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Assessing negotiation skill and its development in an online collaborative simulation game: A social network analysis study

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Abstract

Simulation games are widely used to teach negotiation skills in political science education. However, existing studies focus on the impact of simulation games on students' knowledge gains and affective changes and largely ignore skill assessment and development in the gaming environment. This study aimed to understand the process of student groups practicing negotiation skills in a collaborative simulation game through social network analysis (SNA). We proposed a conceptual framework to assess negotiation skills by identifying different negotiation skillsets based on participatory roles in collaborative learning, investigated the skill development through the change of the skillsets over time, and examined the relationship between the negotiation skillsets and achievement. The results showed that the majority of student groups practiced more complex negotiation skillsets towards the end of the game, and the complexity of skillsets was positively related to the negotiation outcomes in the simulation game. The study demonstrated the possibilities of using SNA as an analytical tool to measure negotiation skills and explore dynamic skill development in a collaborative simulation game. It has also shown the potential of integrating SNA in a collaborative gaming environment for automated analysis of a large volume of data concerning interactions.

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KEYWORDS
collaborative simulation game, political science education, skill assessment, social network analysis

Practitioner notes

What is already known about this topic

- Simulation games are widely used to teach negotiation skills in political science education to improve the connection between theoretical knowledge and skill practice.
- Existing studies focus on the impact of simulation games on learners' knowledge gains and affective changes but ignore the skill assessment and development in the gaming environment, especially in the collaborative simulated gaming environment.

What this paper adds

- The study investigated the process of student groups practicing negotiation skills in a collaborative simulation game through Social Network Analysis (SNA).
- We proposed a novel conceptual framework to measure negotiation skills by identifying different negotiation skillsets through connecting them to learners' participatory roles that emerged during the collaborative gameplay.
- The study demonstrated learners' dynamic and evolutionary process of practicing negotiation skills in the game.
- The results showed that there was a positive relationship between the complexity of negotiation skillsets and negotiation outcomes in the game.

Implications for practice and/or policy

- The study demonstrates the possibilities of using SNA as an analytical tool to measure negotiation skills and explore dynamic skill development in a collaborative gaming environment.
- The results can guide teachers to identify risky game moves and students in need and provide personalized feedback to help improve students' negotiation skills.
- The findings can help teachers optimize the game design to ensure students' equal and active participation in the game.
- The study highlights the potential of integrating SNA in collaborative gaming environments for automated analysis of a large volume of data concerning interactions.

INTRODUCTION

In the age of globalization, negotiation skills are becoming increasingly crucial across various fields such as political science, health care, business, and economics (Anastakis, 2003; Beenen & Barbuto, 2014). In the field of political science, negotiation skills are a significant tool to find peaceful solutions to conflicts of antagonistic interests and a key component of building longstanding relationships among governments and organizations (Pfetsch, 2007). The teaching of negotiation skills thus attracts growing attention in political science education. Traditionally, negotiation skills are taught using the lecture-discussion method based on textbooks and case studies. However, the method is often challenged by the disconnection between theoretical knowledge and skill practice (Sus & Hadeed, 2020).

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Students struggle to see the relevance of abstract political concepts in their lives and have difficulties acquiring the necessary political negotiation skills. To address the challenge, experiential learning is promoted to teach political negotiation skills because it places experience as a central part of the learning process where “knowledge is created through the transformation of experience” (Kolb, 2015, p. 49). Students in the experiential learning classroom are often involved in collaborative and rich-context problem-solving tasks that help them connect theory with practice to understand how politics work and engage them in skill acquisition and development (Coker et al., 2017; Fernández-Soria, 2013).

Simulation games are considered the most popular and effective form of experiential learning currently used in political science education (Baranowski & Weir, 2015; Raymond & Usherwood, 2013). A few studies show that the simulation games or activities used in the classroom significantly improve students' political knowledge acquisition (Levin-Banchik, 2018) and enhance their satisfaction (Lay & Smarick, 2006). However, existing research mainly focuses on students' knowledge gains and affective changes, and largely ignores the evaluation of skills in simulation games such as assessing skill performance and measuring skill development. Since a unique benefit of simulation games is to engage students in skill practice, it is crucial and necessary to understand what specific skills students have utilized in the simulation games, whether selected skills are appropriate and effective to solve problems in the simulations, and whether there is a change in the selection of skills over time.

This study aimed to explore how student groups practiced negotiation skills in a collaborative simulation game used in a graduate-level political science course. Specifically, we employed social network analysis (SNA) to assess negotiation skills and examine the skill changes over four rounds of the simulation game. We then conducted statistical analysis to investigate the relationship between negotiation skills and the outcomes achieved in the game. This study makes several contributions to both literature and teaching practice. First, we propose a conceptual framework that allows the assessment of negotiation skills through SNA. Second, we demonstrate the dynamics of student groups' skill practice over time in the game. Third, we provide insights into the relationship between negotiation skills and achieved outcomes. Finally, based on the findings, we make instructional and game-design suggestions to improve students' skill acquisition and development.

In the following section, we start with the review of literature related to political negotiation skills, the benefits of using simulation games to teach the skills and the connection between learning analytics and skill assessment. We then discuss the use of SNA as an appropriate learning analytics tool to assess negotiation skills in simulation games. The theoretical background ends with our proposed conceptual framework that explains how we map participatory roles onto negotiation skills in collaborative simulation games. We continue with the description of the methodology and the explanation of the results. The paper ends with a discussion of the findings and offers theoretical and instructional insights into using simulation games for teaching negotiation skills.

THEORETICAL BACKGROUND

Simulation games for teaching political negation skills

Negotiation in politics is “a practice in which individuals, usually acting in institutions on behalf of others, make and respond to claims, arguments, and proposals with the aim of reaching mutually acceptable binding agreements” (Martin, 2013, p. 1). Negotiation skills are essential in politics because they are often applied in complex and high-stake social interactions or decision-making processes (Council et al., 2008). Successful political negotiators have “a strong integrative mindset [and] automatically approach negotiations in a collaborative,

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curious, and creative manner, seeking to create value and reach deals in negotiations that all parties will want to implement" (Ade, 2019, p. 363). In contrast, poor negotiators focus on their personal benefits with little or no concern for the others and tend to have less political influence (Hall, 1992). Chapman et al. (2017) proposed three negotiation skillsets—*distributive*, *integrative*, and *adaptable negotiation*. *The distributive negotiation* skillset has a win-lose focus. It emphasizes negotiators' own benefits and utmost short-term negotiation outcomes without much concern for other parties in the negotiations. The *integrative negotiation* skillset aims to solve problems in the negotiations, so negotiators are more involved in information exchange and interest discussion and target mutual gains for both parties. The a*daptable negotiation* skillset reflects the growth of negotiators who learn over time which negotiation skillset is effective in specific contexts and adjust their negotiation skills to obtain optimal negotiation outcomes. Chapman et al. (2017) argue that the three negotiation skillsets fundamentally differ from the amount of exchanged information and the primary concern in terms of negotiation outcomes (ie, self vs. both parties), and the complexity of the skillsets increases as one moves from the *distributive*, to *integrative*, to *adaptable negotiation* skillset.

While the focus of the above lies on individual negotiators, negotiation teams—often called delegations—are very common in political negotiations, as teams are seen as preferable when negotiations are complex, take place in international contexts, and involve multiple constituents, communities, cultures and relationships (Brodt & Thompson, 2001; Shonk, 2022). Although negotiating in teams or groups has its own set of challenges compared to individual negotiators such as coordination, intra-groups dynamics and potentially diverging views, the fundamental distinction of different negotiation skillsets, especially *distributive* and *integrative* negotiation, still holds on at the group level, because "many processes uncovered in interpersonal negotiation also apply to negotiations involving three or more parties" (De Dreu, 2010, p. 1007). Research has shown that the combination of skills and division of labor in negotiation teams results in a group performing better than a single negotiator (Hill, 1982; Sally & O'Connor, 2004). For example, Brodt and Thompson (2001) found that negotiation teams were more likely to result in an *integrative* negotiation due to their ability to avoid biases, analyse information and generate creative ideas for potential solutions. Thompson et al. (1996) concluded that negotiation teams tended to achieve higher joint gains through the enhancement of information exchange and accuracy in judgements. Moreover, much of the literature on political negotiation makes little distinction between the individual negotiator and negotiation in groups. For example, Ade (2019) refers to negotiators as either individual negotiators or groups negotiating without explicitly distinguishing the two. Similarly, Martin (2013) considers individual negotiators and groups without distinction and simply refers to "parties" in the political negotiation. The prevalence and benefits of negotiation teams make it highly relevant to assess the negotiation skills employed by student groups and investigate the skill development in a simulation game.

Negotiation skills are traditionally taught through a mix of lectures and case studies, which allow students to imaginatively occupy the role of the protagonists to interrogate certain political decisions. While the traditional teaching method may help students draw meaningful connections between abstract theory and concrete practice, they are unable to "feel the weight" and take ownership of the decisions (Perry & Robichaud, 2020) and receive personalized feedback to understand how to improve their negotiation skills (Conley Tyler & Cukier, 2007). To address the challenges, simulation games are introduced in teaching negotiation skills, such as the ubiquitous Model United Nations (United Nations, 2022). Political simulation games often provide immersive learning scenarios where individual students and student groups can experience situations that are foreign to their lives, solve "authentic" political problems through active negotiations and communications with peers, and "see" the consequences of both individuals' and groups' decisions and actions (Coffey et al., 2011; Frank & Genauer, 2019). They can also experiment with different negotiation

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skillsets in the simulation games without fear of making mistakes (Cicchi et al., 2021; Lee & Hammer, 2011). More importantly, students and student groups can receive meaningful feedback on their performance in the simulation games to reflect on misunderstandings, identify areas of improvement, and transfer learning to new educational contexts (Erhel & Jamet, 2013; Raymond & Usherwood, 2013).

Despite the rising interest in using simulation games to teach political negotiation skills, there is a lack of research investigating how students and student groups practice negotiation skills in simulation games. The majority of existing studies focus on students' knowledge gains and affective changes in simulation games. For example, Schollmeyer (2006) found that students demonstrated an improved understanding of complicated political issues such as peacekeeping, military combat, and the training of first respondents through playing simulation games. Giovanello et al. (2013) showed that students were more enthusiastic and perceived more educational values in the class that used simulation games. Only a few studies paid attention to students' skill practice in simulation games. For instance, Brunazzo and Settembri (2012) observed that students who participated in a group-based debating simulation game developed a list of meta-skills such as researching, organizing, presenting, negotiation, and teamwork. A unique benefit of simulation games is to allow students to experiment with different negotiation skills without fear of making mistakes in "authentic" political conflicts. Therefore, it is crucial and necessary to understand how students practice negotiation skills in simulation games, for example, which negotiation skillsets students have used to solve simulated problems, whether there is a change in the negotiation skillsets over time, and whether the use of a specific skillset impacts negotiation outcomes in the game (ie, students' achievement). Dynamic and real-time log data captured in the digital game environment provides possibilities to unveil the process of the negotiation skill practice.

The intersection of learning analytics and assessment

The use of data about learners and their contexts for understanding and optimizing learning and the environments in which it occurs has been the focus of the field of learning analytics (Dawson et al., 2014; Long & Siemens, 2011). The majority of learning analytics studies tend to harvest and analyse student-generated data from Learning Management System (LMS) platforms to investigate the potential benefits of learning analytics on students' learning including the prediction of student learning success (Jovanović et al., 2021; Tempelaar et al., 2013) and the enhancement of skills such as communication skills (Ochoa et al., 2018) and self-regulated learning and reflection skills (Gašević et al., 2014). Some research also utilizes learning analytics to track learning progression and inform assessment. For example, Milligan and Griffin (2016) proposed an assessment instrument based on log stream data in Massive Open Online Courses (MOOCs) to measure the "crowd-sourcing learning" (C-SL) capability. The instrument suggests a capability continuum of expertise and classifies MOOC learners into five levels, ranging from novice to expert. The proposed C-SL assessment tool provides a systematic framework for improving higher order learning and the design of MOOCs.

Despite many promises in linking learning analytics and assessment, there is a dearth of research that explores the connection between data and methods from learning analytics and formal assessment (Gašević et al., 2022). One of the fundamental challenges is the validity of data collection and analysis in learning analytics (Gašević et al., 2015). Data used in learning analytics are not always purposefully collected for assessment. For instance, students' behavioural data such as frequencies of posting, viewing, and commenting is often questioned as meaningful indicators of learning in an online forum. Milligan (2015) argued that forum activities "do not in and of themselves generate learning, but skilled learners are

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adept at using them in particular ways to generate learning" (p. 152). Winne (2020) emphasized the critical role of theory in deciding what trace data should be gathered and how the analysis of the trace data can improve learning. Therefore, guided by the theoretical framework of the skill to be measured, it is possible to map patterns of students' activities onto the hypothesized latent skill, and this mapping can be used to infer an individual's skill levels (Milligan, 2018; Winne, 2020).

The connection between game learning analytics and skill assessment

The application of learning analytics in digital game environments has recently emerged in a new field named game learning analytics (GLA), which refers to "the collection, analysis, and extraction of information from data collected from serious games" (Alonso-Fernandez et al., 2019, p. 2). Based on in-game user interaction data, GLA research aims to provide insights into students' learning experience using games and validate and improve game designs and pedagogical interventions (Freire et al., 2016). The most prevalent topic in GLA research is that of learner performance. Some studies focused on using in-game raw log data to predict students' success (Baker et al., 2016), while the other studies employed behaviour profiling techniques to cluster students into novice or expert groups to infer their performance (Loh & Sheng, 2015). Given the great potential of using games to train skills, a few recent studies have used learning analytics methods to assess skills in the gaming environment. For example, Rowe et al. (2021) designed automated detectors based on digital log data generated in gameplay to measure students' computational thinking skills. Peters et al. (2021) used the process data from game log files to measure students' inductive reasoning and visuo-spatial abilities and identified a number of behavioural features associated with spatial reasoning ability. The game-based skill assessment provides an opportunity to look "under the hood" at what skills learners can demonstrate through behavioural indicators in the gameplay, and also offers the possibility for a scalable and replicable measure of implicit skill practice that is often hard to assess in traditional academic tests (Rowe et al., 2021). The existing GLA studies regarding skill assessment were mainly based on single-player games and focused on measuring individual learners' skills (eg, computational skills and spatial reasoning abilities). There is a lack of research that explores multiplayer games and assesses learners' social skills that are required to effectively communicate and collaborate with other individuals and groups in the gameplay. Moreover, the current research emphasized summative skill assessment (eg, measuring skills after completing the game) and ignored learners' skill development as they progress towards the game goal. The present study aims to fill the gap in the literature by measuring social skills – in our case political negotiation skills—and examining skill development in a multiplayer game.

With the emphasis on developing social skills, collaborative simulation games have been widely adopted in education like the above-mentioned political simulation games. Students are expected to solve designed problems through practicing collaboration, communication and other social skills during the collaborative gameplay (Peters et al., 2021). The generated log data in the games is unique since it not only reflects an actor's in-game behaviour but also demonstrates the interactions among actors of collaboration. To analyse the log data concerning relations, SNA is naturally preferred. SNA is a learning analytics tool that provides node-level and network-level statistics to quantify the interactivity among a network of actors during the collaboration (Dado & Bodemer, 2017). It enables the study of how the interactions influence the behaviour of connected actors and how the network structure shapes the embedded actors. These actors can be either individuals or groups (Wasserman & Faust, 1994). It is argued that the study of interactions and structure could help understand the process of learning and skill practice visually and quantitatively in a way not offered by

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other learning analytics methods (Saqr et al., 2020). Several studies have shown that some of the SNA measures are associated with outcomes such as academic achievement and a sense of community (Dawson, 2008; Gašević et al., 2013; Wu & Nian, 2021). Gašević et al. (2019) recently proposed a novel approach named SENS by combing SNA and epistemic network analysis (ENA) to study students' collaborative learning in an online discussion forum and found that students' performance was related to not only whom they talked to but also what they talked about. Guided by SNA research, this study employed SNA as a learning analytics tool to assess skills and investigate skill development in a collaborative gaming environment.

The conceptual framework: Assessing negotiation skills based on social network analysis

Characterization of participatory roles using SNA

Research shows that students commonly take on different participatory roles to support communication and solve problems during collaborative learning (Ouyang & Scharber, 2017). Therefore, participatory roles in the collaborative simulation game offer an opportunity to assess students' skills by mapping the in-game behaviour with related skills (Milligan, 2015). Marcos-García et al. (2015) summarize a list of emerging participatory roles in collaborative learning environments, including *missing, quiet*, *peripheral, active, animator, coordinator* and *leader* roles. Marcos-García and his colleagues (Marcos-García et al., 2015) believe that the roles can be classified based on the level of participation, influence, and mediation in collaborative learning. Therefore, they propose a method—detection and support of participatory roles (DESPRO)—to identify the roles based on the node-level centrality measures of SNA. They argue that *outdegree* and *out-closeness* measures reflect the intensity of a student's interaction in a collaboration network, thus they are treated as the indicators for the participation characteristic, while *indegree* and *in-closeness* measures manifest the popularity of a student in the network, as a result, they serve as the indicators for the influence characteristic. The *betweenness* measure represents the control over the flow of information or resources in a network by a single node, which indicates the mediation characteristic. To effectively classify students into specific participatory roles, they rank the values for each SNA measure into three levels: low, medium, and high, and then match the characteristics of the roles with the appropriate levels of the measures.

Below are the descriptions of the characterization of five roles considered in our work. We adapted five participatory roles from the original list including *peripheral, active, animator, coordinator*, and *leader*, as the two remaining roles—*missing* and *quiet*—were not applicable in the study context. Specifically, the collaborative simulation game was an embedded element of the course, and all students were required to actively participate, thus, they could neither be absent nor inactive during the gameplay.

a) *Peripheral role*: A peripheral player shows limited participation and barely interacts with other players in the collaborative game, so they can hardly influence other players nor mediate communications among players. Thus, a player with a peripheral role tends to have a low level of participation, influence and mediation.
b) *Active role*: An active player is often actively involved in the collaborations initiated by other players but rarely starts an interaction that can stimulate others to participate. Thus, a player with an active role shows an active interaction behaviour, but without initiative, which is reflected in a medium to a high level of participation whereas the level of influence and mediation is low to medium.

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c) *Animator role*: An animator player actively engages in interactions and often initiates collaborations with other players. Not only does the animator player complete their own tasks but also pushes other players to carry out theirs to maintain reciprocal interactions. Occasionally, the animator player might mediate the communication among different players, but facilitation is not their focus. Thus, a player with an animator role shows a medium to a high level of participation and influence, but a low to a medium level of mediation.

d) *Coordinator role*: A coordinator player actively engages in interactions and focuses on facilitation among different players. Rather than initiating collaborations to influence other players, a coordinator is more interested in acting as a mediator among different players, especially when a conflict is detected. A coordinator tends to monitor others' activities and help to maximize the benefits of all players. Thus, a player with a coordinator role has a medium to a high level of participation and mediation, but a low to a medium level of influence.

e) *Leader role*: A leader player actively participates in the game, initiates collaborations to build up relationships with other players, and facilitates interactions among different players to optimize both their own and other players' benefits in the game. Thus, a player with a leader role is likely to exhibit a high level of participation, influence, and mediation.

Matching participatory roles with negotiation skills

Inspired by Marcos-García et al.'s work, we propose a conceptual framework to assess negotiation skills by matching different negotiation skillsets with students' participatory roles in a collaborative simulation game (see Table 1). Although the DESPRO method derives the participatory roles through the analysis of individual students' data, we argue that the method can also be applied to the data of student groups, since the actors of the network could be at either the individual or the group level (Wasserman & Faust, 1994). Moreover,

TABLE 1 List of participatory roles with corresponding SNA value ranges and negotiation skill sets

			Role characteristics				
			Participation		Influence		Mediation
Participatory role	Role description	Negotiation skillset	OD	O-C	ID	I-C	Btw
Peripheral	Limited collaborations with other parties	Distributive	L	L	L	L	L
Active	Frequent participation in collaborations with few initiated negotiations	Distributive	M–H	M–H	L–M	L–M	L–M
Animator	Active initiation of negotiations and maintenance of reciprocal collaborations with other parties	Integrative	M–H	M–H	M–H	M–H	L–M
Coordinator	Facilitation of communication and mediation of conflicts among different parties	Integrative	M–H	M–H	L–M	L–M	M–H
Leader	Frequent participation, active initiation of negotiations, and facilitation of communication among different parties	Adaptable	H	H	H	H	H

Note: Null: 0; Low: [1%–30%]; Medium: [31%–70%]; High: [71%–100%].

Abbreviations: Btw, betweenness; I-C, in-closeness; ID, indegree; O-C, out-closeness; OD, outdegree.

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the aforementioned literature concerning political negotiation often refers to negotiators as delegations or negotiation teams, thus, it is more relevant in this study to match the participatory roles with negotiation skillsets at the group level.

We argue that the student groups who practice the *distributive negotiation* skillset center on their own interests with little or no concern for others. To win the game, on one hand, the groups may initiate negotiations that solely satisfy their own needs, which makes it unlikely to attract collaborators and build up relationships with others in the game. In the game, the groups exhibit a low level of participation, influence, and mediation. Such characteristics match with the ones of the *peripheral role*. On the other hand, *distributive negotiators* can involve in various negotiations that may benefit them in the game but make little contributions to maximize the gains of others. The groups then show active participation but limited influence and mediation in the game. Such characteristics match with the ones of the *active role*.

The student groups who use the *integrative negotiation* skillset emphasize the goals that are important to all negotiation parties, rather than rigidly holding on to their own positions. Thus, to win the game, they can make multiple offers to various groups aiming to find the optimal solutions for all parties in negotiations. In the game, they show a medium to a high level of participation and influence but a medium to a low level of mediation. Such characteristics align with those of the *animator role*. Alternatively, *integrative negotiators* can also focus on mediation among different parties in negotiations. They exchange information with different parties, facilitate communication for mutual gains, and act as a mediator when a conflict is detected. The groups exhibit a medium to a high level of participation and mediation, but a low to a medium level of influence in the game. Such characteristics align with those of the *coordinator role*.

Lastly, the student groups who practice the *adaptable negotiation* skillset are proficient in selecting appropriate negotiation skills based on specific problems and dynamic contexts to achieve win-win situations. They actively engage in communication with others, initiate negotiations when there is a need, and coordinate actions among different parties to maximize mutual gains in the negotiations. They commonly exhibit a high level of participation, influence, and mediation in the game. Such characteristics fit with the *leader role*.

RESEARCH PURPOSE AND QUESTIONS

The purpose of this study was to explore the process of student groups practicing negotiation skills in a collaborative simulation game used in a graduate-level political science course. Firstly, we assessed negotiation skills by identifying different negotiation skillsets through the combination of SNA and DESPRO methods and examined the change of skillsets over time in the simulation game. We then conducted statistical analysis to investigate the relationship between negotiation skillsets and student groups' game achievements. The following three questions guided the design of the study:

1. Which negotiation skillsets did student groups use in each game round?
2. Was there a change in using negotiation skillsets over four game rounds?
3. Was there a relationship between the negotiation skillsets and the achieved goals in the game?

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METHODOLOGY

Participants

A total of fifty-eight graduate students (62% female) from an international security program in a large public European university voluntarily participated in this study. The average age of the participants was 27.

Game context and procedure

The game in the study builds around a fictitious crisis scenario related to territorial disputes in the South China Sea. The game consists of four rounds that are played on two consecutive days. The participants are randomly assigned into 12 groups with four to five students in a group, and each group represents a stakeholder country in the fictitious scenario such as China, the USA, and the Philippines throughout the four rounds of the game. Each student group attempts to achieve two goals during the gameplay. One is the overall goal—resolving the escalating crisis in the game, and the other is the specific set of sub-goals for the stakeholder country that the group plays. An exemplary description of a country and its sub-goals is presented in Appendix 1. Student groups are expected to collaborate with other groups to achieve the set goals through diplomatic negotiations such as making deals and treaties but can also resort to unilateral actions. The groups score a number of points for achieving goals in full or partially. After the end of the game, there is a debriefing and evaluation session where student groups present their negotiation strategies and reflect on their game-based learning experiences. Based on the number of goals achieved cumulatively over four game rounds, the group with the highest score is selected as the game-winner.

One iteration of the game comprises four rounds and the game design remains the same in all four rounds. At the beginning of each game round, a news update is presented to the student groups, where they learn the development in the game scenario such as actions, deals, and treaties that happened in the previous round. Student groups then internally discuss strategies and initiate negotiations to work towards achieving their goals. In the first round, additional time is set aside for internal discussion within the student groups to allow them to divide responsibilities and plan their negotiation strategies for the gameplay. The interfaces of reporting the latest news, making treaties and deals are presented in Figure 1. During the gameplay, none of the groups has the full knowledge of the game situation and other groups' goals, except for a central team of teachers ("Game Masters"), who watches over all ongoing collaborations and actions and uses them to develop the narrative of the game scenario for the following round of the game. Therefore, the scenario of a new round is built on the negotiations, actions, and decisions made by student groups in the previous round.

Dataset

The study utilized two types of data including student groups' log data and their scores achieved in the game. We used the log data to build a directed collaboration network where the node refers to a student group, and the edge represents a political collaboration between two student groups. For example, group A starts a diplomatic negotiation (ie, making a treaty) with group B, and group B accepts the offer. We consider there is a directed political collaboration from group A to B. In the dataset, groups A and B are two nodes of the directed

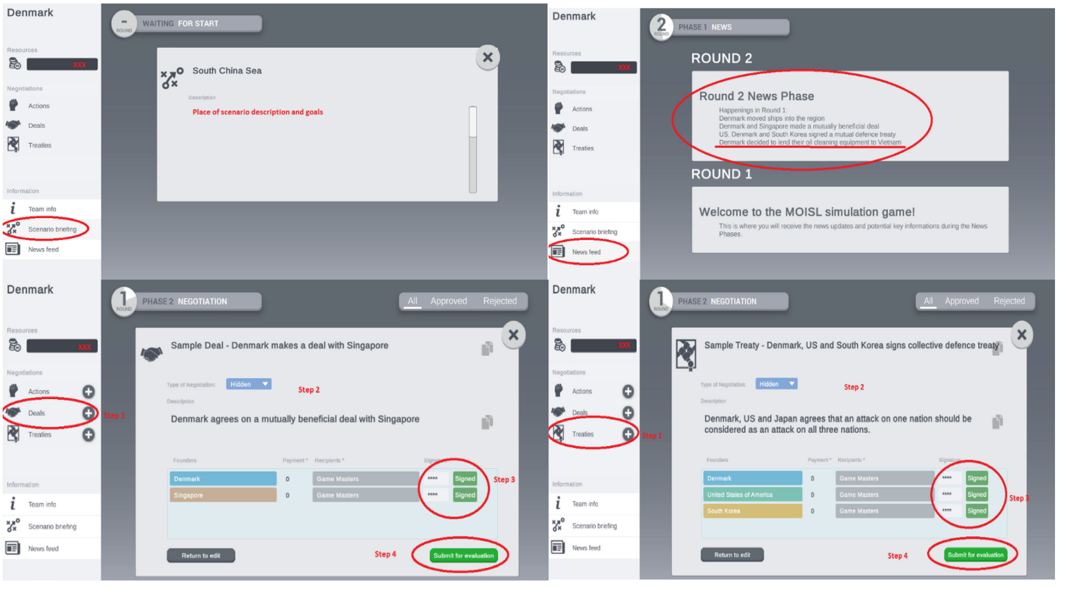

FIGURE 1 Screenshots of the game page including scenario description page (top left), news pages (top right), deals page (bottom left), and treaty page (bottom right).

network, denoted as *cA* and *cB*. A link, denoted *as e*, is an ordered pair (*A, B*) representing a connection from node *cA* to *cB*. If there are *k* times of collaborations from group A to group B, then the weight *w* of the link *e* is *k*. There are 12 nodes in each game round and a total of 1262 weighted links in the entire gameplay with round 1 having the lowest number of weighted links ($N = 6$) and round 3 having the highest number ($N = 516$). In addition, we retrieved individual student groups' scores in each round of the game as a measurement of achievement in the simulation game. The total score is 100.

Analysis processes

Assessment of negotiation skills

Based on the proposed conceptual framework (see Table 1), negotiation skills were measured by identifying different negotiation skillsets in each game round. In specific, we first conducted SNA to obtain five node-level centrality measures including (1) *in-degree* (ie, the number of links pointing to a node), (2) *out-degree* (ie, the number of links pointing away from a node), (3) *in-closeness* (ie, the level of proximal to the rest of the nodes by in-coming links), (4) *out-closeness* (ie, the level of proximal to the rest of the nodes by out-going links), and (5) *betweenness* (ie, how often a node is a bridge between other nodes). We then adapted the DESPRO method and classified each group into one of the five participatory roles (ie, *peripheral, active, animator, coordinator*, and *leader*) in each game round. Lastly, we matched the roles with the three different negotiation skillsets. That is, the group with either a *peripheral* or *active* role was regarded as the practitioner of the *distributive negotiation* skillset. The group that played either an *animator* or *coordinator* role was held to practice the *integrative negotiation* skillset. The group with the *leader* role was considered to utilize the *adaptable negotiation* skillset.

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Analysis of the change in skillsets

To examine the change in using negotiation skillsets over the four game rounds, we obtained network-level indexes of each collaboration network in all four game rounds. The indexes include *density* (ie, how well a network is connected in general), *centralization* (ie, how well a network is connected around particular focal points), *transitivity* (ie, the extent of clusters in the network), and *weighted link* (ie, the number of weighted links between nodes). Based on the indexes, we analysed the structural change of the four networks over time. We also generated four temporal sociograms to visualize the evolution of the networks over the four game rounds, where the node was shaped by the group's achieved score in a specific game round and coloured by the negotiation skillset used in that game round. The visualization of four temporal networks, instead of one aggregated network, helps discover the changing pattern of negotiation skillsets over time that might be disguised from summative network analysis. We used the *igraph* package in R and Gephi to conduct SNA and network visualization (Bastian et al., 2009; Csardi & Nepusz, 2006).

Analysis of the relationship between negotiation skillsets and achievement

One-way ANOVA analysis was conducted to examine the relationship between negotiation skillsets and student groups' achievement in the entire gameplay. The dependent variable is student groups' scores in each game round, and the independent variable is the negotiation skillsets. Before running the ANOVA test, we first checked the three assumptions—independence, normality, and homogeneity of variance. The analysis was conducted in R.

RESULTS

Assessment of negotiation skills

Negotiation skills were measured by identifying different negotiation skillsets. As discussed above, the three skillsets differ in their level of complexity with *distributive negotiation* as the least complex skillset and *adaptable negotiation* as the most complex one. Table 2 summarized the total number of the different negotiation skillsets used in each game round, and Figure 2 visually demonstrated the changing pattern of student groups using the negotiation skillsets across four games. The results showed distinct differences between the *distributive* and *adaptable negotiation* skillset. We observed a clear increasing trend of using the *adaptable negotiation* skillset and a decreasing trend of using the *distributive negotiation* skillset from round 1 to round 4. D*istributive negotiation* was the most used skillset in the 1st game round, but the least used one in the last game round. The usage of the *adaptable negotiation* skillset had an opposite trend as that of the *distributive negotiation* with the minimum usage

TABLE 2 Counts of negotiation skill sets in each game round

Round	Distributive	Integrative	Adaptable
1	10	2	0
2	2	5	5
3	4	4	4
4	2	4	6

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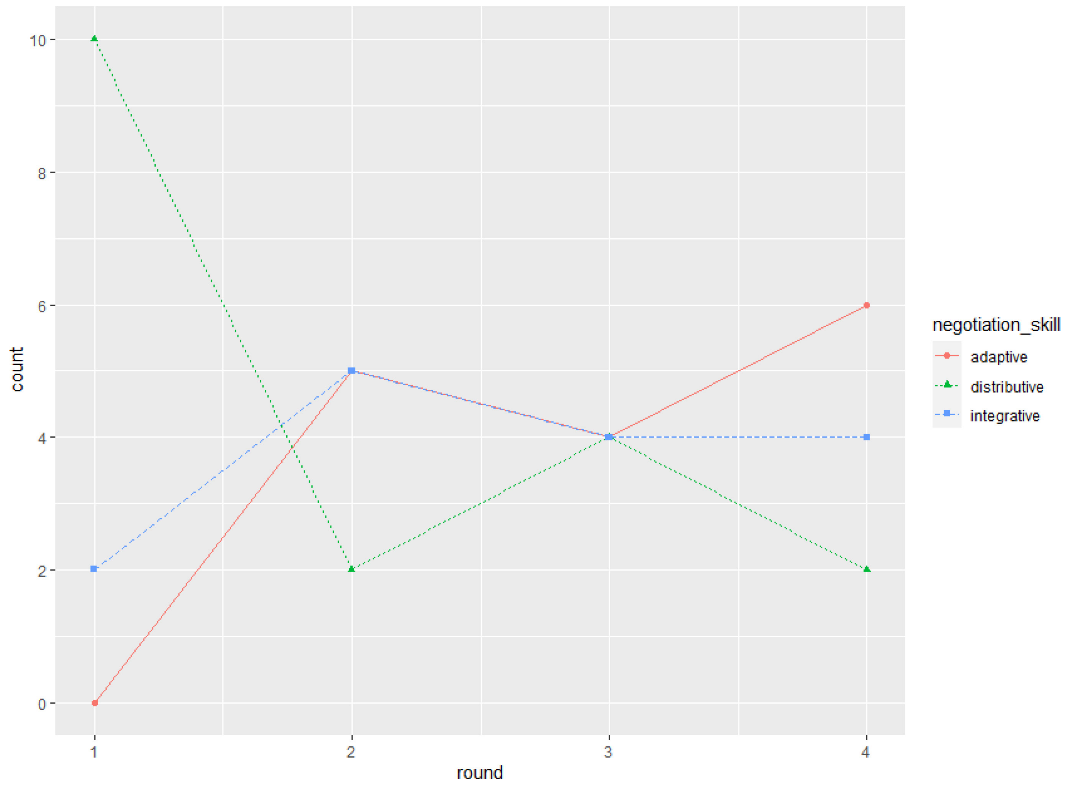

FIGURE 2 The change of negotiation skill sets over four game rounds.

TABLE 3 Summary of the network-level SNA indexes in four game rounds

Round	Density	Centralization	Transitivity	Weighted link
1	0.02	0.96	0	6
2	0.88	0.09	0.95	364
3	1	<0.01	1	516
4	0.86	0.13	0.98	376

in the 1st round but the maximum usage in the last round. The *integrative negotiation* skillset had a medium level usage and the pattern kept relatively stable over four game rounds.

The change of negotiation skillsets over time

To investigate the changes in the negotiation skillsets, we first analysed network-level indexes including network density, centralization, and transitivity in each game round. Based on the summary in Table 3, we found that all student groups gradually formed an *interactive* (reflected by an increasing value of transitivity), *cohesive* (reflected by an increasing value of density), and *equally distributed* (reflected by a decreasing value of centralization) collaboration network over the four game rounds. The evolution of the collaboration networks indicates that, in general, student groups are more confident and skilled to make negotiations and successfully build collaborations over time.

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We then generated two figures to present the nuance of the skillset changes over the four game rounds, which include four temporal sociograms of the collaboration networks in each game round (see Figure 3) and a line chart of the use of the negotiation skillset for each student group over time (see Figure 5). Based on Figure 3, we observed that, in round 1, there were only five groups (ie, c02, c07, c09, c10, and c12) who made moves and formed two local communities. The other groups seemed to play a waiting game to understand the game context and plan the next game move. We also observed that the two active

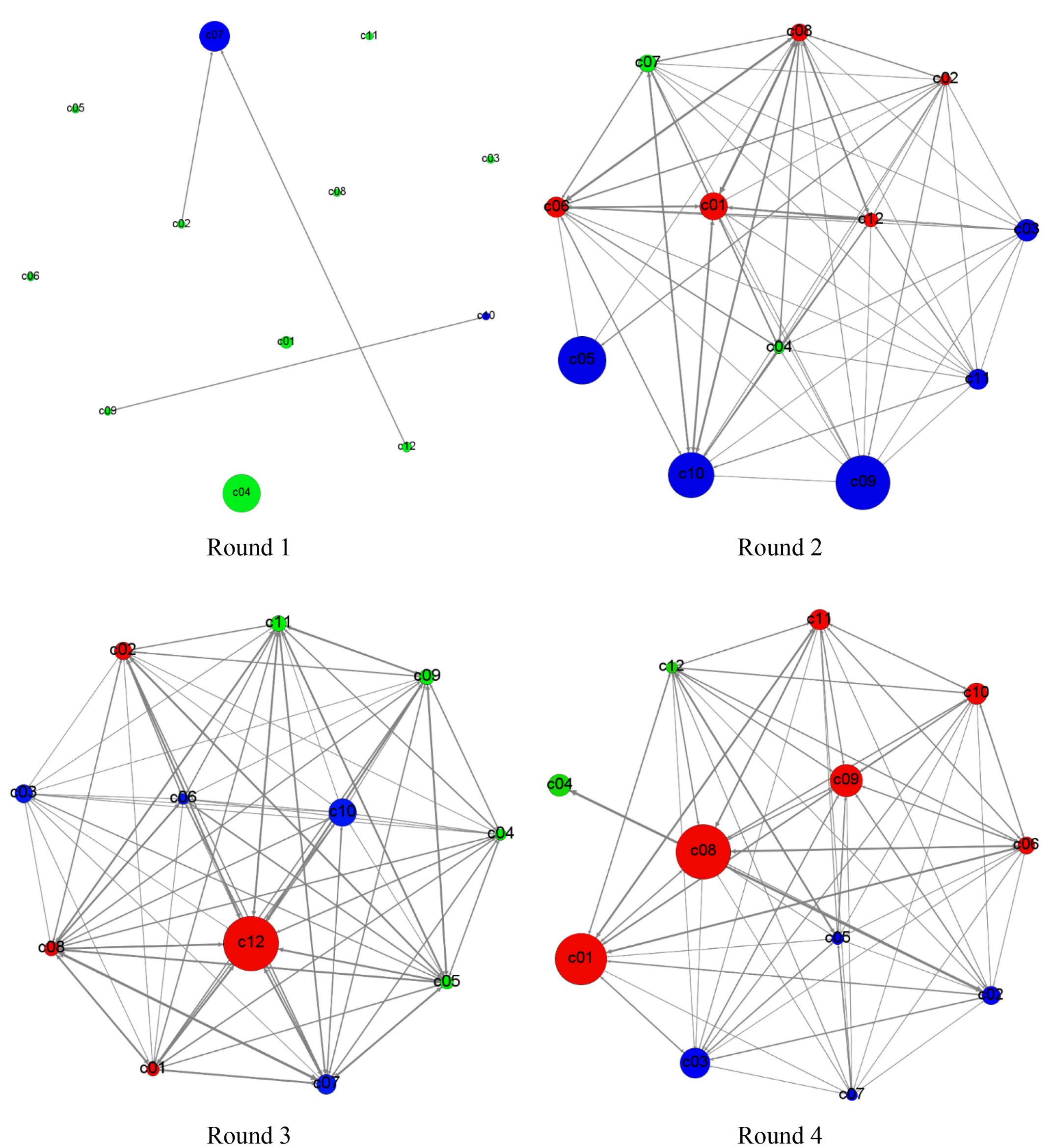

FIGURE 3 Temporal collaboration networks in four game rounds. Node size represents the score achieved in a specific game round and node colour represents a negotiation skill set (green—distributive negotiation, blue—integrative negotiation, and red—adaptable negotiation). Edge represents a political collaboration between two student groups (eg, treaty and deals) and edge width represents the total number of collaborations between the two groups. (for interpretation of the references to colour in this figure legend, the reader is referred to the web version of this paper).

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groups, c07 and c10, received more collaborations from others than their peer groups and played an *influencer* role in the network. Based on our proposed framework (see Table 1), we believe that these two groups practiced the *integrative negotiation* skill while the others used the *distributive negotiation* skill in this game round. Group c04 stood out because they enacted the *distributive negotiation* skill but gained a comparatively high score in this game round. When looking into the details of the log data, we found that this group made several unilateral actions such as privately establishing a toll for passing ships and secretly sending naval vessels to essential areas without communicating with the other groups that are relevant stakeholders in the game. As the analysis of the subsequent rounds below shows, these unilateral actions isolated group c04 for much of the game and prevented the group to achieve other goals. To supplement the discussion of group comparison, particularly the comparison between group c04 and the other groups in the gameplay, we generated four ego networks of group c04 (see Figure 4).

In round 2, the tie weight significantly increased from 6 to 364, indicating a prominent growth of collaborations among all groups. There were five groups (ie, c03, c05, c09, c10, c11) with a medium to a high level of participation and mediation but a low level of influence. They were categorized as the *coordinator* player in this round, who used the *integrative negotiation* skillset to coordinate tasks such as probing others' game moves, exchanging information, and making multiple offers to different groups. There were another five groups (ie, c01, c02, c06, c08, c12) with a medium to a high level of participation, mediation, and influence. They were identified as *leader* players in this round, who used *adaptable negotiation* skillset to facilitate collaborations among groups, take cues from the contexts, and make influential actions to maximize mutual gains with their collaborators. The remaining two groups, c04 and c07, were classified as *active* players, who were actively involved in collaborations initiated by others but had a low success in attracting others to their initiated collaborations. Based on the proposed conceptual model, they were believed to use the *distributive negotiation* skill to achieve goals.

In round 3, all groups actively collaborated, and the collaboration peaked in this round with a tie weight of 516. The formed network became perfectly “dense” and equally distributed (ie, *density* = 1 and *centralization* = 0), indicating groups largely made even contributions to the negotiation game. There were four groups (ie, c04, c05, c09, c11) who played either *peripheral* or *active* roles in this round, implying that they primarily focused on participating in the game and engaging in collaborations initiated by others but paid less attention to their influence on their collaborators and showed less desire for future collaborations. These groups were believed to be *distributive negotiation* practitioners who emphasized short-term goal achievements. In contrast, there were four groups (ie, c01, c02, c08, c12) who played a *leader* role and exhibited *adaptable negotiation* behaviours such as making multiple collaborations with various collaborators, building trust through continuous collaboration with certain groups, and making efficient concessions to achieve desired goals for both parties in the game. The remaining four groups (ie, c03, c06, c07, c10) played either an *animator* or a *coordinator* role in the game and were considered *integrative negotiation* practitioners to make efficient negotiations and maximize mutual gains among collaborators.

In round 4, the number of collaborations slightly decreased with a tie weight of 376. We suspected that groups became more cautious and selective of collaborators since it was the last round of the game. We observed that almost all groups maintained active participation except for two groups – c04 and c12. Group c04 was peripheral to the network and had a sole connection with group c02. Similarly, group c12 also played a *peripheral* role and had a low level of participation, influence, and mediation in this game round. Besides these two groups, the remaining groups played more advanced roles. Specifically, seven groups played a *leader* role, and three groups played a *coordinator* role in the final round. The advancement of roles played by the groups indicates their enhanced confidence to utilize

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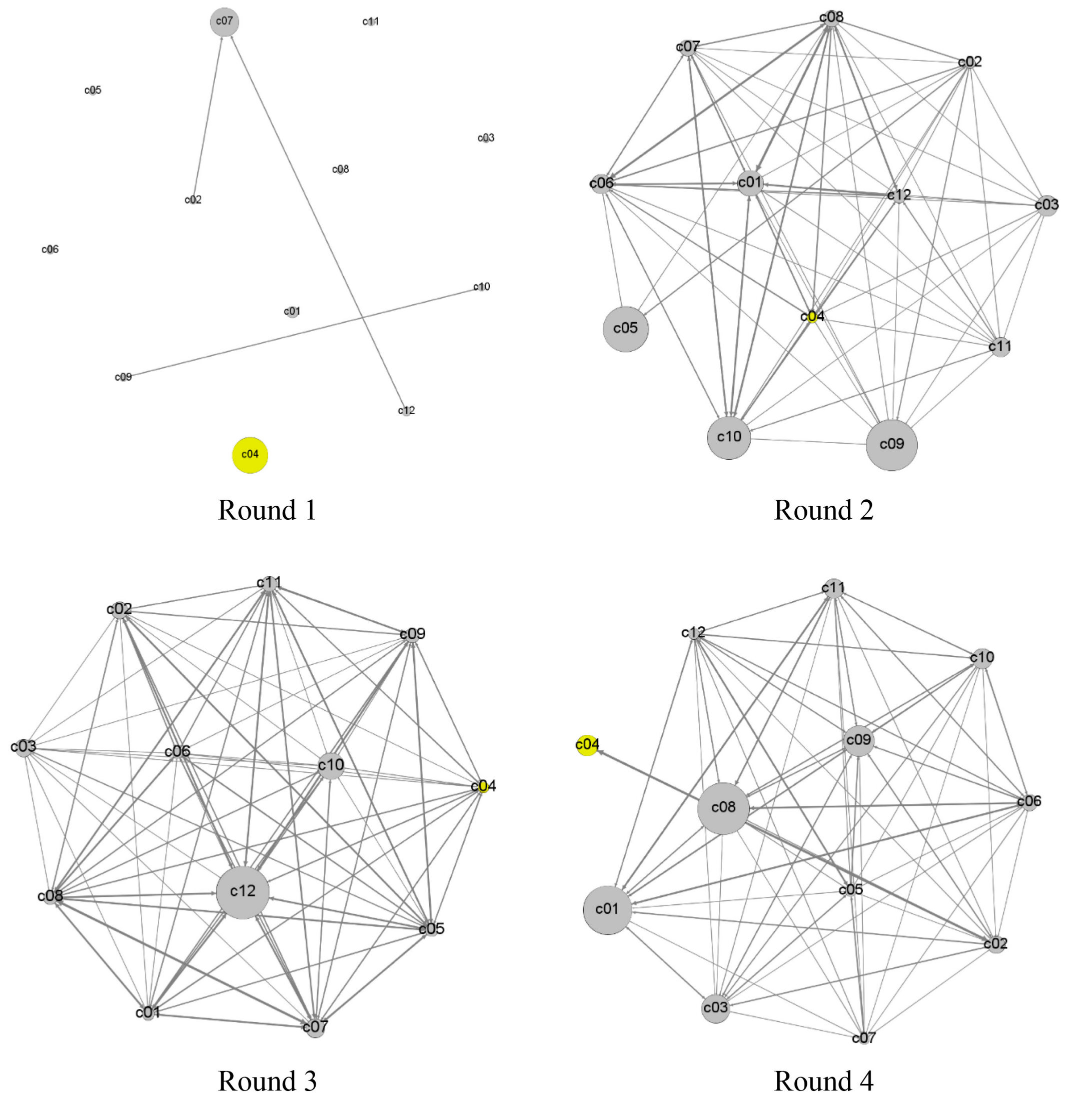

FIGURE 4 Ego networks of group c04 in four game rounds. Node size represents the score achieved in a specific game round. Yellow node represents the interested student group - group c04 and grey nodes represent the other groups in the game. Edge represents a political collaboration between two student groups (eg, treaty and deals) and edge width represents the total number of collaborations between the two groups. (for interpretation of the references to colour in this figure legend, the reader is referred to the web version of this paper).

more complex negotiation skills to achieve game goals. It means that the groups were more capable of asking questions to others to uncover their interests and priorities, building multiple and diverse collaborations to maximize their goal achievements, and selecting appropriate ways to achieve the goals depending on the context. As shown in Figure 5, overall, each student group demonstrated a positive trend of using negotiation skillsets from a less complex one (ie, *distributive negotiation*) to a more complex one (ie, *adaptable negotiation*) over four game rounds, except group c04 who kept using the *distributive negotiation* skillset in the entire game and group c12, who downgraded their skillset to the *distributive negotiation* in the final round.

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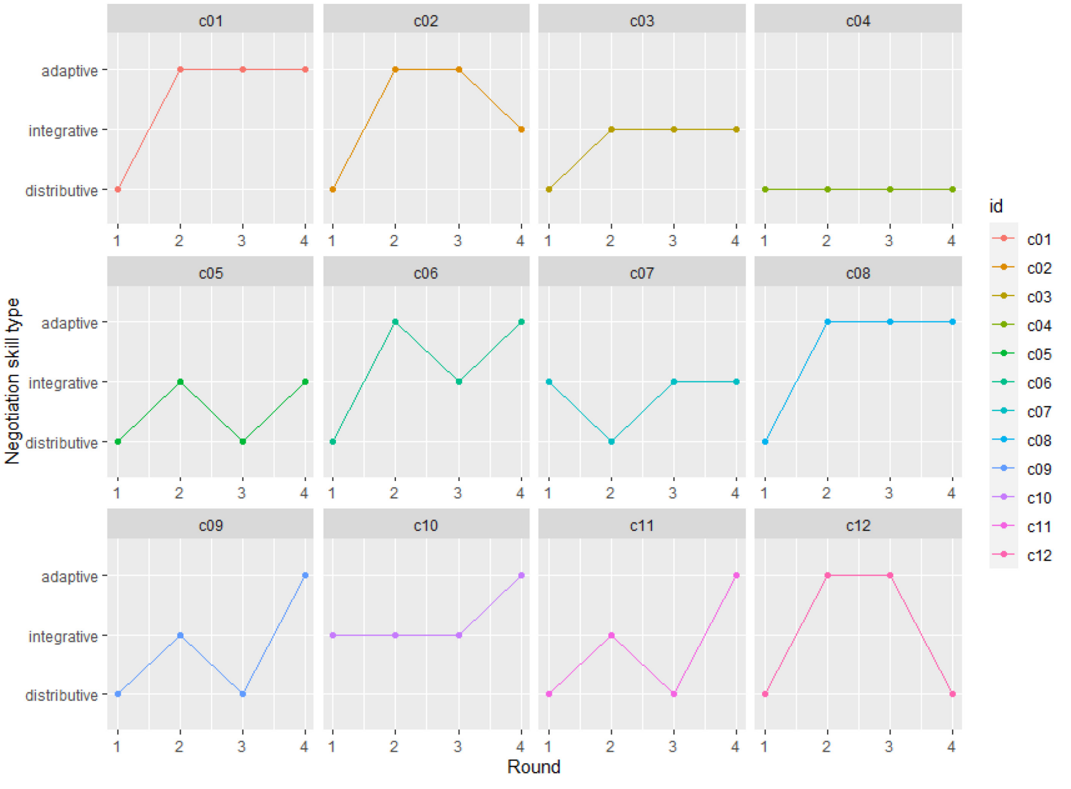

FIGURE 5 The changing pattern of negotiation skill sets of 12 student groups over four game rounds.

The relationship between the negotiation skillset and achieved goals

To examine the relationship between the negotiation skillsets and achieved goals, we conducted a one-way ANOVA test. Before the analysis, we checked the three assumptions including independence, normality, and homogeneity of variance. The normality assumption was violated ($p<0.01$), indicating that the scores were not normally distributed and might have outliers impacting the distribution. Combined with the previous analysis of the change of the negotiation skillset, we considered group c04 as an outlier in the study because it achieved the highest score in round 1 by using the *distributive negotiation* skillset (eg, making unilateral actions), which caused the isolation of the group in the rest of the gameplay. Since this group's score had a significant influence on the distribution of the overall score, its data were excluded in the following analysis.

The one-way ANOVA analysis showed that there was a significant mean score difference between negotiation skillsets, $F(2,41) = 4.82$, $p = 0.01$, and partial η^2 of 0.19. A Tukey post hoc test revealed that the mean score achieved by using the *distributive negotiation* skillset was significantly lower ($M = 1.41$, SD = 1.70) than the mean score achieved by using the adaptable negotiation skillset ($M = 12.04$, SD = 14.03) (see summary in Table 4). There were no significant mean score differences between using the *integrative negotiation* ($M = 8.67$, SD = 7.62) and *adaptable negotiation* skillset. The results, presented in Table 4 and Figure 6, indicate that the more complex the negotiation skillset used by a group, the higher score the group would achieve in the game.

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TABLE 4 One-way ANOVA results

	Sum of squares	*df*	Mean square	*F*	*p*	Partial η^2	Partial η^2 95% CI
Between groups	848.50	2	424.25	4.82	0.01	0.19	[0.00, 0.37]
Within groups	3607.23	41	87.98				
Total	4455.73	43					

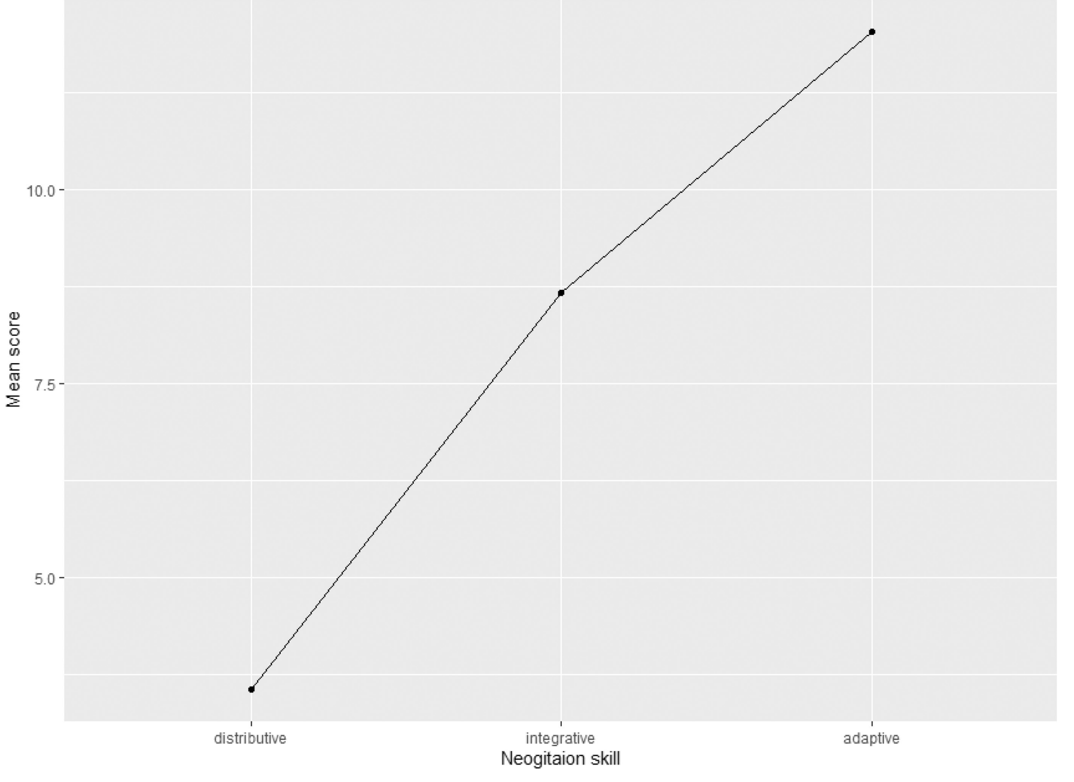

FIGURE 6 The difference of mean scores between negotiation skillsets.

DISCUSSION

The main purpose of this study was to understand the process of student groups practicing negotiation skills in a collaborative simulation game in a graduate-level political science course. We first used the SNA method to assess negotiation skills and examine the change of negotiation skillsets over four game rounds. Then we conducted statistical analysis to investigate the relationship between negotiation skillsets and outcomes in the simulation game. The results showed that, in general, student groups became more skilled at negotiating and gradually formed an interactive, cohesive and equally distributed collaboration network towards the end of the game. They practiced more complex negotiation skillsets over time, which helped them achieve higher scores in the simulation game. The findings of this study provide insights into the dynamic process of practicing negotiation skills in a collaborative gaming environment and have instructional implications for the improvement of using simulation games in teaching political science.

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Implications of skill assessment using temporal social network analysis

Teachers and learners have continuously been challenged by understanding the practice of negotiation skills. Recent research attempts to offer possible solutions by exploiting advanced technologies. For example, Johnson et al. (2017) derived metrics to quantify negotiation principles to discriminate between good and bad negotiators and provide personalized feedback based on the quantified skill levels in human-agent negotiations. Other studies utilized intelligent systems to teach negotiation tactics with individualized assessment and feedback such as an intelligent tutoring system (Johnson et al., 2019) and a social intelligent negotiation dialogue system named SOGO (Zhao et al., 2018). All these studies focus on one-to-one human-agent negotiations. However, negotiations, especially political negotiations, often involve multiple parties. Therefore, good negotiators need to consider the interests of different parties and adjust their negotiation skills to optimize mutual benefits through collaboration. In this study, we proposed a conceptual framework that assesses negotiation skills through mapping the participatory roles in a collaborative simulation game onto theorized negotiation skillsets. In specific, by combing the SNA and DESPRO methods (Marcos-García et al., 2015), we first identified student groups' participatory roles based on their collaboration behaviours in the multi-party negotiation simulation game and then categorized the groups' negotiation skillsets based on their roles. The framework extends the application of SNA from the focus of studying learning interactions to understanding how groups' interactions influence their skill practice and development in a collaborative gaming environment. Beyond reporting the SNA measures and visual inspection of the sociogram, this study sets an example of using SNA as a learning analytics method for the negotiation skill assessment, which offers opportunities for immediate and personalized feedback to help student groups reflect on their negotiation performances and improve their negotiation skills. While our data is at the group level, the proposed conceptual framework will also work at the level of individual learners, if the log data is available at the individual level.

The study also highlights the importance of temporal network analysis. Existing research has emphasized studying learners' collaborative and social learning using aggregated network analysis (Ouyang & Scharber, 2017; Xie et al., 2018). However, using the aggregated network may oversimplify the collaborative learning process mainly because temporal information embedded in the data is overlooked (Saqr & Nouri, 2020). It is well-known that most of the collected data for SNA is time stamped. By aggregating data over time and conducting a “snapshot” analysis, researchers fail to gain insights into how learning occurs over time, who needs support, and when they can provide the support. The current study considered the temporal dimension of the data. Through the analysis of 12 student groups' interactions in the four rounds of a collaborative simulation game, this study contributes with a methodological approach to visualize and quantitatively analyse temporal collaboration networks. The temporal network analysis can help educators understand the evolution of learners' participatory roles and associated negotiation skillsets over time and identify the key moments when attention and support are needed. Furthermore, by integrating the time characteristics of the data in SNA, this study provides opportunities for educators to implement early predictions of performance and timely interventions for students and groups who struggle in gameplay.

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Implications of using simulation games in political science education

Our study has several concrete implications for using simulation games in political science education. First, traditional lecture-based or case-based teaching methods have been challenged in providing feedback to learners due to a lack of efficient skill assessment tools. The effectiveness of using simulation games in teaching political science courses is also questioned because of limitations in measuring skill development (Raymond & Usherwood, 2013; Robinson & Goodridge, 2019). The conceptual framework proposed in our study provides a feasible approach that can effectively utilize in-time social network data to assess negotiation skills and guide teachers to provide personalized feedback and support to student groups. This can be achieved by integrating the SNA analysis function into an online gaming platform that can provide instructors with graphs over the networks and interactions in real- or near real-time. This would allow teachers to make contact with student groups (or individual learners, if the data is collected at that level) who are noticeably less integrated into the network and assist them with advice, feedback, or ideas on how to approach the negotiations in a constructive manner and thereby support their skill development. In this way, group level data also can draw instructors' attention to potential intra-group issues that cause the group to be less integrated into the network; this could flag potential disagreements about strategy and negotiation style among group members, which the instructors then can help resolve constructively. If log data for individual learners is available, this feedback function would be enhanced greatly for the level of the individual student. The framework also offers opportunities for students to reflect on their negotiation behaviours, relate their behaviours to negotiation principles, and reinforce or adjust their negotiation skills to maximize negotiation outcomes in the simulation game.

Moreover, the method that this study proposes allows the instructor to gain insights into the balance between the groups in the game design (ie, the different countries in our case), potentially highlighting roles that marginalize the groups. Already after one iteration of the game (meaning after having played four rounds over two days once), outliers, like group c04, can be spotted, and the instructor can investigate whether this group performed less due to group dynamics, a wrong choice of strategy, or possibly a design flaw of the game, such as an imbalance in groups' roles, objectives, or options. If the same role played by different student groups is constantly the outlier in multiple iterations of the game, this would point to a flawed game design (eg, an imbalance in group roles). The game could then be effectively optimized, as the crucial insights SNA provides permit the instructor to better balance the role descriptions of the individual groups to ensure equal and active roles for all participants – this is of fundamental importance to give every participating student the same learning opportunity.

Finally, understanding the evolution of collaborations among student groups in the simulation game through SNA allows the instructor to pinpoint crucial actions, deals, and treaties in the game. The collaboration development serves as a valuable basis for the de-briefing session, allowing learners to reflect on successes and mistakes in negotiations and decisions that advantaged or disadvantaged their groups for the rest of the game. For example, we observed that group c04 made several moves in the very early of the game that led to their marginalization from other groups in the entire game (shown in Figure 4). The instructor can thus use insights from the SNA to encourage the group to reflect on their strategies and experience during the game.

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CONCLUSIONS AND DIRECTIONS OF FUTURE RESEARCH

Existing studies of simulation games in political science mainly focus on examining learners' knowledge gains and affective changes and largely ignore the evaluation of skills in the gaming environment. This study aimed to understand the process of student groups practicing negotiation skills in a collaborative simulation game with the SNA approach. We proposed a conceptual framework that assesses negotiation skills by identifying different negotiation skillsets. We also investigated the skill development through the change of the skillsets over time in the simulation game and examined the relationship between the negotiation skillsets and achievement. The results showed that the negotiation skill practice was a dynamic and evolutionary process. The majority of student groups became more skilled at negotiating and used more complex negotiation skillsets over time, and the complexity of skillsets was positively related to the negotiation outcomes in the simulation game. This study has demonstrated the possibilities of using SNA as an analytical tool to measure negotiation skills and explore dynamic skill development. It has also shown the potential of integrating SNA in a collaborative gaming environment for automated analysis of a large volume of data concerning interactions, which can serve as the basis for teachers to identify students in need and provide personalized feedback and support. Most importantly, the study highlights the usefulness of applying learning analytics techniques in digital gaming environments, which allows teachers to gain a more holistic view of student learning and skill development and further improve their teaching strategies and game design.

To our best knowledge, this study is the first exploration of the process of practicing negotiation skills based on SNA, so it is subject to certain limitations. Firstly, we indirectly assessed negotiation skills by combing the SNA and DESPRO methods. Future research could use additional assessment tools to measure negotiation skills, crosschecking the results to validate the results obtained in this study. Secondly, the sample size of the present study was relatively small and based on one iteration of the simulation game; thus, it should be cautious to generalize the results to other populations and disciplines. Future research could replicate the study and collect data on multiple iterations of the game to validate the results. Thirdly, the available data was limited to the level of student groups. Future studies could collect data at the level of the individual learner to allow investigation of individual learners' negotiation skill practice and development. It would also be interesting to collect data at both the individual and group level, as that would allow insights into how individual learners' skill practice influences group outcomes. Research in the field of Multimodal Learning Analytics (MMLA) provides guidance on the data collection and analysis at the individual level during within-group communication (Martinez-Maldonado et al., 2016; Olsen et al., 2020). Finally, the results of this study were presented to the teachers after the gameplay. Although teachers valued the summative insights regarding learners' dynamic process of collaboration and skill practices, a timely analysis would be more beneficial for the teachers to provide prompt feedback and support during the gameplay. Therefore, future studies should work towards integrating SNA into the game design from the outset to allow immediate and personalized feedback to learners.

CONFLICT OF INTEREST

No conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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APPENDIX 1: COUNTRY ROLE DESCRIPTION

Country specific paper—Brunei

Brunei gained its independence from the United Kingdom on 1 January 1984. Small in size but rich in oil, Brunei stands out as the only state in the region to apply Sharia law. It had made impressive economic progress under the wise rule of its Sultan. Sadly, not all of its territorial claims are fully recognized, neither the historic claim to Limbang on land nor the claim to the Spratly islands. A non-binding agreement to settle borders was made with Malaysia in 2009.

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Capabilities
The small and aging navy was bolstered by the recent acquisition of fast new coastal patrol vessels built in Germany, while the air force is currently receiving new UAVs and Black Hawk helicopters. The Bruneian military lacks any recent combat experience but has been deployed regionally in humanitarian and peacekeeping missions, and has extensive military relations with Singapore. In addition, the country possesses modern equipment to clear up oil spills.

Development aid budget
$300 million (3 gold coins)

Objectives (5 points each)

- End the interruption of the South China Sea trade route and prevent similar incidents from occurring again.
- Persuade China to accept arbitration to settle maritime boundaries.
- Defend your territorial waters, including your claim to the Spratly islands.
- Use leverage from the current crisis to finally obtain Limbang from Malaysia.
- Secure a military protection guarantee from either the US or China to replace the traditional defence agreement with Britain.

Bonus points
You can earn up to 15 points for exceptional creativity, negotiation skill, ethical behaviour and constructive proposals in multilateral negotiations.

Unofficial strategy paper
Please write a short (max. Half a page) text stating your unofficial overall strategy and hand it in to the Game Masters by 10:15 am on the first day. By unofficial we mean your actual, possibly secret strategy to obtain your objectives throughout the entire game.

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