2. Inquiry- 2-insight:
An international environmental science collaboration

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Introduction

In recent decades environmental issues have been of growing concern. In particular climate change is one of the major issues; for the first time in human history, we have conscience that we can impact our environment on a planetary scale. To solve this global issue, it is of upmost importance that each citizen takes action by engaging in sustainable and environmental behaviors. However taking proper action is difficult for many people because (i) the problem, happening now and accelerating, can seem too big to solve, (ii) climate change does not stop at international boundaries and in that respect people may feel that they have to deal with a problem their society did not create, (iii) despite the consensus in the scientific community[1], the media and internet release tremendous amount of information of different accuracy and quality[2,3]. Deep understanding and international overview of those issues will be the keys for the next generation of educators, citizens and policy maker to envision efficient and international solutions. In that respect education is the critical factor in dealing with global and local environmental problems.

Recent decades have also showed a major change in education: ICT tools are invading the classrooms[4,5] and use of social networks is now beyond the imagination of its own inventors. Indeed the Web is full of social networks dedicated to education[6,7,8]. Students are big social network consumers but their primary interests are entertainment and social exchange. Moreover despite their apparent technological skills, students are not necessarily fluent in information, visual and technical literacy; most student acquisition of these skills is accidental[4].

The Inquiry-to-Insight (I2I) project offers an educational program combining ICT, social networking and pedagogy directed at environmental issues. The I2I idea is to pair classes from different countries within a social network. The students compare views, attitudes and life styles around three environmental issues (climate change, environmental pollution and habitat preservation) and will increase their understanding of those issues with different educational tools mainly based on ICT. Preliminary results indicate that this approach motivates students, provides educational opportunities while enhancing ICT literacy and expands a narrow view of the environmental issues to an international one.

The project

Started in November 2008, the I2I project is collaboration between Stanford University, California, USA and Gothenburg University, Sweden and their respective marine

stations; Hopkins Marine Station and Sven Lovén Center for Marine Sciences- Kristineberg. A pilot study was conducted pairing senior students from Sweden and California. The Swedish students are enrolled in a national marine biology program at Gullmarsgymnasiet, Lysekil. The students from Seaside High school, Seaside, California are members of an advanced biology class.

The tools

I2I aims to implement and evaluate ICT tools to increase student's awareness of environmental issues and to broaden students' views. During our pilot study we evaluated different tools presented and described below.

Social network

We set up an educational social network with the Ning online platform. This platform gives anyone the opportunity to create their own social networks around specific interests with their own visual design, choice of features and member data[9].

We use the I2I social network both as a learning platform and as a socializing place, as we have found that the comfort level of the students increase as they become acquainted with each other and the I2I team.

The I2I Ning page includes 5 main features:

- Students set up their own **personal page** and answer a questionnaire concerning their life and involvement in environmental issues. They read each other's personal page and send comments back and forth. This feature has lead the students across the ocean to get to know one another better. Students can upload pictures and videos on their personal page to illustrate themselves and their life.
- Students have the opportunity to create their own **blog** as a place for free expression. This feature is very important to create personal bonds between students.
- A **forum** feature is dedicated to discussions related to science, class assignments and to introduce new activities. Amongst others, students use it to share environmental perspectives and to measure their personal energy consumption (via our Carbon Footprint activity described below). They then compare and discusse their carbon footprint in the two sister-school classes. The students' data are presented in graphical form so the students can analyze how their footprint compared to the class distributions and means. This facilitates class discussions through a meaningful graphical example.
- Three **RSS feeds**[10,11,12] are displayed in order to keep track of the latest environmental news. Those articles are used as resources for assignments and discussion starters.
- The **chat** feature gives students the chance to talk in real time.

In order to energize the collaboration between students in US and Sweden, they participate in cross-ocean group projects. Each group investigate a question (of their choosing, with teacher approval) related to a broader topic in relation with climate change such as transportation, food choice, household energy, or media attention. Groups lead their inquiry with teacher support. Students are guided to find the resources and evaluate their accuracy by checking sources and author in order to improve their critical thinking abilities.

The students are free to use the communication tools they think are best for the collaboration (email, facebook, skype, elluminate, I2I Ning page…). In order to share their research with their peers from the other groups, students will create a multimedia presentation to be posted on the Ning page.

Virtual activities

All the tools developed are meant to be open resource. So far we developed 2 online curriculums:

The **carbon footprint activity**[13] gives students the opportunity to take a critical view of their own energy consumption and to find solutions to decrease their personal emissions. This virtual activity is divided into three parts. The first is an introduction to the problem and a link to a carbon footprint calculator; each student answers questions concerning their life style to determine their carbon footprint. Once they know how much carbon dioxide they release, they consult a world map with the emission per country in order to see their own consumption in a global context. Finally the animation aims to help students to think about their behavior and how simple actions in their everyday life can significantly decrease their carbon footprint.

The **ocean acidification animation and virtual laboratory**[14] include background information on how or carbon dioxide emissions impact oceans pH (ocean acidification), an interactive model of ocean acidification, a comparison of calcifying organisms believed to be severely affected by ocean acidification, an interactive evolutionary tree of calcifying organisms and a virtual laboratory where students address the question: How does ocean acidification effect sea urchin larval development? In the virtual lab, students complete the procedural steps of the experiment: setting up replicate cultures, feeding the larvae, making water changes, and observing the changes in the larvae over time. Then, they set up slides for measurement analysis. The students make the larval measurements themselves for a subset of the larvae (a different subset for each student), calculate the treatment means, and then can compare their subsample results to the entire statistical sample. The data the students analyze are actual data gathered by I2I scientists leading research on ocean acidification.

VoiceThread

To support a more authentic learning context and to clarify students understanding, interactions between scientists and students are important[15]. Unfortunately this requires more time and money than schools can afford and more time than scientists can allocate. The virtual conference can be a good alternative to gather scientists and students into a discussion. In that respect, VoiceThread seems to be the perfect tool.

A VoiceThread is a collaborative, multimedia slide show that holds images, documents, and videos and allows people to leave comments in different ways – recording voice, typing text, uploading files, videotaping with a webcam- and share with anyone. VoiceThread allows group conversations shared in one place, from anywhere in the world[16].

During our pilot study, Dr. Dupont- a biologist leading researches on effect of ocean acidification at the Sven Lovén Center for Marine Science created a VoiceThread on his research and results and posted it on our Ning page. Students can have a look at the talk at any time, learn at their own pace, and have ongoing discussions on the topic with other students and I2I team members.

All these contacts make the project and the issues more tangible to the students. Furthermore, these more personal and in-depth interactions give students the opportunity to gain a deeper understanding of complex scientific issues such as ocean acidification.

Results

Quantitative data

In order to evaluate I2I project we designed 2 surveys –one general and one focusing on ocean acidification- that students fill in once before they start the project and one at the end of the academic year. As the I2I academic year ends, students will take the general post-survey. They completed the post survey on ocean acidification at the conclusion of the ocean acidification animation.

The ocean acidification survey is designed to assess students' knowledge on this issue and how student evaluate their own knowledge. The ocean acidification survey includes 6 questions. The knowledge score was range from 0 (all wrong answers) to 1 (all right answers).

Our tools significantly increase students' knowledge on ocean acidification. Figure 1 compares the results from the pre and post surveys from the Californian and Swedish students. While there was no significant difference between Sweden and California (an average score of 0.55; $F=0.27$, $p<0.6$), a significant increase in knowledge of 30% ($F=11.6$, $p<0.001$) was observed in both countries as a result of exposure to the I2I OA activity (ANOVA II, $F=3.96$, $p<0.01$).

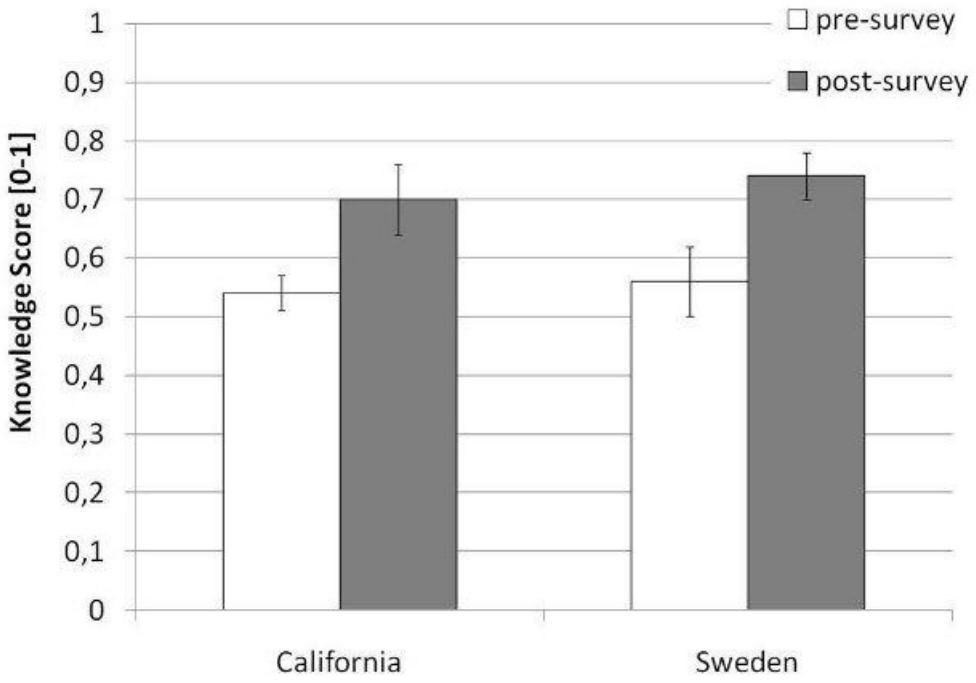

Figure 1: Increase in knowledge (scored between 0 and 1) after the OA animation. Pre-survey in California, n=15. Pre-survey in Sweden, n=15. Post-survey in California, n=9. Post-survey in Sweden, n=13.The error bars represent the standard error of mean.

Students were asked to evaluate their level of knowledge with a value between 0 (no knowledge at all) and 1 (best knowledge). The table 1 shows that student' self-evaluation increases significantly through time by almost 27 % in Californian and by almost 21% in Sweden.

Table 1: Increase in student self-estimation of knowledge on OA before ("pre") and after ("post") undertaking the OA activity. Mean ± standard error of mean.

Value	California (pre) (n=15)	California (post) (n=9)	p	Sweden (pre)(n=15)	Sweden (post) (n=13)	p
[0-1]	0,358±0,052	0,454±0,058	*	0,56±0,0	0,676±0,036	*

Figure 2 illustrates the relation between self-estimation of knowledge and real knowledge on ocean acidification. The symbols (dots and squares) above the line indicates that students' knowledge are higher than their self-estimation of knowledge which means that they under-estimates themselves. The symbols below the line indicate that students overestimate themselves since their knowledge score is under their self-estimation of knowledge.

The majority of our students from both countries underestimate their knowledge before and after I2I participation.

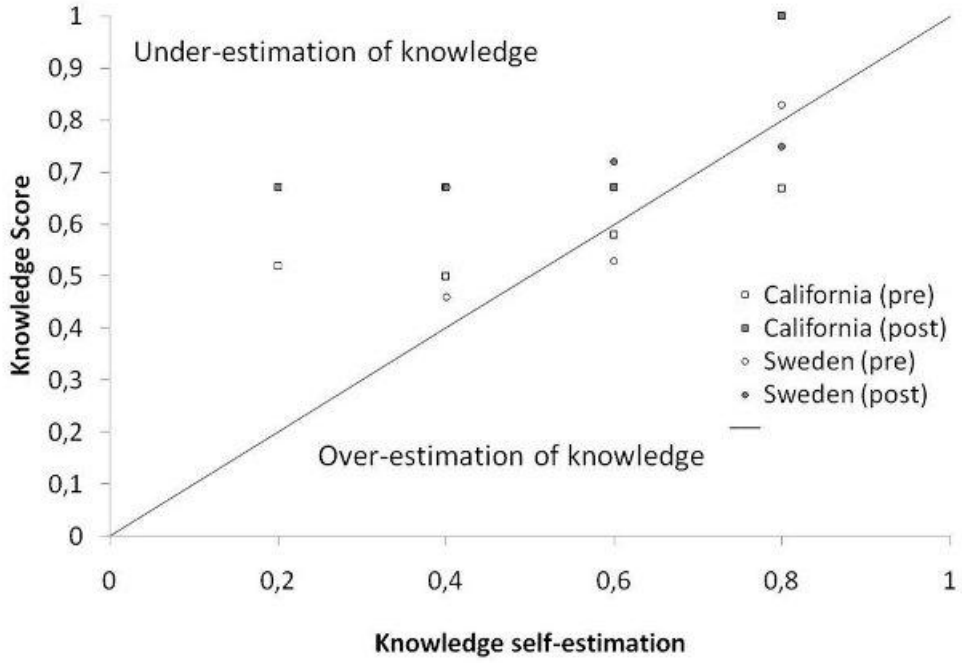

Figure 2: Relation between self-estimation and real knowledge on OA

Qualitative data

Student response and enthusiasm surpassed expectations. On both sides students were eager to meet the sister students and to get to know each other. Students showed an important interest for the social networking aspect. However, it has been a challenge to bring an educational focus to ICT tools that students use mainly or exclusively in a social context. Thus, while students eagerly used the Ning site to design their personal pages and participate in blog discussions, they did not often engage in educational or scientific forum discussions.

By contrast, students participate actively when they are guided in forum discussions such as "bad environmental habits" or "comparison of students' carbon footprint". Moreover students that never or rarely spoke in class often participated very actively.

A concern was that Swedish students could feel a bit insecure and shy with their English compare to the Californian students. The ICT tools show all their potentials by deleting this concern. In fact, ICT tools gave Swedish students time to formulate, modify and improve their comments while interacting with students or the staff.

Discussion

We evaluated a group of 30 high school students –15 in Lysekil, Sweden and 15 in Seaside, California, USA– for their knowledge on the topic of ocean acidification (OA) before and after undertaking our online OA activity. In both groups of students, knowledge of OA increased by about 30% as a result of exposure to the I2I OA activity. These preliminary results, showing similarity across the ocean, may indicate the broad applicability of our OA activity across cultures.

Interestingly, students in both the US and Sweden underestimated their knowledge of OA, both before and especially after exposure to the I2I OA activity. The fact that their knowledge increased more than they realized may be seen as a validation of our interactive approach: our activity is designed to be engaging and entertaining, something the students may not generally associate with the learning process. It is possible that they learn more than they realize in this context, something we might refer to as "stealth teaching." More extensive and complete evaluations will be required to evaluate this possibility.

Conclusions

Our preliminary results show that the new tools that we have developed increase students' awareness and understanding of some environmental issues. This project will also help each school fulfill its goal of education in for four different sides.

(1) The scientific side is provided by virtual laboratory experiences and virtual discussion with scientists. Laboratory experience is critical for understanding science; lectures and readings do not convey the scientific process[17, 18]. Yet laboratories are disappearing because they are expensive, require more time than the typical class period, and entail extensive teacher preparation and set-up. Computer-based virtual activities, which simulate (and ideally complement) real lab experiments give the student the flavor of the actual experience. The labs we have developed are made more relevant[19] since the students repeat actual experiments on environmental problems, including acquisition and analysis of real data. The students will have the opportunity to discuss - amongst others - those data with the scientists who collected them thanks to VoiceThread discussions.

(2) The critical thinking side is provided by teacher-directed (and scientist-validated) analysis of internet content. The web is full of facts about the environment but this information does not necessarily lead to constructive action since this media often presents contradictory views, even on issues that have a broad consensus in the scientific community[2, 3]. Making use of resources that are available in the digital world, evaluating the source of this information, and learning to assess apparently conflicting views is a critical part of the learning process. Student understanding of the strengths and limitations of the web will be an important benefit from this project.

(3) The international side is a unique aspect of this project. Students in sister schools in Sweden and the US (as well as other countries as the project progresses) will communicate, collaborate and compare personal, family and cultural views on attitudes and behaviors related to environmental problems in their respective coun-

tries. We believe that this comparative approach, which provides a novel and motivating experience, will remove the narrow perspective where students in each country may feel that their countries' mode of behavior is the only possible route. This international component broadens the students view and provides a global approach to shared problems[20].

(4) The education side is supported by ICT and the peer discussion via social networks within and between classrooms in the different countries. Various studies[21, 22, 23] show that students' performance, engagement and motivation are improved by ICT tools when they are wisely embedded in the curriculum, and that peer discussion increases understanding[24]. Such findings form an important foundation for our project. We believe this project will be a model for use of those emerging technologies[19].

The innovative hypothesis being examined by the I2I project is that sharing views on common environmental problems by social networking will motivate students, enhance learning and shift student views from an insular to a global one. If validated, this approach would become a paradigm for enriching education and providing global perspectives. The possibilities are limitless, ranging from examination of other shared environmental problems to looking at seemingly intractable differences between warring countries.

Perspectives

In the coming years, our goal will be to develop I2I in three directions:

More tools

- We will improve our developed activities on ocean acidification and carbon footprint regarding to students feedbacks, expectations and needs.
- We will undertake larger-scale and more complete testing of our online activities, including the use of control groups of students exposed to a non-interactive ("paper") acidification curriculum.
- We will develop additional activities on mercury toxicity and sustainability/habitat issues.
- I2I will partner with Ege University, Turkey to develop a new and user-friendly online collaboration learning (OCL) tool. This tool will facilitate students' collaboration and teachers' follow-up of the group assignments, and will be designed with reference to the modes of communication that the students themselves favor in the pursuit of their group projects this year (2009). Then in 2010, we will consult closely with the students as they pilot test the new OCL tool, and subsequently modify the design to accommodate their needs and suggestions.

More students

- The first step will be to involve more classrooms and then more schools in both Sweden and the US.
- We will also invite other countries to be part of Inquiry-to-Insight.
- In order to make our project widely useable around the world, we will translate it into Spanish and French.

Broad accessibility

Inquiry-to-Insight is designed to be viable without our active participation within 3 years. In that respect we will create an "I2I Guide" in English, Spanish & French, freely available for teachers. The I2I Guide will describe each ICT tool and offer specific ideas on how to implement it in their classrooms. As we are cognizant of

school's differing levels of computer technology access, the I2I Guide will help teachers choose the I2I tools and activities that are best suited to their needs.

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For more information

Inquiry-to-Insight website http://i2i.stanford.edu/

Online curriculum:
http://i2i.stanford.edu/footprint/footprint.html
http://i2i.stanford.edu/carbonlab/co2lab.swf