & LeCompte, 1984) of a study. However, findings in this study showed little evidence in supporting team-playing in PaGamO due to the

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nature of the game design itself regardless of the teamwork skills developed in the early stage of the eTournament. Suggestions to address some limitations found in this study will also be presented for future improvement. The findings in this study provided some useful insights for educators/educational developers who want to deploy similar innovative technologies to facilitate students' collaborative team learning through gamification when they can only meet online.

2. Literature Review

2.1 What is Gamification and Challenging Game-based Learning?

Gamification refers to the use of game elements, such as design techniques, thinking, and mechanics to enhance non-game contexts to engage users with the adoption of information technologies (Khaleel, Sahhari, Wook, & Ismail, 2016, p. 868). Gamification does not require "game playing" in the traditional sense, but it requires the adoption of the reward system of games, where participants receive points, proceed to higher levels, or receive badges for good performance (Deterding et al., 2011). This setting allows participants to experience game-like dynamics to earn rewards (e.g., points and badges), track their performance, set goals, join challenges, and compete with others in the community (Burke, 2014). Wang and Chen (2010) found that challenging games enable students more challenging and engaging in gaming activities. Therefore, the positive impact of using challenge-based approach gamification can improve student's engagement, expanding time working on tasks, and increasing satisfaction/enjoyment with learning (Gibson, 2018; Johnson & Adams, 2010). Suh et al. (2016) reported that gamification could offer a wider variety of solutions that can better motivate students to learn collaboratively instead of individually. Clarke-Midura, Code, Mayrath, and Dede (2012) suggested that digital games and simulations designed for team performance are characterised by integrated, media-rich contexts with multiple layers of interaction with peers as well as computational resources, which provides a foundation for authentic performance of individual and team-based problem-solving processes.

2.2 Gamified Learning Experience

Gamified learning not only offers students enjoyable learning experience but also improves their positive perceptions of the overall game experience if they are able to interact with games effectively as suggested by Klimmt, Hartmann, and Frey (2007). Chen, Wann-Yih, and Dennison (2018) further concluded the enjoyable gamified learning experience is dependent on: (i) how participants feel during game-play; (ii) whether game experience matches the prerequisite and characteristics; and (iii) balance between participants' own abilities/skills and demands of the game-tasks.

2.3 How the Use of Internet Technology Facilitate Virtual Team-Collaboration?

The popularity of using internet technology to connect the world allows immediate responses with constant updates through messaging applications like WhatsApp, WeChat, Skype etc. The immediacy of responses received from the virtual platform can better facilitate discussion and engagement with a constant update (Rozzell et al., 2014). Participants are likely using other platforms like social media more frequently for discussion (Bolton et al., 2013; Lau, Chan, Wong, Kwong, & Gibson, 2019). With the

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support of the advanced technologies to facilitate the online challenge-based gamified learning, students will be motivated by their curiosity and desire to learn more by solving real-world problems themselves individually or as a team (Gibson, Irving, & Scott, 2017).

2.4 How to Develop Students' Teamwork Skills for the Workforce in the 21st Century via Online Game-based Learning?

In view of the globalization, it is important for tertiary education students to develop their teamwork skills for the workforce in the 21st century. The benefits of using online game-based learning can be adopted to facilitate students' teamwork skills development in terms of (i) communication skills; (ii) collaborative skills; (iii) critical thinking skills; and (iv) motivation. Bodnar and Clark (2017) remarked that the use of online game-based learning could enhance students' oral and written communication skills (p. 36) when they worked together for game activities. Bakan and Bakan (2018) observed that participants in the game-based learning environment could work collaboratively to achieve the game goals which created a space where they can freely explain, discuss, and listen to each other (p. 17). Cicchino (2015) suggested that by using game-based learning for problem-solving can effectively facilitate students' higher levels of critical thinking development. Last but not least, Brewer et al. (2013) also suggested that gamification can improve students' motivation when they managed to complete related task activities in a game.

2.5 Adopting Tuckman's Four Stages of Team Development Model for Developing Virtual Team

It is suggested by Tuckman's Four Stages of Team Development Model that teams are developed through the process of four stages, i.e., Stage 1: Forming-team members are concerned with resolving both interpersonal relationships and task activities; Stage 2: Storming-starts when intra-group conflict, arises as team members resist the influence of the team and rebel against the accomplishment of the task; Stage 3: Norming-where in-group feeling and cohesiveness develop, new standards evolve and new roles are adopted; Stage 4: Performing-in which the teams shows proficiency in working together to achieve its goals and becomes more flexible in following their procedures for working together (Tuckman, 1965). If a team can be defined as "any group of people who work together" (Collins, 2020) according to the Collins dictionary, then a virtual team would share more or less the same characteristics. The main difference is the virtual team mainly works in an online environment. It was pointed out by Adams and Adams (1997) that a virtual team would rely on electronic communication tools for task discussions because the members were geographically separated.

3. Background of the Study

The project team organised the first "United Nations SDG International eTournament" in early 2019 with 9 of the 17 SDGs adopted as a pilot run. According to the experience gained and the student feedback collected from the first eTournament, the project team implemented several improvements to the eTournament with all the 17 SDGs adopted, and ran the improved eTournament in January 2020 (the event schedule is shown in Figure 1). There were 3 objectives for the 2020 eTournament, namely to (1)

provide opportunities to students from different parts of the world, who do not know each other before joining the eTournament, to learn to work together as online teams to complete specific tasks; (2) allow the participating students to learn more about the SDGs; and (3) learn about the different cultures and background of their teammates.

Figure 1. Schedule of eTournament 2020

A major concern of forming virtual teams in this eTournament was team-building, as the members of each team were put together by the project team and they did not know each other. With reference to Tuckman's Four Stages of Team Development (Tuckman, 1965), the project team purposely designed the procedure of facilitating diverse virtual team development with the effective use of information technologies. Table 1 below explains how the project team facilitated the virtual team development in each stage of the eTournament in reference to Tuckman's model as mentioned in section 2.5.

Table 1. Development of Virtual Teams for eTournament 2020 with Effective Use of Information Technologies and Online Challenge-based Gamified Learning

4 Stages of Tuckman's Team Development	Development of Virtual Teams for eTournament 2020 with Effective Use of Information Technologies and Online Challenge-based Gamified Learning
Forming	In this orientation phase, the project team formed the teams by: • Taking the role to form virtual teams of 4 or 5 participants rather than by participants themselves to ensure diversity (more details will be given below); • Explaining the details of the eTournament to all participants through the "Welcome Guide";

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	• Encouraging virtual team members to make efforts to know each other via online discussions; • Collecting teams' preferred instant messaging applications (i.e., Skype, WeChat, WhatsApp or Moodle) via discussion forum in Moodle in Stage 1. *Note: Project team has the right to access every team's chosen chat platform for progress monitoring and data collection purposes.*
Storming	In this internal team problem-solving phase, newly formed virtual teams come to know each other better and should be able to: • Identify each team member's strengths and weaknesses in achieving the goals of the eTournament before appointing their respective team leaders through communication over different instant messaging tools as suggested by the project team; • Appoint respective team leaders as the contact point between the team and the project team. He/she also has to manage any conflicts that may arise from within their virtual team members.
Norming	A stage of growth and productivity developed among the virtual teams during a period of 5 days in Stage 1 of eTournament for "Team Strategising". The project team provided concise online training materials on Moodle like understanding culture, teamwork, managing conflicts, a brief guide on PaGamO, for each participant to self-learn themselves in their free time in order to prepare/move the teamsfrom the team development phase to the idea development phase for playing PaGamO online, i.e., team strategising. The relationship of the virtual team members should have strengthened in this stage when they agreed on rules and strategies on how to approach/play the game which in turn should increase their trust with each other as a team.
Performing	A final stage for qualified virtual teams to work together to compete on PaGamO through answering questions related to the seventeen SDGs during a period of 7 days in Stage 2 of the eTournament. Each team was assigned with an SDG and was invited to allocate at least 40 minutes for a detailed synchronous online discussion-the purpose was to allow participants the opportunity to exchange and share each other's own experience and knowledge about the chosen SDG.

A two-stage "strategise-play" approach was adopted for eTournament 2020. Figure 2 shows more details of the 2 stages of the eTournament.
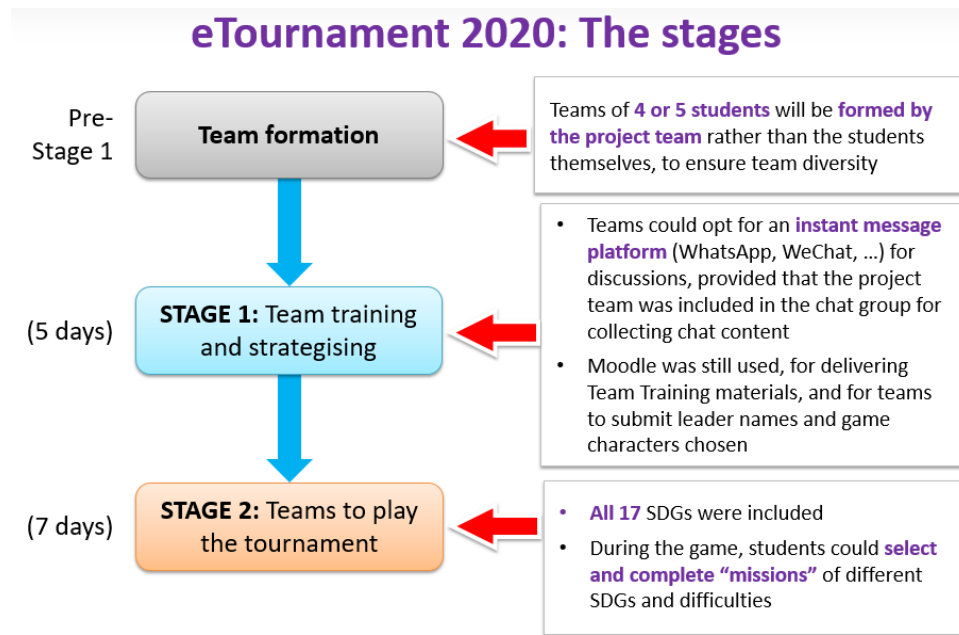
eTournament 2020: The stages

Figure 2. Stages of eTournament 2020

One of the uniqueness of the eTournament was on the team formation. While most competitions require participants to form teams by themselves, it was prohibited in the eTournament. In order to ensure a good mix of students of different backgrounds in a team, teams were formed by the project team. One of the rules followed by the project team in grouping the enrolled students into teams was that there should not be more than 2 students coming from the same institution, even if their home countries/regions were different. At the beginning of the eTournament, 84 virtual teams, of 4 or 5 students per team, were formed among 416 participants.

Moodle was deployed as the portal site of the eTournament, which provided information to the students such as the "Welcome Guide" of the eTournament, for them to complete some of the tasks required, and acted as (for most of the teams) the alternative messaging platform before they chose and moved to their preferred instant messaging platform.

When the students played in Stage 1 of the eTournament (duration: 5 days), they were required to, firstly on the portal site, get to know the teammates and agree on the instant messaging platform to be used during the game (the teams could choose from Skype, WeChat or WhatsApp, or to stay on the Moodle portal site for the discussions). Then, the teams moved to the chosen platform and continued the remaining Stage 1 tasks: (i) to agree on who would be the Team Leader; (ii) to choose the characters to be used in the PaGamO game in Stage 2 to maximise the chance of winning; (iii) to agree on how the team would collaborate (e.g., meeting frequencies); and (iv) to start to work out the team's game strategies for the PaGamO game in Stage 2. When Stage 1 ended, an initial review on the discussions of each team was done to determine the activeness of the participants. All inactive participants were disqualified.

Due to the fact that there were teams with members disqualified, regrouping was done so that the qualified teams in Stage 2 were of more even team sizes. In Stage 2 (duration: 7 days), participants were required to (i) expand/upgrade their territory on PaGamO as much as possible by answering related SDGs questions, (ii) revisit the game strategies discussion done in Stage 1 for adjustments, if necessary. At the beginning of the PaGamO game, a small territory in a virtual world was allocated to each participant by the project team as a start. Participants could (i) acquire the empty slots next to their territories, (ii) attack others' territories next to their territories, and (iii) "train" their own territories for better resistance to attacks. Figure 3 shows the flowchart of playing PaGamO. All the mentioned actions were possible only if they answered the SDG questions correctly.
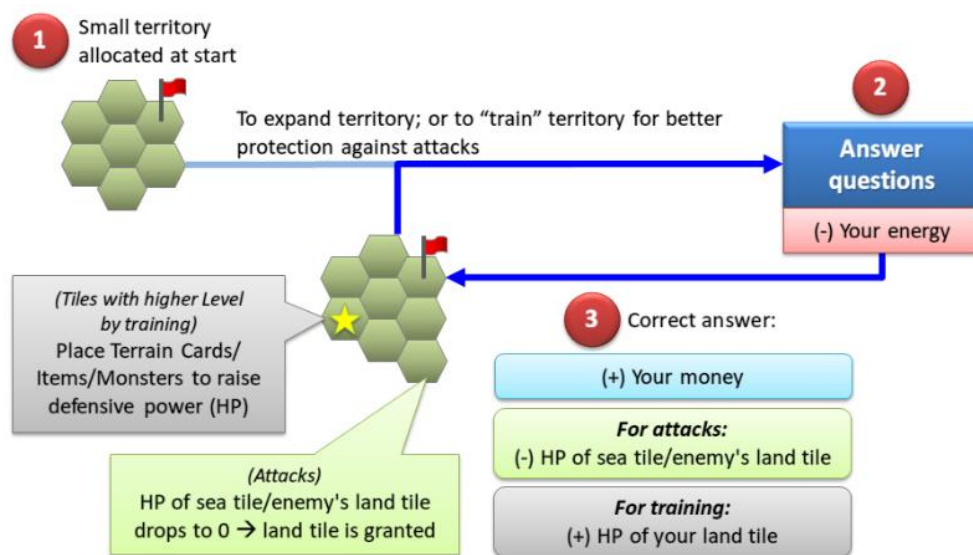

Figure 3. The Game Play of PaGamO

A typical PaGamO game screen is shown in Figure 4. The bigger the territory expanded/upgraded, the higher the score one would get for the game. On playing PaGamO in Stage 2, participants were given a brief guide on how to play PaGamO in Moodle. They could select and complete "missions" of a chosen SDG according to the levels of difficulty (i.e., normal or hard; see Figure 5) for different rates of scoring.

Figure 4. The PaGamO Game Screen

Figure 5. Different Missions for the SDGs

In order to facilitate students to learn more about the different cultures and backgrounds of their teammates, an SDG was assigned to each team, and the teams were invited to spend at least 40 minutes on a synchronous online discussion (Skype or ZOOM were suggested) to discuss on the assigned SDG in more depth, and to submit the recording of the discussion to the project team for a 20% bonus to the team score. To help the teams get started with the discussions, the project team prepared sets of guiding questions for each SDG (see Figure 6).

Figure 6. A Sample of the Guiding Questions for the Synchronous Online Discussions

3.1 Scores and Incentives

The scores of individuals and teams were calculated according to a number of factors, such as the quantity and quality of the discussions done during the eTournament, team members' performance in the PaGamO game in Stage 2 (including the number of correct SDG questions answered, size and level of the land acquired, amount of land upgrades, etc.), and the number of active members on the team. In addition, to motivate students to complete particular activities throughout the eTournament, a number of bonus and penalty scores were set up as incentives. For example, a bonusteam score was given to the teams which completed the synchronous discussion on the assigned SDG, and a penalty was imposed to teams which did not have team leaders.

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Based on the scores, winning teams and individuals were determined, and cash prizes were awarded. The winners were also invited to share their eTournament experience in an online symposium to be organised by the project team in June 2020.

4. Method

4.1 Participants

416 students from 42 home regions (studying at 38 higher education institutions around the world, majoring in different disciplines) registered for the eTournament through open recruitment. 84 teams were formed by the project team as mentioned previously. After Stage 1, inactive students were disqualified and 268 students (64% of the initial number of participants) could proceed to Stage 2 to play PaGamO. Team regrouping was done to the teams with disqualified students, resulting in 59 teams competing with each other on PaGamO in Stage 2. During the eTournament, student discussions were recorded as evidence of participation.

4.2 Data Collection

To obtain performance data of the teams and individual students for scoring, and to better understand whether the eTournament could help participants learn new knowledge collaboratively online, data collection from several sources at different stages of the eTournament was done. Figure 7 illustrates the data taken for the analyses of this study.
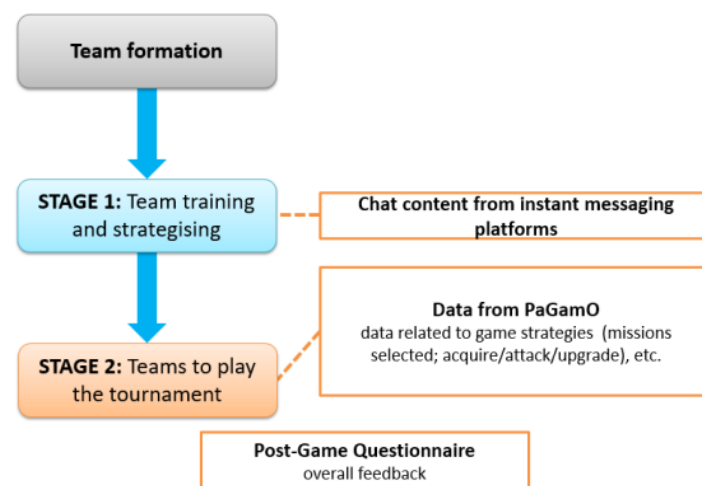

Figure 7. Data Collection in the Study

The focus of this study was on the two types of data collected. The first type of data was the online discussions of the teams. The chat histories of top 10 teams were extracted. The top 10 teams consisted of totally 43 participants with the size of each team ranged from 4 to 5 participants. The chat histories were analysed through the text mining results from Education University of Hong Kong's Bilingual Text Mining System (TMS; http://analytics.ied.edu.hk/tms). One of the core functions of the TMS is to

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"mine" text data by obtaining the occurrence frequencies of specific words against a predefined "keyword framework", which contains categorised lists of keywords and their synonyms (a group of a particular keyword and its synonyms is referred as a "keyword group" in this study). When those text-matching frequencies were inspected by categories, they could be regarded as indicators showing whether students discussed the topics relevant to the various aspects of the eTournament, as well as their extents. In addition, by comparing the keyword occurrence frequencies obtained from the text data collected at different time periods of the eTournament, the changes of discussion foci could be observed. As mentioned above, a keyword framework containing words relevant to the study was required. For this study such a framework was created by adding the keywords anticipated to appear in the online discussions, with further synonyms and related words added according to the observations from the eTournament, thesaurus lookup as well as the Latent Dirichlet Allocation processing provided by the TMS on the discussions collected from all the teams. The keywords were then categorised into four main themes according to the discussion questions set for the eTournament: Team Building (8 keyword groups), Team Leader (5 keyword groups), Collaboration (4 keyword groups) and Game Strategy (13 keyword groups). Please refer to the Appendix for the full list.

In addition to the chat histories of the teams done on the instant messaging platforms, the online discussions analysis also included those on Moodle, on which most of the teams performed initial discussions before agreeing and moving to the instant messaging platforms approved by the eTournament project team. This was to ensure that a more complete picture of the discussions of the target teams were obtained and analysed. The following four text mining exercises (see Table 2) were carried out in order to obtain the occurrence frequencies of the keywords of the four themes mentioned above. Also, by comparing the frequencies in Stage 1 with those in Stage 2, the relevant changes in discussion foci over the course of the eTournament could be observed.

Table 2. The Four Text Mining Exercises

	eTournament Stage 1	eTournament Stage 2
Discussions on team building	1. The discussions on the 3 questions (getting to know the teammates, electing the team leader, and ways to work together) performed in the 5-day Stage 1 of the eTournament	2. The discussions on the 3 questions (getting to know the teammates, electing the team leader, and ways to work together) performed in the 7-day Stage 2 of the eTournament, as well as the 4-day break between the stages
Discussions on game strategising	3. The discussions on game strategies performed in the 5-day Stage 1 of the eTournament	4. The discussions on game strategies performed in the 7-day Stage 1 of the eTournament, as well as the 4-day break between the stages

To better differentiate the discussions on team building from those on strategising, the teams were advised to create two chat groups on their preferred instant messaging platforms, namely "Team Development" (for team building) and "Idea Development" (for strategising) for discussion accordingly. As it servesonly as an advice, it was observed that some teams just performed their online discussions in a single chat group, or some of them discussed on all required topics without observing the nature of the chat groups.

The second type of data analysed in this study was the quantitative data collected from the Post-game Questionnaire for which all the participants who remained active at the end of Stage 2 were invited to complete. The responses to two of the questions in the questionnaire—one asking their "overall impression" of the eTournament and another asking their "perceived improvement of SDGs awareness", with the demographic data of the students (i.e., their levels of study) correlated—will be analysed and presented. The responses to these two questions could serve as indicators showing the effectiveness of the eTournament.

5. Results

Figure 8 shows the keyword occurrence frequency comparison (Stage 1 versus Stage 2) of the discussions related to "Team Development" of the top 10 teams.
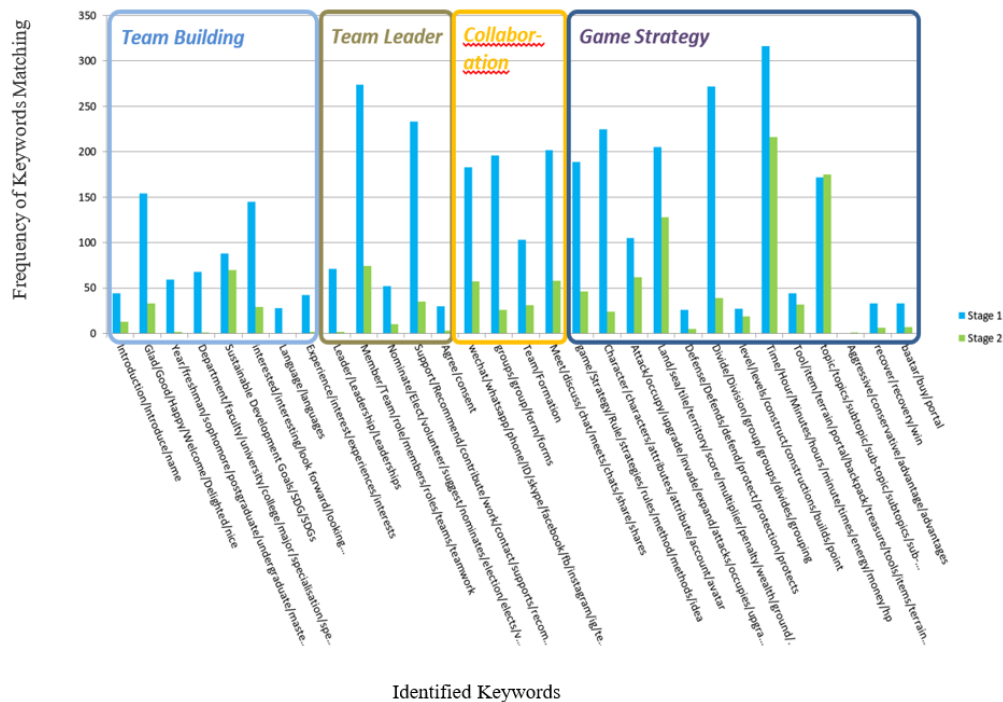

Figure 8. Keyword Occurrence Frequencies of the Discussions Related to "Team Development" of the Top 10 Teams (Stage 1 vs. Stage 2)

As illustrated in Figure 8 (*see the Appendix for the keywords shown on the X-axis*), keywords were grouped under four themes (i.e., Team Building, Team Leader, Collaboration and Game Strategy) with their respective occurrence frequencies found in Stage 1 and 2 of the eTournament upon the online discussions in relation to team development. It was observed that the winning teams did a lot of discussions on team building in Stage 1 than Stage 2; moreover, from the keywords matched, the discussions were seemed to cover not only team building but also the game strategies. This may reflect that winning teams wished to be better prepared for the game by communicating with each other and discussing related strategies on playing PaGamO which involved their interpersonal communication, problem-solving and critical thinking skills to come up with a common consensus in achieving the goals of the eTournament.

Furthermore, Figure 9 shows the keyword occurrence frequency comparison (Stage 1 versus Stage 2) of the discussions related to "Strategising" of the top 10 teams.
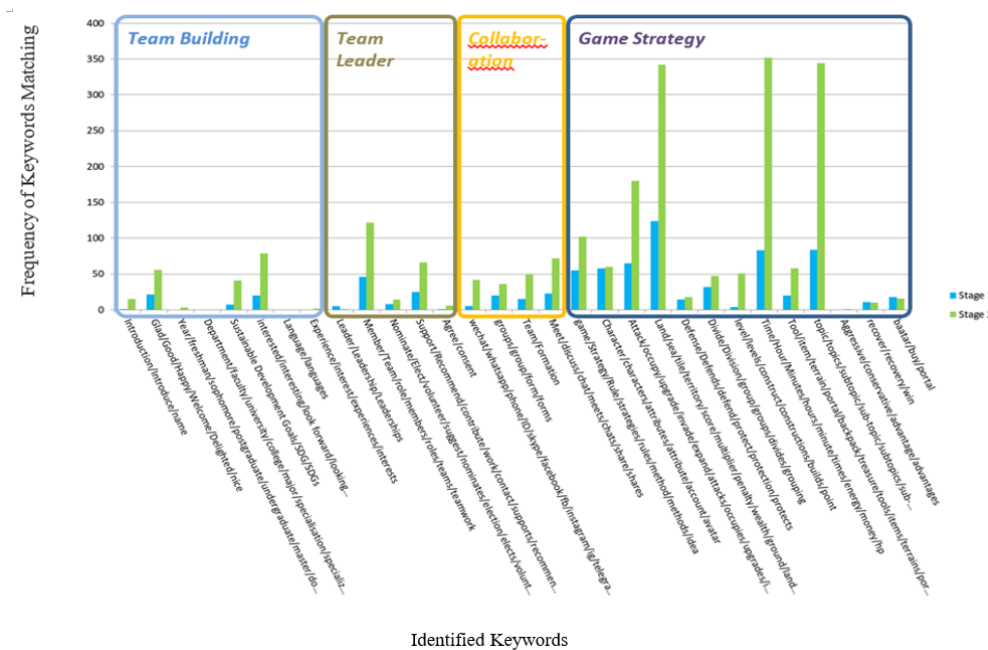

Figure 9. Keyword Occurrence Frequencies of the Discussions Related to "Strategising" of the Top 10 Teams (Stage 1 vs. Stage 2)

According to Figure 9 (*see the Appendix for the keywords shown on the X-axis*), there were more discussions on game strategies in Stage 2 than Stage 1, which is expected, and that the discussions focused on the strategies rather than team building. This observation has reflected that the winning team members placed much of their attention on strategising for the game in Stage 2, as they may regard their team building had finished. These game-winning behaviours seem to be a result of enjoying the challenges (Wang & Chen, 2010) provided by the game which appears to contribute to the success of the teams. However, no team-playing evidence was recorded in playing PaGamO.

In addition, the four highlighted themes shown in Figure 8 and Figure 9 fully match with the rationale of team development as suggested by Tuckman (1965) that the project team adopted in developing the virtual teams of eTournament 2020 with the use of information technologies as described in Table 1. These findings appear to provide positive support to the right approach that the project team adopted for this study.

Overall impression and perceived improvement of SDGs awareness and the level of study of the participant students

286 participants who were qualified to proceed to Stage 2 of eTournament were invited to respond to a Post-game Questionnaire, in which there are two questions about their "overall impression of the eTournament" and their "perceived improvement of SDGs awareness" respectively:

Q1. In general, I enjoyed playing this eTournament

Q2. I become more aware of the United Nations Sustainable Development Goals because of this eTournament

(Both Questions are on Likert Scale, i.e., 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)

162 out of 268 responses (60%) were received, which included 10 sub-degree student participants, 112 undergraduate student participants, 28 master degree student participants and 12 doctoral student participants. The results are shown in Table 3 below.

Table 3. Mean and Standard Deviation of Participants' Overall Impression of the eTournament and Perceived Improvement of Increasing SDGs Awareness (N=162)

Question Items	Level of Study	N	Mean	SD
Q1: In general, I enjoyed playing this eTournament	Sub-degree	10	3.7	1.16
	Bachelor's degree	112	3.99	0.935
	Master degree	28	4.18	0.772
	Doctoral degree	12	4.17	0.718
	Total	**162**	**4.02**	**0.909**
Q2: I become more aware of the SDG	Sub-degree	10	3.4	1.265
	Bachelor's degree	112	4.283	0.808
	Master degree	28	4.32	0.819
	Doctoral degree	12	4.42	0.793
	Total	**162**	**4.24**	**0.862**

In general, most participants enjoyed the eTournament with a mean value of 4.02 (M=4.02) and agreed that the eTournament had raised their awareness of the SDGs with a mean value of 4.24 (M=4.24). The results also indicate that participants from undergraduate and postgraduate degree levels tended to favour with a higher rate, while the sub-degree level of participants had given lower rates in both "overall impression" of the eTournament and "perceived improvement of SDGs awareness". While the sample size is rather small, it seems to indicate that the gamification through eTournament had more impact on participants with higher academic study level as it required a certain level of self-motivation and self-learning skills towards game-playing.

In summary, the overall impression of this eTournament, **79%** of the respondents strongly agree or agree that they enjoyed the eTournament in general, and **84%** (see Figure 10) of the respondents strongly agree or agree that they become more aware of the SDGs because of the eTournament.
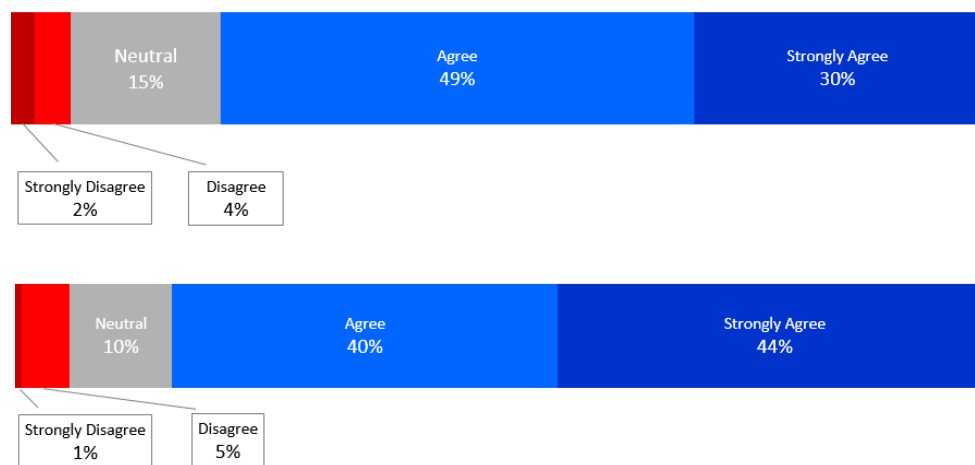

Figure 10. Charts Showing the "Overall Impression" of the eTournament (top) and the "Perceived Improvement of SDGs Awareness" (bottom) of the Respondents (N=162)

6. Discussion

Under the model of Tuckman's Four Stages of Team Development (Tuckman, 1965), this study was designed in such a way to foster a number of 416 international tertiary education students of diverse backgrounds to learn to work in teams collaboratively (Suh et al., 2016) through playing a challenge-based online game (PaGamO) by answering questions on the seventeen SDGs. A series of online tasks and training was designed to prepare participants to understand the necessary team building concepts like team communication, collaborative teamwork, problem-solving and critical thinking, and how to play PaGamO. Findings revealed that 79% of respondents enjoyed and engaged in the challenge gaming activities (Wang & Chen, 2010) designed in the eTournament because of their good feeling of playing the game that matched the game prerequisite and their ability to handle the demands of the game-tasks as suggested by Chen, Wu and Dennison (2018). 84% of the respondents become more aware

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of the SDGs (see Figure 10). The reward system adopted in the eTournament required participants to complete the mandatory online tasks/training before they were qualified to move up stages and earn scoring as explained in section 3.1 for good performance, this kind of setting allowed participants to experience game-like dynamics as suggested by Deterding et al. (2011). Different data analyses were carried out onto the online discussions of the top 10 teams, as described in section 4.2. The four themes according to the discussion questions set for the eTournament, namely Team Building, Team Leader, Collaboration and Game Strategy were closely followed the design strategy of the eTournament for fostering the team development of the virtual teams under the model of Tuckman's Four Stages of Team Development (Tuckman, 1965) as described in Table 1. Below are the observations made from Figure 8 regarding the keyword occurrence frequencies of the discussions related to "Team Development" of the top 10 teams.

- At the beginning of the eTournament, the team members were new to each other, and the winning team members spent a lot of time on discussing team-related issues (i.e., team building) and game strategies in Stage 1 than in Stage 2 under the provision of ICTs and e-tools (Powell et al., 2004) to communicate with each other. The use of these e-tools like instant messaging could enhance virtual team's ability to interact and create a strategic advantage (Razmerita, Kirchner, & Sudzina, 2009) online with instant responses.

- Winning team members seemed to demonstrate their interpersonal communication, problem-solving and critical thinking skills when discussing with their virtual teammates to come out with a common consensus in achieving the game goals (i.e., team's game strategies) of the eTournament in Stage 1.

- With the better understanding of the goals of the eTournament after completing a series of online tasks and training, the winning team members spent more time on discussing the best candidate among themselves to be the respective team leaders under the theme of "Team Leader" in Stage 1 than in Stage 2.

- Once team members developed trust and the winning team members spent more time on discussing how to collaborate with each other for playing the game in Stage 1 under the theme of "Collaboration" than that of Stage 2.

- It was observed that the virtual teams spent a significant amount of time in discussing game strategies in Stage 1 than in Stage 2 under the theme of "Game Strategy" which appears to contribute to their success in playing the game.

Further observations were made from Figure 9 regarding the keyword occurrence frequencies of the discussions related to "Idea Development" of the top 10 teams are described below.

- The frequencies show that the members of the winning teams spent a lot of time on discussing game strategies and very little in team-related matters in Stage 2 as participants mainly focused on strategies how to play PaGamO in order to earn more score and neglected the team playing element.

- The PaGamO game is designed for individual players rather than teams. Despite the fact that team members' scores would be combined as the team's score, it was observed that participants played the challenges of PaGamO by themselves.

  Not much teamwork skills nor game strategising they discussed in the early stage of the eTournament could apply in playing PaGamO in Stage 2. There was no record of recording team playing pattern.

7. Conclusion

In summary, the study indicated that a thoughtful design of the eTournament by integrating the concepts of gamification and the four stages of Tuckman's Team Development Model as explained in Table 1, could facilitate participants from multicultural and multidisciplinary to learn to work in teams collaboratively in a challenge-based online game. In addition, the eTournament had provided game-like dynamics (Burke, 2014) for participants to earn rewards like scores, prizes as described in section 3.1 which seemed to motivate their participation as reflected by the number of 268 out of 416 participants qualified to proceed to Stage 2 of eTournament to play the challenging game of PaGamO. From the evidence presented in the previous sections, many participants seemed to be able to learn to work in virtual teams collaboratively through the different stages of the eTournament with increasing enjoyment in learning new knowledge (Gibson, 2018; Johnson & Adams, 2010). By relating the results obtained from Post-game Questionnaire, requiring participants to answer SDG-related questions on the challenge-based gamified learning platform PaGamO seemed to promote their awareness of the issues relevant to the SDGs. The analysis results of this study appear to show that the provision of information technologies and etools in the study greatly facilitate participants' teamwork skills as explained previously. In addition, gamification via challenge-based learning could enhance student's learning by offering a more enjoyable and motivating experience at the individual level as well as at team level if the game was designed in a team-playing style. Furthermore, it could be seen that the teamwork skills developed at the early stages of the eTournament facilitated participants' interpersonal communication, collaborative learning and team-based problem-solving skills which are all important teamwork skills for the 21st century. Therefore, this study concludes that the adoption of challenge-based online game could help students from multicultural and multidisciplinary to learn new knowledge collaboratively in teams to some degree, which in turn facilitated their teamwork skills development. These are encouraging results from the thoughtful design of the eTournament.

8. Limitations

Despite the positive and supportive findings found in this study, no record or evidence of team-playing game was found due to the design of PaGamO as it was a very much an individual-playing game and data collection for team-playing was therefore missing. Moreover, more specific teamwork elements could be incorporated/built into the team-playing game design for direct data collection from the game

itself. Last but not least, the period of time for team development could be longer to allow team members more time to develop their trust and confidence in working together as a virtual team for achieving higher game performance. A period of 16 days designed for this eTournament was rather short. These limitations could be used as tips for future improvement if a similar design will be used to engage and motivate student learning through online gamified learning in the tertiary education sector where international students can only meet online.

Acknowledgement

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Appendix

Keyword framework for this study

Identified Themes	Keywords Matching
Team Building	introduction/ introduce/ name
	glad/good/happy/welcome/delighted/ nice
	year/freshman/sophomore/postgraduate/undergraduate/master/doctor/doctoral/associate degree/bachelor degree/certificate/diploma/degree
	department/faculty/university/college/major/specialisation/specialization
	sustainable development goals/sdg/sdgs
	interested/interesting/look forward/looking
	forward/expect/expectation/expects/hope/hopes/wish/wishes/friend/friends/together/altogether/anticipate
	language/ languages
	experience/interest/experiences/interests
Team Leader	leader/leadership/leaderships
	member/team/role/members/roles/teams/teamwork
	nominate/elect/volunteer/suggest/nominates/election/elects/volunteers/suggests
	support/recommend/contribute/work/contact/supports/recommends/contributes/works/contributions/contribution
	agree/consent
Collaboration	wechat/whatsapp/phone/id/ skype/facebook/fb/ instagram/ig/telegram/tg/messenger/line
	groups/group/form/forms
	team/formation
	meet/discuss/chat/meets/chats/share/shares
Game Strategy	game/strategy/rule/strategies/rules/method/methods/idea
	character/characters/attributes/attribute/account/avatar
	attack/occupy/upgrade/invade/expand/attacks/occupies/upgrades/invades/invasion/expands/expansion/assault/assaults
	land/sea/tile/territory/score/multiplier/penalty/wealth/ground/lands/seas/tiles/territories/scores/multipliers/penalties/
	defense/defends/defend/protect/protection/protects
	divide/division/group/groups/divides/grouping
	level/levels/construct/constructions/builds/point
	time/hour/minutes/hours/minute/times/energy/money/hp
	tool/item/terrain/portal/backpack/treasure/tools/items/terrains/portals/backpacks/treasures/resources/resource
	topic/topics/subtopic/sub-topic/subtopics/sub-topics/question/questions/answer/answers
	aggressive/conservative/advantage/advantages
	recover/recovery/win
	baatar/ buy/ portal

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