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

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
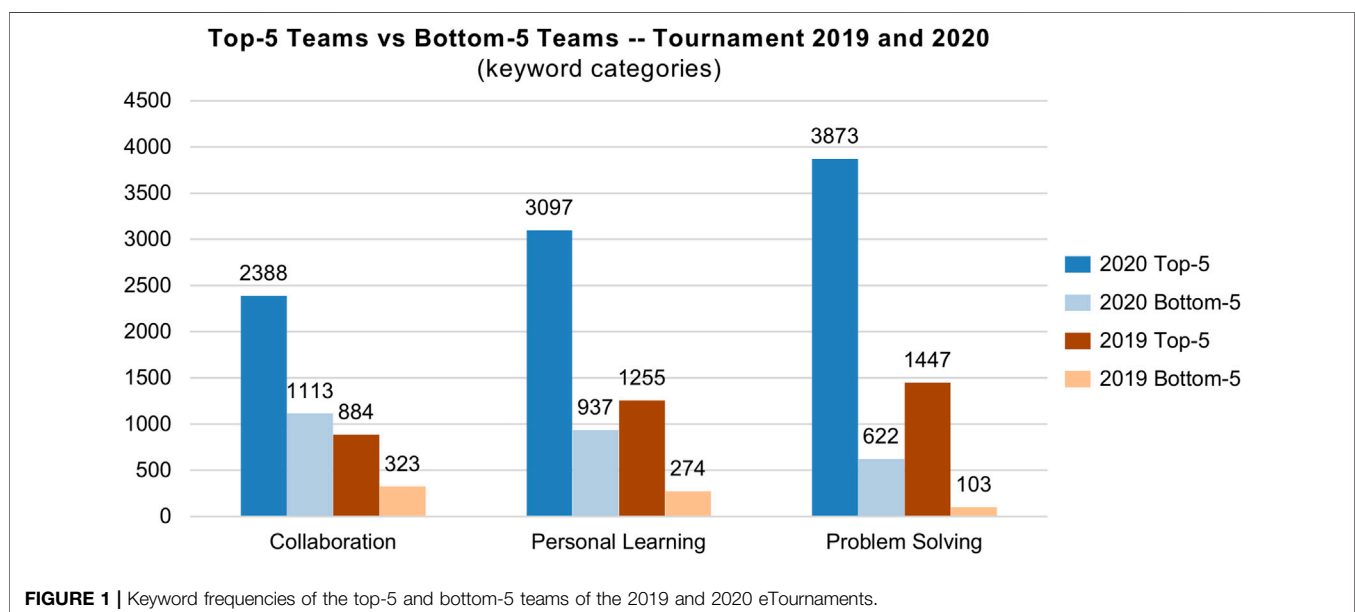

FIGURE 1 | Keyword frequencies of the top-5 and bottom-5 teams of the 2019 and 2020 eTournaments.
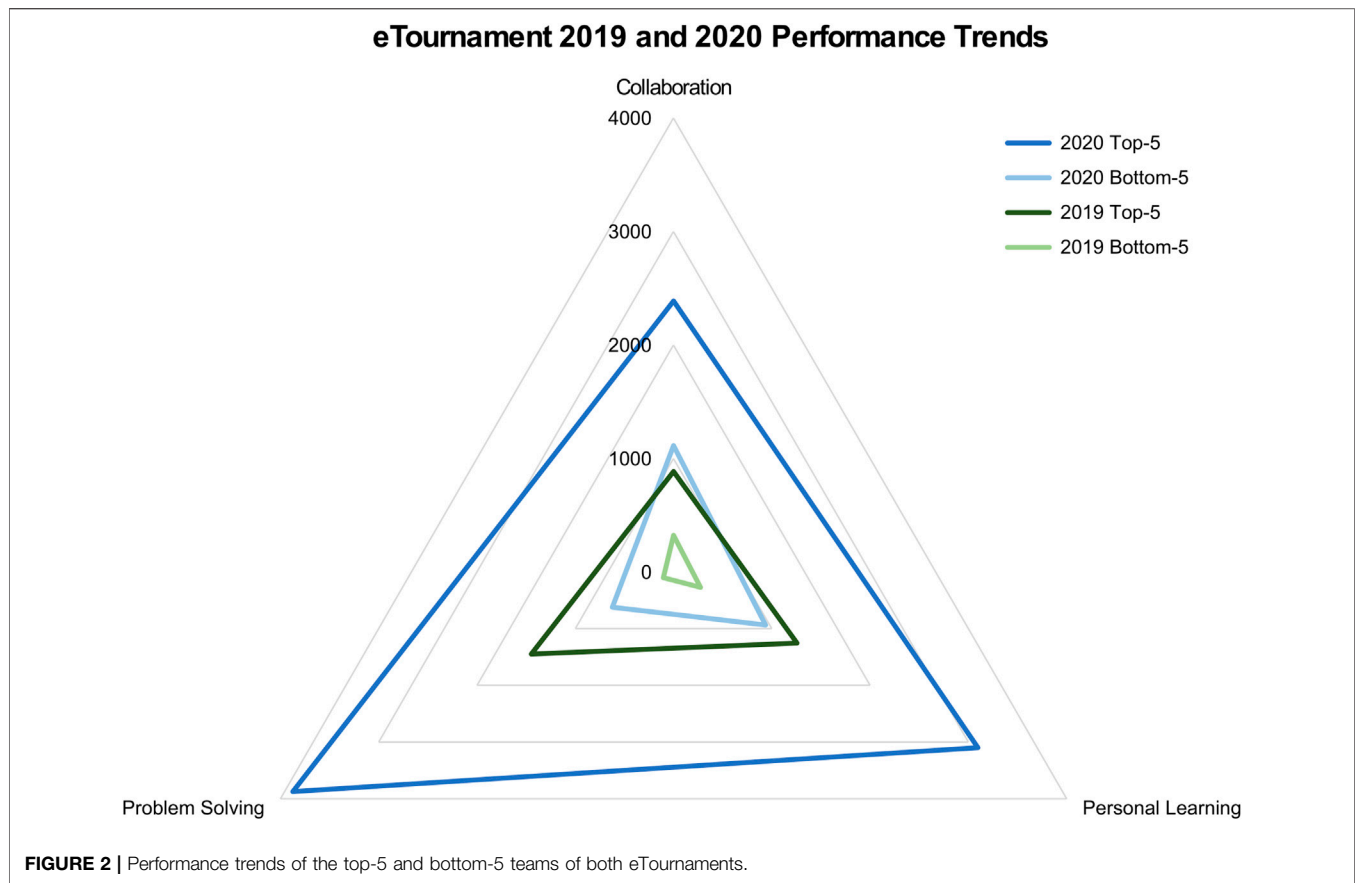
FIGURE 2 | Performance trends of the top-5 and bottom-5 teams of both eTournaments.

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

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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