Bridging Web-based Science with Outdoor Inquiry using Palm Computers

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The following are responses to questions posed during a structured poster session at AERA 2000 in the session titled “Supporting Flexibly Adaptive Design of Science Curricular Materials” held on Thursday April 27, 2000. This poster focuses on a pilot study conducted with Palm computers and probeware called the Alameda Creek Project and the design approach undertaken to leverage resources from the field and advance our understanding of learning supported by innovative technologies. The question addressed is: How do you create new science curricula that builds on prior curriculum development projects, yet integrates novel approaches to learning with technology and is adaptable for various local instructional conditions? Our goals as education researchers, as part of the Center for Innovative Learning Technologies CILT Synergy Water Quality Project, were not to re-create more water quality curricular materials, but to refine design principles, ensure student learning, and improve curriculum design practices. I describe how design and customization partnerships can create curriculum materials from multiple existing sources and guide its adaptation into a customized curriculum.

What intellectual and technological resources did you draw from in your research?

We customized water quality science curricula for Alameda Creek (10th grade unit) and Pine Creek (6th grade unit). From a pedagogical and technological standpoint, we began with the Web-based integrated science environment because of its ease of use, instructionally-sound , and free availability to both curriculum developers and teachers. We integrated modeling tools I (cf. Baumgartner in this session) which were developed after surveying the field for similar and appropriate tools. We adapted learning assessments and test items from the Stone’s River Mystery from the Scientist in Action Series at the Learning Technology Center (LTC) at Vanderbilt. These assessments, originally designed for 5th graders, were adapted to 10th grader. We also leveraged field-based inquiry activities supported by portable computers from the Science Learning in Context project at the Concord Consortium.

At the beginning of the project, we surveyed broadly materials from the field of water quality and related science topics. Materials we looked at included the Global Lab, Project GREEEN, Lawrence Hall of Science’s OBIS Activites (outdoor biology), SEPUP curricular materials, “Kids & Creeks”: a local California education outreach program, and various teacher-constructed materials found at NSTA conferences. While there were many interesting activities, many of these materials in their current form were unusable.

In particular, I was interested in drawing as many materials from prior curricular materials that accompany probeware (e.g. Texas Instruments CBL for chemistry, eMates, Vernier probes, Pasco, etc.), commercially available or otherwise. While a handful of research papers articulate the use of probes for scientific inquiry, few chronicle the design rationale, the specific impact on learning, and adaptability of materials to different contexts and audiences. Through personal networking, many of these articles and original curricular materials became available. (As a positive consequence, a website was created at the Concord Consortium called ProbeSight to gather links and resources on probeware. http://www.concord.org/probesight.)

What barriers did you encounter in trying to re-use materials, tools, or assessments?

While a topic of water quality was universal and several subtopics of science instruction overlapped (e.g. pH, sources of pollution, watersheds) across materials, material re-use was hard than anticipated. The barriers we encountered to re-use of curriculum materials are not unlike those encountered for re-use of software/hardware technologies between development groups.

Different Schools of Thought

At several points during the development cycle, we compared and contrasted the "patterns of inquiry" and instructional frameworks across each of these research projects. Several that were considered are shown in Table 1. The goal was to explore what was similar, what could be generalized, and if possible, what features could be made into a coherent, but generic sequence of activities for a 'template' of sorts. We identified common elements across each sequence of activities. For example, in WISE activities that start with "What's the Problem?" would be similar to 'Foundations of Science' step to "What's the driving question?".

WISE	LEGACY	Foundations of Science	Inquiry Cycle	MORE Cycle	Artemis
Linn, Slotta Bell	Bransford Brophy Vye	Krajcik Soloway Marx Blumenfeld	White Fredericksen	Stacy Rickey Tien	Wallace Bos

Ownership – Materials were not always easily accessible for sharing. Designers felt ownership to particular materials which impeded sharing. In some cases, materials were proprietary (for commercial development) or only commercial available which was less incentive for teachers and schools who wanted to adopt curricula broadly.

Different contexts of use – While a lesson plan seems to be a universal unit of sharing among school teachers, a technology-supported curriculum poses more challenges such as a) age of the students, b) length of the curriculum, c) existing school resources, and d) teacher practices.

Age of students – Materials are typically designed for a particular grade and competence level in mind. Designing learning assessments and activities for middle or high school students were not developmentally appropriate for 2nd graders (e.g. typing long sentences using a keyboard, interpretting graphs, critiquing evidence.)

Curriculum timing – Different lengths of curriculum units may or may not fit into the schedule of an existing curriculum. Some curriculum materials that would fit into block schedules or year-long programs with frequent visits to a local creek did not fit well into early adopter teachers and schools who could only commit 1 or 2 weeks to learning about ecosystems.

Teacher goals and preferences – As we know, not all teachers are the same in their preferences for particular activities. Differences in field experiences, preferences for using video or lecturing or inclass labs would affect curriculum adoption. In the Alameda Creek project, the teacher was highly motivated to use as much technology in the project as possible to support the school's vision of a technology-magnet school (thus introducing Powerpoint presentations as a capstone activity, steering away from working with standard microscopes). This made conditions favorable for introducing a web-based curricula and probeware instruction (despite little prior experience with either instructional technologies.)

Locally available resources – Often the use of curricula is driven by not just the instructional goals, but local resources such as a local creek, computers in the school, science laboratory equipment. While the Alameda creek materials were being developed, we tested re-used of the Strawberry creek materials. Strawberry creek teachers and the participating school used lab-based sciences and had already been involved in local creek stewardship and were eager to also make use of the school's well-equipped science labs with microscopes, photo spectrometers, centrifuges, aspiration filters, and other equipment. The Alameda project which took place at a school without these resources had to be adapted and laboratory components had to be removed.

How did you negotiate different cognitive perspectives and instructional frameworks?

A first step in negotiating different cognitive perspectives was to identify areas of commonality. As mentioned earlier, we compared instructional frameworks and started to converge on a 'generic creek project' which had the same activity sequences. Rather than defining similar elements by media types (e.g. a video, a simulation, a modeling tool, an online discussion), curriculum projects were compared from an instructional activity perspective (e.g. identify a goal, make a prediction, generate alternatives, reflect and revise ideas, analyze data, go public.)

Concurrently, the partnership tried to refine existing design principles to see if they applied to the creation of new materials. We are currently articulating pragmatic science principles (see Linn & Hsi's book "Computers, Teachers, Peers, 2000) such as “as temperature increases, dissolved oxygen decreases” to agree upon goals of instruction.

Process of Collaboration

Establishing a focused collaboration was necessary to understand deeper issues in ‘design for flexibility’ and ‘design for adoption.” With our colleagues at other universities and non-profits, we established a practice of sharing materials (drafts rather than just final polished documents) in a distributed living repository. The shared practice was continuous exchange of materials-in-progress, critical friends, and continuous improvements. This repository contained documents that articulated instructional goals, design rationale, assessments, and software examples from animations, modeling tools.

Collaboration was supported by a combination of communication technologies to discuss design rationale, successes, and failures in implementing curricular materials in our respective classrooms. Some of these technologies included phone conferences, video conferencing, live chats, and asynchronous communication.

These design and customization partnerships highlight particular tensions and challenges in negotiating instructional goals and frameworks among partnership members, and differences in individual and collaborative research practices. The adaptation of existing materials and design improvements were possible when instructional goals, instructional frameworks, and assessment criteria on prior materials including prior designer’s decisions and rationale were clearly articulated, documented, and made easily accessible to new designers. Moreover, participatory design and review by teachers and scientists was a necessary component of successful partnerships. The process of design was impeded when partners did not share similar design histories, collaborative work practices, and beliefs about collaboration.

Participating with industry presented a different set of challenges pointing to a mismatch in goals. While industry needed PR stories to fuel sales and ensure market viability, researchers were more interested in improving student learning experiences and improving the design of the technology to better support learning. Industry partners needed to sell products quickly before being able to address redesign recommendations from R & D.

What pivotal events or mechanisms facilitated collaboration within and outside your research group or institution?

Dedicated Time to Work with Teachers

Teachers were instrumental in making a curriculum success in the classroom. Having teachers available at the beginning and throughout the stages of develop provided information critical to making a project successful and providing teacher insights into the pragmatics of classroom research. In the cases where the teacher was too busy to attend meetings, the project was less successful. The WISE teacher workshop held every summer in August provides 3 days in which teachers can elaborate their ideas about science instruction and co-design a curriculum unit in partnership with an education researcher and curriculum developer. These kinds of opportunities promote shared visions and commitments.

Technology Donations

Research on handheld computers and probeware would not be possible without donations and contributions from ImagiWorks and Palm Computing, Inc. The timeliness of this motivated schools to participate too. These technologies enabled students to carry out field experiments, collect real-time data, and inform

Knowledge-sharing Across Organizations

Each member of the partnership (in CILT) made visits to partner institutions. The author and post-doc of the ubiqujitous computing theme team at CILT also formed outside collaborations with the Berkeley Wireless Research Center and the Human-Centered Computing group at UC Berkeley which provided expertise in hardware design feasibility, programming support,k and user interface design issues into the conversation. A Water Quality Summit held at the University of Michigan in January 2000 was held to broader the scope of the collaboration and invite more critical friends to the curriculum design process and synergy partnership.