

A new framework for smart classroom research: Co-designing curriculum, research and technology

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Abstract: This new program of research explores how technology can enable smart classrooms where learning transcends traditional class borders, engages students and teachers with Web 2.0 approaches, and supports a community of learners in developing knowledge. We report on key aspects of our open source smart classroom environment, including an online database of student-generated, tagged, and socially connected learning objects, the integration of handheld learning devices, and supports for visualizing, sorting, and sharing collaboratively generated artifacts.

Introduction

Now more than ever, schools must prepare students as lifelong learners in a society where change is the only constant. New issues, new opportunities, and increasingly complex range of messages and materials will greet them at every turn. As the demands of the workplace and everyday life become increasingly diverse, students must become skilled at interacting with peers, solving problems and embracing this complexity. The development of these skills has become a vital piece of an educator's role in the classroom, and the objective of this research is to empower teachers to embrace new technologies that turn their classrooms into knowledge communities.

Inquiry learning often employs technology environments in scaffolding students to respond to problems that go beyond traditional laboratory and lecture activities (Collins, 2002; Slotta & Linn, 2000; Soloway et al., 1999). The notion of "scaffolded inquiry" (Songer, 2007; Linn & Eylon, 2006) is quite relevant to the challenge of engaging students with technologies, particularly as their lives outside the classroom become increasingly immersed in technology (Tinker, 1997; Nirula et al., 2003; Swan et al., 2005). An even more transformative approach to learning is that of knowledge communities, where students collaborate with their peers and teachers to develop knowledge resources and define their own learning goals (Brown & Campione, 1994, Nirula & Woodruff, 2008; Scardamalia & Bereiter, 1992). This kind of learning complements the foundations of "Web 2.0", which are characterized by socially driven web experiences (e.g., Facebook) or semantically linked resources (e.g., YouTube, Flickr) – where learning becomes a collective product rather than the output of singular minds.

With the arrival of new technologies in classrooms, the conditions are ripe for the investigation of new approaches to teaching and learning that connect classroom communities with the world at large. At the heart of this connection between classroom and outside world is the ability to create rich and varied relations between the learners and the objects of knowledge, resulting in personally relevant curriculum that promotes deep understanding (Woodruff, 2005; Bereiter, 2002). This poster describes a new program of work that addresses the following research questions: **(1)** What kinds of learning activities are best suited to connecting students' home, school and informal learning environments? **(2)** What new opportunities for teaching and learning emerge from Web 2.0 technologies and approaches? **(3)** How can we employ the physical space of the classroom to engage learners and enable new forms of interaction between students, peers and teachers? In our first year, we have successfully established four curriculum projects with teachers from a variety of domains. Given space constraints, we detail here only one of the curriculum innovations that have now been completed. We continue to work with teachers from the school to revise and improve such innovations and develop a framework for smart classroom applications.

Methods

This design-oriented study investigates new ways in which technology can support communities of learners in physical and virtual spaces. In close collaboration with a local high school, we are developing a "smart classroom" in several layers, using a range of devices and approaches. At the most basic level is the portal and user registration system, which manages user accounts for each student and coordinates the grouping and collaboration services that are employed by higher-level software systems. A second important layer is that of the pedagogical architecture, which represents the logical dependencies, conditions, and grouping configurations, and links to many different kinds of content materials, devices, and user interface paradigms. This allows for the choreography of our smart classroom, managing the flow of people, roles, goals, materials and devices. A third layer is that of content, which is responsible for storing the actual materials encountered by students, such as written instructions, discussion topics, reflection prompts and notes, or rich media objects (e.g., simulations or models).

The smartroom includes functionality for a flexible "smart wall" – a large touch-surface of approximate 2

X 3 meters dimension. Students can work collaboratively at the smart wall, jointly manipulating multi-media objects and Internet enabled applications. We also support a flexible array of monitors, and a hand-held pointing device (an iTouch) that can interoperate with the Smart Wall. The smart wall can be configured in many arrangements, as shown in Figure 1.

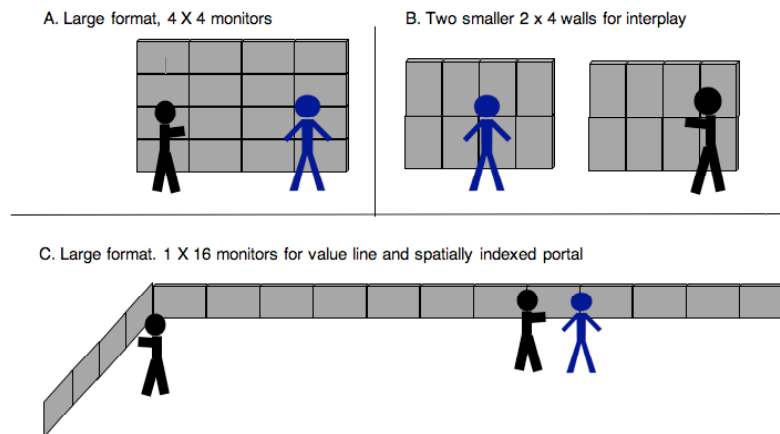


Figure 1. Concept wall in 3 different configurations: A single large wall (16 monitors), 2 smaller walls (8 monitors each), permitting exchange of digital objects, and a linear array of 16 monitors that wraps around the room.

Other important functional elements include a portal and user registration system, a Repository of Open Learning Objects (RoOLO), a Web-based Virtual Learning Environment (VLE), and Handheld Learning Devices (HLD) that include software for geotagged forms. All software elements are offered under open source license. Through the combination of the HLDs and Smart classroom technologies, and a light-weight Java-based program installed on the HLDs, students can combine captured images (using the HLD’s embedded camera) with contextual information such as the submitter’s name, the time and date, and more importantly, using the HLD’s built in GPS tracker, the geotagged location of where the photo was taken (see Fig. 2). Students can also add relevant “social tags” from a combination of pre-set and student derived vocabulary. The information that is added by the students is then uploaded to the smartroom central server where it is then overlaid on a Google Map, using Google MyMaps technology. In the room (on the large displays) or online, students can then see the collective artifacts of their class, which comprise a community knowledge dataset. Subsequent curriculum activities are designed according to the Knowledge Community and Inquiry (KCI) model (Slotta and Peters, 2008) where scripted collaborative inquiry activities are connected into the community knowledge base. Students are able to query their various resources according to the semantic metadata they added, combining results to create interesting cross sections of the architectural entries. The instructor receives reports of student activities that allows rich interactions related to the deep structure of the instructional domain. Information can also be uploaded to students’ HLDs, enabling them to become both continuous learners outside of the classroom, and socially connected to the rest of the class through their continually updated and shared experiences.



Figure 2. HLD information flow: Captured images from the HLD are geotagged and sent via wi-fi to the smartroom server where they are saved on the server and loaded onto the SmartWall; other students’ receive HLD updates.

Working closely with a math teacher, we have co-designed a “knowledge community” approach in which a grade 12 class is responsible for the development of student-created artifacts that are accessible by the entire class through an online portal. Students access the portal through a website that uses an application programming interface (API) for

Flickr, a popular online image hosting service. Using the website's API, students can upload, tag, and annotate their own math problems, as well as search, comment, and make connections between problems uploaded by other students in the class. This allows students to become co-creators of the community's knowledge objects as well as take control of the design of their learning environment. Working alone or in collaborative groups, students use the various configurations of the "smart wall" to offer different ways of organizing and visualizing the information. Students can also receive notifications sent directly to their HLD, when other students comment or add to any of the problems they have uploaded. Data sources include pre and post-interviews with teachers about formal and informal learning environments, the use of technology-mediated instruction, and classroom participation. Additionally, we examined the logged student data, all artifacts created by students, and curricular assessments employed by teachers.

Outcomes

Students created and uploaded 36 Math problems to the Flickr database and tagged them with specific mathematics categories – a basic set of terms was provided, but students were free to add new ones. Students then visualized the problems and solution sets in the smartroom on the large display screens using specified queries to the Flickr database. Through these visualizations students were able to see relationships/connections between problems and solutions sets that they had previously considered disconnected. A problem-sorting pre-test was developed to establish the impact of this design on student understanding of relationships. Results were positive and are currently in analysis stage. Through the combination of varied points of access, and collaborative development of artifacts by students, we have demonstrated the capacity of the smartroom to scaffold distributed intelligence within a knowledge community.

References

- Bereiter, C. (2002). *Education and Mind in the Knowledge Age*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Brown, A.L. & Campione, J.C. (1994). Guided discovery in a community of learners. In McGilly, K. (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice*. Cambridge: MIT/Bradford.
- Chi, M. T. H. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *Journal of the Learning Sciences* 6(3), 271-315.
- Collins, A. (2002) The Balance Between task focus and Understanding focus: Education as apprenticeship versus education as research. (pgs. 43-48) In T. Koschmann, R. Hall, and N. Miyake (eds.) *CSCL 2 Carrying Forward the Conversation*. Lawrence Erlbaum Associates, New Jersey.
- Linn, M. C., & Eylon, B.-S. (2006). Science Education: Integrating Views of Learning and Instruction. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of Educational Psychology*. 511-544.. Mahwah, NJ: LEA.
- Nirula, L. & Woodruff, E. (2008, August). Participation in the knowledge age for all: Designing handheld-supported literacy innovations for struggling readers. Paper presented at the Summer Institute for the Institute for Knowledge Innovation and Technology, Toronto, ON.
- Nirula, L., Woodruff, E., Scardamalia, M., & Macdonald, P. (2003). Handhelds in a grade two classroom: Innovations to support knowledge-building and epistemic agency. In K.T. Lee & Mitchell (Eds.), *Proceedings of the International Conference on Computers in Education 2003*. Hong Kong: ICCE 2003.
- Scardamalia, M. and C. Bereiter (1992). A knowledge building architecture for computer supported learning. *Computer-based learning environments and problem solving*. E. De Corte, M. C. Linn, H. Mandl and L. Verschaffel. Berlin, Springer-Verlag.
- Slotta, J., & Linn, M. C. (2000). How do students make sense of Internet resources in the science classroom? In M. J. Jacobson & R. Kozma (Eds.), *Learning the Sciences of the 21st Century* Hillsdale: Erlbaum.
- Slotta, J., and Peters, V. (2008). A Blended Model for Knowledge Communities: Embedding Scaffolded Inquiry. *Proceedings of the International Conference of the Learning Sciences*. Utrecht.
- Soloway E., Grant W., Tinker R., Roschelle J., Mills, M., Resnick M., Berg R. and Eisenberg M. (1999). Science in the Palms of Their Hands. *Communications of the ACM*, 42(8), 1999, 21-27.
- Songer, N.B. (2007) Digital Resources versus Cognitive Tools: A Discussion of Learning Science with Technology. In S. Abell and N. Lederman (Eds.), *Handbook of Res. on Science Education*. 471-491. Mahwah, NJ. LEA.
- Swan, K., van't Hooft, M., Kratcoski, A., & Unger, D. (2005). Uses and effects of mobile computing devices in K-8 classrooms. *Journal of Research on Technology in Education*, 38(1), 99-112.
- Tinker, R. (1997). The whole world in their hands. Concord. (<http://www.concord.org/library/pdf/future.pdf>).
- Woodruff, E. (2005). Manifold relational understanding: Moving beyond the mind-as-container metaphor in educational technology. *Proceedings of AMKLC' 05* Espoo, Finland.