Socially Situated Science for Authentic Inquiry Learning (S³AIL)

*Masters Project Proposal*

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Learning, Design, & Technology
2009
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I. PROJECT SUMMARY

Building on current research promoting “learning-in-doing” in situated environments and doing authentic science, we are creating Socially Situated Science for Authentic Inquiry Learning (S³AIL), a situated science inquiry learning science environment that ties together social networking and mobile devices. The social network will provide an environment that allows media-rich information to be easily managed between students, groups, and the teacher. It also provides opportunities for discussion and collaboration about the topic at hand both inside and outside of the classroom. We hope to augment student learning through this situated science learning environment that ties together the use of social networking, mobile technologies, and science data collection devices.
II. THE LEARNING PROBLEM

Since the days of Dewey, education reformers in the United States and other parts of the world have aspired towards the goal of making the learning of science more authentic, closer to the practice of science (Edelson, 1998). As Dewey put it, “...science has been taught too much as an accumulation of ready-made material with which students are to be made familiar, not enough as a method of thinking, an attitude of mind, after the pattern of which mental habits are to be transformed” (Dewey, 1964). Unfortunately, even today, many approaches to the teaching of science have stressed memorizing and parroting the “content” of science, such as established scientific theories. School science is viewed as a propaedeutic activity to prepare students for university science (Roth & McGinn, 1997). As a result, for many topics taught in schools and colleges, there is evidence showing that students are often unable to meaningfully apply the knowledge they acquire in school (e.g., Caramazza, McCloskey & Green, 1981; Halloun & Hestenes, 1985). It seems that for all the effort put in to meet science standards and to keep up with test scores, science education has not adequately prepared students to live and think in this modern world of science and technology.

Developments in research on cognitive apprenticeship and situated learning (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991) have subsequently put a new spin on Dewey’s principles of “learning by doing” (Dewey, 1964). Complemented with a sociocultural view of learning (Vygotsky, 1978), advocates of science reform champion teaching approaches that are project- and inquiry-based discovery learning. Typically, project-based approaches stress the importance of learning the “process” of science, such as formulating questions that can be investigated empirically, and supporting scientific claims with evidence. The goal of providing students with the means to engage in scientific practice is to enable them to acquire a body of scientific knowledge that is integrated with an understanding of science knowledge, techniques, attitudes, tools, and social interaction - essentially situating the learning of science in the practice of science. (O’Neill & Polman, 2004)

Although the rationale for the implementation of project-based inquiry learning approaches for science teaching is strong, actual implementation in the school context paints a different picture. Polman (2000) described the problems faced by students, teachers and school administrators when such approaches are brought into the classroom. He described case studies highlighting aspects of school culture (for example, ambiguity of practices, differing epistemologies, teachers’ lack of time),
which hindered the successful implementation of project-based approaches. Furthermore, Hammer (1997) describes a detailed account of a week of discovery learning and instruction from the author's high school physics course. He highlights the tension between progressive objectives of engaging students in their own "scientific inquiry" and traditional objectives of "covering the content." From the details of the case study, it is apparent that there was a fundamental disconnect between expectations and the realities of practice. In the face of time and resource constraints, one wonders whether it is realistically possible to implement discovery and inquiry-based learning in its true essence in the classroom without compromising on content coverage.

**Work Done in Addressing the Problem Using Technology**

With advancements in technology, education reformers have sought to explore the use of technology to mediate and address these issues. For example, research done by Linn (1992) indicates that computers can serve as effective learning partners. This research showed that computers used to collect and display data can challenge students to interpret the data. Computer networks are effective at communicating information to students, in turn helping students be effective interpreter and analysts of this information. This points to the potential use of computers as data representational tools through which educators can challenge students in the learning of science.

Research done by Pea (2002) reported on the Learning through Collaborative Visualization, or CoVis project, which was a heavily funded endeavor to “design, implement and research the promises and problems of a distributed multimedia science learning environment that used broadband desktop videoconferencing and screen sharing, scientific visualization tools and distributed datasets, virtual field trips, scientist tele-mentoring, and a Collaboratory Notebook for enabling project-based learning of science in the high school.” In contrast to learning-before-doing—the model of most educational settings—he advocated learning-in-doing, where learners were increasingly involved in the authentic practices of communities through learning conversations and activities involving expert practitioners, educators and peers.

The CoVis project provided a broad range of lessons for how situated authentic science learning may be effectively supported through the uses of learner-centered collaboration technologies and scientific visualization tools (Pea, 2002). With the emergence of Web 2.0, the open source software revolution, and ubiquitous mobile technology, one wonders if the vision of CoVis and other similar projects like LabNet (Ruopp, Gal, Drayton & Pfister, 1993), Kids as Global Scientists (Sonner, 1996), and Global Lab (Feldman, Konold & Coulter, 2000) can be achieved on a
faster, much less resource-intensive, yet authentic manner to render the approach both scalable and sustainable.

### III. THE VALUE OF SOCIAL NETWORKS AND MOBILE TECHNOLOGY IN EDUCATION

The idea of virtual communities is not a new one. The distinctive feature of a virtual community is, of course, its “virtuality”. At the advent of the Internet age, this feature was afforded by technology applications such as electronic mail, chatrooms and newsrooms. Consequently, the idea of virtual learning communities is also not a new one - educators have tried to leverage on the affordances of the same technology for teaching and learning. In pre-Web 2.0 days, these efforts have only seen sporadic success, perhaps due to the somewhat linear communication processes, and the use of the Internet mainly for information transmission and exchange. Web 2.0 has transformed the World Wide Web into a social web, and has transformed the way people interact over the Internet. If the first iteration of the Web is likened to a digital newspaper where one could open its pages and observe its information, but could not modify or interact with it, Web 2.0 is fundamentally different in both its architecture and applications. Tapscott and Williams (2007) likened it to a shared canvas where “every splash of paint contributed by one user provides a richer tapestry for the next user to modify or build on. Whether people are creating, sharing, or socializing, the new Web is principally about participating rather than about passively receiving information.” Just as virtual communities transformed into social networks, these trends in Web 2.0 have the potential to transform virtual learning communities into social learning networks.

Parallel to the development of the social web, the explosive impact of mobile devices has made access to the Web available nearly anywhere, anytime and anyplace (Rheingold, 2002). In recent studies, the impact of this new technology on communication and learning in the younger generation is described as highly relevant for new forms of learning support (Green and Hannon, 2007). According to Jong, Specht and Koper (2008), “with the introduction of new multi-faceted mobile devices, the latest research aims at the potential of mobile content creation and sharing, personalized and contextualized services or sense-based and contextualized human–computer interaction.” The current trends in social network software, coupled with increasingly advanced and ubiquitous mobile technology point towards great potential for their use in learning support.

Through the CoVis project, Pea described the multi-dimensional role of information and communication technology in learning (Pea, 2002). Using open source social network software
called Ning to create a customized social network, parallels can be drawn between the roles played by technology described by Pea, and the affordances of a combination of social network and mobile technology, illustrated in Table 1.
<table>
<thead>
<tr>
<th>Role of Technology in Authentic Science Learning</th>
<th>Affordances of a social network (e.g. Ning)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>As a meta-representational substrate</em> in which authors create media-rich documents using symbol systems such as language, diagrams, video, audio, mathematical notations, and scientific or data visualizations, and make conceptual linkages between documents or document components (as in hypermedia) in ways that were awkward or impossible in non-computational systems like print.</td>
<td>The social network can be embedded with widgets that facilitate concept mapping, simple word processing, and other artifact creation applications. Wiki-like functions that the network allow for creation of media-rich documents with multiple symbol systems, collaboratively.</td>
</tr>
<tr>
<td>2. <em>As a communication channel</em> for establishing highly interactive conversations among individuals distributed across space and time. These communications in “media spaces” may transcend in some respects what is possible in face-to-face encounters, e.g., when the application allows for joint activities such as the production of a common artifact.</td>
<td>The live chat function in the social network allows for synchronous meeting, and the discussion forums allow for asynchronously engagement in discussions. In addition, the network can be embedded with a widget that allows for web-conferencing (<a href="http://www.WizIQ.com">www.WizIQ.com</a>), which also allows for application and desktop sharing.</td>
</tr>
<tr>
<td>3. <em>As interface to individual, group, and cultural memories</em>—archives of information, knowledge, and representations of past activities that can be accessed, drawn upon, and extended as needed when new problems arise, or when reflection leads to new insights.</td>
<td>Participants in the social network build up a repository of videos, music files, conversations in discussion forums, and personal reflections. All these artifacts are tagged, and can be called upon when needed.</td>
</tr>
<tr>
<td>4. <em>To establish spaces and places</em> in which individuals come together synchronously or asynchronously to collectively engage in some activity together.</td>
<td>The live chat function in the social network allows for online meeting, and the discussion forums allow for asynchronous engagement in discussions.</td>
</tr>
<tr>
<td>5. <em>As cognitive tools</em> for augmenting human performance in complex tasks and for learning.</td>
<td>The social network platform is integrated with mobile technologies in that data can be sent to the network from mobile devices. Location and context-aware mobile technologies facilitate data collection during field experimentation for upload to the network, anytime, anywhere.</td>
</tr>
</tbody>
</table>
These parallels serve to illustrate the possible application of mobile technologies and social networks to support authentic science inquiry learning in a scalable, sustainable way. This project therefore proposes the use of open source social networking software and ubiquitous mobile technology as platforms to achieve situated science learning. This project will seek to use a design framework with which to create an authentic learning environment with these tools, to initiate high school students into the knowledge-building practices of science.

IV. THE DESIGN FRAMEWORK: THINK

Edelson (1998) articulated a vision of authentic science learning, which integrated features of scientific process and “has students investigating open questions about which they are genuinely concerned, using methods that parallel those of scientists. Throughout the process, they are engaged in active interchange with others who share their interest. Just as scientists accumulate knowledge and understanding through the course of posing and investigating research questions, students will too. Before engaging in any investigations, students will need to accumulate enough knowledge to pose well-framed questions. In the course of conducting investigations, they will need to master the tools and techniques that allow them to generate and analyze meaningful data. Finally, to be able to work with others, they must develop a vocabulary and framework for their understanding that allows them to communicate clearly about the knowledge they acquire. The result of these learning activities will be student knowledge that is firmly situated in a context that reinforces both the applicability and value of that knowledge.”

The most fertile use of technology in adapting scientific practice for the purposes of science learning has been in the adaptation of scientific tools, techniques, and resources. Edelson (1998) described four strands that facilitate the adoption of the attitudes, techniques, and social interactions that characterize the scientific community. These strands are: 1) collection and sharing of data, 2) analysis of data through modeling and visualization, 3) evidence gathering and evaluation, and 4) communication and collaboration.

In spite of the affordances and ease of use of open source social network software to create focused social networks (as opposed to generic social networks like Facebook and MySpace, which have an environment that is too open for specific use), it is still not realistic to expect that these tools will naturally fall into place to realize Edelson’s vision along the four strands listed above. A five-prong design framework (THINK, an acronym for Trigger, Harness, Investigate, Network and
Know) is thus proposed, to guide technology use and design of the social network for authentic science learning in this project.

(1) TRIGGER

To support an inquiry-based approach to the teaching of science, the social network will be used as a platform to trigger thinking in the students. This may be in the form of a phenomenon shown on video or heard in a sound file, or a picture, or described in text as a Trigger statement or scenario in an open forum discussion. The key is to design a social network with the feature of allowing for teachers to pose Trigger activities to whet students’ curiosities, and to develop inquiry-based investigations following the Trigger.

(2) HARNESS

Consistent with Edelson’s vision of authentic science learning, students need to be able to explore information and resources available, and to harness enough knowledge in order to derive meaningful questions for inquiry. In describing a community of practice, Lave and Wenger (1991) describe the problem of access to people, tools and knowledge that can hinder a legitimate peripheral participant’s move towards full participation. This project will design a social network for situated science learning that allows participants to harness resources through artifact tag-and-search functions, content repositories, and information exchange.

(3) INVESTIGATE

Sandoval and Reiser (2004) articulated an important consideration in approaching inquiry learning from the standpoint of cognitive apprenticeship into scientific practice, and that is the importance of guiding students in formulating researchable questions and to conduct informative investigations. The social network designed in this project will incorporate applications for formulating questions in response to Trigger events, and after reflection upon the resources and information harnessed. Features like a discussion forum and personal reflection space, with flexibility for interaction, should be scaffolded to guide learners in the way of fruitful investigative efforts.
The social platform will also integrate information gathered from various data collection tools and technologies. Mobile technologies may be used in data collection, as investigations can take the learner out into the field. Data sensors (e.g. pH and temperature sensors) enable the learner to engage in authentic investigations, and to send the data to a central workspace on the social network. Geographical Positional System (GPS)-enabled devices allow the data collected to be geotagged. Mobile technologies with a central collaborative space on the social network allow for a distributed approach to science investigations, consistent with current concepts of distributed cognition (Gomez, Fishman & Pea, 1998). Google Docs currently already allow for a collaborative workspace for these purposes.

(4) NETWORK

According to Dewey (1964), communication is the central process of education. It is the means by which we negotiate differences, understand each other’s experiences, and establish shared meaning. In immersing students in authentic scientific practice, they need to be engaged in the reasoning and discursive practices of scientists. (Sandoval & Reiser, 2004). One of the key roles of the social network is to serve as a platform for engaging in scientific discourse – to network. In the context of science inquiry in a social learning network, the discourse could be in the form of discussion around pieces of data or artifacts and how they support and shed light on the research questions. It could be a response to thoughts, experiences and ideas shared by others in the community. The social network has to be designed to encourage and facilitate scientific discourse through the juxtaposition of data with discussion.

The use of a digital social network is uniquely suited to facilitate this aspect of scientific inquiry. Rollet et al (2007) presented a scan of the Web 2.0 movement and the social web, and considered its implications for knowledge transfer. Using a general framework for analysis of knowledge work (presented in Figure 1), which was developed by Efimova (2001), the final conclusion drawn was that “at the heart of it all – of the framework for knowledge work analysis of Web 2.0, and of knowledge transfer – are conversations: individuals engaging with the community through ideas.” Indeed it is this aspect of the social network that will be harnessed – conversations between students, teachers and experts, not in a hierarchical manner, but as members of a community of science practice – for authentic science learning.
The principle of knowing will be applied in the design framework at two levels: at one level, the social network will facilitate the learners’ ways of knowing, with a structure and scaffold to encourage metacognition. Features like personal blog spaces naturally lend themselves to this, but the learning environment will be designed to guide learners in meaningful reflection about their data, results and conclusions of their investigations, as well as to be metacognitive about their ways of reasoning.

At a different level, the principle of knowing will also be applied in the area of formative assessment. Science assessment has always been conducted in the form of summative evaluations of concept attainment. Pellegrino, Chudowsky & Glaser (2001) described the problem of assessment faced by educators today, and proposed a rethink of the fundamental approaches toward measurement of how much and what students know. Indeed the THINK framework proposes a situated approach to assessment to support the situated learning it designs for. The interactions, discourse, artifacts, reflections that learners engage in provide rich data which present a more

Figure 1: Framework for knowledge work analysis according to Efimova (2004)
accurate picture of what a student knows, than his test scores can. Sandoval and Reiser (2004) presented epistemic components of explanation rubrics used in their study, which included criteria like (i) thoroughness and clarity of explanations; (ii) use of data; (iii) ruling out alternative explanations; and (iv) documenting the limitations of explanations. Evidence of these can be easily captured and called up when the inquiry-based activities are conducted in the context of a social network; consequently, the social network will be designed with this principle of knowing in mind.

Formative assessment can also take the form of actively engaging students in assessment-related work. “Considered broadly, assessment encompasses all activity wherein the quality of work or behavior is discussed, reflected upon, examined, or established.” (Coffey, 2003) Involving students in assessment-related work would benefit students directly through the emergences of a shared understanding of what constitutes quality work. Students can also become more self-directed with reference to assessing content, learning how to look for evidence and sources. The social network thus presents opportune moments to present questions about evidence and sources that can guide student work, reflection and revision.

The THINK framework in not expected to be applied in a linear manner. Inasmuch as its components mirror stages in the inquiry-based learning process, various aspects of the framework are essentially iterative. The proposed solution will therefore be designed with such flexibility in mind. It is envisioned that the proposed solution will also serve to scaffold the process of inquiry for students, thereby guiding them in authentic science practice.

V. PROPOSED SOLUTION: S$^3$AIL

We propose a learning environment that encompasses the THINK design framework: the Socially Situated Science Authentic Inquiry Learning (S$^3$AIL) environment. S$^3$AIL takes advantage of mobile phone technologies, science data collection tools, and online social networking to create an environment that enables students to learn science in a dynamic, highly collaborative and authentic way.

Figure 2 shows the proposed S$^3$AIL system. At the heart of S$^3$AIL is a social networking site, the platform for communication and collaboration between students, teachers, and experts. S$^3$AIL integrates mobile technologies and data collection tools onto the social networking site to
make it easier to share and collaborate. Students collect data using digital probes that can collect information and be uploaded onto the social network. Mobile phones will be used to capture photos, video, and GPS data. The S3AIL integrated platform will tie all these technologies together.

Students, teachers, and experts collaborate on the social networking site. Learning is student-driven, where students work together in groups, ask questions, reflect, collect and analyze data, and discuss findings with their peers. Experts partner with students to provide real-world context and support to encourage authentic learning. Teachers serve as facilitators of this process.

**Figure 2: Situated Science Environment**

There are four different technologies that we are combining to create our science environment: social networking using Ning, mobile phones running the Android open source mobile platform, science data collection using PASCO, and Livescribe smartpens. The components developed for Ning will be modular, such that in the event that either the PASCO tools or mobile phones are not available, the environment on Ning can still function.
Keeping costs minimal by using open source platforms is a key part of our design decisions. All the developed software and technology will reside on open source platforms that will allow for changes and innovations to be made by students and teachers. Students, experts, and teachers will not need highly technical backgrounds to use this environment, but modifying the integrating code may require some technical expertise.

**Social Networking: Ning**

Ning is a free website that enables anyone to create a social network. This platform was chosen because it is of no cost to the teacher and runs OpenSocial Applications, making it highly customizable. Additionally, unlike other content management systems or learning management systems, Ning is focused on social networking. By building on this platform, collaboration can remain at the heart of S³AIL.

We will develop a Ning site and write OpenSocial applications for it that will collect science data from students and facilitate interaction between students, teachers, and industry experts. Students will be able to create their own project groups for an assignment. Inside the project group, students will be able to assign roles, such as leader, recorder, group member, etc. Additionally, projects may have roles that require different people to be in charge of disciplines, such as biologist, chemist, and physicist. In such scenarios, students would be able to also form community of practice groups that would link all the biologists together, all the chemists together, and all the physicists together. This would allow students to work collaboratively both within their own project group and with other members of their chosen specialty field for that project.
Ning will provide an environment for data visualization, reflection, data collection, links to external resources, and collaboration. Figure 3 shows the different features that will be implemented and utilized on Ning.

**Figure 3: SAIL on Ning**

**Mobile Technologies: Android**

Android is a free, open source mobile platform. This platform was chosen over other popular mobile platforms like the iPhone because it is open source. Mobile phones running Android typically have access to GPS, photo, and video capabilities. The mobile phones will be used to record location data, take photos and videos, record notes, and send these to the Ning site. Data that is geotagged with the phone will also be visible from Ning.

**Science Data Collection: PASCO**

PASCO creates science tools for use in schools. PASCO devices have the ability to collect science data with Probeware that can connect via a USB port to a computer to download.
Additionally, the SPARK device can be used to collect and visualize data while out in the field. Using PASCO probes cuts down on the tedium of data collection, freeing up students time to think about the data being collected rather than collecting the data itself.

**Data Recording: Livescribe Smartpen**

The Livescribe smartpen records handwritten notes and links audio to what is written. This will help with data collection so students can spend more time out collecting data and less time trying to record all the data by hand and typing it up later.

### VI. User Story

The following scenario provides an example of how a science activity might look with this science environment.

**Ecology Problem**

Kristy is a high school student. In her biology class, they have been learning the basics about ecology and she is looking forward to working on the big project her biology teacher, Mr. Firley, keeps talking about. For weeks, Mr. Firley has been asking them to think about how the information they have been learning can be applied to investigate things in nature related to environmental problems that they observe and that they would be coming up with their own project assignment as a class. Last night, each student in the class posted a question as a possible project topic on Ning and each student voted.

In class, Mr. Firley announces the question that received the most votes: “Is there a difference between the types of material and living organisms on the right side of the stream than on the left side of the stream at Jasper Ridge?” He then organizes the class into teams and suggests they determine a transect to designate the area where they will investigate the different types of organisms. There are 6 teams, so 3 teams examine the left side of the stream and 3 groups examine the right side of the stream.

Kristy’s team starts brainstorming ideas about how they will determine the differences on either side of the stream. They hypothesize that there will be a difference because it is on a hill and the sun hits the one side of the stream differently than the other. Kristy’s group records all of this on a wiki on the Ning site. Each team lays out a project plan on the Ning site. They choose roles, so some are biologists and some are chemists.
At the end of class, Mr. Firley gives them a brief overview about the types of technology tools available to them to facilitate their investigation. Every student in each team is assigned a technology to be in charge of during the field investigations. For homework that night, the students are assigned to read an overview about the technology so that they know what the capabilities of each piece of technology are. They are also assigned to update the project plan as needed based on what they learn about what the technology is capable of doing.

Additionally, they each post one or two resources that they have found online about biology or chemistry around streams. The students read the other resources posted by their classmates who have the same role of biologist or chemist.

The next class, her team gathers around a laptop and logs onto the Ning website. There, a video is waiting for them. It is a local biologist, Mrs. Roper, with an introduction and the work that she does and provides background information on streams. The next video is specifically for their team where she is commenting on their project plan. The rest of the class time is spent updating the project plan based on the feedback from Mrs. Roper and Mr. Firley.

The next day, the students head out to Jasper Ridge. They are equipped with the mobile phones, the PASCO devices, and the Livescribe smartpens. Each one in the group is in charge of a different device. Kristy’s group starts to count up the different types of plants and insects, examine the quality of ecological conditions there like soil quality, temperature, pH of the water, conductivity. Kristy counts up 10 red ants, so she records this with her Livescribe smartpen. Billy, her teammate, takes the temperature of the water with a probe that gets collected into the Spark system. Joey takes pictures with the mobile phone and he geotags them.

The next day in class, all the groups upload their science data they collected from the PASCO tools. All the data is placed on Ning, and then they aggregate all the data from the right side of the stream and all the data from the left side of the stream. In their teams, they look at all the aggregated data and compare them to see if there is a difference between the left and the right. They start to produce plots and post them up on Ning to spark discussion about what they see. Each team has to come up with their own conclusions. Each team posts their conclusion on Ning and experts view their posts and comment on the data and conclusions.

Once all the conclusions are posted on Ning, the teacher leads a class discussion. After the discussion, students get back into their groups and create a modified project plan based on what
they learned from the class discussion with ideas for future research and things they would do differently. Students write a reflection on the blog about the scientific process, the science content they learned, and the team collaboration.

### VII. PROPOSED EVALUATION FRAMEWORK

User testing will be conducted with a group of high school science students during the summer. Using Ning, we will present a problem for them to investigate. Students will go out into the field with the mobile phones and data collection devices, gather data, discuss on Ning, and consult with experts.

The following will be assessed: attitudes, skills, knowledge, usability and socio-collaborative learning. (ASK-US). This assessment framework will be targeted at two units of analyses: (i) the student as an individual, as aligned to the goals of developing scientific attitudes, skills and knowledge; and (ii) the project groups, as aligned to the social dimensions of the proposed solution. Through this assessment framework, we will determine how effective this science-learning environment is on student learning. In light of the time constraints and limited access to students, we are not using a randomized control group to evaluate S³AIL’s effectiveness, but rather we will be evaluating based on a pre- and post-test model. Evaluations will be administered to students before and after the project based on attitudes, skills, and knowledge. Group interactions and dynamics will also be observed on the social network to track socio-collaborative learning.

**(1) Attitudes**

Throughout the activity, student attitudes toward science will be assessed. Are they excited about science? A questionnaire will be given at the end to determine how student attitudes toward science may have changed before and after the activity.

**(2) Skills**

How proficient are students at forming hypotheses, collecting and analyzing data, and drawing conclusions? This data will be assessed based on responses posted on Ning.

**(3) Knowledge**

Have they learned anything about the topic they are studying? Have they met the learning objectives? Do they understand the scientific process? This data will be assessed based on responses on Ning.
(4) Usability

How easy is it to use the devices and integrate the data onto Ning? How useful are the technology components to achieve their goals? This will be determined by watching students use the technology, recording any problems they encounter, and determine if the technology helped, hindered, or was neutral for the activity. Through this testing we will evaluate the effectiveness of our system and make refinements as necessary.

(5) Socio-Collaborative learning

Group interactions, online and offline, will be observed to track socio-collaborative learning. How well is the group interacting? Is there synergy in the group? How actively do individuals contribute to attainment of group goals?

VIII. TIMELINE

Table 2: Timeline

<table>
<thead>
<tr>
<th>Key Milestones</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Proposal (Draft)</td>
<td>March 18</td>
</tr>
<tr>
<td>Project Proposal Submitted</td>
<td>April 23</td>
</tr>
<tr>
<td>Observe and Interview</td>
<td>April 30</td>
</tr>
<tr>
<td>Lo-Fidelity Prototype</td>
<td>May 5</td>
</tr>
<tr>
<td>Develop Curriculum and Test Plan</td>
<td>May 19</td>
</tr>
<tr>
<td>Hi-Fidelity Prototype</td>
<td>May 19</td>
</tr>
<tr>
<td>Develop, Test, and Iterate</td>
<td>Early June</td>
</tr>
<tr>
<td>Testing</td>
<td>July</td>
</tr>
<tr>
<td>LDT Expo</td>
<td>August 7</td>
</tr>
<tr>
<td>Final Report</td>
<td>August 13</td>
</tr>
</tbody>
</table>
IX. SUPPORTERS

Paul Kim, Ph.D.
Angela Booker, Ph.D.

From the LET’S GO Project

Professor Roy Pea
Heidy Maldonado

X. REFERENCES


XI. Appendix

Appendix A: Preliminary Learning Points from Pilot Inquiry-based Learning Activity with some high school students

As part of the design process, observations were made on an inquiry-based learning activity conducted with some high school students as part of an ongoing research project (WGLN LET’S GO) between Stanford and Redwood High School. The activity made use of some of the technologies described in the above proposal, framed in an inquiry-based learning context. Observations and learning points from this pilot activity were used as part of the design considerations for the proposed solution.

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WGLN LET’S GO PILOT ACTIVITY ON WATER QUALITY
Redwood High School
16, 19 and 20 March 2009

OVERALL DESCRIPTION OF LEARNING ACTIVITY

I. SETTING THE TONE

The learning activity is prefaced by a session with the Principal, called the Gratitude Circle. The students and all involved in the lesson activities for the day gather in a circle, and they take turns introducing themselves, and one thing they are grateful for that day. This activity was initiated by the Principal, and prefaces all learning activities for REAL. Its intent is to start the lesson on a positive note, to remind students to take a moment of reflection.

Following the Gratefulness Circle, the students gather at the covered bench area, where the Principal introduces the learning activities for the day. The unit for study being “Environmental Justice,” he leads the students in thinking through the topic, and in making links to Essential Questions to be asked in Environmental Justice. He also encourages the students to write their reflections of the topic in their Reflection Journals.

The teacher then goes through the logistical arrangements for the lesson. There are two stations of learning activities. At any one time, one group of students will be involved in the inquiry-based learning activity at the Creek.

II. DEMONSTRATING THE TECHNOLOGY
The group of students involved in the inquiry-based learning activity is directed to the shed, where the various technologies are briefly introduced to them. They are taught how to use the Livescribe smartpen, introduced to the SPARK system and data sensors, and the video camera. The students are then assigned one of the following roles: Data Recorder (using the Livescribe smartpen), Videographer or Data Collectors.

III. Student data collection (activities of inquiry, using the technology)

The students, led by the facilitators, go to the pond area. Along the way, they discuss the purpose of the learning activity, which is to investigate the different quality of water in the pond, compared to the Creek. They also discuss what they expect to be some differences in water quality.

Some of the students venture down to the Creek with plastic cups and the Livescribe smartpen and notebook. While down at the Creek, they are prompted to observe the conditions of the water, and surroundings, and to record their observations on the notebook using the Livescribe smartpen. One of the students draws water samples from the Creek. At that point, he is prompted with questions of the appropriate area to collect water samples, and to note the conditions around the point of collection.

The students go back up from the Creek. They first observe the physical appearance of the water – whether it was clear, muddy etc. The SPARK system, with the relevant data probes (pH, temperature, dissolved oxygen, conductivity and GPS) has been set up already. The students insert the various probes into the water collected, and read the data off the SPARK display screen. They also use the dissolved carbon dioxide sensor to take measurement of this.

After collecting data about the Creek water samples, the students proceed to collect water from the pond. As with the Creek water, the students are prompted to make general physical observations, and to collect the corresponding data using relevant data probes.

The students may then make initial comparisons between pond and Creek water, in the various water quality parameters. They may also think about possible reasons for any differences observed, making explicit references to the proximity of the Creek to a factory nearby.

IV. Student reflections on learning

Following the data collection exercise, the students return to the shed, where they fill out a worksheet, which asks them about the data collected, and their reflections about possible
explanations for the differences between the two samples of water. They are also asked for their reflections on the learning activity itself, and to highlight areas which they liked, and areas in which they can suggest changes to.

**STUDENT FEEDBACK REGARDING THE LEARNING ACTIVITY**

**What the students liked**

1. It was fun and engaging.

2. They enjoyed using the technology – using the Livescribe smartpen and the video camera. (“I liked the technology – I didn’t even know the technology existed.”)

3. They had not used the technology before (“I think the closest I’ve ever been was to a pipette.”), and needed time to learn how to use it. So the use of the technology was hard initially, but later the technology is fun to use. (“When you learn how to use it, it gets easier. Like in order to walk, you have to fall … and those are the things you don’t like, but in the long run, you actually end up doing it, regardless.”)

**Suggestions for improvement**

1. Find a trail to the Creek that is less challenging. (“I don’t like the trail.”)

2. There should be a tutorial session before this learning activity, teaching them how to use the technology in greater detail. This is so that when they get out there, they already know how to use the technology, rather than having to learn as they collect the data.

3. A tutorial session introducing the various terms would help in understanding the science.

**GENERAL OBSERVATIONS AND LEARNING POINTS**

This learning activity was done as a standalone activity, to be completed within a short period of time. Within this time, the students were expected to learn how to use the various technologies, make predictions in response to the question of inquiry, collect data, make comparisons and formulate possible explanations for any similarities and differences observed. Although the students could make some postulations, and draw some links with concepts of environmental justice, the following are some learning points about the science inquiry-based
learning process were drawn from general observations of the learning activity. These may be incorporated into the next iteration of the activity design.

(1) Ascertaining prior knowledge

Due to the nature of the REAL program, and the erratic attendance patterns of some students, it was difficult to ascertain and make links to the prior knowledge of students who finally attended the learning activity. The students who underwent the learning activity ranged from some with no prior knowledge and experience with the topic and the technology, to some who had learned the topic before. Some students had even some prior experience with the use of the data probes.

In subsequent learning activities, it would be useful to find an avenue through which the prior knowledge of students can be ascertained. The learning activity and probing questions can then make links to, and build on, students’ prior knowledge.

(2) Preparatory session

As mentioned earlier, some students go through the learning activity without having any prior experience or knowledge of the topic. It was therefore difficult for these students to fully engage in the inquiry process. A preparatory session before this learning activity would be useful in introducing the topic to all students, in setting the context for the activity, in framing the inquiry question, and in sparking the students’ interest and thoughts on the question of inquiry. This session may also be useful for students to plan their approach of inquiry and data collection.

(3) Allowing more time for inquiry

It was apparent that the learning activity had to be completed in a limited period of time. The students were therefore not provided with sufficient time for inquiry, for pondering the data collected, and for probing further in addressing the question of inquiry. It seemed like the inquiry process was short-circuited due to time constraints. Provision of more time would augment students’ inquiry process.

(4) Highlighting multiple ways of data representation

Due to the affordances of the technology that was used to collect data, there may be various ways and approaches of representing that data. Due to the limited time for the activity, these various approaches were not discussed with the students, nor were they prompted to think about how they
should be representing the data they collected. The students should be provided with a platform for thinking about these approaches.

(5) Encouraging more student discourse

One of the most valuable segments in the learning activity was the session at the end of the activity, where students discussed what they learned, what they found useful, and what would help them learn better. This was when they engaged in discourse on what they did, and made links to what was relevant to their lives. This segment could be further developed, to encourage further in-depth discourse, on the data collected, and the big ideas of environmental justice.
Appendix B: Resumes
CHEN KEE NG

EDUCATION

2008 - current  Stanford University
Master of Arts (Education) in Learning, Design and Technology (pending)

1996 - 1997  National Institute of Education
Post-Graduate Diploma in Education (Distinction)

1992 - 1995  National University of Singapore
Bachelor of Science (with Honors) in Cell and Molecular Biology

PROFESSIONAL EXPERIENCE

1997 - 2006  Temasek Junior College
- 1997 – 1999  Teacher (Biology)
- 2000 – 2001  Subject Head (Biology)
- 2002  Head of Department (Civics)
- 2003 – 2006  Head of Department (Science)

2007 – 2008  Ministry of Education (Singapore)
- Assistant Director, Technologies for Learning, Educational Technology Division

LANGUAGES

English (fluent in speaking, reading and writing)
Chinese (fluent in speaking, reading and writing)

AWARDS RECEIVED

Singapore Teachers’ Union Book Prize (for best-performing PGDE student in the National Institute of Education) – 1997
Innopreneur Award (Gold) – 2004 (for innovative use of technology in teaching and learning)
HP Init Award (Gold) – 2005 (for innovative use of technology in teaching and learning)
President’s Award for Teachers (Finalist) – 2005
OBJECTIVE
To obtain a position where I can utilize my learning sciences, design, and technical background to impact K-12 education through the use of technology to improve learning.

EDUCATION

Stanford University (expected 8/2009)
M.A. in Education - Learning, Design & Technology

M.S. in Information Technology - Software Development and Management

B.A. in Cognitive Science, concentration in Computational Modeling with a minor in Education

WORK EXPERIENCE

Krause Center for Innovation at Foothill College (02/2009 – present)
Intern
 Developed an interactive multimedia certificate program for teachers to learn how to incorporate multimedia into their classrooms. Revised course descriptions and student learning outcomes

Flight Software Systems Engineer
 Maintained flight software using assembly language for the TIROS N and N-Prime polar-orbiting weather satellites built for NASA, operated by the National Oceanic Atmospheric Association (NOAA)
 Coded and tested major flight software changes to accommodate hardware modifications. Performed requirements verification of flight software. Developed flight software patches for on-orbit satellites
 Collaborated with systems and test engineers to maintain test scripts used for spacecraft integration testing and launch. Ensured test objectives were accurately achieved in test scripts
 Coordinated software engineering process group meetings to discuss areas for process improvement, created a software maintenance plan and software test plan, following guidelines for CMMI Level 3

Software Engineering Associate
 Created computer-based training for introductory software process courses. Coordinated software engineering training. Maintained Software Process Asset Repository (SPAR) website. Performed metrics collection and analysis

College Technical Intern
 Streamlined the process of the software and hardware reclamation process, increasing cost savings

Undergraduate Assistant
 Helped increase computer literacy among students and integrate technology into school subjects

SKILLS
 Design Thinking, Curriculum Development, Qualitative Research Methods, Human Computer Interaction, Artificial Intelligence, Agile Software Development
 Languages and Web Technologies: Assembly, C/C++, Java, JavaScript, LISP, MATLAB, Visual Basic, SQL, UML, J2EE, JSP, HTML, Actionscript 3.0
 Tools: Exceed, CVS, Rational Rose, DOORS, JUnit, JBuilder, Eclipse, Adobe Flash, Adobe Photoshop CS3
 Operating Systems: Microsoft Windows XP, UNIX, Mac OS X

ACTIVITIES

Ames Exploration Encounter (AEE) at NASA Ames Research Center (2007- present)
 Led 4th-6th graders through space exploration, aeronautics, physics, and earth exploration activities

Han Moo Kwan Taek Kwon Do Club (2004 – present)
 Club member; Secretary/Treasurer since 6/2007: manage communications, and finances

 Presented at grade schools to relate practical applications of math, science, and engineering