**Computer-supported Collaborative Learning for the Development of Environmental Literacies**

**Objectives and Significance**

The goals of this project are to explore the use of interactive surfaces (see Figure 1) to support collaborative learning in middle school science classes. Specifically, this project will develop an environmental literacies curriculum, focused on climate change, for use on interactive surfaces for 7th and 8th grade students. This project addresses three key emerging goals in K12 education: 1) the need to engage students in collaborative problem solving; 2) the need to integrate technology into classrooms more effectively and 3) an increasing focus on environmental science and climate change.

Figure 1: Students working on interactive surfaces

***Collaborative problem solving***

In anticipation of an increasing need for collaborative activities in the workplace, there has been a recent national and international attention to the need to engage students in collaborative activities in order to prepare them for future collaborations. In 2015, the first international assessment of collaborative skills will be conducted (OECD, 2013), with the Program for International Student Assessment (PISA) including collaborative problem solving in their assessment materials. While in the US, new curriculum standards have included collaborative learning as a key component (e.g. NGSS; NRC, 2012 and CCSS, 2010). However, despite decades of research indicating that collaborative learning is a productive learning strategy (see Barron & Darling-Hammond, 2008; O’Donnell, 2006 for a review), we still see little implementation of this strategy in schools (Blatchford, Kutnick, Baines, & Galton, 2003; Summers & Volet, 2010) and know little about issues of implementation in classrooms, particularly with technology (Dillenbourg & Jermann, 2010; Webb, 2009).

***Interactive surfaces to support collaborative learning***

Interactive surfaces, such as iPads, have the potential to change the way we interact with technology, and with other people when using technology (Dillenbourg & Evans, 2011; Higgins, Mercier, Burd, & Hatch, 2011). Being able to directly interact with screens reduces the need for additional input devices such as a mouse or keyboard. Large multi-touch surfaces in particular have the potential to change co-located computer-supported collaborative learning, allowing all collaborators equal access to content, removing upright screens from obscuring the view between group members, and providing teachers more direct view of their students.

Research that compares students using a multi-touch surface with a single-touch surface, found that students engaged in more task-focused and less process-focused conversation in the multi-touch condition (Harris et al., 2009).  When comparing interactive surfaces to a traditional personal computer, pairs of undergraduate students spent more time working on the problems together in the interactive surface condition, and more time with one member working on the problem while the other observed their actions in the pc condition (Basheri & Burd, 2012).  When compared to paper, groups engaged in more interactive discussion, elaborating and negotiating on the comments made by other students, in the multi-touch condition (Higgins, Mercier, Burd, & Joyce-Gibbons, 2011) and were more likely to build on the ideas proposed by other students (Mercier, Vourloumi, & Higgins, 2013).

There is evidence that groups can use the interactive surfaces to monitor and support interaction behaviours (Bachour, Kaplan, & Dillenbourg, 2009; Piper, O’Brien, Morris, & Winograd, 2006) and to support collaborative story telling (Helmes, Cao, Lindley, & Sellen, 2009; Russell, 2010).  There is also evidence that finds that interactive surfaces can be integrated into classrooms, becoming part of the device ecology of the classroom and supporting within and between group collaboration, and whole class interactions (Mercier & Higgins, 2013).

***Environmental science and climate change.***

The importance of environmental literacy, and the need to educate an environmentally literate population, is becoming increasingly recognized within the US and internationally. Scientists are converging on evidence that indicates the human influence on climate change, and the likely significant impacts of this change on the lives of many of the world’s population (e.g. Hsiang, Burke, & Miguel, 2013; McMichael, 2013; Min, Zhang, Zwiers, & Hegerl, 2011). Educating and engaging people in activities that highlight the importance of individual choices, as well as global policy issues, is seen as an essential element in creating a population who can make scientifically informed decisions about how their actions, and the actions of their governments, will influence their future lives.

The Next Generation Science Standards (NGSS; NRC, 2012) explicitly include environmental literacy knowledge across the curriculum, introducing issues of global climate change in the middle school grades (see Table 1). However, the need for rich educational content is highlighted by Bofferding & Kloser (2015) who note that middle and high school students still have limited understanding of the reasons for climate change and mitigation strategies, although they report positive levels of understanding after an intervention. The National Center for Science Education (2015) also calls for the development of resources to teach this content in ways in which students can develop sufficient environmental literacy.

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|  | Grade level | | | |
| Standard | K-2 | 3-5 | 6-8 | 9-12 |
| ESS2.D  Weather  and climate | Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region and time. People record weather patterns over time. | Climate describes patterns of typical weather conditions over different scales and variations. Historical weather patterns can be analyzed. | Complex interactions determine local weather patterns and influence climate, including the role of the ocean. | The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundation for the global climate system. Global climate models are used to predict future changes, including changes influenced by human behavior and natural factors. |
| ESS3.D  Global climate change | N/A | N/A | Human activities affect global warming. Decisions to reduce the impact of global warming depend on understanding climate science, engineering capabilities, and social dynamics. | Global climate models used to predict changes continue to be improved, although discoveries about the global climate system are ongoing and continually needed. |

Table 1: NGSS Climate and Climate Change Standards

***What are environmental literacies?***

The term *Environmental Literacies* was coined to address the issue that knowledge of the environment was not considered to be sufficient when defining the characteristics of a scientifically and environmentally literate population. Environmental Literacies have been defined as a combination of competencies, knowledge, dispositions and environmentally responsible behavior in the Framework for Assessing Environmental Literacies (Holoweg et al, 2011). This framework seeks to provide guidance and a common set of evaluation standards, drawing on research, assessment, and evaluation expertise from a range of fields, including social studies education, science education and environmental education.

The Environmental Literacies Framework (Huffman et al, 2011) will be used as the guiding curriculum tool as we begin to work on this. The framework, which focuses on climate change, provides five contexts through which to develop environmental literacies (energy, geosphere, hydrosphere, biosphere and atmosphere). One of these contexts will be selected for the development of a series of activities that engage students in collaborative, problem based activities using interactive surfaces. The sequence of activities will be guided by the need for students to develop the knowledge, competencies, dispositions and behavior outlined in the assessment framework (Holoweg et al, 2011).

**Research Question and Methodology**

The primary research question that will be addressed in this project is:

* *Does engaging in a sequence of computer-supported collaborative learning activities, promote the development of environmental literacies?*

This question will be addressed through a development and implementation project that will require development of curricular activities and their implementation in a classroom setting. There will be three phases to this project. During the first stage, the curriculum and software will be developed, with pilot testing of the tools and activities. The second phase will focus on implementation of the curriculum. Analysis of data collected during the second phase, dissemination, and planning a larger proposal, will be conducted during the third and final phase of this project (See Table 2).

***Phase 1: Development of curriculum and activities***

Due to the scale of this project, the curriculum will draw on one context of the Environmental Literacy Framework (e.g. energy, geosphere, hydrosphere, biosphere and atmosphere). The context will be chosen in consolation with the partner teacher in order to ensure the implementation studies coincide with her curriculum arc for the year. This project is intended to provide preliminary material and data to support a larger proposal to the NSF in later years, where all of the ELF principles will be included in a greater range of activities that will be used throughout the school year.

The project will take an iterative approach to designing the curriculum and software, engaging in extensive pilot testing, consultation with the partner teacher and discussion with science education experts to ensure the activities are suitable and well scoped for in-class activities. The software development will be aligned with the curriculum and pilot users will provide insight into human-computer interaction issues that arise when multiple people work on interactive surfaces to complete these tasks. The software will be built within the SynergyNet framework, an open-source platform designed for interactive surfaces in classrooms, which will allow for relatively straightforward development.

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| **Activity** | **Phase 1** | | | | | | **Phase 2** | | **Phase 3** | | | |
| 8/  15 | 9/  15 | 10/  15 | 11/  15 | 12/  15 | 1/  16 | 2/  16 | 3/  16 | 4/  16 | 5/  16 | 6/  16 | 7/  16 |
| Seek IRB approval | X |  |  |  |  |  |  |  |  |  |  |  |
| Develop curriculum materials | X | X | X | X | X | X |  |  |  |  |  |  |
| Develop software | X | X | X | X | X | X |  |  |  |  |  |  |
| Pilot test materials & software |  |  |  | X | X | X |  |  |  |  |  |  |
| Implementation |  |  |  |  |  |  | X | X |  |  |  |  |
| Analysis & dissemination |  |  |  |  |  |  |  |  | X | X | X | X |
| Revision of software & curriculum |  |  |  |  |  |  |  |  | X | X |  |  |
| Prepare future proposals |  |  |  |  |  |  |  |  |  |  | X | X |

Table 2: Study Timeline

***Phase 2: Implementation***

During Spring 2016, we intend to implement this curriculum over a two-month period, bringing students from the partner school to the DELTA lab in the College of Education to work on the activities we have created. The DELTA lab has been designed for classroom data collection, including ceiling-mounted pan-tilt-zoom and fishbowl cameras, a wireless microphone system for audio recordings, a one-way mirror and a range of software and hardware tools. By collecting the data in the DELTA lab, we will be able to capture detailed video of multiple groups working in the same classroom, and views of the whole classroom and the tools they are working on. This will allow us to conduct multi-level analysis of the collaborative learning process.

A number of other measures will also be collected, including pre and post-tests of environmental literacies and attitude and engagement measures in relation to the technology and collaborative learning activities.

***Phase 3: Data analysis, dissemination and future proposals***

The final stage of this project will focus on the analysis of the data collected in phase two, the dissemination of findings, and the development of new proposals to increase the scale of the project.

There will be two concurrent analysis processes. The first will be a quantitative analysis of the pre and post-test data to determine how, and in what aspects, the curriculum influences the students’ environmental literacies. The second analysis process will be video analysis of the within-group and whole class interactions. This will provide insight into how the curriculum was implemented and how the interactions and activities lead to any learning seen in the quantitative data.

Dissemination activities will include the submission of journal articles submitted to such journals as the International Journal of Computer Supported Collaborative Learning, and conference proposals to conferences such as the Interactive Tables and Surfaces conference or the American Educational Research Association’s annual meeting.

A future proposal for a larger project will include both a greater number of principles from the Environmental Literacies Framework, and a larger number of schools and participants. Funding will be sought from grants such as the NSF Discovery Research K-12 program (DRK12). This program is focused on the development of resources, models or tools to enhance the learning and teaching of science, technology, engineering and mathematics (STEM) in k-12 classrooms.

**Role of personnel and relevant previous work**

***PI:*** The PI, Emma Mercier’s area of expertise is computer supported collaborative learning and she has a history of research in the use of interactive surfaces in classrooms. She spent four years working on the SynergyNet project in Durham, UK, where she was part of a team that developed and studied multi-touch tables in a lab classroom setting. She is currently PI on an NSF Cyberlearning and Future Technologies exploratory grant to explore the use of interactive surfaces for sketching in introductory engineering courses. During this project, Mercier will work directly with the partner teacher and the graduate and undergraduate students employed on this project. She will contribute her knowledge on computer-supported collaborative learning in classrooms, and her expertise in working on interdisciplinary projects, to ensure the development of tools and curriculum that are suitable for use in classrooms. She will manage the data collection and analysis, again bringing her expertise to this process as she guides the research team.

***School and teacher partner:***The project team will partner with The University of Illinois Laboratory High School (Uni High), working closely with one of their science teachers, Dr. Sharlene Denos. Dr. Denos teaches Earth Studies and Sustainable Energy, and will collaborate with us to design a curriculum appropriate for her sub-freshman class (7th and 8th grade students). These students will be invited to participate in the study, and those who provide assent, and whose parents consent to their participation, will attend the DELTA lab implementation sessions. Dr. Denos has extensive experience in curriculum development and in particular, a focus on bridging the gap between research at the university and school science. ***Graduate student:*** Doctoral student, Susan Kelly, will be the graduate research assistant on this project. Kelly, a geologist by training, has spent many years engaged in creating environmental education curricula for use in a range of informal learning settings (e.g. summer camps, the National Park Service) and is now seeking a PhD in science education to deepen her expertise in this area. She will bring significant content knowledge of environmental education and climate science, to this project, while learning about the process of design research projects in education.

***Undergraduate students*:** An undergraduate computer science student will be recruited to support the software development activities on this project. It is anticipated that this student will work 10 hours a week for the academic year, developing the software and supporting the implementation process. Once implementation is complete, the student will complete any final iteration to software to ensure it is usable for future work. An undergraduate design student will also be recruited during the design stages to help create images and layouts that are visually appealing.

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