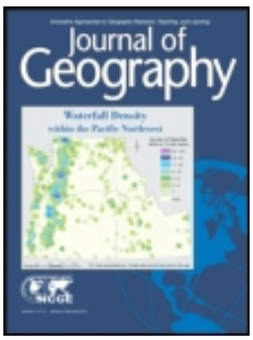

Journal of Geography

ISSN: 0022-1341 (Print) 1752-6868 (Online) Journal homepage: http://www.tandfonline.com/loi/rjog20

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To cite this article: Matthew A. Schnurr, Elizabeth M. De Santo, Amanda D. Green & Alanna Taylor (2015) Investigating Student Perceptions of Knowledge Acquisition within a Role-Play Simulation of the Convention on Biological Diversity, Journal of Geography, 114:3, 94-107, DOI: 10.1080/00221341.2014.937738

To link to this article: http://dx.doi.org/10.1080/00221341.2014.937738

Published online: 10 Sep 2014.

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Abstract

This article investigates the particular mechanisms through which a role-play simulation impacts student perceptions of knowledge acquisition. Longitudinal data were mobilized in the form of quantitative and qualitative surveys to examine whether the simulation succeeded in increasing knowledge around both content and skills. It then delves deeper into the relationship between simulations and knowledge transmission by exploring the role of online technologies and stakeholder choice as mediators. This analysis reveals two major insights: (1) the importance of thoughtfully embedding the simulation within the overarching logic of the course itself, and (2) the potential contribution of online technologies to enhancing student knowledge acquisition.

Key Words: *role-play simulation, knowledge acquisition, blended learning, Convention on Biological Diversity*

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Introduction

The relationship between role-play simulations and knowledge acquisition is less clear than it may first appear. Much of the pedagogic literature on using role-play simulations—in which students immerse themselves in a particular role and advance their interests in a fictionalized classroom setting designed to mirror real-world processes—demonstrates that students find these exercises to be fun, engaging, and stimulating (Belloni 2008; Coffey, Miller, and Feuerstein 2011). However, as Shellman and Turan (2006) emphasize, engaging students is not necessarily the same as teaching them. This article investigates the particular mechanisms through which a role-play simulation premised on recreating an international environmental negotiation can enhance students' assessments of their learning. We mobilize longitudinal data in the form of quantitative and qualitative surveys to examine whether this learning exercise succeeded in increasing self-reported knowledge around both content and skills. Results show that our role-play simulation successfully increased students' ratings of knowledge related to content, but did not meaningfully enhance their perceived knowledge of associated practical skills.

These questions should be particularly valuable to geographers seeking innovative mechanisms for stimulating knowledge acquisition. Role-play simulations are especially useful in geographical pedagogy as they underscore the multiscalar nature of human-environment relations, as well as the often messy and multidimensional process of creating governance regimes to manage such complex interactions (Howard 2011). As Dengler (2008, 483) emphasizes, simulations are particularly useful tools for teaching within the intersections of geography, sustainability, and governance as they allow students to grasp how environmental issues "transcend traditional political boundaries, such as (1) issues of globalization, which join North and South; (2) linages across different spatial scales (local, regional, national, multinational, and global); and (3) the importance of tailoring solutions to different sociocultural contexts." Even more critically, role-play simulations can help students achieve a level of "emancipatory geography" (Maddrell 1994), by exposing students to alternative views and fostering identification with marginalized or vulnerable actors (Wheeler 2006). The immersive and interactive model that we have elaborated here has the added advantage of blending face-to-face and online forums, allowing students to appreciate how the spaces in which debates are conducted can influence political outcomes.

What Kinds of Knowledge Do Students Gain from Role-Play Simulations?

Much of the literature examining how role-play simulations enhance knowledge transmission approaches the question by teasing out knowledge associated with content from that associated with skills. If the goal is the former, then researchers recommend that instructors focus on incremental self-paced learning, to allow students time to accumulate information on the particular topics or themes at hand (Dunn 2009). Asal and Blake (2006) suggest that preparation is critical to attaining the deep learning potential of the role-play simulation: they endorse using background readings, writing statements, and position papers as tools to help achieve this goal. Haack (2008) argues that preparatory learning is particularly salient when teaching in the realm of international negotiation, in which simulations have a tendency to privilege experiential learning over

theoretical-conceptual learning. Case studies of the UN Security Council (Chasek 2005) and conflict in the Middle East (Baylouny 2009) underline how crucial this incremental accumulation of knowledge is to the goal of understanding and retaining content within the delivery of a role-play simulation.

Other accounts emphasize the interactive, experiential learning associated with role-play simulations as the best means for ensuring successful knowledge transmission, especially that which is related to practical skills. Authors such as Brown and King (2000), Belloni (2008), and Crossley-Frolick (2010) stress the importance of student-driven learning within the simulation, arguing that the most valuable learning occurs as a result of the dynamic, face-to-face interactions that take place among students. Thus, the most beneficial knowledge accumulated during the simulation is constructed by the students themselves via exchange and dialogue, making students active partners in the learning process (Crossley-Frolick 2010). Within this view, learning is best achieved by structuring a simulation that allows students "to consider alternative viewpoints, examine opportunities and obstacles, and develop each student's own personal understanding and critical thinking" (Belloni 2008, 222).

The existing literature thus posits a dichotomy between teaching content versus teaching skills in a role-play simulation; as Asal and Blake (2006, 4) emphasize, "most simulations provide opportunities for learning on both fronts, [content versus skills] but you must decide which is primary. This will help you to determine the proper balance between the preparation and interaction stages." But do instructors need to choose between the two? We expect that a role-play simulation of an international environmental negotiation can achieve both goals simultaneously by thoughtfully embedding the simulation within the logic of the course itself and carefully integrating experimental online learning tools alongside more traditional approaches such as preparatory learning and face-to-face learning. We hypothesize that these different modes of learning are best combined in order to maximize knowledge acquisition that is both content- and skills-based.

What Factors Mediate the Acquisition of Knowledge within Simulations?

The second objective of this study is to explore the significance of the two most commonly discussed mediators of knowledge transmission within role-play simulations: the integration of online tools and the choice of stakeholder. Computer-mediated technologies are increasingly being recognized as a key pillar of a successful simulation, particularly when the learning objectives span the realms of both content and skills (Ruyters, Douglas, and Law 2011). In order to be successful, however, online learning technologies need to be selected carefully to ensure they reflect the broader learning objectives of the role-play exercise and integrated thoughtfully to ensure that students are confident and proficient participants (Harsell 2010). We have argued elsewhere that the best means for achieving these goals is to ascribe to a model of blended learning, whereby computer-mediated tools are strategically incorporated along more traditional classroom methods in order to replicate the dynamism and complexity of international negotiation (Schnurr, De Santo, and Craig 2013). In this article, we seek to delve deeper into the role of online technologies in mediating knowledge acquisition by empirically evaluating the benefits of incorporating multiple learning forums.

A second factor that has been identified as an important determinant of a student's learning experience is the choice of role they portray. In particular, the relationship between the student's own views and the views of the stakeholder s/he represents might play a key role here. But researchers disagree on the direction of this learning: in Baylouny's (2009) exercise conducted with American military officers, those representing *terrorist* roles (e.g., those with oppositional views to their own) gained a better understanding and appreciation of the complexity of such negotiations, while Youde (2008) recounts the frustrating and humbling experience of a student representing a stakeholder sharing her own political views. This study aims to empirically evaluate these anecdotal experiences by investigating whether the choice of stakeholder impacts knowledge transmission.

In many simulations discussed in the literature, students are assigned roles (purposefully or randomly), rather than allowed to choose their stakeholder. In our simulation, stakeholder positions are opened at a set time and students can choose whom they wish to represent (within limits—if two students want the same position, the first one to select it gets it, and the other student must choose an alternative). Consequently some students represent stakeholders with the same perspective as their own, and others take on roles that are quite different or even oppositional to their own views on the topic. This provides an opportunity to examine the impact of stakeholder choice on knowledge transmission: do students learn more by representing roles that coincide or conflict with their own views and beliefs?

Measuring Knowledge Acquisition in Role-Play Simulations

In order to evaluate whether and in what ways our role-play simulation enhances the transmission of knowledge, we devised mechanisms for measuring student self-perceptions of learning. Scholars have experimented with various methodologies designed to assess the impacts of role-play simulations on learning. Three strategies have emerged as the most promising means of accomplishing this. First, researchers have investigated the relationship between the role-play simulation and student academic performance. For instance, both Chasek (2005) and Frederking (2005) show that final exam scores improved as

a result of their role-play simulation. Second, researchers have employed control groups of students, using a variety of qualitative and quantitative tools to identify differences in knowledge acquisition between those students who participated in the simulation and those that did not (Frederking 2005; Baranowski 2006; Krain and Lantis 2006). Third, and by far the most common in the literature, others have employed a combination of pre- and postsurveys to identify students' self-perceived changes in knowledge that occurred as a result of the simulation (examples include Brown and King 2000; Krain and Shadle 2006; Shellman and Turan 2006; Osgood, Stangl, and Bernotsky 2012). We decided to employ the latter method, due in part to ethical reasons (we were reluctant to use student academic performance as a proxy for knowledge acquisition) and pedagogical reasons (the simulation was created as the culmination of the entire course, making it difficult to imagine creating another version sans simulation that could be used as a control). Though we recognize that self-reported changes in learning do not align perfectly with experimentally validated learning tasks, previous research has shown a moderate correlation between self-reports and performance (Chesebro and McCroskey 2000; Sitzmann *et al.* 2010), which is amplified when the questions posed relate to a specific domain, as they do in this study (Zell and Krizan 2014).

One of the major shortcomings within the current literature evaluating the ability of the simulation to increase student knowledge is the dearth of longitudinal analyses. Almost all of the existing studies that examine these relationships do so over a single semester (exceptions include Cutler and Hay 2000 and Frederking 2005). This greatly limits the possibility for extrapolating broader trends, which may in fact reflect that particular group of students. Our aim was to provide more rigor to these results by incorporating results taken from two consecutive cohorts of students who experienced the simulation. While we acknowledge that two years of data offer only partial insight into the long-term impacts on this exercise, a multiyear comparison does offer some understanding of how student perceptions of their learning change over time.

The Convention on Biological Diversity (CBD) Simulation

Our role-play simulation took place within SUST 2001 Environment, Sustainability and Governance: A Global Perspective, a second-year course that is a core requirement of Dalhousie University's new College of Sustainability. Cotaught by two geographers appointed to different faculties, SUST 2001 is a full-year course compressed into a single semester, with annual enrolments of approximately 100 students. It comprises six contact hours per week: three hours of lecture, two hours of tutorial, and one hour of guest lecture. The course is anchored by three substantive modules on biodiversity, food, and agriculture, and environmental security, culminating in a three-week simulation that recreates a recent negotiation of the Conference of Parties to the UN Convention on Biological Diversity (CBD) over the issue of Access and Benefit Sharing (ABS); that is, the equitable sharing of financial benefits that accrue from the commercialization of genetic resources through ventures such as bioprospecting.

We designed the CBD simulation as the culmination of the content and skills students learn throughout this course (see Table 1 for full timeline). The simulation is first introduced in week 3: we begin by surveying the general history and function of multilateral environmental agreements (MEAs), explain the genesis and functions of the CBD, ending with the current contentious negotiations surrounding ABS. Students are further introduced to the process of the role-play simulation via a community meeting around community-based conservation, which takes place over the first three weeks of tutorial. In the community meeting students pair up and represent the interests of a particular stakeholder (e.g., wildlife authority, national government, conservation NGO, community member) and advance their stakeholder's particular interests within a fictionalized meeting around the community benefits of conservation. Teaching assistants (TAs) introduce and mentor many of the skills that students will need to rely on in the simulation, including how to effectively represent a stakeholder and how to write a position paper, as well as skill development related to negotiation, mediation, and consensus building.

Students choose the role they wish to represent in the CBD simulation early on in the semester to allow them lots of time to engage in background reading and preparation, choosing from a list of stakeholders comprising nation-states, NGOs, multinational organizations, and industry representatives. Continual skill development workshops are sprinkled throughout the semester to supplement this initial introduction to both the content and process of role-play simulations. We devote time in lectures and tutorials to effective policy analysis, successful negotiation strategies, and understanding the complex language of UN policy documents. Two assignments during the semester further help students hone the skills they will need to be successful in the simulation itself. The first is a policy analysis assignment, which asks students to analyze one article of the existing protocol on access and benefit sharing and critically evaluate whether this constitutes an effective example of environmental governance (see Appendix A for more details on readings and assignments used). The second is a position paper assignment, which requires students to undertake research into their stakeholder's position on the access and benefit sharing provisions of the CBD, and is due on the day that the simulation begins. The goal of this assignment is for students to clearly and concisely articulate their stakeholder's position going into the negotiation.

The simulation itself spans the final two weeks of the semester. Our simulation begins where the real-life negotiation into ABS left off: with the reopening of debate on six of the most contentious articles in the Nagoya

Table 1. An overview of the simulation timeline, with components, skill development, and outputs of simulation.

	Simulation component				
Week	**Lecture**	**Tutorial**	**Online**	**Skill development**	**Outputs**
2		Introduce role-play via a small-scale simulation exercise		Representing a stakeholder in a simulation	
3	MEAs, CBD, Nayaga Protocol introduced	Students participate in small-scale simulation exercise		Representing a stakeholder in a simulation	Position paper for small-scale simulation
4	**Introduce simulation:** discussion on how to choose a stakeholder				
5	Introduce policy analysis assignment		Stakeholder sign-up opens	Effective policy analysis	
6	Negotiation tactics			Negotiation tactics	
7	Introduce position paper assignment				
9	Understanding UN language	Introduce online component of the simulation		Understanding UN language	Policy analysis assignment due
11	Procedural rules for simulation	Procedural rules for simulation			
12	**Simulation begins** (two plenary sessions)	**Simulation begins** (one working group session)	Virtual negotiation (editing draft text)		Position paper assignment due
13	**Simulation ends** (final plenary session, voting on final wording of draft text, debrief)	**Simulation ends** (final working group session, debrief)	Virtual negotiation (editing draft text)	Guest speaker presentation from a participant in the actual CBD negotiations	

Protocol on ABS (negotiated by the CBD Conference of Parties at Nagoya, Japan, in 2010). The goal for all stakeholders is to amend this existing text with changes that reflect their particular bargaining position but also satisfies enough other stakeholders that the new language will be adopted by two-thirds majority voting. Students advance their interests in three separate but interconnected forums. First, the plenary sessions (lectures) presided over by the secretaries-general (course instructors). These are the formal meetings attended by all stakeholders, which allow time for moderated debate on each of the six articles under discussion, as well as the forum for the final votes on the new language proposed for each article. The plenary sessions are also the site for any acts of organized dissent. Second, the working group sessions (tutorials), presided over by the working group chair (teaching assistant). Each working group is tasked with delving into one of the six articles under debate and developing the specific clauses that would then be voted on in plenary. The smaller and more informal nature of the working group also allows more opportunities for lobbying, mediation, and coalition building. Third, we integrated online technology using Dalhousie University's Online Web Learning Software (OWL). Our aim was to strategically integrate e-learning technologies in order to recreate the complexity of real-world international negotiation and increase the frequency and intensity of student-to-student learning. We relied on two tools to achieve this: (1) an in-role discussion board, which allowed students to find other stakeholders with like-minded positions, build coalitions, schedule meetings outside of class, coordinate their negotiation efforts, and advance their position by creating videos or documents and sharing these with other students, and (2) Campus Pack Wiki, an editable software that allows students to collectively build on the existing text of each of the six articles up for debate. This tool allows students to post amendments, edits, and additions to the six articles under debate in real time, creating newly updated versions that reflect their bargaining position. Other students can then comment on these changes, indicate their support or opposition, and suggest compromise wording to overcome impasses.

METHODS

Student feedback to the CBD simulation was evaluated using mixed quantitative and qualitative surveys distributed before the simulation was introduced (in week 3) and once the simulation exercise was complete (in week 13). This analysis makes use of student responses taken from two separate years of the simulation: 2011/12 (Year 1) and 2012/13 (Year 2). In Year 1, seventy students completed both surveys, while thirty-three students completed only one or the other. In Year 2, seventy-four students completed both surveys, while twenty-two students completed only one or the other.

The first three questions in the surveys address demographics. A majority of participants identified themselves as Sustainability majors (Year 1, n = 50; Year 2, n = 41) and in their second year (Year 1, n = 45; Year 2, n = 47). In Year 1, nineteen students reported they had participated in a simulation previously (while sixty-six had not), and in Year 2, seventeen students reported they had previously participated in a simulation, while sixty-one reported they had not. Taken together, these data suggest that demographic information was similar between Year 1 and Year 2 of the simulation, allowing for easier longitudinal analysis.

Surveys in Year 1 were completed on a 5-point Likert scale, while surveys in Year 2 were completed on a 7-point Likert scale, as we identified a need for a greater range of responses. Consequently we were unable to directly combine the data to analyze overall pre-simulation to post-simulation effects when examining averaged subscales. Instead, Year 1 and Year 2 data were analyzed independently for changes in students' responses to questions that were present on both survey A (pre-simulation), and survey B (post-simulation). Sixteen questions (Q6–Q21) were present on both surveys. We averaged student responses on similar questions to create subscales based on changes in *knowledge of the topics* and *practical skills and knowledge of policy analysis*, and then analyzed changes in average student responses from pre- to post-simulation using repeated-measures ANOVA. In cases of significant differences, subsequent analyses examined differences between pre- and post-simulation responses to individual questions within that subscale using a Wilcoxon signed-rank test.

RESULTS AND DISCUSSION

Improvements in Perceived Topic Knowledge

After participating in the simulation (survey B), students mean ratings of their knowledge of classroom topics were significantly higher than initial ratings (survey A) in both Year 1 and Year 2 of the project (see Table 2). When we

Table 2. Changes in mean (± *SD*) student ratings of topic knowledge from survey A (pre-simulation) to survey B (post-simulation) on a Likert scale from 1–5 (Year 1) or 1–7 (Year 2). (↑ indicates a significant increase in ratings from pre- to post-simulation ($p \leq 0.001$), $\eta 2$ indicates the effect size.)

	Year 1				Year 2			
	Survey A (pre-simulation)	Survey B (post-simulation)	Significant change from survey A to B?	Statistics	Survey A (pre-simulation)	Survey B (post-simulation)	Significant change from survey A to B?	Statistics
Overall mean rating of self-reported knowledge	2.5 ± 0.72	3.43 ± 0.74	↑	*F(1, 69) = 117.91* p≤ 0.0001 *η^2 = 0.634*	3.51 ± 0.78	5.12 ± 0.87	↑	*F(1,67) = 162.96* p ≤ 0.0001 $\eta^2 = 0.709$
Q14. Please rate your knowledge of multilateral environmental agreements.	2.77 ± 0.87	3.16 ± 0.88	↑	*Z = −3.38* *p ≤ 0.001*	3.61 ± 1.06	4.74 ± 1.1	↑	$Z = -5.58$ $p \leq 0.0001$
Q15. Please rate your knowledge of access and benefit sharing	2.41 ±1.01	3.51 ± 0.91	↑	$Z = -5.85$ $p \leq 0.001$	3.41 ± 0.98	5.35 ± 1.13	↑	$Z = -7.06$ $p \leq 0.0001$
Q16. Please rate your knowledge of the UN Convention on Biological Diversity	2.34 ± 0.86	3.64 ± 0.78	↑	$Z = -6.65$ $p \leq 0.001$	3.51± 1.22	5.22± 0.95	↑	*Z = −6.62* *p ≤ 0.0001*

examine these results by individual questions, it appears that students felt they significantly improved their knowledge on all of the main topics addressed in the simulation, including their understanding of multilateral environmental agreements (Q14), access and benefit sharing (Q15), and the Convention on Biological Diversity (Q16), and that these results were not driven by changes in one specific topic area. This suggests that, on average, students felt that the simulation improved their understanding of course material.

Qualitative comments reveal that the simulation was an effective means of inculcating the substantive concepts—MEAs, ABS, CBD—that were at the core of the course itself. Students emphasize that the interactive and engaging nature of the simulation helped to spur their learning: "it made me *want* to learn more about the Nagoya Protocol so I went out of my way to find more information" (original emphasis). Students appreciated the real-world application of concepts previously encountered in other parts of the course. One student expressed this as "the simulation gave me a hands-on interaction into the material we were learning which resulted in the improvement of my knowledge on the subject material," while another reflected, "it helped me to understand more clearly the intricacies of environmental governance structures and policies because we had to live them!" Still another commented that, "the simulated negotiation helped me better understand course content, as it required us to put what we've learned into practice in realistic ways."

These quantitative and qualitative results lend support to one of the most entrenched beliefs about the learning value of the role-play simulation: that increasing student engagement and enthusiasm translates into increases in self-reported knowledge. These data confirm that the simulation was an effective means of operationalizing many of the core concepts that were introduced in the more traditional forums of lectures, tutorials, or readings earlier in the semester. Our findings corroborate previous studies undertaken by Shellman and Turan (2006) and Bachen, Hernandez-Ramos, and Raphael (2012), which underline the positive relationship between stimulating student interest and learning within simulations.

Improvements in Perceived Practical Knowledge

Along with the changes in students' perceived knowledge about the topics covered in the course, we also wished to evaluate whether the simulation had any effect on students' self-reported abilities with the processes and skills associated with international negotiation (see Table 3). Students' self-reported capacity in nearly all of the skills that were evaluated in the surveys—including negotiation (Q17), mediation (Q18), lobbying (Q19), and public speaking (Q20)—either decreased or did not significantly change from pre- to post-simulation in either Year 1 or Year 2.[1] The only exception to this trend related to the skill of policy analysis (Q21): in Year 1, participation in the simulation had no effect on students' perceived policy analysis skill, but in Year 2, students believed that participation in the simulation substantially improved their policy analysis knowledge/skills. Qualitative data reveal that many students felt underprepared for the task of policy analysis in Year 1: one student complained there was "little instruction for wording of policy, [and] language skills were not taught prior. [As a result], students struggled." Another asked for "more exposure to the language used beforehand. . . some tutorials around policy analysis would be beneficial." In contrast, students in Year 2 seemed more confident: "[the simulation] gave us real hands-on experience, which gave us a deeper understanding of policy, its creation and implementation."

We hypothesize that this Year 2 change in student self-assessment in the skill of policy analysis stems from two major changes implemented in response to student feedback. The first was a complete revamp of the policy analysis assignment. In Year 1 the policy analysis assignment explored different MEAs, and student feedback indicated that they had difficulty applying the skills they had developed in this assignment to the different substantive focus of the simulation. We revised this assignment in Year 2 so that it focused on analyzing the same six articles of the simulation debate. Reformulating the assignment to make it explicitly complement the skill development related to policy analysis helped achieve this learning outcome. The lack of comparable success achieved in the realms of other skills such as negotiation, public speaking, etc. suggests that future iterations would be best served by developing additional assignments explicitly targeting each particular skill development, which could yield more comprehensive increases in perceived practical knowledge.

The second major change impacted the timeline of the simulation. The most common comments received from students in Year 1 were that they felt underprepared for the skills they would need to be successful in the simulation: representative feedback included "I do not feel like the [professors] prepared us enough for what to expect (they should dedicate a lecture to explaining the negotiation process, etc.)," and "there was a lack of preparation teaching us how to engage in an activity such as this."

To address these concerns we overhauled the preparatory learning phase of the simulation by dedicating more time to skill development workshops and spreading these out over the entire semester, in an effort to make students more familiar with the skills they would need to succeed in the simulation. The increased self-assessment of policy analysis indicates that this revised timeline was more successful in achieving this goal, underlining the importance that incremental preparatory learning plays in ensuring that students feel confident participating in such complex and dynamic learning exercises.

Table 3. Changes in mean (± *SD*) student ratings of practical skills from survey A (pre-simulation) to survey B (post-simulation) on a Likert scale from 1–5 (Year 1) or 1–7 (Year 2). (↑ / ↓ indicate a significant increase/decrease in ratings from pre- to post-simulation ($p \leq 0.05$), ↓↓ indicates a trend towards a decrease with $p \leq 0.09$, $\eta 2$ indicates the effect size.)

	Year 1				Year 2			
	Survey A (pre-simulation)	Survey B (post-simulation)	Significant change from survey A to B?	Statistics	Survey A (pre-simulation)	Survey B (post-simulation)	Significant change from survey A to B?	Statistics
Overall mean rating of perceived practical skills	3.19 ± 0.73	3.04 ± 0.86	↓↓	*F(1,67) = 3.06* *p ≤ 0.077* *η^2 =0.044*	4.53 ± 1.06	4.5 ± 0.99	—	*F(1,67) = 0.18* *p ≤ 0.74* *η^2 = 0.002*
Q17. Please rate your skill level in negotiation (i.e. successfully advancing your stakeholder's agenda).	3.2 ± 1.11	2.98 ± 1.12	↓↓	*Z = − 1.68* *p ≤ 0.09*	4.61 ± 1.42	4.62 ± 1.1	—	*Z = − 0.64* *p ≤ 0.5*
Q18. Please rate your skill level in mediation (i.e., facilitating compromise).	3.53 ± 0.98	3.318 ± 0.96	—	*Z = − 1.58* *p ≤ 0.114*	4.92 ± 1.18	4.82 ± 1.19	—	*Z = − 1.47* *p ≤ 0.14*
Q19. Please rate your skill level in lobbying (i.e., influencing others to help achieve your objectives).	3.29 ± 1.04	2.93 ± 1.22	↓	*Z = − 2.34* *p ≤ 0.02*	4.55 ± 1.35	4.44 ± 1.42	—	*Z = − 0.9* *p ≤ 0.37*
Q20. Please rate your skill level in public speaking.	3.14 ± 1.23	2.97 ± 1.2	↓↓	*Z = − 1.74* *p ≤ 0.08*	4.64 ± 1.63	4.11 ± 1.69	↓	*Z = − 3.18* *p ≤ 0.001*
Q21. Please rate your skill level in policy analysis.	2.841 ± 1.04	3.0 ± 1.12	—	*Z = − 1.14* *p ≤ 0.25*	3.85 ± 1.29	4.51 ± 1.31	↑	*Z = − 3.65* *p ≤ 0.001*

The Use of Online Tools and Changes in Knowledge

In order to investigate some of the mediators that could contribute to these changes in learning outcomes, we analyzed both Year 1 and Year 2 data (combined and separately) to examine the underlying group and correlational factors that could contribute to these changes in perceived knowledge. Subsequent analyses were performed to examine the potential role of online learning tools and choice of stakeholder to mediate changes in self-reported knowledge.

Between-subjects ANOVAs were performed examining which online tools the students reported using the most (Q2; Campus Pack Wiki, or Discussion Forum) and which forums they used most actively (Q3; lecture, tutorial, online) as grouping variables, with post-simulation topic knowledge, change in topic knowledge, post-simulation policy analysis scores, and changes in policy analysis scores as dependent variables.

Multivariate ANOVA revealed an overall main effect of group ($F(8, 125) = 2.58$, $p \leq 0.05$) on the most actively used forum (Q3), suggesting that there were differences in ratings of perceived topic knowledge and policy analysis skills, depending on which forum students used most. Posthoc tests revealed that students who chose the lecture as their most used forum had significantly higher post-simulation knowledge ratings, and larger changes in their self-reported knowledge from pre- to post-simulation as compared to those students who used the tutorial or online forums most often (ps ≤ 0.05; see Table 4). When students reported their perceived skills in policy analysis, those who selected lecture as their most active forum had higher post-simulation ratings than those that used the tutorial or online

Table 4. Students' mean (± *SD*) ratings of self-reported knowledge and policy analysis skills from survey A (pre-simulation) to survey B (post-simulation), grouped by their most actively used forum for discussion (*indicates a significant posthoc difference from students in lecture with a $p \leq 0.05$).

Mean ratings of knowledge or skill	Most actively used forum			Overall between subject ANOVA statistics
	Lecture	Tutorial	Online	
Survey B: Overall self-reported knowledge	4.95 ± 1.03	4.24 ± 1.11*	4.35 ± 1.21*	$F(2,133) = 2.75$ $p \leq 0.07$
Change from survey A to survey B in self-reported knowledge	1.95 ± 1.42	1.22 ± 0.86*	1.26 ± 0.88*	$F(2,133) = 4.1$ $p \leq 0.06$
Survey B: Overall perceived policy analysis skills	4.93 ± 1.22	3.58 ± 1.35*	3.92 ± 1.46*	$F(2,133) = 7.43$ $p \leq 0.001$
Change from survey A to survey B in perceived policy analysis skills	1.00 ± 1.64	0.22 ± 1.3*	0.7 ± 1.45	$F(2,133) = 4.29$ $p \leq 0.06$

forums the most (ps < 0.05; see Table 4). However, the *change* in self-reported skills from pre- to post-simulation was only significantly larger when comparing lecture to tutorial (but not online). That is, there was no significant difference between changes in perceived skill between students who used lecture or online the most.

Taken together, these results suggest that while the tutorial and online tools may be useful add-ons to the simulation, students who reported that they participated the most in lecture/plenary received the largest benefit in terms of their self-reported knowledge. These findings accord with our own impressions of the simulation's mechanics. While all three forums (lecture/tutorial/online) are designed to feed into one another, the plenary debates that take place within lectures are the heart of the simulation exercise. The plenary debates are the most formal, and the most immersive. We relocate the class to a special room to increase the gravitas of the event, and provide nametags and placards based on those used at the actual Convention on Biological Diversity to give the feel of a real-world meeting. As instructors, we take on the role of secretaries-general and facilitate the plenary session according to the same rules of procedure that govern the real CBD meetings, asking students to address one another as "Honourable Delegate" and raising their flag when they wish to speak. We encourage students to dress their parts. Plenary sessions are also the venue in which we finalize voting on each article and the site for acts of dissent (examples over the past two years include a symbolic walk-out, indigenous groups handing out seeds, a coordinated silent protest, and the delegate from Greenpeace dressing up as a tree to highlight the importance of biodiversity). The most critical element of a successful role-play simulation is that students are convinced of the premise and are willing to engage in the fictionalization of this real-world debate. Our commitment to ensuring student buy-in started with the plenary sessions; thus it is not surprising that those students who participated most actively in these forums reported the largest increases in knowledge.

Examining the impact of students overall use/comfort with any online tools on their knowledge scores sheds further insight into how online teaching technologies can be best combined with face-to-face interactions to optimize student learning. A subscale was created for *comfort and usage of online tools* (averaging responses to Q23: "The online learning tools enhanced my learning experience during the simulation" and Q24: "I felt comfortable participating in the on-line components of the simulation" on survey B). This subscale was then correlated with changes in students' self-reported topic knowledge and policy analysis skills using Pearson's product moment correlations. Analyses revealed that there was a significant positive correlation between higher scores on the "comfort and usage of online tools" subscale and their increased self-reported topic knowledge ($r^2 = 0.244$, $p \leq 0.004$), as well as between higher comfort scores and increased ratings of policy analysis skills ($r^2 = 0.257$, $p \leq 0.002$). This suggests that a student's level of comfort and usage of these online tools improved self-reported knowledge, suggesting that the integration of these technologies was beneficial to learning outcomes.

The multivariate ANOVA analyzing the effects of Q2 (type of online tool used) did not reveal an overall main effect of group ($F(8, 125) = 0.271$, $p = 0.2$), which indicates that the type of tool used did not have a significant impact on student ratings of perceived topic knowledge and policy analysis. Further analysis revealed that the type of online tools used most did not significantly affect the change in student ratings in topic knowledge (ps > 0.05), but did have a trend towards impacting the degree of change in students' ratings of perceived policy analysis skills (see Table 5). Students who relied primarily on the Campus Pack Wiki had a significantly larger change in their self-perceived learning than those who preferred the online discussion forum ($p \leq 0.08$).

This makes sense to us as instructors: the wiki tool was conceptualized as a means of allowing students to edit the six articles under debate in real time by proposing new text, amending other students' proposals, and commenting on the current wording. Quickly, students discovered that this

Table 5. Students' mean (±*SD*) ratings of self-reported knowledge and policy analysis skills from survey A (pre-simulation) to survey B (post-simulation), grouped by their preferred online tool usage. (*indicates a significant posthoc difference between campus pack wiki and discussion forum, with $p \leq 0.05$, # indicates a trend towards a difference between Campus Pack Wiki and Discussion Forum with $p \leq 0.09$.)

Mean ratings of knowledge or skill	Most used online tool		Overall between subject ANOVA statistics
	Campus pack Wiki	Discussion forum	
Survey B: Overall self-reported knowledge	4.44 ± 1.05	4.25 ± 1.25	*F(2,133) = 0.71 p = 0.5*
Change from survey A to survey B in self-reported knowledge	1.29 ± 0.98	1.4 ± 0.92	*F(2,133) =1.53 p ≤ 0.22*
Survey B: Overall perceived policy analysis skills	4.01 ± 1.33	3.61 ± 1.51	*F(2,133) =2.1 p ≤ .13*
Change from survey A to survey B in perceived policy analysis skills	0.62 ± 1.37	0.21 ± 1.43#	*F(2,133) =3.55 p ≤ 0.05*

process policy formation and analysis is complex, slow, and messy (just as it is in real life). We believe that the utility of the wiki stems from its ability to simulate the real-world nuance and complexity of international negotiation. Also, the wiki facilitated student-to-student learning, shifting the mode of knowledge translation from one that is linear (professor-to-student) to one that is much more dynamic (student-to-student-to-student). Students praised the value of this learning: "[the wikis] allowed for amendments to be discussed and debated, they allowed for other's multiple inputs and helped to bolster communication between students," said one. Another emphasized: "[the wiki] allowed you to understand the opinion of others and further your own knowledge."

Yet qualitative comments underscore that it is not just *which* online technology instructors utilize but *how* it is utilized that impacts student learning. In Year 1, a number of students expressed frustration with the limitations of multiple-user editing (see also Wheeler, Yeomansn, and Wheeler 2008). One student commented, "I didn't like the wiki. I felt like it was pretty confusing because people kept crossing out and deleting different things. I think it would be good to have a certain number of people to change things," while another complained that the "online wiki was so chaotic! Couldn't get a word in!" In Year 2, we offered more specific instructions on how to properly add, delete, and build upon previous contributions, and made a conscious effort to be more structured and active in moderating these interactions. To assess the impact of these changes on how online tools influenced self-reported knowledge and policy skills, we separately analyzed the impact of the most actively used forum for Year 1 and Year 2 (see Table 6).

In Year 1, there were very few differences between the groups. In Year 2, students who chose lecture as their most active forum had a significantly larger change in their pre- to post-simulation perceived knowledge than students who chose tutorial or online forums. Interestingly, unlike in Year 1, post-simulation policy analysis skills, and change in policy analysis skills, were significantly increased in students who chose lecture compared to tutorial, but not when compared to online tools. This suggests that the online tools were more effective in Year 2 (no longer different from lecture), indicating that this more structured approach to the management of the wiki produced more positive learning outcomes in Year 2.

Unlike the wikis, students did not make use of the discussion boards in the way they were intended. We envisaged the discussion boards as serving a dual role: they offered a venue for uploading documents or videos to advance their negotiation position, and an opportunity for students to coordinate efforts with other stakeholders. While the discussion boards were extremely active both years (over 250 student posts were made in each iteration of the simulation), almost all students used it for the latter purpose rather than the former; indeed, fewer than ten documents or videos were posted over the two years combined. Part of this can be ascribed to the limitations of the technology itself: the layout of discussion board on the OWL system is quite clunky; as one student commented "using the discussion boards takes time going through each thread." Even more crucially, we believe the wiki technology was more successful because it targeted the particular skill development of policy analysis and formulation. These findings offer an important qualification for those seeking to utilize online technologies within a simulation exercise. Technologies can enhance student learning, but need to be thoughtfully integrated, functional, and target specific content or skill development.

The Choice of Stakeholder and Changes in Knowledge

Previous evidence suggests that the choice of stakeholder can play a role in a student's learning experience during a role-play simulation (Youde 2008; Baylouny 2009). On survey A, students were asked to indicate which of six factors ([1] Interested in learning more about the

Table 6. Students' mean (± SD) ratings of self-reported knowledge and policy analysis skills from survey A (pre-simulation) to survey B (post-simulation), on a Likert scale from 1–5 (Year 1) or 1–7 (Year 2), grouped by their most actively used forum for discussion. (* indicates a significant posthoc difference from the lecture group with a $p \leq 0.05$.)

	Year 1				Year 2			
	Lecture	**Tutorial**	**Online**	**Statistics**	**Lecture**	**Tutorial**	**Online**	**Statistics**
Survey B: Overall self-reported knowledge	3.66 ± 0.47	3.48 ± 0.74	3.35 ± 0.72	*F(2,53) = 0 .72* *p ≤ 0.49* $\eta^2 = 0.026$	5.42 ± 0.71	4.99 ± 0.86	5.06 ± 0.95	*F(2,68) = 0.72* *p ≤ 0.49* $\eta^2 = 0.021$
Change from survey A to survey B in self-reported knowledge	0.91 ± 0.5	0.94 ± 0.68	0.88 ± 0.76	*F(2,53) = 0.94* *p ≤ 0.91* $\eta^2 = 0.004$	2.33 ± 1.19	1.48 ± 0.94*	1.53 ± 0.86*	*F(2,68) = 2.79* *p ≤ 0.07* $\eta^2 = 0.08$
Survey B: Overall perceived policy analysis skills	4.25 ± 0.95	2.97 ± 1.1*	2.8 ± 1.14*	*F(2,53) = 3.53* *p ≤ 0.036* $\eta^2 = 0.118$	5.19 ± 1.25	4.21 ± 1.29*	4.71 ± 1.1	*F(2,68) = 2.53* *p ≤ 0.09* $\eta^2 = 0.08$
Change from survey A to survey B in perceived policy analysis skills	0.0 ± 1.41	0.22 ± 1.12	0.15 ± 1.19	*F(2,53) = 0.44* *p ≤ 0.95* $\eta^2 = 0.002$	1.36 ± 1.62	0.23 ± 1.42*	1.19 ± 1.32	*F(2,68) = 6.15* *p ≤ 0.003* $\eta^2 = 0.153$

stakeholder, [2] Similar views to the stakeholder, [3] Workload and time expectations, [4] Interested in future employment with stakeholder, [5] Choice of working independently or in a group was important, [6] Expectation to work more in plenary, online, or in working groups) was most important in their choice of stakeholder, either by checking all that applied (Year 1) or ranking the six factors from most to least important (Year 2). In our study, there were no correlations between the factors involved in choosing a particular stakeholder and the change in a student's topic knowledge from pre- to post-simulation, nor were there significant relationships between these factors and a change in policy analysis skill (all ps > 0.1). This suggests that the rationale students used to choose a particular stakeholder did not impact how much knowledge they gained throughout the situation.

However, the choice of stakeholder itself did appear to play some role in the increase in topic knowledge and policy analysis skills, as students who agreed more strongly with the statement *My views were similar to those of my stakeholder* (Q22) displayed a trend towards a correlation with a greater increase in self-reported knowledge ($r^2 = 0.158$, $p = 0.06$), and was significantly correlated with increased ratings of policy analysis skills ($r^2 = 0.419$, $p = 0.0001$) after the simulation. These findings run counter to the prevailing wisdom that suggests that students learn the most by choosing to represent stakeholders that hold different views than their own; for instance, Kurtz (2004) recommends deliberately assigning student stakeholders with opposing views to their own in order to maximize learning outcomes. Some of our students reflected similar thoughts: "because I chose a stakeholder I am completely against it forced me to view and understand their perspective . . . [which helped to] broaden my mind and not be biased." However, such anecdotal responses run counter to the more general trend, which suggests that more learning might actually take place when a student represents a stakeholder with similar views to his/her own.

Conclusion

This study sought to evaluate the success of the CBD simulation as a mechanism for enhancing student acquisition of knowledge. Our first hypothesis was that the CBD role-play simulation could enhance student perception of knowledge transmission within the realms of both content and skills. Quantitative and qualitative data show that we succeeded in cultivating the former more than the latter; the only skill in which self-perceived knowledge increased was policy analysis, which was significant in Year 2 and not in Year 1. We argue this solitary change was due to the complete overhaul of the policy analysis assignment, which was much more targeted and focused on developing this skill in Year 2, and the extension and expansion of the preparatory learning, which now straddled the entire semester. These findings underline the importance of creating targeted assignments and expansive, incremental timelines to in solidifying skill development.

Our second hypothesis proved more fruitful: integrating online technologies alongside face-to-face interactions allowed for more effective knowledge transmission. These results emphasize the utility of the blended learning model for role-play simulations. Again, though, student feedback offers important qualification. The wikis were much more successful than the discussion boards, due largely to their ability to simulate the real-world nuance and complexity of international negotiation, and their superior functionality. As well, the more structured and active management model adopted in Year 2 helped students feel more confident about participating in this dynamic forum. Adopting a blended learning approach means instructors need to think carefully both about which online tools they choose to integrate and how these can meaningfully enhance the learning objectives of the simulation.

Two more important qualifications emerge from this study. First, students who relied primarily on face-to-face interactions gained more knowledge than those who prioritized the online tools. We interpret this as a reminder that computer-mediated technologies should be treated as a complement—but not a supplement—to in-person interactions. We share Ruyters, Douglas, and Law's (2011) hesitation about locating simulations exclusively in the digital realm. The most significant obstacle for a successful simulation is student buy-in, which, in our experience, is much easier to cultivate in-person than it is online. Second, while the particular criteria determining a student's choice of stakeholder did not impact student learning, there was a slight correlation between the degree to which the stakeholder's views matched that of the student and knowledge acquisition, suggesting that this could be an important mediator in this relationship. The role that stakeholder choice plays within the process of student learning deserves further investigation.

The case of the CBD simulation provides an example of a geographical exercise that resonates with Fink's (2003) insights regarding significant learning. This learning exercise fulfills a number of his oft-cited strata of educational goals including (1) foundational knowledge (students overwhelming confirmed that the simulation increased their knowledge about the Nagoya Protocol, the CBD, and MEAs more generally), (2) applications (the focus on skill development and its operationalization in a fictionalized debate, even though students only reported significant increases in the area of policy analysis), (3) integration (student data suggest that the multiple learning forums helped learning outcomes, underlining the importance of thoughtfully embedding the simulation within the overarching logic of the course itself), (4) human dimension (student preferences for the plenary sessions indicate that the dynamic face-to-face interactions were crucial to the simulation's success), and (5) caring (student interest spiked as a result of this exercise, with qualitative comments revealing that students felt a lot more invested in the simulation exercise than other course components). Whether the CBD simulation fulfills Fink's final criteria on learning on how to learn is more

difficult to assess. Our aim is to track student perceptions on their learning experience long after their participation in this course, which should shed valuable insight into whether and how this exercise impacted their long-term learning trajectory.

Most students enjoy role-play simulations because they find them fun and engaging. But instructors need to structure these exercises carefully to ensure meaningful learning experiences ensue. A successful simulation needs to be thoughtfully embedded within the course's broader learning objectives. Knowledge transmission can occur within the realms of both content and skills, but targeted interventions produce better results. Online tools can help, but they need to be strategically integrated. Our hope is that these insights will help geographers to create simulations that are able to stimulate student interest while at the same time produce meaningful learning outcomes.

Note

1. For a more detailed discussion of the decrease reported in these skills see Schnurr, De Santo, and Green (2014).

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Appendix: Readings and Assignments Used in the CBD Simulation

Students were given several readings to prepare them for both the substantive and procedural elements of the simulation.

1. Buck, M., and C. Hamilton. 2011. The Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization to the Convention on Biological Diversity. *Review of European Community & International Environmental Law* 20 (1): 47–61.
2. Rosendal, G. 2006. Balancing ABS and legal protection of innovations from bioprospecting: impacts on conservation of biodiversity. *Journal of Environment & Development* 15: 428–447.
3. Patton, B., ed. 1991. Chapter 2: Separate the People from the Problem. In *Getting to Yes: Negotiating Agreement Without Giving In*, 2nd ed., R. Fisher and W. Ury, pp. 17–40. New York: Penguin Books.
4. International Institute for Sustainable Development. 2010. Summary of the Tenth Conference of Parties to the Convention on Biological Diversity, October 18–29, 2010, Earth Negotiations Bulletin Vol. 9, No. 544.
5. Chiarolla, C. 2010. *Making Sense of the Draft Protocol on Access and Benefit Sharing for COP 10.* Paris: Institut du Développement Durable et des Relations Internationales (IDDRI).

Students' marks in the simulation comprised (1) a policy analysis assignment, (2) a position paper assignment, and (3) their participation in the exercise. The simulation was worth 35 percent of their overall mark in the course.

Policy Analysis Assignment (15% of overall course mark)

This assignment asked students to analyze one article of the Nagoya Protocol on access and benefit sharing to the Convention on Biological Diversity (CBD), and critically evaluate whether the article constitutes an effective example of environmental governance. The aim of this assignment was to hone the students' policy analysis skills by investigating the strengths and limitations of a specific example of global environmental governance, as well as to introduce students to the Nagoya Protocol, the basis for the simulation. The first time we used this assignment, we had the same aims, but provided a wider range of environmental agreements to analyze. In Year 2 we decided to focus the assignment on the Nagoya Protocol in order to help students obtain a deeper knowledge of the instrument we were working within the simulation. This assignment was introduced and turned in before the simulation commenced.

Position Paper Assignment (10% of overall course mark)

This assignment required students to undertake research into their stakeholder's position on the access and benefit sharing (ABS) provisions of the CBD, and to write a position paper that briefly summarized (1) relevant background information on their stakeholder, (2) their position on the critical elements of ABS, and (3) their intended outcomes for the simulation. In addition to this, the last portion of the assignment required students to come up with draft text written in the language of the CBD that reflected their position and preferred outcomes for the simulation. This assignment was due on the first day of the simulation, such that students would come prepared to negotiate and could refer to their position paper as the proceedings unfolded.

Participation in the Simulation (10% of overall course mark)

Student participation in the simulation was evaluated based on their contributions to all three elements of the exercise, plenary sessions (lectures), working group sessions (tutorials), and virtual negotiations (online). The professors and teaching assistants worked together to assign final marks.