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Promoting Positive Academic Dispositions Using a Web-based PBL Environment: The GlobalEd 2 Project

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Promoting Positive Academic Dispositions Using a Web-based PBL Environment: The GlobalEd 2 Project

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Abstract

Problem-based learning (PBL) is an instructional design approach for promoting student learning, understanding and knowledge development in context rich settings. Previous PBL research has primarily focused on face-to-face learning environments, but current technologies afford PBL designers the opportunities to create online, virtual, PBL environments. The GlobalEd 2 Project is an example of a PBL environment that combines the positive characteristics of both face-to-face and online environments in a 14-week simulation of international negotiations of science advisors on global water resource issues. The GlobalEd 2 PBL environment is described examining the impact it has had on middle school students' interest in future science education experiences, self-efficacy related to writing in science and self-efficacy related to technology use for academic purposes using a pre-test post-test design. Analyses using ANOVAs of gain scores and ANCOVAs of subgroup differences demonstrate a positive impact on the science interest and self-efficacy of 208 middle-grade students from urban and suburban schools.

Keywords: problem-based learning, self-efficacy, writing, science interest, global education

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Introduction

Historically, problem-based learning (PBL) has represented a significant paradigm shift from the traditional college lecture-based delivery of education to a curriculum integrating real-world, authentic problems as the core of the instruction (Evensen & Hmelo, 2000; Nelson, 1999). This radical approach to education, moving from lectures to focusing on problems in an interactive format, caught on quickly in medical schools in the US and Europe and Australia. Moreover, as with many new approaches to education, PBL soon spread to other domains such as business, engineering and the preparation of teachers.

It is generally agreed that PBL is epistemologically founded on a form of constructivism. Savery and Duffy (1996) describe three critical aspects of PBL constructivism. First, we must learn and create our understandings based on our own interactions with the environment (both physical and social). Second, learning is the result of struggling to understand and effortful. Third, our understandings must be tested through "social negotiation and the ongoing testing of the viability of existing concepts in the face of personal experience as the principle forces involved in the evolution of knowledge" (Greening, 1998, p. 4).

Although there is common agreement on the goals and objectives of PBL, as well as the underlying philosophy associated with it, there is also a great deal of methodological and implementation variability. As stated by Newman in 2003, "A review of the field found that the practice of PBL was described in a variety of ways that could be summarized as a complex mixture of general teaching philosophy, learning objectives and goals and faculty attitudes and values" (p. 10). However, in spite of a multitude of implementation variants, Nelson (2010) lists six common traits of successful PBL environments. These include:

1. Student-centered;
2. Ill-structured contextualized problems;
3. A multi-disciplinary focus;
4. Stressing self-regulation and collaboration;
5. Reflection and evaluation; and
6. Closing analyses

Each of these attributes is a critical aspect for any successful PBL environment, whether as a face-to-face or a virtual (synchronous and asynchronous) learning environment. In the case of the GlobalEd 2 Project, the strengths of the face-to-face and virtual PBL environments are combined in order to provide an additive impact on the promotion of middle school students' self-efficacy skills related to science, technology use and writing about science skills.

The goal of this study is to examine the impact of the GlobalEd 2 (GE2) Project on middle grade students' academic dispositions toward science, writing and the use of technology as a learning tool.

Statement of the Problem

A decline in both the quantity and quality of students pursuing careers in science is widely noted in policy reports, the popular press, and by higher education. Fears of increasing global competition compound the perception that there has been a significant drop in the supply of high-quality students moving up through the STEM pipeline in the United States. Schools today are faced with enormous pressures to guarantee students' competence with a growing body of STEM content knowledge (Gredler, 2004) while simultaneously assuring that they are prepared to enter a highly skilled 21st century workforce that can think critically, collaborate on interdisciplinary teams, direct their own learning processes and communicate effectively in writing (Dundis & Benson, 2003; Murray & Savin-Baden, 2000). In response, academic standards in these areas have changed and expanded, requiring teachers to cover more material (NRC, 1996) in a curricular space that has not grown commensurately.

One potential solution to the curricular space issue in science and the need for additional focused instruction on writing is to look for alternative venues to expand the time associated with the teaching of science within the school day. Many have argued that using the social sciences as forum for integrating and applying science has the potential to develop a scientifically literate citizenry capable of bringing a scientific approach to bear on the practical, social, economic and political issues of modern life (Hargreaves & Moore, 2000; Jenkins, 1999). Additionally, problem-based learning (PBL) researchers have demonstrated for decades that leveraging multidisciplinary content areas, such as the social sciences, as a context to engage in real-world problem solving, can deepen students' understanding, flexibility in application, and transfer of content knowledge (e.g., Bednar, Cunningham, Duffy, & Perry, 1992; Brown, Lawless & Boyer, 2009; Koschmann, Kelson, Feltovich, & Barrows, 1996; Mergendoller, Maxwell & Bellisimo, 2000).

Recognizing this, the GlobalEd 2 Project is an educational multi-team game that uses educational technologies currently available in most middle schools. It builds upon the interdisciplinary nature of social studies using an expanded curricular application aimed at increasing instructional time devoted to science and persuasive writing in a virtual, problem-based environment. For the purposes of this paper, only the results for interest in science and self-efficacy related to writing skills and technology use are presented.

National Trends in Science Education and Student Performance

The stated intent behind the National Science Education Standards (NRC, 1996), was to shift the emphasis in the teaching of science toward the development of concepts, processes and skills that promote scientific literacy among the nation's students. Scientific literacy involves critical thinking, cognitive and metacognitive abilities, collaborative teamwork and the effective use of technology to solve personal problems, engage in scientific discourse around global issues and persuade others to take informed action (Hurd, 1998; Yore, 2001).

The new science standards signaled a significant reform in the pedagogical approaches to promote scientific literacy through scientific inquiry. Within a classroom, scientific inquiry involves student-centered projects that actively engage students observing, questioning, information gathering, data analysis, explanation and communication of the results (Krajcik, Blumengeld, Marx, & Soloway, 1994; Minstrell & van Zee, 2000; NRC, 1996; Roth & Roychoudhury, 1993). However, these authentic activities in science inquiry are not frequently found in typical science classrooms (Chinn & Malhotra, 2002; Driver, Leach, Millar, & Scott, 1996; Roth, 1995; Ryder, Leach, & Driver, 1999). The underutilization of authentic inquiry tasks likely results from the fact that the shift in the science standards towards scientific literacy and related pedagogical reform was set forth without commensurate alteration of the curricular space devoted to the teaching of science in the schools (Sadler, Barab & Scott, 2007). Inquiry-based curricula, especially programs that immerse learners in active investigations of contemporary issues, can consume significant chunks of classroom time. Given the standardized test-driven culture of today's schools, the allocation of scarce instructional time and resources is a major concern for both teachers and administrators (Sadler, Amirshokoohi, Kazempour, & Allspaw, 2006). Furthermore, research on science teachers has found that they feel underprepared and lack the confidence necessary to implement and manage socio-scientific inquiry (Bartholomew, Osborne, & Ratcliffe, 2004; Bennett , Lubben, Hogarth, & Campbell, 2005; Levinson & Turner, 2001). So, while it appears that we know what to do in science to boost achievement, we simply are not doing it as often as we should or could.

National Trends in Writing Performance

Concomitantly with issues related to science achievement and instruction, scores on standardized tests of writing also indicate that our students are underprepared. Results from the 2002 NAEP indicate that only 22% to 29% of students scored at the proficient level for writing, and only 2% of students at all grade levels scored at the advanced level (Grigg, Daane, Jin, & Campbell, 2003). In 2002, the College Board established the National Commission on Writing to address mounting concerns from educators, businesses and government leaders that writing aptitude in the United States is not what it should be (McEwen, 2004). In their 2003 report, the Commission concluded "American education will never realize its potential as an engine of opportunity and economic growth until a writing revolution puts language and communication in their proper place in the classroom" (p. 3). Moreover, the Commission challenged state and local curriculum agencies to require writing in every course and at all grade levels, because writing is the most neglected of the three "Rs" in the schools.

The trends in the national data and the calls to action did not go unnoticed by the professional organizations that publish national education standards, particularly in the domain of science. The 1996 National Science Education Standards (NSES) clearly identify the need for students to be able to explain their thinking and reasoning processes concerning science related concepts and problem solving strategies through writing. The goal of this orientation is to encourage students to see writing as a skill and resource for communication, argument, justification, and clarification of viewpoint. Thus, writing is a tool for learning, as well as for displaying and organizing knowledge. Further buttressing this movement, the National Research Council (1996) has argued that in order to help today's students gain scientific literacies for the 21st century, those students must be required to "construct explanations of natural phenomena, test these explanations in many different ways and communicate their ideas to others" (p. 20). Many have suggested that ignoring the teaching of written communication genres, such as persuasion and argumentation, puts certain segments of the population, such as poor children, at a disadvantage for learning to read and write scientific forms of discourse (Berkenkotter & Huckin, 1995). While contemporary researchers have identified the significance of writing to inform and persuade an audience (Holliday, Yore, & Alvermann, 1994), little attention has been given to writing to communicate as a form of learning in science classrooms.

National Trends in Technology and Student Performance

Using any one of a dozen different indicators, it is clear that technology has become an omnipresent feature of modern education. Consider first the presence of computers in the classroom. A recent survey of public schools indicates that from 1998 to 2007, schools cut their student to computer ratio in half, from 7.8 to 3.8 students per computer (Mitani, 2007). Further, classroom connectivity to the Internet has become virtually universal (Ed Week, 2007). In conjunction with such changes in school computer usage, there is also an similar trend regarding computer usage at home, particularly among children in the 9–17 year age bracket, growing from about one third in 1997 to about 87% in 2004 (Lenhart, Madden, & Hitlin, 2005; U.S. Department of Commerce, 2002). Survey research has also indicted that 94% of students between 12 and 17, with computers in the home, used the computer for homework. Nearly 71% of these students used digital resources as the primary source of information on their most recent school report or project, while only 24% reported using standard library materials for the same task (Lenhart et al., 2005). These statistics make it clear that not only are computers a prominent learning tool, but that digital resources are rapidly overtaking their more traditional counterparts as the primary information sources in the K–12 setting.

As the pervasiveness of computers in education has grown exponentially, the focus has turned from issues of gaining access to computers to issues of how computers impact student learning. Findings show that when technology is meaningfully integrated into the curriculum, students:

- delve deeper into the content-area,
- are more motivated,
- spend more engaged time on task,
- move beyond knowledge and comprehension to application and analysis of information,
- learn where to locate information in an information rich world, and
- develop computer literacy by applying various computer skills as part of the learning process rather than in isolation (Dockstader, 1999; Lawless, 2005).

Disappointingly, while technology can have powerful effects on the quality of instruction and student outcomes, when it is used in instruction, it is frequently poorly integrated with other classroom activities (Cuban, Kirkpatrick, & Peck, 2001; Dede, 2007; Oppenheimer, 2003; Pellegrino, Goldman, Bertenthal, & Lawless, 2007). Rather than using technology to transform classroom pedagogies and engage students in a knowledge-based world, technology is often used to merely replicate traditional curriculum (Cuban et al., 2001). Word processing and basic skills practice remain the most frequent uses of computers at all levels (Gewertz, 2007). At the same time, use of software applications that engage analytical thinking through simulations and multimedia production is relatively infrequent, particularly in high need, urban school districts (Becker, 1999; Hart, Allensworth, Lauen, & Gladden, 2002). These trends have occurred despite federal mandates that all children be technologically literate by the time they leave the 8th grade (No Child Left Behind Act, 2001) and national standards and benchmarks (NETS) set by the International Society for Technology in Education (ISTE, 1998; 2007).

Academic Dispositions

Students' attitudes about a particular topic or domain of study can greatly impact their performance and future choices within that discipline (Alexander, Jetton, & Kulikowich, 1995; Krapp, et al., 1992; Schiefele, 1996). When addressing STEM workforce readiness, empirical studies have demonstrated that the selection of academic subjects and occupational tracks are mediated by a student's interest and self-efficacy (Arnot, David, & Weiner, 1999; Harackiewicz, Barron, Trauer, Carter, & Elliott, 2000; Harackiewicz, Barron, Trauer, & Elliott, 2002; O'Brien et al., 1999). Interest can be defined as a deep-seated investment in the pursuit of knowledge related to a particular topic or domain (Alexander, 2000; Hidi, 1990; Renninger, 1992). In general, as a person's interest in a domain increases, so does their achievement and their motivation to continue learning in that area (Lawless, Brown, Mills, & Mayall, 2003; Schiefele, 1996). Regarding science, compared to other subjects, students' interest has decreased dramatically over time (Todt, 1978; Todt & Schreiber, 1998). This decline in the interest in science during middle school is of particular concern, since it is in these years that the attitudes to the pursuit of science subjects and careers are formed (Speering & Rennie, 1996). While this deficit may be attributed to a number of factors, a major contributor is the pedagogical approach to teaching implemented in science classrooms. Research suggests that one way to remedy this situation is to engage students in authentic real world inquiry with activities requiring collaborative problem-solving grounded in the "lived world" students' experience (Haury, 1993; Wise & Okey, 1983).

A second attitudinal attribute related to academic performance is that of self-efficacy. Put simply, Bandura (1997) defined self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainment" (p.3). Self-efficacy is not a measure of ability, or assessment of skills, but rather is an individual's belief (level of confidence) about what they can achieve and the degree of success possible. Researchers have demonstrated that self-efficacy can be a valid predictor of performance outcomes, including academic achievement and behavior (Schunk & Swartz, 1993; Schunk 2003). The importance of examining the role of self-efficacy in academics and the impact on student achievement is clear. Additionally, Bandura (1997) stated, "Perceived self-efficacy is a better predictor of intellectual performance than skills alone" (p. 450). As with other domains of self-efficacy, academic self-efficacy is linked to whether individuals will attempt a certain behavior, will persist when meeting obstacles, will exert effort and will attribute failure to self or others. "Self-efficacy plays a central role in academic performance" and must be considered an essential element when considering factors affecting student success (Feldmann, Martinez-Pons, & Shaham, 1995, p. 977). If students' academic experiences are unsuccessful, then their self-efficacy is diminished, decreasing the likelihood of future engagement in a discipline (Bandura, 1986; Zimmerman & Bandura, 1994). It stands to reason, then, that, if we can develop settings where students have the opportunity to experience success and illustrate the personal relevance of science and writing to the world in which students live, we can positively impact their academic self-efficacy. As a result, we may better be able to address problematic trend in writing and science achievement.

GlobalEd 2 as a PBL Environment

GlobalEd2 (GE2) places a pronounced emphasis on the development of students' understanding of science topics and self-efficacy for writing skills through PBL combining both F2F and virtual environments. The GE2 virtual environment contains both an asynchronous and synchronous components.

GlobalEd 2 operates within a middle school social studies class, focusing on a problem-based scenario regarding an international science crisis. Capitalizing on the interdisciplinary nature of social studies, GE2 expands the curricular space for additional opportunities to learn science and the use of educational technology, without sacrificing the curricular goals of the social studies curriculum, and in fact enhancing them through an international context generally not experienced in middle schools. The simulations for GE2 are based on the PBL principles and design components of Goodnough and Hung (2008), Koschmann, Myers, Feltovich, and Barrow, (1994), Savery and Duffy (1996), and Greening (1998), which have stated that the successful PBL environment must:

- Anchor the learning activities to the larger task or problem presented in the situation;
- Support the learners in developing ownership and control over the problem;
- Be based on authentic, real-world, global problems;
- Be challenging;
- Provide alternative views and solutions; and
- Require the students to reflect on both the content and the process.

Further, GE2 is consistent with the *How People Learn* (HPL) framework (Bransford, Brown, Cocking, Donovan, & Pellegrino, 1999), incorporating what the research base illustrates are important elements of successful learning environments (e.g., knowledge, student, assessment, and community centers).

The GlobalEd 2 platform, an Oracle-based communications system, operates over the Internet, linking classrooms of students, otherwise isolated from one another by physical distance and socio-economic boundaries, through collaborative synchronous and asynchronous communications. The GE2 interactive simulation is embedded in a semester-long middle school curriculum module. Through the simulation, students engage in online, simulated, international negotiations, collaboratively attempting to create resolutions to real world, socio-political science problems (such as a natural disaster or a water pollution incident) through the development of "multinational" agreements. The introduction to the scenario used for this study on global water resources is presented in Appendix A. The entire scenario is presented to the students once they have completed their pre-test assessment battery.

Participating classrooms are assigned to represent the interests of specific countries. Fourteen countries are selected accounting for diversity across economic development, location, political structures, and their centrality to the science issues being discussed in the simulation scenario. This diversity provides an opportunity for students to experience global science issues from a wide variety of perspectives (i.e., geographic, economic, cultural).

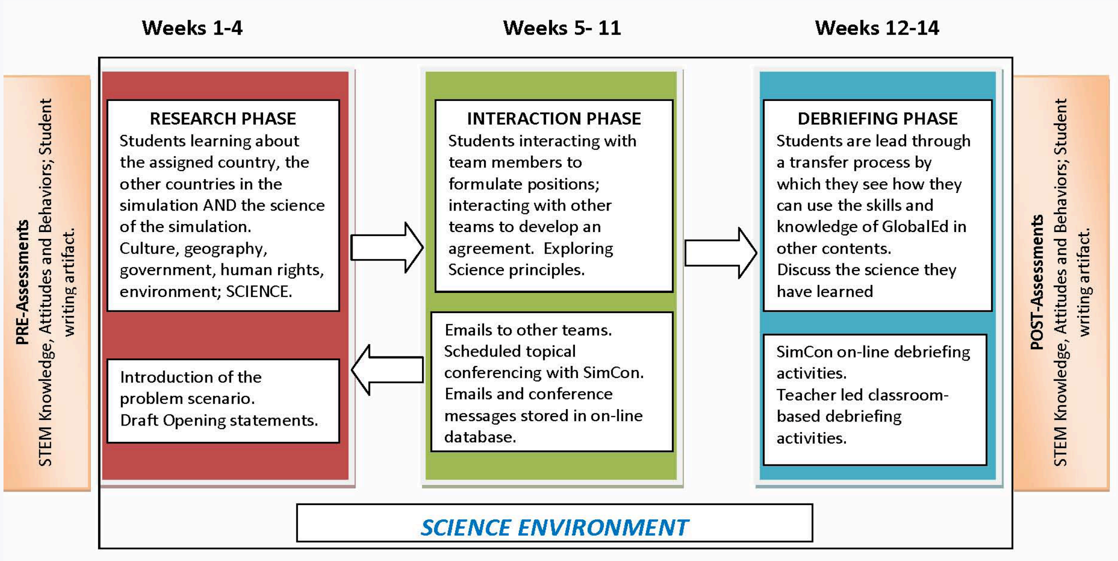
Students are told that their country has to "stay in character" (e.g., remain consistent with the policy positions and core national and cultural value systems of their assigned country), while attempting to develop comprehensive policy responses to particular problems within the issue areas. The scenario for the simulation is set six months into the future to minimize any impact of current news events. The scenario developed for the current simulation was focused on global water resources.

Integral to the multidisciplinary nature of the simulation, there are four issue areas within each simulation: Economics, Human Rights, Health and the Environment. These issue areas provide the bases for participating classrooms to divide into smaller collaborative working groups of students preparing for the simulation and to coordinate the development of the negotiations within the class and across classes/countries. These four issue areas are consistent across all the classrooms, enabling the students from one issue area to communicate with their counterparts playing another country. In essence, by working across these four issue areas, students are immersed in a learning environment where natural science, social science, and engineering knowledge and concepts are interdependent and seamlessly integrated.

Unbeknownst to the student teams, the USA team is played by members of the GE2 project staff. In this role, the USA team operates as a "sophisticate" within the simulation, providing a model for students with respect to argumentation, negotiation, communication and the effective integration of science and socio-political policy.

Figure 1 depicts the three phases of the GE2 simulation, lasting approximately 14 weeks. The first phase, the Research Phase, is six weeks and requires the students to use text and web resources to research the simulation scenario issues. During this phase, students must identify the key scientific issues of concern (e.g., pollution, desalinization, greenhouses gases, climatology) as well as how their assigned country's culture, political system, geography and economy influence their science perspectives. Additionally, students must also become familiar with the policies of the other countries included in the

Figure 1. The three phases of the GE2 PBL environment.



simulation in order to develop initial statements and plan for potential collaborations. As the outcome of the Research Phase, students develop opening policy statements (a.k.a. scientific arguments) containing sections on their national position across each of the four issue areas. These policy statements are then shared electronically within the online communication system to launch negotiations (Phase 2).

Throughout the six weeks of the Interactive Phase (Phase 2), students work within their class to refine their arguments and negotiate international agreements shared within the web-based simulation system with the other classrooms/countries about scenario issues. The interactions in GE2 are text only and may be sent as messages via email to one or selected members of the simulation, and during weekly scheduled online conferences moderated by SimCon.

The use of this anonymous communication software is purposive, as it allows educators to hold some factors in the educational context neutral (such as personal appearance, gender, race/ethnicity, and verbal communication abilities and accents). Students only identify themselves within GE2 as country, issue and initials; for example, "ChinaEnvioSWB" (China's environmental negotiator), blinding their actual identities. As a result, typical stereotypes associated with gender, race/ethnicity or socio-economic class, are eliminated as a factor influencing the interactions among participants online.

To assure that web-based simulations do not devolve into simple game-playing, a trained simulation coordinator, or "SimCon," monitors the flow of e-messages between teams and facilitates scheduled web-based multilateral conferences. SimCon's role is similar to that of a virtual teacher/facilitator in an active learning classroom, where that person oversees all aspects of the learning process and coaches students to think critically about the complex issues central to their scientific arguments.

The culminating event of the Interactive Simulation phase are the posting of the closing statements, reflecting the final position of each country-team on the four issue areas. Students work collaboratively within their country-team issue area to construct these closing arguments, which are then shared with the other participants in the simulation, marking the start of the third and final phase of the GE2 experience, Debriefing. The Debriefing phase lasts two weeks and is designed to activate metacognitive processes in students as they review what they learned and how they can apply this new science content knowledge and associated skills in other contexts. SimCon facilitates an on-line virtual debriefing conference with all students and countries represented, exploring issues related to learning outcomes from the simulation experience. Teachers are also trained to perform multiple debriefing activities within their classrooms to promote learning and transfer. These include educational activities, such as analyzing the "behind-the-scenes" negotiations available to students after the simulation ends, writing final essays about the experience, or completing other tasks aimed at relating the experience back to the educational context and the real world of environmental sustainability and global affairs.

Nelson's (2010) Conceptual Framework andGE2

GE2 was designed to be consistent with Nelson's (2010) six elements conceptual framework of PBL, discussed earlier. Specifically:

- GE2 is student-centered, placing the responsibility and control for learning on the student. The teacher serves as a facilitator for students encouraging them to think about options they may have and places where they may gather additional information for their research interactions (both in class and online) and final debriefing and reflection.
- GE2 is both ill-structured, as a contextualized problem and also dynamic, as the problems emerge and transform through the interactions of students within their own team and across teams. There is no one, single, final answer, nor are there right answers to memorize, but strategies and conceptual understandings to explore and evaluate.
- GE2 is multi-disciplinary by design, encompassing many facets of social studies (government, economics, human rights, the environment) with science topics (water resources and climate change), as is the case in the real world.
- Self-regulation and collaboration are critical skills in GE2, as students develop the ownership for their own learning and become increasingly self-directed while also working within their groups of issue areas, countries and an international community.
- The students in GE2 reflect and evaluate their learning and their current state of understanding during each phase of the simulation, but most importantly during the debriefing phase. Teachers lead classroom discussions and activities as students examine what they have learned, how they performed, and how they have developed deeper understandings throughout the simulation. Additionally, SimCon conducts a synchronous online debriefing from a total simulation perspective focusing on team patterns and strategies, and their effectiveness across multiple countries.
- The closing analysis is also part of the debriefing phase of GE2. As students reflect on the metacognitive skills they have employed and strengthened , they also explore opportunities to transfer these skills into other contexts, both academic and non-academic, as they see how they can apply these new understandings. The closing statements that each country/team develops, the students write about where they are in their negotiations, what they have

achieved, and what they have left to address in order to address the science crisis presented in the original problem statement.

Research Questions

Given this overview of GlobalEd 2, the present research examines if the technology mediated, problem-based approach espoused by the curriculum can have a positive impact on students' academic dispositions toward science, writing and the use of technology as a learning tool. The two specific research questions addressed in this study are:

1. Do middle school students participating in a GlobalEd2 simulation show a positive increase in: (a) Interest in pursuing additional science coursework and careers in science; (b) self-efficacy for writing in science; and, (c) academic technology use?
2. Are there demographic (race/ethnicity and gender) differences in the impact of GlobalEd 2 with respect to interest in science coursework and careers and self-efficacy for writing about science and technology use?

Methods

The Sample

A total of 259 students participated in the International Water Resources GlobalEd 2 simulation during the fall of academic year 2010–11, with 209 students providing completed parental consent and student assent forms. All 259 students participated in the GE2 learning activities since this was "a whole class activity" but no assessment data was collected on those without completed consent and assent forms.

Student participants were from two public school samples in two different states. One state provided the data from suburban schools (47.4%) and the other state provided the urban schools (52.6%) from one large metropolitan district. All participating classroom teachers and their respective students were from 7th (14.4%) or 8th (85.6%) grade social studies classes. Suburban schools were markedly higher with respect to socioeconomic status, with fewer than 15% of participants receiving free or reduced lunches. Students

Group	Gender		Race/Ethnicity					Grade	
	Males	Females	White	Black	Hispanic	Asian/PI	Other	7th	8th
Suburban	54	45	82	3	8	2	4	17	82
Urban	51	54	7	26	63	3	5	13	96
Total	105	99	89	29	71	5	9	30	178

Table 1. GE2 demographics: Gender, race/ethnicity and grade frequency (N).

from urban schools were significantly lower socio-economically, with over 80% of student receiving subsidies for lunches. The sample student demographics for both samples are included in Table 1. It is important to note that the disparate cell sizes for race/ethnicity were a direct result of recruiting intact classes. Race/ethnicity analyses eliminated those from Asian/Pacific Islander and Other due to the relatively small cell sizes.

Those students who did not complete the required IRB consent forms participated in the simulation activities as full members of GE2 but were not assessed in any manner. GE2 is a curriculum for the entire class and not a "pull-out" activity, so all students participated in the educational components of GE2 but only those students with consent and assent are reported for evaluation and analyses purposes.

The data reported here is based on students with complete data for the demographics and Technology and Writing Self-efficacy scales. Students with missing data for the creation of the scales were eliminated from the analyses and only complete data sets for each set of scales are reported.

Implementation of GE2

Prior to implementing the GlobalEd 2 simulation in their classrooms, teachers from both sites attended a simultaneous three-day online professional development (PD) seminar to prepare them for the GlobalEd 2 curriculum. The PD focused on the assumptions of PBL, the implementation, and specifically the teachers' role during each phase of the simulation. The PD also provided instruction and GE2 activities related to science knowledge, writing assignments and assessments, and the integration of social studies and science curriculums at the middle grades. Teachers were also provided online science, writing and technology support during the GE2 implementation.

Teams for the simulation were split approximately evenly across the two school contexts (urban and suburban) such that each simulation consisted of students playing countries without knowing the identities or locations of the students playing the other country/teams. Only upon the end of the debriefing conference by SimCon did students learn of the locations of the other teams.

Assessments

Students completed a battery of pre-assessments prior to being introduced to GlobalEd2. Within this battery were two self-efficacy scales: A 6-item measure of educational technology self-efficacy and a 5-item measure of writing skills self-efficacy. Both instruments used a 5-point Likert-scale format where 1 = *Not Confident* and 5 = *Extremely Confident*. Additionally, there was a 5-item, Likert-scale measure of interest in pursuing future educational experiences in science and science based careers (1 = *Not Interested*, 5 = *Extremely Interested*). Once the students completed the three assessments, they then began participation in the first phase of GlobalEd 2: Research. After completing the entire GE2 simulation, students were administered the post-test battery of assessments, which were the same as the pre-test battery.

Results

To address the two research questions, which focused on learning gains and differential impacts of GE2 on student subgroups, the interest and self-efficacy scale scores were each created by summing the responses for the items associated with the scale and dividing the sum by the number of items, thereby retaining each scale on the original 5-point response scale. A previously reported study using these scales revealed a single factor solution and high internal reliability estimates (Brown et al., 2010). Cronbach's alpha reliability estimates for the three scales range from .82 to .88 for this current sample.

	Gender	Race	Mean	SD	N
Interest in Science Careers Pre	**Male**	**White**	2.50	1.105	50
		Black	2.27	1.106	13
		Hispanic	2.28	1.13	35
	Female	**White**	2.24	0.933	39
		Black	2.04	1.126	16
		Hispanic	2.15	1.208	36
Interest in Science Careers Post	**Male**	**White**	2.62	1.229	49
		Black	2.89	1.266	11
		Hispanic	2.64	1.061	27
	Female	**White**	2.41	1.158	37
		Black	2.25	1.338	13
		Hispanic	1.96	1.071	33

Table 2. Pre- and post-test means and standard deviations for the science career interest scale.

	Gender	Race	Mean	SD	N
Technology SE Pre	**Male**	**White**	4.37	0.570	50
		Black	4.23	0.715	13
		Hispanic	4.09	0.713	35
	Female	**White**	4.21	0.729	39
		Black	4.07	0.590	13
		Hispanic	4.02	0.691	36
Technology SE Post	**Male**	**White**	4.35	0.684	49
		Black	4.12	0.605	11
		Hispanic	4.36	0.430	27
	Female	**White**	4.31	0.708	36
		Black	4.14	0.796	13
		Hispanic	4.18	0.653	33

Table 3. Pre- and post-test means and standard deviations for technology use self-efficacy scale.

	Gender	Race	Mean	SD	N
Writing Task SE Pre	Male	White	3.60	.717	50
		Black	3.51	.729	13
		Hispanic	3.54	.881	35
	Female	White	3.87	.650	39
		Black	3.75	.787	15
		Hispanic	3.72	.660	36
Writing Task SE Post	Male	White	3.66	.603	50
		Black	3.58	.607	10
		Hispanic	3.81	.761	28
	Female	White	3.79	.608	36
		Black	3.86	.655	13
		Hispanic	3.71	.640	33

Table 4. Pre- and post-test means and standard deviations for the writing skills self-efficacy scale.

Learning Gains

Since the focus of the first research question was on learning gains and there was no comparison group in this study that did not receive GE2, one way to investigate the impact of GE2 on the students' interest in science and self-efficacy is to create a gain score of their pre-post differences. While the use of gain scores raises some concerns over scale reliability and representativeness of the learning gain variable (see Sax, 1989, p. 281 for a list of issues), gain scores can provide a general view of cognitive and affective outcomes, though they must be interpreted with caution.

Additionally, for the purposes of the statistical analyses to follow, the race/ethnicity variable was truncated into three major categories: White, Black and Hispanic, due to the very small cell sizes for students reporting other race/ethnicity categories (less than 7% total). Truncating the race/ethnicity variable to three groups increased the robustness of the ANOVA and ANCOVA results.

As can be seen in Tables 2 through 4, the majority (13 of 18) of the means of the demographic subgroups of students rose from pre- to post across all three scales, suggesting a pattern of development in science interest and self-efficacy by students during the GE2 project.

To further address the first research question, a series of 2 (Gender) x 3 (Race/Ethnicity) repeated measures ANOVAs examining the gain score for each scale revealed that the greatest gains in the Science Interest, Technology Use Self-efficacy and Writing Self-efficacy were for Hispanic males, although the ANOVA for each variable failed to reveal a statistically significant main effect or interaction for Gender and Race/Ethnicity. It is important to note that the 2 x 3 repeated measures ANOVAs may have been affected by the large differences in cell sizes for each Race/Ethnicity or Gender subgroup (ranging from n = 10 to n = 50; a ratio of 1:5). The mean science interest and two self-efficacy scale gain scores for each demographic subgroup are reported in Table 5.

Gender	Race	**Science Career Interest**	**Technology Use SE**	**Writing SE**
Males	**White**	.128 (.954) n = 50	-.020 (.575) n = 49	.056 (.587) n = 50
	Black	.112 (.752) n = 11	-.046 (.752) n = 11	.120 (.368) n = 10
	Hispanic	.335 (.978) n = 27	.241 (.646) n = 27	.207 (.989) n = 28
Female	**White**	.141 (.818) n = 37	.120 (.551) n = 36	-.111 (.611) n = 36
	Black	.146 (.575) n = 13	.069 (.552) n = 12	.062 (.793) n = 13
	Hispanic	-.182 (.660) n = 33	.147 (.518) n = 33	.012 (.783) n = 33

Table 5. Means and standard deviations of the science career interest scale, technology use self-efficacy scale and the writing self-efficacy scale gain scores.

A second set of 2 x 3 repeated measures ANOVAs were conducted on the pre- and post-test Science Interest score, yielding a statistically significant difference between the pre- and post-testing ($F_{1,171} = 188.33$, $p < .001$, Partial Eta squared = .535) with the overall post-test significantly greater than the pre-test score. No Gender or Race main effects or interactions were found ($p > .05$), suggesting that there was not a differential impact based on Gender, Race/Ethnicity or the interaction.

The results of the repeated measures ANOVAs for the two self-efficacy measures indicated a statistically significant difference between the pre- and post-testing for both Technology self-efficacy and Writing self-efficacy ($F_{1,167} = 109.54$, $p < .001$, Partial Eta squared = .450 and $F_{1,170} = 38.18$, $p < .001$, Partial Eta squared = 1.90; respectively). This finding suggests that there was a significant increase in self-efficacy from pre- to post-testing for both self-efficacy domains. However, once again, neither Gender nor Race/Ethnicity effects resulted in a significant main effect or interaction ($p > .05$).

Examining Subgroup Differences: Analysis of Covariance

In order to address the second set of research questions focused on potential subgroup outcome differences, a series of three 2 x 3 analyses of covariance (ANCOVAs) were conducted examining the post-test score for the interest in science scale and the two self-efficacy scales, with pre-test scores serving as a covariate. The pre-test was used as a covariate for two reasons. First, there was not a comparison group in this study to compare scale outcomes with the GE2 treatment group. Second, students were not randomly assigned to teachers; classrooms were selected as intact classrooms. The use of the pre-test variable for each scale as a covariate is a procedure for statistically controlling for initial pre-test scale differences that may have existed between subgroups of students.

The interest in science 2 x 3 ANCOVA yielded a marginally significant result for the main effect of Gender ($F_{1,171} = 3.920$, $p < .049$, Partial Eta squared = .023) with males (M = 2.66, SD 1.173) performing higher than females (M = 2.44, SD 1.183) on the post-test, once the pre-test was statistically accounted for. No other significant effects were found.

The two 2 x 3 ANCOVAs conducted separately on the two self-efficacy scales (Technology and Writing) failed to reveal statistically significant main effects or interactions ($p > .05$), suggesting that the intervention did not have a significant differential effect on students across either of the two demographic variables.

Conclusion and Implications

The results of the present study must be interpreted with some caution, as it contains neither a comparison group nor an assessment of distal outcomes, which are needed to determine the specific effects of the treatment and their long-term impact. Additionally, this is not a randomized controlled trial, which is recommended for efficacy and replication trials. However, despite these concerns, the results are promising, suggesting the positive impact of PBL for middle grade students' interest in science and self-efficacy.

The findings presented here speak to the potential of GE2, and other similar web-based PBL environments, for promoting the development interests and self-efficacy skills within an academically meaningful context. The GlobalEd 2 PBL environment is consistent with Nelson's (2010) six components of an effective PBL environment, while also presenting an ill-structured dynamic problem within which students are engaged in addressing science issues in a multidisciplinary social studies classroom over the span of 14 weeks.

This study suggests that GlobalEd 2 successfully builds upon the combined affordances associated with both face-to-face and virtual learning environments, presenting students the opportunities to develop their self-efficacy about technology use and writing skills in deep and meaningful ways. The curricular implications regarding the utilization of an interdisciplinary, PBL approaches like GlobalEd 2 have been yet to be fully explored within different contents, age groups, durations and contexts (i.e., afterschool programs, summer programs). However, the present data suggests that, as long as the assumptions outlined by Nelson (2010) and others regarding the development and implementation of rich PBL environments are followed, the student learning outcomes will follow.

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References

Alexander, P. A. (2000). Toward a model of academic development: Schooling and the acquisition of knowledge. *Educational Researcher*, *29*(2), 28–44. http://dx.doi.org/10.3102/0013189X029002028

Alexander, P. A., Jetton, T. L., & Kulikowich, J. M. (1995). Interrelationship of knowledge, interest, and recall: Assessing a model of domain learning. *Journal of Educational Psychology*, *87*(4), 559–575. http://dx.doi.org/10.1037/0022-0663.87.4.559

Arnot, M., David., M., & Weiner, G. (1999). *Closing the gender gap: Postwar education and social change*. Cambridge, UK: Polity Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman.

Bartholomew, H., Osborne, J., & Ratcliffe, M. (2004). Teaching students "ideas-about-science": Five dimensions of effective practice. *Science Education*, *88*(5), 655–682. http://dx.doi.org/10.1002/sce.10136

Becker, H. J. (1999). Teaching, learning, and computing—1998: A national survey of schools and teachers. Irvine, CA: University of California, Center for Research on Information Technology and Organizations. http://www.crito.uci.edu/TLC/html/home.html

Bednar, A. K., Cunningham, D., Duffy, T. M., & Perry, J. D. (1992). Theory into practice: How do we link? In T. M. Duffy and D. J. Jonassen (Eds.), *Constructivism and the technology of instruction: A conversation* (pp. 17–34). Hillsdale, NJ: Lawrence Erlbaum.

Bennett, J., Lubben, F., Hogarth, S., & Campbell, B. (2005). Systematic review of research in science education: Rigour or rigidity. *International Journal of Science Education*, *27*(4), 387–406. http://dx.doi.org/10.1080/0950069042000323719

Berkenkotter, C., & Huckin, T. N. (Eds.). (1995). *Genre knowledge in disciplinary communication*. Hillsdale, NJ: Lawrence Erlbaum.

Bransford, J. D., Brown, A. L., Cocking, R. R., Donovan, M. S., & Pellegrino, J. W. (Eds.). (2000). *How people learn: Brain, mind, experience, and school* (Expanded ed.). Washington, DC: National Academy Press.

Brown, S. W., Lawless, K. A., & Boyer, M. A., (2009, October). The GlobalEd 2 project: Expanding the science and literacy curricular space. In T. Bastiaens et al. (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2009* (pp. 160–164). Chesapeake, VA: AACE. Retrieved from http://www.editlib.org/p/32449.

Brown, S. W., Lawless, K. A., & Boyer, M. A., (2010, June). *Expanding science and literacy curricular space: Results of the GlobalEd 2 simulation on water resources*. Poster presented at the Institute for Education Sciences research Conference, Washington, DC.

Chinn, C. A., & Malhotra, B. A. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education*, *86*(2), 175–218. http://dx.doi.org/10.1002/sce.10001

College Entrance Examination Board (2003). *The National Commission on Writing in America's Schools and Colleges.* http://www.vantagelearning.com/docs/myaccess/neglectedr.pdf

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal*, *38*(4), 813–834. http://dx.doi.org/10.3102/00028312038004813

Dede, C. (2007). Reinventing the role of information and communications technologies in education. *The Yearbook for the National Society for the Study of Education*, *106*(2). https://nsse-chicago.org/Chapter.asp?uid=2817

Dockstader, J. (1999). Teachers of the 21st century know the what, why, and how of technology integration. *T.H.E. Journal*, *26*(6), 73–74.

Driver, R., Leach, J., Millar, R., & Scott, P. (1996). *Young people's images of science*. Philadelphia: Open University Press.

Evensen, D. H. & Hmelo, C. E. (2000). *Problem-based learning: A research perspective on learning interactions*. Hillsdale, NJ: Lawrence Erlbaum.

Gewertz, C. (2007). Outside interests: Young people typically plug in to new technology far more often on their own time than in school. *Education Week*, Technology Counts 2007. http://www.edweek.org/ew/articles/2007/03/29/30tcstudent.h26.html

Goodnough, K., & Hung, W. (2008). Engaging teacher's pedagogical content knowledge: Adopting a nine-step problem-based learning model. *Interdisciplinary Journal of Problem-based Learning, 2*(2), 61–90.

Gredler, M. E. (2004). Games and simulations and their relationships to learning. In D. H. Jonassen (Ed.), *Handbook of research on educational communications and technology* (pp. 571–581). Mahwah, NJ: Lawrence Erlbaum.

Greening, T. (1998). Scaffolding for success in problem-based learning. *Medical Education Online. 3*(4), Article 12. http://dx.doi.org/10.3402/meo.v3i.4297

Grigg, W. S., Daane, M. C., Jin, Y., & Campbell, J. R. (2003). *The nation's report card: Reading 2002* (NCES 2003521). Washington, DC: Institute of Education Sciences.

Harackiewicz, J. M., Barron, K. E., Trauer, J. M., Carter, S. M., & Elliott, A. J. (2000). Short-term and long-term consequences of achievement: Predicting continued interest and performance over time. *Journal of Educational Psychology, 92*(2), 316–330. http://dx.doi.org/10.1037/0022-0663.92.2.316

Harackiewicz, J. M., Barron, K. E., Trauer, J. M., & Elliott, A. J. (2002). Predicting success in college: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. *Journal of Educational Psychology, 94*(3), 562–575. http://dx.doi.org/10.1037/0022-0663.94.3.562

Hargreaves, A., & Moore, S. (2000). Curriculum integration and classroom relevance: A study of teachers' practice. *Journal of Curriculum and Supervision, 15*(2), 89–122.

Hart, H., Allensworth, E., Lauen, D., & Gladden, R. M. (2002*). Educational technology: Its availability and use in Chicago's public schools*. Chicago: University of Chicago Consortium on Chicago School Research. http://ccsr.uchicago.edu/publications/educational-technology-its-availability-and-use-chicagos-public-schools

Haury, D. L. (1993). *Teaching science through inquiry* (ERIC Digest EDO-SE-93-4), Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. http://www.ericdigests.org/1993/inquiry.htm

Hidi, S. (1990). Interest and its contribution as a mental resource for learning. *Review of Educational Research*, *60*(4), 549–571.

Holliday, W. G., Yore, L. D., & Alvermann, D. E. (1994). The reading-science learning-writing connection: Breakthroughs, barriers, and promises. *Journal of Research in Science Teaching, 31*(9), 877–893. http://dx.doi.org/10.1002/tea.3660310905

Hurd, P. D. (1998). Science literacy: New minds for a changing world. *Science Education, 82*(3), 407–418. http://dx.doi.org/10.1002/(SICI)1098-237X(199806)82:3<407::AID-SCE6>3.0.CO;2-G

International Society for Technology in Education [iSTE]. (1998). *National educational technology standards for students*. Washington, DC: ISTE. http://www.iste.org/docs/pdfs/nets_for_students_1998_standards.pdf?sfvrsn=2

International Society for Technology in Education [iSTE]. (2007). *National educational technology standards for students* (2nd Ed.). Washington, DC: ISTE.

Jenkins, E. W. (1999). School science, citizenship and the public understanding of science. *International Journal of Science Education*, *21*(7), 703–710. http://dx.doi.org/10.1080/095006999290363

Koschmann, T. D., Kelson, A. C., Feltovich, P. J., & Barrows, H. S. (1996). Computer-supported problem-based learning: A principled approach to the use of computers in collaborative learning. In T. Koschmann (Ed.), *CSCL: Theory and Practice of an Emerging Paradigm* (pp. 83–124). Mahwah, NJ: Lawrence Erlbaum.

Koschmann, T. D., Myers, A. C., Feltovich, P. J., & Barrows, H. S. (1994). Using technology to assist in realizing effective learning and instruction: A principled approach to the use of computers in collaborative learning. *Journal of the Learning Sciences*, *3*(3), 219–225. http://dx.doi.org/10.1207/s15327809jls0303_2

Krajcik, J. S., Blumengeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade teachers learn project-based instruction. *The Elementary School Journal, 94*(5), 483–497. http://dx.doi.org/10.1086/461779

Lawless, K. A. (2005). *Meaningful integration of technology into the classroom with Jamestown Reading Navigator*. White Paper published as a part of the Jamestown Navigator Reading Series, Houghton Mifflin. http://www.glencoe.com/glencoe_research/Jamestown/meaningful_integration_of_technology_into_the_classroom.pdf

Lawless, K. A., & Brown, S. W., Mills, R. J., & Mayall. H. J. (2003). Knowledge, interest, recall and navigation: A look at hypertext processing. *Journal of Literacy Research, 35*(3), 911–934. http://dx.doi.org/10.1207/s15548430jlr3503_5

Lenhart, A., Madden, M., & Hitlin, P. (2005). *Teens and technology: Youth are leading the transition to a fully wired and mobile nation*. Washington, DC: Pew Internet and American Life Project. http://www.pewinternet.org/~/media//Files/Reports/2005/PIP_Teens_Tech_July2005web.pdf

Levinson, R., & Turner, S. (Eds.). (2001). *The teaching of social and ethical issues in the school curriculum, arising from developments in biomedical research: A research study of teachers.* London: Institute of Education. http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtd003444.pdf

McEwen, B. C. (2004). Writing in the discipline: Why and how. Paper presented at the *Annual Atlantic Coast Business and Marketing Education Conference*. Raleigh, NC.

Mergendoller, J. R., Maxwell, N. L., & Bellisimo, Y. (2000). Comparing problem-based learning and traditional instruction in high school economics. *Journal of Educational Research, 93*(6), 374–382. http://dx.doi.org/10.1080/00220670009598732

Minstrell, J. A., & van Zee, E. H. (Eds.). (2000). *Inquiring into inquiry: learning and teaching in science.* Washington, DC: American Association for the Advancement of Science.

Mitani, H. (2007). Computer access at school improves. *Education Week*. Retrieved October 2, 2007 from http://www.edweek.org/rc/articles/2007/04/12/sow0412.h26.html

Murray, I., & Savin-Baden, M. (2000). Staff development in problem-based learning. *Teaching in Higher Education, 5*(1), 107–126. http://dx.doi.org/10.1080/135625100114993

National Research Council [NRC]. (1996). *National science education standards*. Washington, DC: National Academy Press.

Nelson, E. (2010). Elements of problem-based learning: Suggestions for implementation in the asynchronous environment. *International Journal on E-Learning, 9*(1), 99–114.

Nelson, L. M. (1999).Collaborative problem solving. In C. M. Reigeluth (Ed.). *Instructional design theories and models: A new paradigm of instructional theory: Vol. 4* (pp. 241–267). Mahwah NJ: Lawrence Erlbaum.

Newman, M. (2003). *A pilot systematic review and meta-analysis on the effectiveness of problem-based learning*. ERIC Digests. Retrieved March 20, 2012, from the EDTS.

No Child Left Behind Act, Title II, Part D, §2402. (2001).

Pellegrino, J. W., Goldman, S. G., Bertenthal, M. & Lawless, K. A. (2007). Teacher education and technology: Initial results from the "what works and why" project. *The Yearbook for the National Society for the Study of Education*, *106*(2), 52–86.

Renninger, K. A. (1992). Individual interest and development: Implications for theory and practice. In K. A. Renninger, S. Hidi, & A. Krapp (Eds.), *The role of interest in learning and development* (pp. 361–395). Hillsdale, NJ: Lawrence Erlbaum.

Roth, W. M. (1995). *Authentic school science: Knowing and learning in open-inquiry science laboratories*. Dordrecht: Kluwer. http://dx.doi.org/10.1007/978-94-011-0495-1

Roth, W. M., & Roychoudhury, A. (1993). The development of science process skills in authentic contexts. *Journal of Research in Science Teaching, 30*(2), 127–152. http://dx.doi.org/10.1002/tea.3660300203

Ryder, J., Leach, J. & Driver, R. (1999). Undergraduate science students' images of the nature of science. *Journal of Research in Science Teaching, 36*(2), 201–220. http://dx.doi.org/10.1002/(SICI)1098-2736(199902)36:2<201::AID-TEA6>3.0.CO;2-H

Sadler, T. D., Amirshokoohi, A., Kazempour, M. & Allspaw, K. M. (2006). Socioscience and ethics in science classrooms: Teacher perspectives and strategies. *Journal of Research in Science Teaching, 43*(4), 353–376. http://dx.doi.org/10.1002/tea.20142

Sadler, T. D., Barab, S. A., & Scott, B. (2007). What do students gain by engaging in socioscientific inquiry? *Research in Science Education, 37(*4), 371–391. http://dx.doi.org/10.1007/s11165-006-9030-9

Savery, J. R., & Duffy, T. M. (1996). Problem based learning: An instructional model and its constructivist framework. *Educational Technology, 35*(5), 31–37.

Sax, G. (1989). *Principles of educational and psychological measurement and evaluation*. Belmont, CA: Wadsworth.

Schiefele, U. (1996). Topic interest, text representation, and quality of experience. *Contemporary Educational Psychology, 21*(1), 3–18. http://dx.doi.org/10.1006/ceps.1996.0002

Schunk, D. H., & Swartz, C. W. (1993). Goals and progressive feedback: Effects on self-efficacy and writing achievement. *Contemporary Educational Psychology, 18*(3), 337–354. http://dx.doi.org/10.1006/ceps.1993.1024

Schunk, D. H. (2003). Self-efficacy for reading and writing: Influence of modeling, goal-setting, and self-evaluation. *Reading & Writing Quarterly, 19*(2), 159–172. http://dx.doi.org/10.1080/10573560308219

Speering, W., & Rennie, L. J. (1996). Students' perceptions about science: the impact of transition from primary to secondary school. *Research in Science Education, 26*(3), 283–298. http://dx.doi.org/10.1007/BF02356940

Todt, E. (1978). *Das Interesse: Empirische Untersuchungen zu einem Motivationskonzept*. Berne: Huber.

Todt, E., & Schreiber, S. (1998). Development of interests. In L. Hoffman, A. Krapp, A. Remminger, and Baumert (Eds.), *Interest and learning* (pp. 25–40). Kiel, Germany: IPN.

Wise, K. C., & Okey, J. R. (1983). A meta-analysis of the effects of various science teaching strategies on achievement. *Journal of Research in Science Teaching, 20*(5): 419–435. http://dx.doi.org/10.1002/tea.3660200506

Yore, L. D. (2001). What is meant by constructivist science teaching and will the science education community stay the course for meaningful reform? *Electronic Journal of Science Education, 5*(4).

Zimmerman, B. J., & Bandura, A. (1994). Impact of self-regulatory influences on writing course attainment. *American Educational Research Journal 31*(4), 845–862. http://dx.doi.org/10.3102/00028312031004845

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Appendix A

International Water Resources Scenario

This simulation scenario contains background information on world water issues and the potential of global water scarcity. All countries and issue area groups must read the entire scenario as it provides ideas that will help guide your research and highlights issues that you must consider as you think about your interactions with other countries within the simulation.

Part 1: Introduction

Water is the most abundant compound on Earth, making up about three fourths of the Earth's surface. Approximately 70% of an adult's body is made up of water, and at birth water accounts for roughly 80% of an infant's body weight. Without water, humans could not survive. Water to drink; Water to cook food; Water to bathe; Water for hydroelectric power; Water for irrigation/farming; Water to extinguish fires . . . Imagine a world without water!!

Nearly 97% of the water on Earth is found in oceans, which cannot be used by living things that live on land because it contains salt. This means that fresh water that can be used for human consumption makes up only about 3%. With many countries seeking to satisfy increasing water needs because of limited water resources and increasing populations, water might increasingly become a source of international conflict. As the UN Secretary General, Ban Ki Moon remarked recently, "Water scarcity is the potential fuel for wars and conflict. But cooperation, not conflict should guide us in our quest for a solution to this crisis."

The focus of your international negotiations will be on water as it relates to issues of the environment, global health, human rights and economics. Each of you will be acting as a scientific policy advisor for your country to develop policies, in cooperation with other countries that help to stabilize world issues related to fresh water needs. To do this, each of you will have to understand the scientific principles governing the amount of freshwater on Earth, the geographic distribution of water across the planet, the political regulation of water as a natural resource, health issues related to water and the cost of maintaining enough fresh water for everyone on the planet. In each instance, it is essential for decision-makers to understand the science and international politics of water that underlies sound global policy-making. It is also necessary to recognize that each country's decision-makers are presented with policy choices that can either promote or minimize the potential for both conflict and cooperation.

To see the full scenario, please visit the GlobalEd 2 website at: http://www.globaled.uconn.edu/student_water/simulation/simulation_introduction.html#part_1