Chapter 7
Developing Written Argumentation Skills With an Educational Simulation Game (ESG): The Design and Implementation of the GlobalEd ESG

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EXECUTIVE SUMMARY

In this chapter, the authors present the case of GlobalEd, a virtual educational simulation game (ESG) that focuses on the development of student written argumentation and socio-scientific literacy skills over the course of play. Interactions within the simulation emphasize the use of written argumentation among players throughout the game's entire duration through an online communications system that is a fundamental part of all play interactions. Through this case illustration, they describe the rationale and design for GlobalEd, particularly toward its primary learning outcomes of written communication, argumentation, and collaboration. They illustrate the interactive portions of the game that are designed to elicit skill development in these areas and provide examples of actual interactions by students as they work toward these goals. Finally, they provide a brief synopsis of the studied effects of GlobalEd over the last decade in authentic classroom settings through experimental and other efficacy analyses.

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INTRODUCTION

Over the last three decades, worldwide emphasis has been placed on high stakes standardized testing and curricular standards. Although such foci on mastery and testing are targeted toward meeting the modern needs of the knowledge-based workforce, this shift has subsequently reduced the frequency and richness of opportunities that are dedicated to learning critical skills for success in multiple fields (Andriessen, Baker, & Suthers, 2003; Applebee & Langer, 2006; NRC, 2014). 21st Century skills, such as socioscientific literacy, inquiry, written communication, critical thinking, and problem solving are all universally hailed as essential for success in careers today but are often set to the wayside in lieu of subjects that consume the most classroom time during a typical class day due to their prominent appearance in standardized testing batteries (Chalkiadaki, 2018; Pellegrino, 2017).

As one of these essential skills, argumentation mastery is critical for 21st century success to enable scientifically literate citizens to engage with the challenges and future work of the digital economy (Scogin et al., 2017). Specifically, argumentation skills are critical within most modern fields of work, with people required to increasingly perform tasks that include critical thinking, evidence-based analysis, and effective collaboration across multiple team contexts (Bathgate et al., 2015). Additionally, argumentation skills lend to success in other mastery areas, such as information literacy, effective evaluation of evidence, analysis and synthesis of information, and research skills are all hallmark skills for work in the digital era (Van Laar et al., 2017). As such, the ability to successfully engage with content and make evidence-based decisions is a key skill that should be gained during the typical K-12 school experience.

Simulations and games that emphasize authentic play continue to demonstrate effectiveness at providing critical experiences for students to practice 21st century skills, including written communication and argumentation (Noroozi, Dehghanzadeh, & Talaee, 2020; Pinkwart & Mclaren, 2012; Veerman, 2000). Simulations and games that prioritize open-ended challenges for players to solve give players control of the direction of play and allow them to pursue their own interests while practicing key skills that are embedded into the game's play mechanics (Hmelo-Silver & Barrows, 2006; Veletsianos & Doering, 2010).

In this chapter, we present the case of GlobalEd, a virtual educational simulation game (ESG) that focuses on the development of student written argumentation skills over the course of play. Since 2000, GlobalEd has been implemented in hundreds of classrooms and has been used by thousands of students. Interactions within the simulation emphasize the use of written argumentation among players throughout the game's entire duration through an online communications system that is a fundamental part of all play interactions. In GlobalEd, argumentation skills are repeatedly modeled through a variety of instructional and curricular prompts, teacher participation in the simulation, live human moderators, and through peer interactions with other players.

Through this case illustration, we describe the rationale and design for GlobalEd, particularly toward its primary learning outcomes of written communication, argumentation, and collaboration. We illustrate the interactive portions of the game that are designed to elicit skill development in these areas and provide examples of actual interactions by students as they work toward these goals. Finally, we provide a brief synopsis of the studied effects of GlobalEd over the last decade in authentic classroom settings through experimental and other efficacy analyses.

BACKGROUND

The Need for Written Argumentation Skills Among 21st Century Learners

Over the last two decades, the scientific community and political leaders have repeatedly made calls for increasing the number of STEM professionals in the workforce. Because the global networked economy will focus on knowledge creation, innovation, and creative solutions to challenges, this recruitment toward the STEM fields is seen as the key solution to global challenges in the 21st century.

However, there is a greater crisis that needs to be addressed than simply recruiting more STEM professionals globally: there is a critical need to develop a scientifically literate citizenry to help populations make better everyday decisions and to be successful in modern jobs. Emerging global challenges continue to test and strain the current workforce worldwide, such as globalized economies and supply chains, proliferation of technologies and ubiquitous networking, mass migrations, and instabilities caused by public health issues, pandemics, food supply, climate change, and natural resource loss. The COVID-19 pandemic has all but uprooted traditional educational institutions and economic supply chains alike, requiring rapid and transformative solutions that are solved in part by skilled workers. As a result, challenges such as these are redefining the required skills for citizens to be successful in both their careers and everyday lives, and thus require substantial opportunities for students to practice key skills.

These scientific literacy skills parallel those employed in the authentic, socio-scientific work of 21st century scientists (Chinn & Malhotra, 2002; Newcombe, et al., 2009; Schwartz, Lederman, & Crawford, 2004). Contemporary scientists need to be able to bring their knowledge, insights, and analytical skills to bear on matters of public importance. Often, they can help the public and its representatives understand the likely causes of events (such as natural and technological disasters) and to estimate the potential effects of projected policies (such as the ecological impacts of various water conservation methods). In this advisory role, scientists are expected to be especially careful in distinguishing fact from interpretation, and research findings from speculation and opinion, in order to develop valid arguments (Millar, Osborne, & Nott, 1998; Monk & Osborne, 1997), as are the citizens who are consuming this information to develop their own positions – the essence of a scientifically literate citizen (NRC, 2011). As such, argumentation is a central process necessary for the development of a scientifically literate citizenry (Duschl & Osborne, 2002).

Argumentation is defined as the process of communication or dialog in which participants engage with "the coordination of evidence and theory to support or refute an explanatory conclusion, model, or prediction" (Osborne, Erduran, & Simon, 2004, p. 995). Argumentation does not necessarily mean to disagree with someone, but instead to confront thoughts, ideas, and information in a constructive, systematic way toward making a decision (Andriessen, Baker, & Suthers, 2003). In this growing area of study, scholars continue to show that that when learners engage in scientific argumentation, they not only build their skill with developing valid arguments but also engage with science content while they do so in the authentic contexts in which the science content may be encountered in real life (e.g., Cavagnetto, 2010; Erduran, Simon, & Osborne, 2004; Schwarz, Neuman, Gil, & Ilya, 2003). Additionally, studies have also shown that providing any amount of instruction with writing, including giving students ample opportunities to practice writing and written argumentation artifacts, readily improves writing skill (Bereiter & Scardamalia, 1987; Hayes, 2000). Scholars have long called for the presence of argumentation and writing in science curricula, however opportunities for students to learn how to

engage in productive scientific argumentation and writing have been rare (Driver, Leach, Millar, & Scott, 1996; Sampson & Clark, 2008).

A scientifically literate citizenry among populations in every country promises to provide a sound foundation for enabling the ways of thinking and decision making that are necessary for people to go about their daily lives while facing today's global challenges (Özdem Yilmaz, Cakiroglu, Ertepinar, & Erduran, 2017). Given the interconnected global economy and the proliferation of computing and networked technologies, socio-scientific complexities abound in virtually every decision made by individuals, families, businesses, and governments alike. As a result, mastery of socio-scientific skills, such as scientific inquiry skills, multidisciplinary perspectives, systems thinking, information and digital literacies, evaluation and analysis skills, and use of evidence and reasoning set the foundation for success in any career today, both STEM and non-STEM-related (Erduran, Guilfoyle, Park, Chan, & Fancourt, 2019; Van Laar, Van Deursen, Van Dijk, & De Haan, 2017).

In addition to the need for cross-disciplinary understanding through socio-scientific skills and information and argumentation literacies, schools are also facing a loss of instructional time for critical skills development, especially in K-12 learning. Both in the United States and internationally, there is increasingly less time for critical skill development that cross disciplinary boundaries, instead requiring schools to focus on standardized testing outcomes. Therefore, an urgent need has arisen for educational interventions that can expand opportunities for learning and "de-silo" disciplines outside of their subject-bound class times to maximize course time across the disciplines (Erduran et al., 2019). As a result, opportunities for authentic cross-disciplinary study and synthesis of subjects have been repeatedly demonstrated to allow for more authentic learning of content and skills in a way that mirrors real-world work environments and everyday life (Hoy, 2018; Van Laar et al., 2017).

In this way, educational simulation games (ESGs) can help mitigate the loss of instructional time while building up key opportunities for making interdisciplinary connections and developing critical skills (Chalkiadaki, 2018; D'Angelo et al., 2014; Rutten et al., 2012). An ESG can be defined as (1) a *simulation* in that it simulates real-world phenomena, social practices, and areas of work; (2) a *game* in that there are defined game elements to guide play, such as a defined win condition or end state and stated player roles and rules; and (3) *educational*, in that it is embedded with specific, intentional learning outcomes by design as a part of play (Riel & Lawless, forthcoming). ESGs create a robust, in-depth environment for understanding authentic scenarios, albeit in a simulated fashion. While providing a simulated game world or challenge scenario for players to work through, ESGs typically place an emphasis on simulating authentic practices in real domains, with players taking an agentive role in the game to develop solutions to the game's challenges (Brom, Stárková, Bromová, & Děchtěrenko, 2019; Konia & Yao, 2013; Vlachopoulos & Makri, 2017). ESGs also often use real-world content and history so that the game can mirror the contexts, skills, and practices of professionals within the fields or subjects that are being studied (de Freitas & Maharg, 2011; Hoy, 2018; Sauve et al., 2007). In ESGs, players as part of their regular play perform simulated tasks that mirror those used in authentic contexts, such as social settings, historical events, careers, or political contexts, thus providing substantial opportunities to engage with and develop key skills in the same way that these skills would be encountered in the real world. Thus, aside from a fun way to engage with content, the primary function of ESGs is for students to develop actionable knowledge and skills in the very contexts that they would be used, which leads to substantially improved transfer of these skills to other similar applications (Dawley & Dede, 2014).

Opportunities to generate authentic written works and to engage in critical argumentation practices remain low in current school settings (Driver, Leach, Millar, & Scott, 1996; Lamb et al., 2019; Öztürk

& Doğanay, 2019; Sampson & Clark, 2008). If this trend continues, students will remain underprepared with the guidance and training necessary to be successful in 21st century careers due to lack of access and opportunity to authentic experiences for skill practice. In addition, with the documented reduction of curricular time focused on essential 21st century skills in socio-scientific literacy, scientific inquiry, and interdisciplinary connection-making, K-12 students increasingly miss the chance to develop these key skills within their coursework in lieu of the emphasis on standardized testing, rigid educational standards, and an already-full educational day (Johnson, Bailey, & Van Buskirk, 2017; Özdem Yilmaz, Cakiroglu, Ertepinar, & Erduran, 2017; Perdana, Jumadi, & Rosana, 2019). Open-ended educational environments that embrace complexity and problem-solving skills, such as ESGs, give students a rich environment for exploring dynamic, authentic challenges that expose them to content from multiple domains and engage them with key socio-scientific practices that are key to success in today's knowledge economy (D'Angelo et al., 2014; Moshen, Abdollahi, & Omar, 2018; Suephatthima & Faikhamta, 2018).

Written Argumentation as a Game Mechanic: Playing as Teaching

To ensure that students have ample opportunities for practicing written communication and argumentation skills, these skills should be embedded as a part of regular student interactions in the curriculum or everyday activities within classrooms. One method for approaching this is to use ESGs in classroom settings to both demonstrate and integrate students' practice of skills within the game as a core *game mechanic* to successfully play the game. From a game design perspective, game mechanics are defined as the primary play actions or "primitives" within games that players do to progress in the game or win - they are the key features or moves in a game that must be done for the game to progress. To this end, intended skills that are integrated into play as key game mechanics will require students to perform the desired tasks as a part of the core game play and, as a result, students cannot proceed without engaging with the skills that the designers intend for the players to learn.

By definition, all ESGs include intentional learning objectives as a part of their design. However, the degree to which players are exposed to the intended educational content and skills in a game can vary. To this end, educational game designers can integrate desired skills and knowledge as a part of the game's core game mechanics with which players must interact to engage and win. In one useful perspective on educational game design, Clark and Martinez-Garza (2012) describe "conceptually integrated games" as those that place learning objectives within the regular interactions of the game themselves so that players are required to to interface and practice with content and skills that are included in the game's learning objectives. This approach involves more than just requiring students to read content or to memorize facts to proceed in the game. Instead, a conceptually integrated game simulates the skills and application of knowledge in ways that have high fidelity toward their real-world counterparts (de Freitas & Maharg, 2011; Gredler, 2013; Vlachopoulos & Makri, 2017).

The conceptually integrated design approach is particularly suited for ESGs, as both skills and the applied use of knowledge and facts in authentic contexts are the primary focus of these types of games. Instead of talking about or reading about key skills, players actively perform these skills in ways that mirror that of real-world practices. In other words, within this approach, students are taught key skills by *playing* them - they repeatedly perform and develop skills of interest in multiple contexts within their play. This "teach by play" pedagogical method is certainly not new in the educational world but is instead finding many new possibilities today with the ubiquity of tools for offering digitally mediated simulations, games, and classroom interventions that emphasize student-centered work and learning

by doing (Gredler, 1996; Lunce, 2006). Thus, ESGs are poised to model the work and cognitive skills that are performed by experts and likewise give players ample opportunity to practice these skills in a simulated environment that has a high level of fidelity to real-world contexts.

An ESG that integrates simulated skills as core game mechanics should also plan for and support varying degrees of competency as students develop their skill level (Shute et al., 2020; Wambsganss et al., 2020). Game play should assume students enter the game with little to no experience with the skills that are expected and should thus actively develop student competency through a series of scaffolds, coaching, support materials, hints, and tutorials. Players should thus be faced with increasing levels of difficulty as their skills improve, which allows them to further develop their skills and to be increasingly challenged as play progresses.

GlobalEd: An Educational Simulation Game That Conceptually Integrates Argumentation

In this chapter, we describe the case of the GlobalEd ESG and how it addresses the need for a globally literate citizenry via robust argumentation skills through authentic play of a classroom-based simulation. GlobalEd is targeted toward middle-school, high-school, and college students in authentic classroom settings, either entirely virtual or in a hybrid online / face-to-face situation. Although team members can interact in person within the team, interactions between teams occur entirely online. Students play as members of a team with other players from their own class, and entire classrooms play with other classrooms over a distance (even internationally). Through authentic, real-world problem scenarios built on problem-based learning (PBL) principles that are provided to players to work out during the course of the game, the GlobalEd ESG models real worldwide issues for students to solve by using genuine argumentative writing and analysis skills.

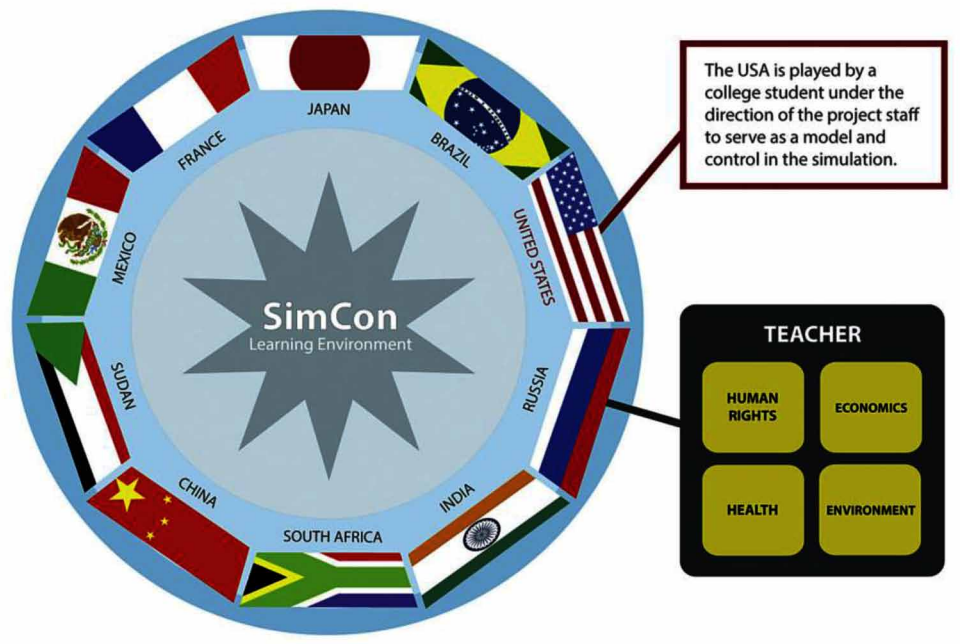
In GlobalEd, students play the role of scientific advisors who are working to solve an international crisis that faces several members of the global community. Players are assigned a "problem scenario," which details an authentic, simulated crisis that is being faced by the participants in the game for which solutions that are international in scope are the only feasible and realistic outcomes. Each classroom is assigned to play a specific country in the game and all of the countries (i.e., classrooms) meet together at a simulated international negotiations summit to solve the crisis. Students must represent their assigned country's interests at the summit and maximize the outcome for their country, but also work collaboratively to solve the crisis.

Within their classrooms, students are further divided into small teams called "issue area focus groups" to further maximize their play time and make the problem scenario less complex for the purposes of game play. Issue area focus groups include economics, environment, public health, and human rights. Although the problem scenario is multifaceted and simulates the complexities of the real world, students can focus their efforts based on their assigned issue area group within the classroom, which helps to guide and narrow their play to prevent it from being too overwhelming. Although each classroom represents a country as a whole, each classroom of players contains the same four issue groups and each specific issue group interacts with other players in that same issue group, such as economics-focused players interacting with other economics-focused players. Thus, players from all four issue groups come together as a class to represent the whole needs and interests of their assigned country.

In addition to the student players, teachers actively monitor and coach students on all of their interactions in the game. Alongside each teacher, all game interactions are moderated by a trained simulation

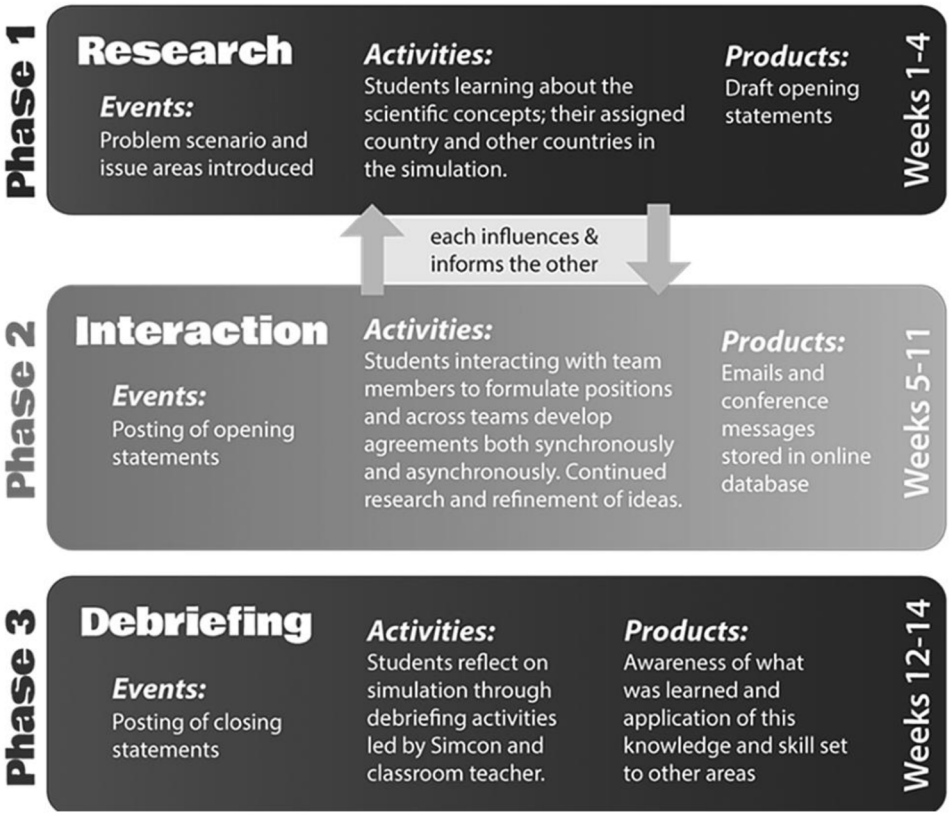
moderator called Simcon. Simcon is a human facilitator who does not use their real name to maintain the professional diplomatic feel of the game. The job of Simcon is to keep all of the student interactions moving along, maintain appropriate messages and communications between players, promote ongoing interaction with teams who demonstrate low participation, and to actively coach students with their written argumentation skills. A representative image of student and Simcon interactions appears in Figure 1.

Figure 1. Representation of student, teacher, and Simcon (i.e., game facilitator and moderator) interactions in a typical GlobalEd game between 10 "countries" (i.e., individual classrooms).



A typical GlobalEd game lasts between 10 to 14 weeks and game play occurs over three phases: (1) the research phase, (2) the interactive phase, and (3) the debriefing phase. Over the course of the three phases, players meet in a virtual platform to negotiate and develop solutions to the given problem scenario. Because the negotiations summit is simulated, GlobalEd models for students the subject matter content, skills, and ways of thinking that naturally occur in these real-world contexts where such issues would be debated and solved. This includes realistic play of roles as scientific advisors and that of an individual country meeting at a summit to discuss complex topics. Roleplaying in an authentic way also requires players to maintain their individual country's interests as the primary goal, as well as "winning" the debated solutions by getting the most for their country. As students play through the game, they vet the proposals of other players and refine the arguments of what constitutes viable solutions to the problem. Figure 2 highlights the three phases of the game in summary.

Figure 2. Three phases of GlobalEd game play progression over an example 14-week period.



In the first phase, the *research phase*, players are tasked with familiarizing themselves with the country to which they were assigned to play. Countries that are largely unfamiliar to the players are selected for scenarios, as it gives a greater opportunity to dive into the history, social structure, economy, and current events of each country played. Players are also tasked with researching the assigned problem scenario and how it affects both their assigned country and the other countries playing the game. Players use authentic primary and secondary sources in both print and digital formats to perform the research phase, gaining experience with identifying, analyzing, evaluating, and synthesizing genuine information.

At the conclusion of the research phase, each issue area team within each country develops an *opening statement* that outline's their country's initial position related to the problem scenario, their country's needs, their willingness to help solve the scenario, and some initial solutions to the assigned problem. In generating this opening statement, many scaffolds are provided to the students to develop sound, well-reasoned arguments toward their country's positions and their proposed initial solutions to the problem. This opening statement sets the stage for future negotiations and regular use of argumentation skills that will be a focus in the interactive phase.

In the second phase, the *interactive phase,* players begin to perform back-and-forth messaging to the other players who are representing other countries in the simulated negotiations summit. At the beginning of this phase, all players log into the virtual communications platform where the simulated negotiations summit is held, and negotiations and argumentation become the primary form of interaction in the game.

Players establish and maintain diplomatic-style communications with other player teams to begin their collaborative development of solutions to the problem scenario.

In an email-like interface, players send messages asynchronously to one another to suggest ideas, solicit interest in co-sponsorship of proposals, seek clarification from other teams, ask for more evidence to support players' claims, and generally inquire other players' thoughts about ideas. Each player team is required to establish communications and proposals with at least one other team, but almost always players co-develop proposals among many teams. Players are all logged in as individuals but maintain only their country persona and not their real names during the interactive phase. Over the course of the interactive phase, the asynchronous messaging will continue until teams develop their closing proposals that they will submit for consideration and voting by all delegate teams to the negotiations summit. The Simcon moderator monitors all asynchronous communications to ensure that messages remain appropriate and that players are engaging in increasingly sophisticated argumentation based on their level of skill. Simcon coaches various methods of argumentation, particularly in the use and evaluation of evidence to support claims.

In addition to asynchronous communications, players also participate in scheduled live conferences. In the live conference, players discuss important points related to solving the problem scenario in a real-time, instant messaging style chat room. Like the asynchronous portion of the interactive phase, Simcon moderates the live conferences, including maintaining an agenda of items that will be discussed in the allotted time. This agenda is provided to students ahead of the conference so that they can prepare. Transcripts of the conferences are available for download after each live conference closes.

At the conclusion of the interactive phase, all participants are required to generate a closing proposal that outlines a solution to the problem scenario. The closing proposal is generated over both the research and interactive phases as a culminating event and work product that exemplifies students' expertise in argumentative writing, as well as their collaborative work with other players. To be eligible to finish the game, each team must have at least one co-sponsoring country sign on and collaborate on their proposal through regular negotiations. After all proposals are submitted, Simcon hosts a ranked-ordered vote on the strongest proposals. Using a rubric, players then cast their opinions on the best proposals that were generated during the game. The top voted proposal in each issue area group is declared the winning proposal for the game.

In the final phase, the *debriefing phase*, players participate in a series of reflective exercises within their class and within the entire simulation with all players. Teachers host guided debriefing conversations within their classes to evaluate the play of the class, what went well, how things might have gone better, and how the skills and knowledge gained from the game might be used in other contexts. Furthermore, Simcon hosts one final live conference for all players to debrief about the game and share each of the classes' experiences and reflections from play. By reflecting on play in a structured way, players may more readily draw lessons from their experiences and ideally be more prepared to use their newly gained knowledge and skills in other contexts outside of the game or even outside of class.

Each problem scenario in GlobalEd is built on a real-world, complex issue with no right answers toward its solution, leaving the trajectory of the game completely open-ended and in the hands of the student players. Thus, the development and use of argumentation skills are essential toward successful play as students work toward identifying the multiple facets of the problem, how the problem affects their assigned country and its neighbors, and how the problem might be realistically solved. Problem scenarios that have been used in past GlobalEd implementations include global freshwater scarcity, food security, and climate change. Given the vast array of real-world challenges facing global leaders, the

number of potential GlobalEd problem scenarios are numerous and can readily address current events or whatever topics are under study within a given classroom (e.g., pandemics, political change, refugees and migration, pollution, human trafficking, global economic disruption, cyber security).

The GlobalEd game is typically played in a hybrid face-to-face and online environment. Some interactions occur within the face-to-face whole classroom and small group settings to allow for the benefits of rapid, in-person social interaction, collaboration, and problem-based learning. Additionally, because GlobalEd is played across multiple classrooms simultaneously, an online web app facilitates interactions between entire classrooms, allowing up to 18-20 classrooms to interact with each other at a time. Therefore, one of the key advantages of GlobalEd is to leverage web-based technologies and multiple participating classrooms to elicit problem-solving, research, and reflective actions not only among individuals, but also at the small group, single classroom, and multiple classroom contexts. When potentially hundreds of students play simultaneously, real-time participation by a large group can provide a large amount of activity that keeps players engaged and excited.

GlobalEd's scenarios and play interactions also target specific learning objectives. Player interactions directly give the players experiences with content in domains that are being studied. Different problem scenarios can be used in conjunction with teachers' goals. In addition, written argumentation and socio-scientific literacy skills are targeted throughout play as they regularly interact in the game with other players. In addition, play is designed to foster increased interest and self-efficacy in STEM-related subjects through experiences with real-world situations.

Integrating Written Argumentation as a Key Game Mechanic Into GlobalEd

Exposing players to content within a game world or through the game's theme and hoping that players remember about it after playing is a common approach toward educational games. However, games might best be used as pedagogical approaches when designs go one step further to integrate actual social and scientific practices by embedding these practices directly into the game mechanics themselves for players to do and must perform to play the game successfully (Clark & Martinez-Garza, 2012). In the case of GlobalEd, not only is argumentation a primary learning objective and is discussed thoroughly in the game's materials and theme, but argumentation is also a key game mechanic or action with which students are required to interact as they progress in the game.

There are multiple ways in which GlobalEd conceptually integrates argumentation and writing into the game. This section details the specific design features of the GlobalEd game that integrate writing and argumentation into the game's mechanics and interface. Each feature discussed below is specifically designed to elicit certain actions or teach skills and content related to writing and argumentation to students as they play the game. These design commitments highlight the details of how each component was developed to be conceptually integrated into the game's design, the technologies used, and the intended outcome from each feature.

Emphasis on the process of argumentation and collaborative writing. To integrate written argumentation as a key skill to be performed within the game, GlobalEd is designed with a commitment that through a process of collaborative negotiation, or argumentation with others, there will be a greater depth of understanding than if an individual studied it on their own. As learners work together, they engage in a process of negotiation or back and forth argumentation to develop a shared understanding or agreement (Andriessen, Baker, & Suthers, 2003; Von Aufschnaiter et al., 2008). In this view, scholars have both argued for and successfully demonstrated that the development of knowledge is a socially

negotiated process and that learning itself can stem from practice of argumentation and challenging one's own ideas, understandings, and cognitive processes (Andriessen, Erkens, van de Laak, Peters, & Coirer, 2003; Scardamalia & Bereiter, 2006).

Under this lens, understandings are debated, analyzed, and collaboratively constructed by all participants within the negotiation in a far richer way than if it was simply learned from text or multimedia (Asterhan & Schwarz, 2016; Jiménez-Aleixandre, 2007; Schwarz, 2009). The goal of this process is not just about learning the material or content goals, but instead also getting groups to perform at their highest levels possible by constructively challenging each other, even when performing true argumentative activities, like debate. Through an established culture of interaction and negotiation within the game world, the players are more readily able to perform the expected interactions in a negotiation-style argumentative role (Pilkington & Walker, 2003).

Toward this goal of teaching argumentation as a process, negotiation is a required component of play in GlobalEd. Players regularly interact with others to negotiate their solutions to the problem scenario. Argumentation as a learning process does not necessarily only mean arguing or debating issues - it can also be a process of confronting one's ideas, positions, and thought processes in ways that consider new information or reconcile counterclaims (Andreissen, Baker, & Suthers, 2003). In addition, to properly play one's role, players are required to regularly challenge other teams when they feel that their communications lack an acceptable level of argumentation, when there is a lack of clarity, or if players are not assuming their roles adequately. Finally, when negotiating throughout the interactive phase toward the crafting of each team's final closing proposals, each team must actively negotiate with at least one other team and have them co-sponsor their proposal for it to be accepted. As a result, never throughout the game are players allowed to solitarily develop their own positions without at least being challenged to defend their claims and provide ample evidence to persuade other teams that their proposals are worth consideration.

Emphasis on argumentation as a product through different types of written works. In addition to facilitating the process of argumentation, GlobalEd also promotes the development of argumentative products, such as written works and formalized argumentative documents. Although the process of argumentation is equally important, written argumentative artifacts can additionally be reviewed, analyzed, reflected upon, and revised, allowing for further development of argumentative skill among players. GlobalEd includes initial, ongoing formative, and summative argumentative written products as conditions of play, with each team having to complete regular written tasks and to reflect upon their written artifacts once they are completed.

Players craft multiple types of argumentative documents throughout their experience with GlobalEd: their initial opening statements at the beginning of the interactive phase, short asynchronous messages between teams, research reports, summaries of arguments, proposals to advance ideas, and their final closing proposals. Additionally, players must review, evaluate, and argue for their written works to the other players to encourage their adoption by teams in the game. With these tasks, players are regularly practicing the art of argumentation both as an ongoing process, but also through the review and critique of existing argumentative documents.

Figure 3. Example opening statement.

Msg: 37 | Date: Oct 20, 2017 15:10 EST
From: Egypt
To: All
Issue: Human Rights
Subject: Egypt Opening Statement - HR

Ahlan wa sahlan from Egypt! We look forward to working with other representatives from our fellow countries.

Water scarcity and economic scarcity are two severe issues we have been facing for a while. Water scarcity is when there absence of water; caused by too much heat, which leads the water to evaporate. It is also caused by people polluting fresh water sources such as factories dumping hot water and also household items and waste being dumped into our water supply, polluting our water rendering it useless to use and making it harder to get water from the Nile River.

Our country has made a policy that addresses water pollution and water allocation, and two laws, Law 48/1992 that protects the Nile and other waterways from pollution, and our other law, Law 4/1994 which works on protection for the environment. We also have used infrastructure methods such as groundwater wells and other irrigation and drainage systems, as well as a water quality-monitoring network, which helps us keep track of how clean our water is, so it can be used safely by our people. We are having issues with our infrastructure and water quality-monitoring network though, as well as pollution in the Nile, our main water source. We hope we can all work together to solve the water scarcity and water pollution problem that is present in the majority of the countries here.

Water pollution and water scarcity is an issue that doesn't just effect our country, it affects the rest of the global community as well. Water scarcity and water pollution is a global issue that may take different forms, but it affects us all the same. We need to work together to resolve this issue, not only for ourselves, but for our people as well. It is our duty to help and provide for our people so that way we as a people are successful and we can give our people the opportunities they need to succeed in the global community.

Shukraan,

Your Fellow Representatives from Egypt.

In one example of a written product, Figure 3 highlights a typical opening statement published by a team, in this case the Egyptian team representing the human rights issue area group. Following a set of basic established protocols and structure for crafting an opening statement, the team establishes communications with the other players at the beginning of the interactive phase by submitting an opening statement to the rest of the players. Opening statements outline the country's initial positions, their needs and interests, and some possible first solutions toward solving the problem scenario. There is a particular emphasis during the game to publish evidence within any written works when claims are made, which is seen in the citations of local laws as well as the detrimental effects that the problem scenario has on their country. Like all written works, opening statements are crafted with claims and evidence, and likely also reasoning and responses to opposition. As opening statements are the first major written milestone in the game, it is also expected to be the least sophisticated. However, players take their roles seriously and typically present impressive written works from the outset.

Figure 4. Example asynchronous message and reply.


Msg 518 | Date: Nov 9, 2017 09:30 EST
From: Saudi Arabia
To: Brazil
Issue: Economics
Subject: Proposal

Dear Brazilian delegates,

Saudi Arabia has noticed that Australia is the third biggest producer of beef. We also buy a lot of beef from you guys. We feel we are taking away freshwater from you. Saudi Arabia has a proposal for you. Saudi Arabia will reduce how much beef we buy from Australia, so then Saudi Arabia saves money. Then Brazil will save water in return. Please let us know your decision as soon as possible.

Sincerely,
The Saudi Arabian Delegation

REPLY to Msg 518
Msg 623 | Date: Nov 14, 2017 14:42 EST
From: Brazil | To: Saudi Arabia | Issue: Economics
Subject: RE: Proposal

Greetings Saudi Arabia Economic Team,

We realize that you are concerned with saving money and you have decided that the best way to save money is to cut the beef trade with Brazil. This may save money for your country and this money could be used for spending on solutions aimed at solving the water crisis. Although cutting the beef trade with Brazil will lead to extreme shortages of food in your country. This will obviously cause much of your population to starve and could possibly lead to more money being spent to feed these starving populations than would be saved by cutting beef. For the sake of both of our countries, we highly advise you against stopping the beef trade with our country. We suggest that your country looks for other solutions to the water crisis.

Sincerely,
The Brazil Economic Team

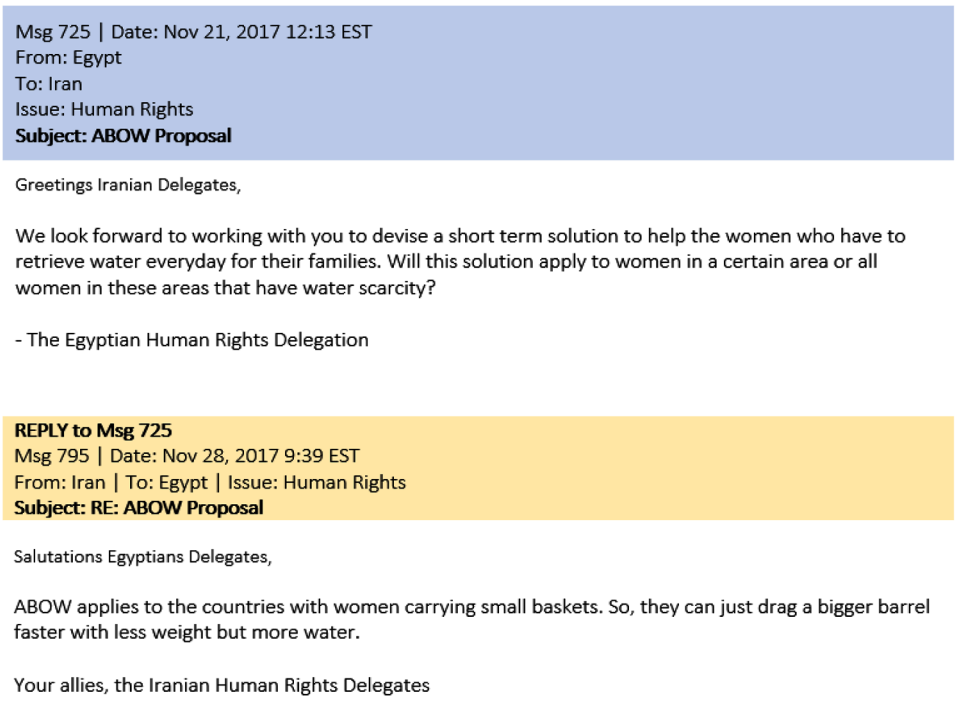
After the opening statements are posted, all players will regularly communicate with other teams and collaborate on solutions to the problem scenario. As seen in Figure 4, the Saudi Arabian and Brazil teams are sending asynchronous messages to one another to work on developing a solution to a global freshwater scarcity crisis. In both the message and its reply, players present a claim that too much money is being spent which could be used toward solving the crisis, provide some evidence of why money is being spent, and then link the provided evidence and claim with reasoning.

Most of the messages in the simulated negotiations of GlobalEd during the interactive phase are similar to this - some are respectfully confrontational like those seen in Figure 4 as players assume their role, but many also address key issues of economics, health, human rights, and environment as players seek to generate authentic, believable solutions. As such, the ample number of written products that are generated by the players in GlobalEd also serve as milestones for players' progress and can be reviewed, evaluated, and analyzed for mastery of argumentative skill.

Continual refinement and clarification. As a form of peer interaction and negotiation toward learning argumentation skills, players are encouraged to regularly seek clarifications, amend ideas and

proposals, and to constructively challenge other teams to provide more information. For example, as detailed in Figure 5, the Egyptian and Iranian teams are seen interacting in the asynchronous messaging system. Egypt posts a reply to Iran's opening statement and seeks clarification to some of the claims that they made. Iran then follows up with some responses to these questions.

Figure 5. Example of clarification request between two player teams.



As play progresses, clarification requests and revisions to claims are one of the most common forms of messages sent back and forth. In fact, asking questions or for clarification to other teams is one of the simplest ways to practice argumentation skills and engage with other teams. As questions are answered, all teams participating in the dialogue generate a greater understanding than if they just simply read a claim and did not interact.

Scaffolding and modeling from multiple examples. From the first day of play, students' development of argumentative skills are scaffolded via structured activities, modeled examples, and ample opportunities for practice. Players of every skill level are provided a series of worksheets and activities to help them craft and organize every type of message or written document that they will need during game play. For example, in Figure 6, a worksheet on constructing a basic opening statement argument is provided to students, which takes the shape of making a hamburger with multiple toppings. As such, it helps players organize their thoughts and ideas into well-crafted arguments. Worksheets such as these are used prolifically during the game by both students and teachers until players gain enough expertise that they aren't needed. Worksheets also increase in their level of sophistication and difficulty based on where players are in the game.

Additionally, many types of argumentation skills are modeled through worked examples and supplementary documents. In one example, Figure 7 provides a screenshot of a "policy brief" that is provided to each team that provides some initial arguments for the country to which players are assigned. The brief provides a logical, clearly linked argument on why the country's current situation is of interest during the negotiations summit, and why players might want to pursue a number of given paths toward negotiating with other teams. Reference documents and worked examples such as these provide players with instances of real argumentation at work, particularly in the use of evidence to make claims and decisions.

Figure 6. Example hamburger graphic organizer to scaffold players' construction of claims.

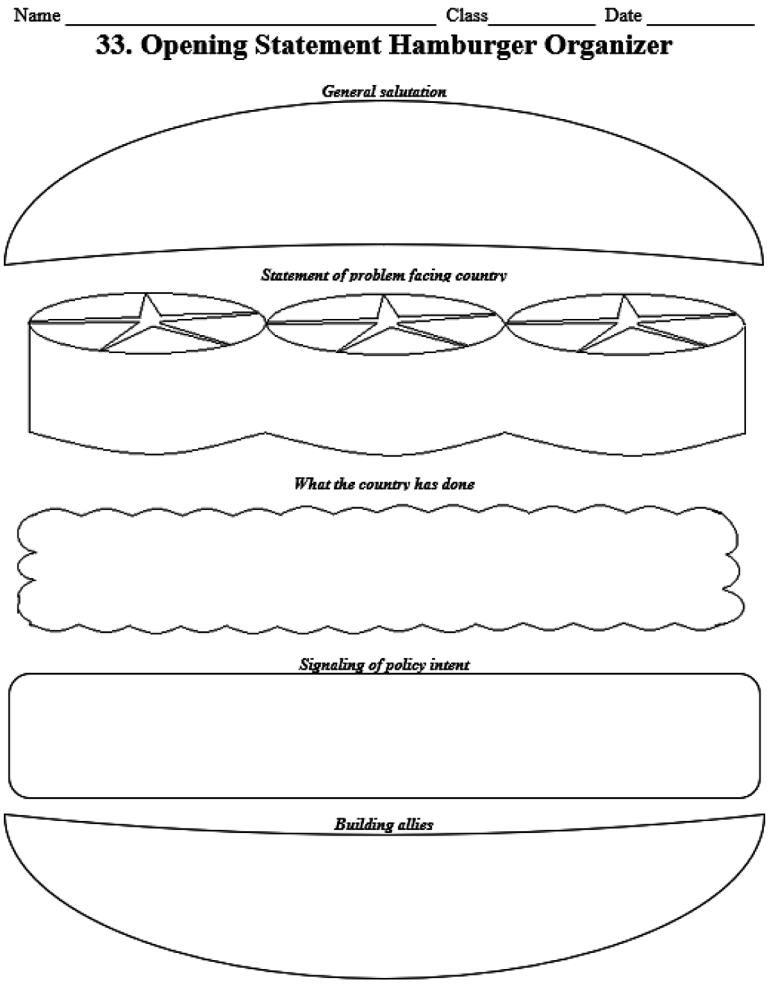


Figure 7. Example policy brief

The GlobalEd 2 Project

India and Water

An Overview of India[1]

India is a federal parliamentary republic. This means that state and federal legislative branches with specific functions need majority support in their unit to govern and make decisions.

India's executive branch is lead by their chief of state, the President, assisted by the Vice President, and the head of government, the prime minister. Similar to the United States, the president is indirectly elected by an electoral college for a five-year term. Members of the legislative branch's majority party elect the prime minister.

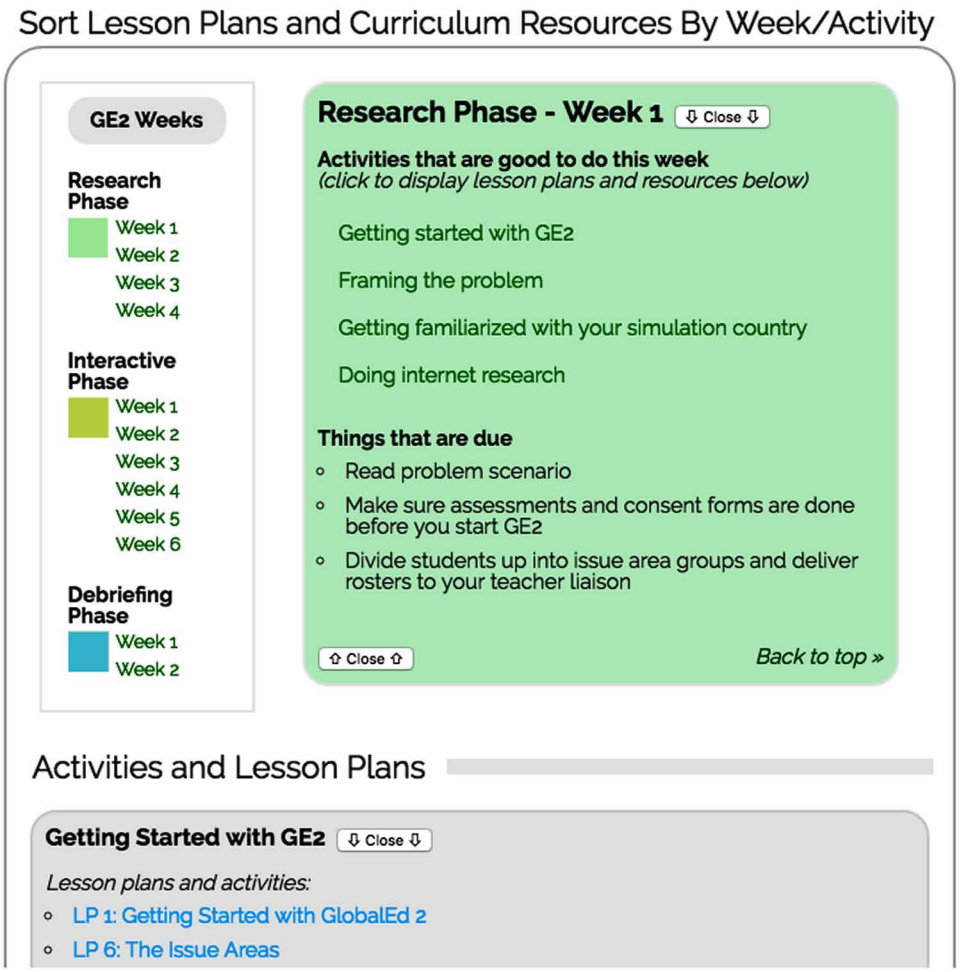
India's legislative branch, called Parliament, is composed of two houses. The first house, called the Council of States is composed of 245

Supplemental lessons on key argumentation concepts. Teachers may wish to further investigate or highlight specific skills, content, and ideas that players are gaining from the game. In GlobalEd, a suite of lesson plans and supplemental activities is provided to teachers that can be performed in a way that complements game play. As shown in the screenshot in Figure 8, a curriculum lesson browser and library is provided to teachers with over 60 supplemental lessons and activities that each focus in more depth on a specific aspect of game play.

Topics of the provided supplemental lessons include information literacy, evidence analysis, linking evidence with claims using reasoning, and evaluating information from the internet, all of which are related to the development of argumentation skills. Thus, these lessons are side projects alongside game play that teachers can use while playing the game to further enrich players' experiences and ensure that teachers' specific learning objectives are met for their students. Relevant to the game's happenings, but not the game itself.

Timing. In GlobalEd, there are both asynchronous communications and live conference events for students to interact with other players. Each type of communication requires different styles of thinking and practice, and thus provides exposure to multiple dimensions of argumentation that are to be encountered. Both the asynchronous and live timings also require different degrees of preparation. As such, the structure, requirements, and expected level of argumentative skills differ in the level of acceptability in making claims between the modes.

Figure 8. Example lesson plan browser



In the case of live conferences, as seen in Figure 9, rapid communications in an instant-messaging style format afford for more ideas to be generated and for negotiation partners to be quickly identified, but all participants are still expected to bring evidence to their claims and practice the argumentative skills that they had been learning throughout the game. In the live conference, a Simcon moderator monitors all conversations for the presence of argumentative skills and privately messages teams when they are veering off of their expected use of argumentation.

To keep the asynchronous conversations flowing well, the online learning environment is designed to sort, keep, and organize message threads and conversations to retain the contexts of conversations, as well as to point to other related conversations. These tools assist with maintaining high levels of organization and focus as students continue to practice and play.

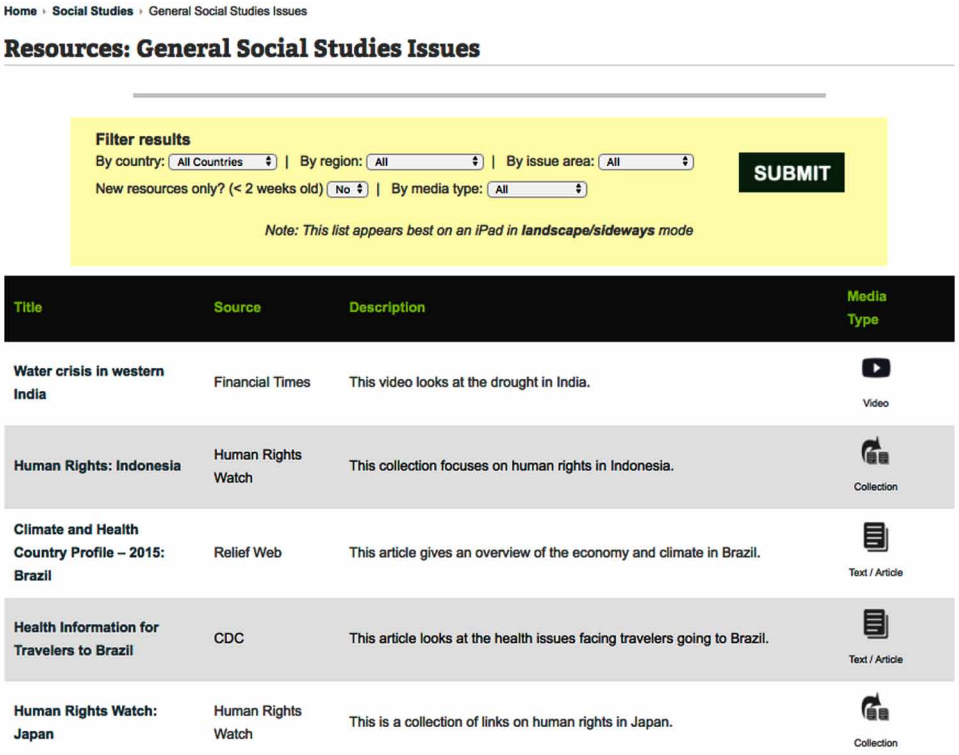
Emphasis on authenticity. The GlobalEd simulation emphasizes the exposure to multiple kinds of authentic documents, resources, and content related to the simulation scenario. It is important to maintain authenticity and realism in the problem scenario and surrounding information, as the purpose of the ESG is to allow students to experience problems and problem solving in genuine, albeit simulated contexts.

Figure 9. Example live conference.

In GlobalEd, a priority is placed on genuine primary and secondary sources that students use to conduct their research. Players are also provided an initial database of vetted research documents at the players' grade level to familiarize themselves with their countries and the problem scenario at the beginning of the game, of which a screenshot appears in Figure 10. In the database, players can sort and filter entries

by topic, region, and media type, which aid in the maximization of their use. As a result, providing a real-world context even when simulated gives similar conditions, complexities, and outcomes that could be expected when performing in a related situation. This gives players direct experience with making decisions, performing skills, and using knowledge in highly similar situations to promote the transfer of

Figure 10. Example research database for students to assist with beginning the research phase.



skills and knowledge to these new contexts.

Increasing level of difficulty based on skill. The phases of GlobalEd play are designed to provide progressively challenging levels of required argumentation, all based on the players' observed level of skill. Teachers and the Simcon moderators regularly coach students when they see opportunities for formative improvement of their communications between teams, providing review and suggestions over multiple iterations of written works like the opening statement and closing proposal, and in the development of players' final polished written products. In the beginning of the game, less polished or low levels of argumentative exercise suffice, but as the game progresses, the depth of the rubrics by which written argumentation is evaluated increases and players are expected to demonstrate increasingly higher sophistication with their arguments as time goes on.

Emphasis on active guidance. The GlobalEd game provides multiple layers of active guidance to support student play, and subsequently, their progressive development of argumentation skills:

1. Human moderators (i.e., Simcons) are present to model argumentative writing and promote strong argument structure. Additionally, Simcons monitor all communications toward keeping discussions appropriate, prevent bullying and negative comments, and to promote peer-to-peer interactions.
2. Teachers also monitor the communications from their class and work with students on the development of their negotiation strategies, communications with other teams, and the writing of their opening statements and closing proposals. Teachers are assisted with guidance with multiple structured activities, lessons, and organizers to help prompt students in the development of their play.
3. Peer interactions from other players provide a substantial amount of guidance. While in the interactive phase, players' written works and communications between teams are reviewed and commented on by other players. This form of peer review helps promote a sense of collaboration among teams, as well as maximize the potential that players can learn from their peers. By negotiating reviews on written documents like the opening statements and closing proposals, players can continually improve their written works, consider other perspectives and understandings, and be confronted in a low-risk way with opportunities to strengthen their argumentation skills. To be the winning proposal, it is more important for a proposal to have sound argumentation and participate in realistic collaboration, instead of simply the subject matter or facts discussed in the proposal. Thus, students' written works are continually refined via feedback from other students, not just the teachers or Simcon moderator.

Student roleplaying. In GlobalEd, students assume different roles than they are normally exposed to, which allows for students to take different perspectives, see multiple sides of arguments, and focus on the process of crafting sound arguments despite taking a different perspective. Playing as a scientific advisor to a country with which the players are largely unfamiliar helps to encourage consideration of social, historical, and scientific content that may not have been investigated otherwise by the players. By assuming the role of a character in the game instead of their real selves, students can also stay safer in online environments by not using real names or identities in lieu of the play personae.

RESULTS

Studies of GlobalEd in Authentic Classroom Settings

The positive benefits to students who play GlobalEd have been empirically demonstrated over the last decade. Since 2011, the GlobalEd ESG experience has demonstrated significant short- and long-term benefits to both student learning and teachers' practices, with additional studies conducted on the effectiveness of the supplementary curricular lesson plans, teacher professional development programs, and supportive materials (Lawless et al., 2014; 2015; 2016; 2018; 2019; Riel et al., 2015; Riel, 2020; Yukhymenko, 2011).

Concerning the primary learning outcome of *written argumentation* in GlobalEd, game play over 14 weeks during a randomized field trial indicated moderate to strong effect sizes (represented by Cohen's *d*) for students' written scientific argumentation skills (d=.43-.69) in their ability to construct chains of argumentation with claims, evidence, and reasoning (Lawless et al., 2015). Additionally, students' writing self-efficacy and perceptions of their own writing skill ability was observed to be stronger to a

moderate effect after game play (d=.20) (Lawless et al., 2015). Additional studies demonstrated higher levels of written argumentation skills among students who participated in the game more (Lawless et al., 2018; Riel, 2020).

Implementation of GlobalEd as intended by the game developers is also important to ensure that the principles and theoretical underpinnings upon which the game was designed are adhered to by the teachers. Although flexibility and adaptation of the game is expected and desired, certain game elements and milestones are essential to activate key learning processes. In previous studies, when a teacher implemented GlobalEd with a high degree of fidelity to the design, observed learning effects were moderated further (Lawless et al., 2015). This was specifically the case when teachers integrated a high degree of problem-based learning pedagogy within their classrooms and encouraged high degrees of participation within the game (Lawless et al., 2018; 2019; Riel et al., 2015a; 2021; Riel, 2020). When fidelity of implementation of GlobalEd was higher among teachers, their students' effect sizes of learning written argumentation skills were much larger (d=1.16) in contrast to classrooms with low fidelity of implementation of the GlobalEd game demonstrating no significant change in pre-post scores in written argumentation skills (d=.13). In other studies, teachers who most closely guided their students through the activities as prescribed observed much higher achievement than those whose classes did not participate in as many of the game's activities (Lawless et al., 2016; 2018; Riel, 2020; Riel et al., 2021). Although students ultimately participate in educational games, the results from these studies demonstrate the need for also focusing on teachers' participation and implementation of simulation games, as they are the primary persons who determine with what activities students will engage in the classroom.

Studies on GlobalEd also demonstrated effects between key student demographics who have participated in the simulations. Primarily, during the previously mentioned randomized field trial, written argumentation scores differed between urban and suburban students as well as gender, illustrating sometime large gaps between subgroups, such as d=.30 for suburban females to d=.69 for urban males (Lawless et al., 2015). Subgroup differences again were substantially large with classrooms whose teachers demonstrated higher degrees of fidelity of implementing the game having higher levels of effects compared to low-fidelity implementation classrooms (e.g., suburban females at d=1.71 to urban males at d=2.44).

With respect to efficacy studies examining other benefits to playing the game and additional short- and long-term impacts of the simulation, effect sizes indicated a moderate effect toward science knowledge, self-efficacy, interest, and written argumentation as proximal outcomes (d=.20-.69) (Lawless et al., 2018). Further significant interactions were also found for the distal outcomes scientific inquiry skills and socio-scientific literacy skills (d=.20-.35). Perhaps due to the interconnected and interdiciplinary nature of play during ESGs, additional learning outcomes can be measured and observed in content areas and skills in which the game explores.

CONCLUSION

Educational simulation games are poised to provide meaningful, authentic experiences for players that require them to model many of the skills and ways of thinking that are required of today's knowledge workforce. ESGs are a natural environment for the practice of argumentation skills, as most ESGs readily model complex social processes in which participants must interact with information, make decisions, and persuade others. As such, argumentation can natively occur within such environments. In virtual or hybrid/blended ESGs, this is especially true for written argumentation skills, as players' primary

mode of interaction is written communications with other players. Players of all writing skill levels can readily be scaffolded, coached, and supported in their writing as they play the game through a variety of supports embedded in the game.

In the example case provided, GlobalEd as delivered either fully virtually or in a hybrid blended way demonstrates a comprehensive ESG that integrates the primary learning objective skills as the actual game mechanics and interactions that are expected to be successful in the game. As such, GlobalEd provides a conceptually integrated experience to players instead of the more common approach of casually exposing students to themed games or talking about content within games but are neither the focus of actual game play mechanisms nor interactions. Additionally, GlobalEd is designed with key supportive interactions, such as teacher instructional supports, curricular materials, teacher implementation assistance and professional development, and long-term engagement nudges and notifications for student players. Designs such as GlobalEd in a hybrid or completely virtual manner are particularly valuable today, as rich, successful authentic learning environments are essential in the post-pandemic world where students can develop critical skills that will lead to their success in their future careers and everyday life.

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