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ABSTRACT

This study examines undergraduate non-science majors' perceptions of a cooperative-collaborative science pedagogy employed in a course on global change that was one course in a pilot project of a newly-designed environmental science program. Non-traditional evaluation tools such as portfolios, focus groups, group assessments, and self-assessments were employed in the course. This paper describes how research led to practical pedagogical applications in developing and assessing students' environmental science knowledge, applying science content to non-science majors' career goals, and promoting problem-solving skills in collaborative contexts. (Contains 45 references.) (WRM)

Fresh Footprints: Assessment of an Environmental Science Collaborative Learning Project for Undergraduate, Non-science Majors

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Abstract

What is the best way to teach and assess college-level science to undergraduates not majoring in the sciences, including students preparing for careers as early childhood and elementary education teachers who will teach science? The purpose of this study was to examine students' perceptions of a cooperative-collaborative science pedagogy employed in a course on Global Change which was one course in a pilot project of a newly designed environmental science program. Non-traditional evaluation tools, such as portfolios, focus groups, group assessments, and self-assessments were employed. The research led to practical pedagogical applications in developing and assessing students' environmental science knowledge, applying science content to non-science majors' career goals, and promoting problem-solving skills in collaborative contexts.

Key words: college science teaching, global change, cooperative-collaborative learning strategies, progress evaluation, integrated and theme-based learning.

Introduction and Background

While there have been several national initiatives to improve environmental literacy at the elementary, middle, and secondary levels in the United States and abroad (e.g., Mortensen, 1995; McKenzie Group, 1995; O'Connor, 1995; Paraskevopoulos, Padeliadu, & Zafiropoulos, 1998), these initiatives have had little impact at the college level. In fall, 1997, undergraduate, non-science majors embarked in the *Adventures in Science* (AIS) program, a National Science Foundation funded project. Students in AIS completed three sequential courses with each course based on the general theme of environmental science: Ecosystems, Global Change, and Environmental Health (see Website for *Adventures in Science*).

The primary goal of the AIS program is to investigate if an integrated, thematic-based and hands-on learning approach improves the scientific and environmental literacy of college students, relative to traditional course offerings for non-science majors. Program goals are consistent with those of the National Research Council (1996), the American Association for the Advancement of Science, and Costa's (1991) educational goals for the 21st century, specifically that students learn how to reason, how to cooperate, and how to conserve our planet as a delicate, fragile ecosystem. The specific goals of AIS are: 1) to increase the scientific, including environmental, literacy of students by providing an integrated approach to the study of science, with an emphasis on the many ways science is interwoven with everyday life and public policy; 2) to improve higher-order thinking skills of students; 3) to promote increased student appreciation of and ability to apply mathematics and computer skills; 4) to develop cooperative skills and provide shared learning opportunities for students; 5) to give students meaningful experience in the laboratory and to expose them to methods employed in the field; and 6) to give prospective teachers a more integrated and engaging curriculum in the sciences. Teaching ecological literacy and modeling activities for teachers to replicate in classrooms is an important science reform effort, especially by science professors who indirectly influence the learning-to-teach ecosystem for preservice teachers (Bowers, 1996; Wideen, Mayer-Smith, & Moon, 1998). There are few opportunities for preservice teachers to not only learn about science, but do science by thinking and acting like scientists (Raizen, 1994). These six goals are integral to each course however, this study focuses on cooperative learning skill development.

The purpose of this paper is a progress evaluation of efforts in accomplishing goal four by examining students' perceptions of *Kyoto Redoux* which was a major, cooperative-collaborative learning project of the second course, Global Change. Although the National Science Foundation (1996) recommends collaborative and small-group work in science course and field experiences, few college educators have developed or assessed such experiences (Springer, Stanne, & Donovan, 1999). Science evaluation should include new research approaches, such as progress evaluation and mixed method evaluations, in order to assess ongoing project activities, students' attitudes towards science, problem-solving and laboratory skills (National Science Foundation, 1993;1997).

Kyoto Redoux was designed to present science in a format that allowed students to better understand and appreciate science in terms of its applicability to their everyday lives and their major fields of study. Its design incorporated both cross-disciplinary study, i.e., the interconnections within the sciences, and interdisciplinary studies, i.e., the interconnections across the sciences and other subjects. This multi-faceted cooperative learning exercise utilized faculty from diverse disciplines in its conceptual design, facilitation, implementation, and evaluation. It was a simulation of the Conference of the Parties-2 (COP-3), sponsored by the United Nations

Framework Convention of Climate Change (UNFCC) which took place in Kyoto, Japan in 1997. The actual Kyoto conference was a global gathering of representatives from the governments of over 160 nations and individuals representing many public interest groups. After heated negotiations, the first steps for controlling the problem of human-induced climate change by reducing the emissions of greenhouse gases that contribute to global warming were made with a follow-up conference in Buenos Aires in 1998.

The authors document what was done and the strengths and weaknesses of the *Kyoto Redoux* project as identified through students' self-reporting using non-traditional science assessments, i.e., portfolios, focus group interviews, student and group evaluations, and faculty observations and notes. Although traditional measures of evaluation were utilized for AIS, (e.g., likert-type sentiment scales, pre and post scientific literacy tests, laboratory reports, exams, reports), the focus of this study is on what was learned through alternative assessments, including affective outcomes.

Theoretical Perspective

The importance of an integrated approach to the study of science, utilized in this program design and implementation, has been stressed by numerous studies, including Project 2061 sponsored by the American Association for the Advancement of Science (1989), and the National Science Teacher Association's Scope, Sequence, and Coordination Project (Pearsall, 1992). The National Research Council (1996) and Hazen & Trefil (1995) also emphasize the importance of an integrated approach to the study of science that nourishes a community of learners. Anbar (1983) notes that an understanding of the environment based only on one discipline is superficial and unrewarding. Kieg (1994) argues that a theme provides a broad perspective on science by connecting concepts and applications across the traditional science disciplines.

Constructivist theory from the work of Piaget (1965) and sociocultural theory (Vygotsky (1978) each support that dialogue and interaction with peers is essential to students' developing cognition, construction of knowledge and personal theory building. A cooperative learning model was utilized for the purpose of motivating and empowering learners to high levels of achievement while encouraging them to support, not compete, against each other in a democratic, team fashion (Baloche, 1998). Essential to the cooperative design was team and individual accountability (Johnson & Johnson, 1999; 1994). Students of all ability levels had opportunities to interact in a shared task and to promote group success towards a mutual goal.

Group investigation, a well-researched and productive task specialization cooperative learning technique incorporating peer and teacher review (Slavin, 1995) was utilized. The method dates back to Dewey (1938) and was later refined by Thelen (1954), and Sharon & Sharon (1976). It is appropriate for integrated study projects that deal with the acquisition, analysis, and synthesis of information in order to solve a multi-faceted problem that goes beyond answering factual questions (Slavin, 1995). The Group Investigation approach uses: topic selection, cooperative planning, implementation, analysis and synthesis, presentation of final topic, and evaluation (Arends, 1998). The role of the instructor includes: introducing the broad topic, assigning subtopics according to student backgrounds and interests, serving as a facilitator, assisting the groups throughout the project in class, and helping locate resources.

Methodology

Project Description

Kyoto Redoux was carefully designed to provide students with multiple opportunities for students to work within their task group as well as across groups. The class met for a one-hour class twice a week, a two-hour laboratory experience once a week, and participated in a variety of field trips. The students were asked to provide preliminary information regarding their majors and areas of interest and/or knowledge, so that they could be involved in activities that would utilize their skills and talents. After analysis and study of the provided information, students were assigned to one of six working groups for design, preparation, and achievement of the conference. These six groups were: 1) Representatives of Countries and Coalitions, 2) Representatives of Special Interest Groups or Non-Governmental Organizations (NGO's), 3) Science Background and Policy Task Group, 4) Production and Protocol Task Group, 5) Design and Facilities Group, and 6) Public Relations and Press Task Group.

Assignment to groups was primarily aimed at major areas of study, e.g., an English major served as a conference reporter, drama majors prepared the design and facilities and coached speeches, and communication majors filmed the presentation and presented speeches. This was in agreement with the National Research Council's (1996) science teaching standard A: "Select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students" (p. 30). Each of the groups had specific responsibilities for the success of the conference. For example, representatives of the countries and coalitions group were required write a position paper on their country's position after first researching their country's interests, investigating climate change on their country's economy and trade, lifestyle and necessary adaptation to any changes made. Evaluations were completed for each student as well as the individual groups and included multiple assessment measures, e.g., research and position papers, participation, weekly reports, self, group, and faculty evaluations, information kits, promotional material, and portfolios.

Based on the diversity of disciplines necessary to design, implement, produce, and facilitate a conference of such proportions and multiple interests, faculty from the departments of politics, drama and communications were also invited to participate. Students were assigned a faculty or staff representative to whom they were to report and use as a reference individual. Faculty from the Department of Politics served as faculty advisors for students representing the countries and coalitions as well as the special interest groups and non-governmental organizations. A faculty member from the Department of Drama oversaw the activities of the design and facilities and production and protocol groups, while a faculty member from the Department of Communications directed students in the public relations and press group.

The coordinator of the grant project was primarily responsible for oversight of the entire conference and a faculty member from the Department of Education was primarily responsible for the evaluation of the conference. An environmental lawyer with the U.S. Department of Justice, who had participated in the actual Kyoto conference in Japan, shared his experiences and knowledge of COP-3 with class members. Creativity was encouraged within the framework of the assigned tasks. The culmination of the project was a reenactment of the actual conference with invited guests from the University and distinguished environmental organizations.

Participants

Participants were 59 undergraduate students (39 females, 20 males) enrolled in the second of a three course sequence environmental science program at a middle-sized urban university in the District of Columbia. One of the requirements for enrollment was no previous college-level science instruction, consequently resulting in a population of mainly freshmen: 52 freshmen, six sophomores, and one junior. Students represented a variety of disciplines including, but not limited to: anthropology, communications, English, politics, American government, pre-law, international business, drama, music, psychology, social work, history, and education. There were 19 students majoring in education who were required to participate in the program since it was deemed essential to their teaching. Students not majoring in education elected to participate in the program and committed to completing the three sequential science courses, which also satisfied university distribution requirements.

Data Sources and Collection

This was a naturalistic study (Lincoln & Guba, 1985) designed to describe students' perspectives of a project-based curriculum in an environmental science course. A qualitative method was chosen to acquire actual participant statements as data. Traditional educational evaluation strategies in science education that rely exclusively on quantitative data, exclusively measure student achievement, or attribute any impacts to a single source, "are not as directly applicable to the majority of the research-oriented, ground breaking inquires that make up the portfolios of many of the Foundation's efforts" (National Science Foundation, 1995, p. 1).

The method for progress evaluation for *Kyoto Redoux* was based on information gathered during and after the project. According to Arends (1998), evaluation of student achievement in Group Investigation can include either self or group assessment or both and investigate students' affective experiences, (e.g., motivation, personal contribution), and higher-level thinking and reflection about their learning (e.g., methods of investigation, application of knowledge, problem-solving, decision-making). To this end, during *Kyoto Redoux*, two assessment instruments were used: (a) team and self-assessment during the project, and (b) group and faculty observation and assessment of the negotiation phase of the project. After *Kyoto Redoux,* evaluative instruments employed were: (a) student portfolios and (b) focus group interviews.

As a dynamic assessment activity, students were expected to continuously collect, select, and reflect over time in their portfolios (e.g., a progress journal, description of student's role and responsibility in group, a summary of investigation, application of research to respective task, reflection and assessment). The purpose of this developmental portfolio was to chronicle and document students' contributions and performance for *Kyoto Redoux,* to promote self-analysis and critical reflection, and allow faculty to view and monitor students' integration of content knowledge. Portfolios assist in the evaluation of new instructional approaches which promote students' personal construction of knowledge and the support received in that process (OERI, 1993). Slater, Ryan, & Samson (1997) found that portfolios in a college science course were an accurate measure for student achievement as traditional assessment procedures (i.e., objective exams). Incorporating portfolios is a part of an assessment system reform in science evaluation--a feminist pedagogy that shifts some control to students by representing their diverse experiences, perspectives, and abilities (see Roychoudhury, Tippins, & Nichols, 1993-1994). For those working with pre-service teachers, portfolios provide a unique lens for learning about future teachers' diverse linguistic and learning styles, cultural backgrounds, and personal experiences (Garcia & Pearson, 1994).

A second alternative science assessment utilized in this study was focus group interviews. Students responded to questions about the planning, implementing and assessment procedures that were used for the *Kyoto Redoux* project. Focus group interviews have become an increasingly popular technique for gathering information as a descriptive progress evaluation tool and are particularly revealing of the dynamics, within group and across groups, affective measures such as attitudes, dispositions, motivation, and the identification of project strengths, weaknesses, and recommendations (Morgan, 1993; National Science Foundation, 1993; 1997; Stewart & Shamdasani, 1990). During final exam week, students submitted their portfolios and participated in focus groups interviews. At that time, they also turned in their final take-home exam and completed course evaluations. Six groups of intact *Kyoto Redoux* groups were designated for the focus groups. Two class instructors and one program consultant served as focus group moderators and conducted 30-45 minute audio-taped recorded focus group sessions. Tapes were transcribed and analyzed.

Data Analysis

In regard to qualitative analysis, the multi-data source was read and reread with marginal remarks and memos. As each data source was read from the written and transcribed data sources, repeated statements were coded and checked with other statements across the data. This process allowed an analysis of patterns of similarities and differences and the marking of preliminary categories. Once categories were identified, the data was re-analyzed more systematically with line-by-line coding. Pattern coding was used to group overarching categories of students' views about the *Kyoto Redoux* project and to cluster views across informants (Bogdan & Biklen, 1992). Pattern coding, analogous to the cluster-analytic and factor-analytic devices used in statistical analysis, is a way of grouping summaries into a smaller number of constructs that identify an emergent "theme" (Miles & Huberman, 1984). Each data set was read again, with continuous refinement and reduction of categories.

Findings

Five major themes emerged from the qualitative data: 1) learning about environmental science issues, 2) making connections, 3) collaboration, 4) confusion and problem-solving, and 5) portfolios as a positive assessment tool.

Theme 1: Learning about Environmental Science Issues

Overall, the students viewed *Kyoto Redoux* as a valuable learning experience in learning about environmental issues. By the end of the semester, each student recognized the purpose, goals, and results of the actual Kyoto conference. They noted that they could now identify the causes and effects of global change, which gases cause environmental problems and why, while also recognizing that "this particular science consists of more than just formulas and equations." Students expressed their appreciation, awareness, and a sense of responsibility in learning and caring about the environment and the immediacy for world-wide reform and action. The project appeared to spark an awakened interest and conviction as obvious in the following remarks:

> This project was not proposed by the professors simply to keep us busy, but instead to show the class through the redoux, what it takes for the entire world to make a conscious effort to help save our environment...This conference occurred so all countries would make an effort to reduce the amount of pollution and waste that has caused so much change that could be fatal to Mother Earth very soon.

> I feel privileged to have learned about an important issue that troubles many environmentalists, politicians, and many citizens around the world...there must be hope, determination, and education in which others will learn the truth of our living and being.

A student shouted out in the focus-group interviews: "We better care about the environment! I am aware of that now." This is a viewpoint we hope to develop further for all students.

Theme 2: Making Connections

Students explained how they appreciated the applicability of the project to the real world and to their area of study. During Earth Week when people came to campus, students were able to talk about things other countries had done at the Kyoto conference. Many students noted how environmental science, applied to a variety of disciplines, helped them understand their surroundings. For students representing countries and coalitions during *Kyoto Redoux*, the nature of the project required the application of scientific knowledge in order to explain and justify their country's position on levels of gas emissions as noted here:

> I think just the fact that we had to come up with positions that were based on science - like the reasons why certain countries were in favor of different policies was because this is what their strengths and weaknesses were based on science and the economy.

There were numerous comments about the connections that students made between *Kyoto Redoux* and their major area of study. An education major states, "I can see myself going into a fourth grade class and doing the same (project)." Another education major reflects in her portfolio, "broadening your perspective will help make you a better teacher." An undecided major expressed his realization of the interdisciplinary connections he had made:

> That's what the whole experience was about - like the politics of environmental issues, educating people about the environment...from a communication standpoint giving a speech, from an education standpoint learning to reflect, and from a drama standpoint, being able to deliver a speech.

The integrated project appeared to create a sense of competitiveness between the disciplines for several students and a cohesiveness for others. For example, students who worked in the special task groups, e.g., Production and Protocol and Design and Facilities groups, indicated they had not learned as much about science as they did about their major. One student felt that "there was not enough science in this environmental course but a lot of the work that we had to do on Kyoto was politics and economics oriented." Nonetheless, another student, working in the Design and Facilities group, stated that she researched the actual conference thoroughly in preparing the design and facilities to help her understand what the conference actually presented. Other students explained that they "saw environmental issues through politics" and enjoyed being able "to view the scientific world through another discipline" and "to see the important role of policy in environmental issues." The differentiated tasks and learning experiences in the cooperative learning groups, may also have encouraged some students to make the connections more easily than others.

Theme 3: Collaboration

Peers and faculty supported students' in their developing understanding of environmental science during group work, as they presented and reported to others. A student representative from the European Union coalition stated: "Our coalition bonded in an odd sort of way and I left excited when arguing with my friend about emissions trading." The "truly collaborative effort" as one described, was required in order to prepare one major paper. Operating like a "tag team," tasks could be easily separated but synthesized for a team report and presentation. The idea of going public motivated many students to do their best. As one student remarked, "Knowing we had a big presentation meant we had to do a good job so we all got together and said "Yea! Let's do this. Let's make it work." Students commented that the major presentation forced them to get serious, polish their writing and speaking skills, and not let the school or program look foolish.

According to students, the cooperative effort entailed learning to deal with each other's attitudes, feelings, and perspectives. It involved searching and working with material and being responsible for a personal contribution "because you don't want to let someone else down." It meant arranging out of class meetings and making deadlines. Problems arose across groups when deadlines were revised but ultimately "the groups had to work interactively to make the conference happen."

From a Vygotskian (1978) perspective, students learned by listening, questioning their opinions, discussing, and negotiating. "I learned more about where I stood by hearing about other countries' points of view and working together." A student who had difficulties in understanding Kyoto states that, "Talking with my peers helped me understand it better and contribute to the project." Nonetheless, students repeatedly mentioned, the structure for cooperative learning needed more thought, particularly the classroom arrangement--a large auditorium with unmovable theatre-like seating--made it difficult to work in groups.

Theme 4: Confusion and Problem-Solving

Students remarked that they were confused about the purpose of the project and their assignments, especially in the beginning. The "big words" were intimidating and the big picture was not in focus. For several students there was too much information to sort through and for others, there was limited information available (e.g., the unresponsiveness of some embassies and the special visitation passes needed to enter the World Bank). For the most part, the inquiry approach utilized was novel and caused tension as did the use of multiple instructors. Students, accustomed to a traditional format of science teaching, expressed their frustrations to the project coordinators. Students also attributed some of their confusion to other factors including: the distant project goal, the particulars that led up to the final conference presentation, the large class size, the lack of input in reshaping the final positions of countries during the negotiation and presentation phases, the time allocated for the project, negotiations, and reflections, and revised schedules and deadlines. The majority of students recommended a tighter course structure in the future (e.g., laboratory work connected to Kyoto project, better organization, clarity, and direction). As in any course, there was a large variance in students' scientific knowledge and sense of competence in dealing with scientific content.

Fortunately, during the negotiation process, things became much clearer:

> I started very slowly and confusingly and ended with a bang. I learned more in the negotiation process. Once I understood the point of everything, then I became more interested. In the last few weeks everything really pulled together.

Much of the confusion was alleviated through students' own ingenuity and problem solving, e.g., collaboration, peer coaching, and finding alternative information sources. For instance, students found additional information at bookstores and on the Internet, especially when the link-up for translations from Spanish and French were not available. They shared research material found and rearranged meetings. Students also moved beyond the facts in thinking through negotiations, made decisions about what to give up, and learned how to deal with the confusion and discomfort. In essence, students were learning many skills in critical assessment, synthesis, analysis, learning to give and take, and work toward a common goal.

Another outcome was that the simulation was a cathartic exercise in working on environmental issues, i.e., the role-playing enabled them to feel as if they were actually attending the conference:

> This project let me pretend I was really there and helping the Earth along with all of the other countries in the world (a drama major).
>
> I wanted to let the audience know and believe that I was an actual representative of Japan...I next found myself thinking like I was really from the Japanese coalition (a politics major).

McCaslin (1996) states that simulation exercises help students develop critical judgement and a sense of personal responsibility. According to Heller (1995), a formal recreating is like a play where students learn on the most basic level--by seeing, hearing, and doing. Nonetheless, being from another country was not always a comfortable or choice role. A representative from the Developing Countries coalition complained: "I couldn't stand the fact that China really didn't want to make an initiative to help stop gas emissions." When a representative from India found out "India had spoiled everyone's plans!" (by not agreeing to any set gas emissions standards), she exclaimed:

> How was I to defend a country that crushed the plans of my home? (The United States)...I wrote a letter to all the professors of Kyoto stating my disgust for having to defend a country [to which] I was randomly assigned and that goes against my views. I wanted to quit, but I didn't. Instead, I researched. I began to see the light....

A new-found confidence evolved as students conducted research in order to effectively negotiate: "I learned that I truly do like politics and that I should not be intimidated by those who appear more affiliated with the world than me." Many students reported their disappointment in the poor turnout of visitors to the presentation, the length of the re-enactment, and the grade value allocated to this major course project. A student asserted, however, "I think if people really understood the true meaning behind the conference, they would have been a lot more excited about it." Another writes: "I can't believe these words as I type them but, I had fun and learned a lot about international diplomacy. Next semester I plan to join the model UN (United Nations) club on campus and do some more negotiating."

Theme 5: Portfolios as a Positive Assessment Tool

In the focus group interviews, students stated that the portfolios helped them successfully organize, synthesize, and review their newly acquired scientific knowledge. Through the developmental portfolio process, students commented that they were "able to access and really bring everything together," that it allowed them "by looking back to see and think about what was important", and helped them realize how much they had learned:

> I think one of the most interesting points was when you look back at the different drafts you turned in for one paper and see how each draft was different and how much you progressed, that really helped. You could go back and see what you learned from someone else.

Several students commented that they were pleased for the opportunity to showcase and document their individual efforts, which might not have been obvious to the instructors because of the nature of the group work.

A student from the Press and Public Relations task group writes in his portfolio, "It's different for everyone. I mean what you get out of an experience. Me, personally, I thought it (the portfolio) was more work." Another member of the same group reflects in her portfolio: "The project made me look at the Earth with a smile...I learned a lot about global warming and what we need to do."

Quantitative Analysis

Quantitative analysis was also conducted resulting in significant findings in relation to gender and portfolios. A correlation analysis indicated a statistically significant correlation between gender and portfolio grade with females receiving higher grades; $r = .334$ ($p < 0.05$). Perhaps the portfolio, as an assessment tool, offers opportunities for relational ways of knowing common to many women (Belenky, Clinchy, Goldberger, & Tarule, 1986). Also, the portfolio may be a less competitive way of learning (Seymour, 1995) or being evaluated. Female instructors who graded the portfolios, also designed its grading rubric. This alternative form of documenting one's learning, may help foster females' positive attitudes toward science which have been found consistently lower than that of males (Weinburgh, 1995).

Conclusions

In this study, much information was gained in employing cooperative learning and simulation exercises and in refining and improving course work in the development of a prospective environmental science program. The *Kyoto Redoux* project was useful in facilitating and developing cooperative skills and shared learning opportunities for students which was one of the program goals. Qualitative analysis and measures were sensitive to evaluating this larger program goal with both cognitive and affective outcomes. In terms of quantitative analysis, the significant correlation between females and grades on portfolios is an interesting area for further research on possible gender preference in science assessment.

The overall program objectives may seem rhetorical, i.e., one might expect that an integrated, thematic-based and hands-on-learning cooperative approach would be successful. However, *Kyoto Redoux* exemplifies the difficulties in the implementation of theoretical-based pedagogy. Organizing for cooperative learning necessitates structured, long-term planning. It must involve: consideration for creating a conducive learning environment for peer interaction and review, consideration of group size and composition, frequent teacher monitoring of both scientific knowledge and group dynamics, and meaningful interactions between faculty and students, e.g., questioning, providing feedback, and encouraging self-regulation of student learning (Mandel, 1991).

Science education has historically involved students in proposing a hypothesis, conducting an investigation, answering a question, writing results, and stating a conclusion – whether the hypothesis was correct, incorrect, or undetermined. Science learning typically occurs in structured lab experiments and from information gathered from lectures, textbooks, and decontexualized experimentation. Global Change was a science course in which students were active participants, researchers, and decision-makers on a human-induced climate change. They had to make a plan, partition tasks, share expertise with team members and other teams, and reach closure of their investigation for a campus-wide presentation. There was a great deal of interactive work necessary to inform each other of the historical decisions actually reached. It was an event that had an immediate impact on their personal lives, as world citizens, living and protecting Earth.

Nonetheless, students freely reported on the strong and weak aspects of the cooperative project and offered many recommendations for the radical and new pedagogy employed. Several students complained about the lack of structure of group work and the need to know more exactly what was expected of them. For many, this pedagogical shift may have been too much of a stretch--too uncomfortable, perhaps too much, too fast, or perhaps there needed to be more thoughtfulness in its design and execution. Despite the confusion and discomfort, students' self-reporting does suggest that in cooperative learning experiences, they acquired an understanding of environmental issues and scientific knowledge related to global change, an applicability of environmental science across disciplines and within their own discipline, and had opportunities in developing collaborative and problem-solving skills. Utilizing cooperative activities and simulations of environmental events at the college level, even those of a much smaller scale and complexity than *Kyoto Redoux*, is a promising science pedagogy that merits further investigation.

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