To Unlock the Learning Value of Wireless Mobile Devices, Understand Coupling

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Abstract

Handheld computers will become an increasingly compelling choice of technology for K-12 classrooms because they will enable a transition from occasional, supplemental use to frequent, integral use. Early evaluations suggest teachers and students respond to handhelds favorably. At the same time, these devices will become communication enabled, through wireless technologies such as infrared beaming or radio-based local area networks. This current research base, however, is insufficient to unlock the value of wireless internet learning devices (WILDs). A important issue, hinted at but not fully explored in prior work, now must become our central focus of attention. The issue is the nature of the coupling between social and informatic worlds, and within the social and informatic worlds. We articulate three coupling issues: (1) Curricular Activity Spaces versus Personal Learning Connections (2) Integrated vs. Synchronized Educational Databases (3) Broad vs. Narrow Technological Mediation of Discourse.

1. Introduction

Handheld computers will become an increasingly compelling choice of technology for K-12 classrooms because they will enable a transition from occasional, supplemental use to frequent, integral use [1, 2]. Early evaluations suggest teachers and students respond to handhelds favorably [3]. At the same time, these devices will become communication enabled, through wireless technologies such as infrared beaming or radio-based local area networks. The clarity with which we can see the potential has led some to declare that the revolution has arrived and that by rapidly moving to this new technological platform, innovators could achieve large scale impact on learning. Perhaps. But perhaps not.

Every new generation of learning technology brings with it a new deep conceptual issue that learning technologists must entangle in order to unlock the learning value of raw technological potential [4]. The field of computer supported collaborative learning has already successfully tackled two key issues, control and representation [5]. This current research base, however, is insufficient to unlock the value of wireless internet learning devices (WILDs). A third issue, hinted at but not fully explored in prior work [6], now must become our central focus of attention. The issue is the nature of the coupling between social and informatic worlds, and within the social and informatic worlds [4].

To understand the excitement behind WILDs in the classroom, we start with a utopian scenario:

Mrs. Palio, an 10th grade science teacher, has always been interested in her students' visual and spatial reasoning, and she has a deep belief that her students develop visual and spatial understandings of some difficult science concepts before they can adequately verbalize their understanding. But she has never had a quick way to check for visual and spatial understanding in class. But recently her students have been arriving to class with WILDs. Through a small grant, Mrs. Palio got a WILD herself, some special software, a wireless network and a projector.

Now when she wants to check visual and spatial understanding, Mrs. Palio points camera on her WILD at a page in her text, and captures and image. She then sends the image to everyone in her class, and asks a question, like "Which of these molecules has a double bond?" The students circle the images they believe to be correct. Instantly, all the circles appear on the projected display of the image at the front of the class. Mrs. Palio can now quickly see if all the students agree on what a double bond looks like, or not. She can use this as a *leaping off point for class discussions that are tuned to what the students need the most help with.*

To understand why the effort to mobilize a product so obviously affordable and desirable as WILDs could get mired in quicksand, consider this reactionary scenario:

Presently in the United States, parents purchase the vast majority of educational handheld for their children, based on recommendations of teachers and rules from testing companies. In particular, math teachers overwhelmingly recommend Texas Instruments graphing calculators, which parents then purchase. This creates an installed base that covers most high school students. On top of such a large, uniform installed base, large scale impact on learning is indeed possible: math curricula have been dramatically reformed to leverage the representational power of instant graphing in every child's hand.

But notice how quickly the potential for scale could unravel as WILDs are introduced. The testing companies adamantly refuse to allow WILDs into college admissions tests, because they allow students to bring in copious notes, too much computing power, and the ability to communicate. Math teachers, therefore, can no longer strongly recommend a WILD platform. Meanwhile, the desirability of WILD features in students' personal life presents a dilemma for parents: which device should they buy for their children, the one that lets their child take the college admission test or the one that helps them organize their life? The market comes fragmented, with now only 20% or less of all students having a common handheld platform available. The platform companies have no interest in educational interoperability. Teachers refuse to cope with the hassles of poorly compatible, vastly different operating systems in the classroom (e.g. PalmOS, TI calculators, WinCE, Java-based cell phones). Publishers can now only make their textbooks rely on a particular graphing technology at the risk of losing market share, and so they opt out. The WILD revolution, which once looked so promising, in fact causes a drastic drop in the ability of teachers to make everyday, frequent use of curriculum-specific features like graphing.

The scenario may be overly pessimistic, but it is far from implausible. Equally plausible are bans on cell phones in school just as they begin to incorporate bigger colorful screens and keyboard, because instant 'texting' features allow cheating [7]. Or harsh lockdowns on the degree to which students can use a school-supplied device personally because some students are found to have downloaded pornography and shared it on school premises [8]. Or bans on Palmtops because students are using infrared beaming to disrupt classrooms [9]. School is by no means a simple place to introduce a WILD without running into massive opposition from powerful stakeholders, much less a WILD that is powerful enough to support innovative pedagogy.

We are not pessimists. The situation is not intractable but nor do we expect there to be quick technological fixes. It will require a large research and development effort with devoted attention to resolving the cluster of issues we group under the name of socio-informatic coupling.

2. Socio-informatic Coupling

These issues are fundamentally those involving challenges at the interface of policies and activities, and across the boundaries of organizations, communities, groups and the individual self. As these realms come to interpenetrate in our increasingly socio-informatic spaces for living, it will become more central to confront the conundrums of couplings. Our challenges include questions such as:

- What should be the *control processes for messaging topology* among student devices? Who will have what types of control, and over what scope of content or forms of interactivity?
- What should be the *principles of regulation for roles in a shared information space*? And how will they be enacted and enforced?
- What are appropriate decision rules around *how locally or globally digital learning objects are stored and with what levels of quality*? And who will make these decisions involving the properties of resource accessibility?
- What agents should determine *privacy levels for the processes and products of learning work*, and under what conditions of time, space and other variables?
- What should be the control mechanisms and policies for *whether content and processor power are fixed or flexible* in structure?
- How shall the *integration or segregation of the differing learning environments* through which a student moves be determined, and by whom?

In this paper, we begin the hard work of untangling the coupling conundrums by introducing four crosscutting design problems:

1. Curricular activity spaces vs. personal learning connections
2. Integrated vs. synchronization of educational databases
3. Strong vs. weak technological-mediation of discourse

3.1. Curricular Activity Spaces versus Personal Learning Connections

As suggested by our scenarios, we suspect that the foundational coupling design problem is to resolve the tension between curricular activity spaces and personal organizers/communicators. We begin by describing each side of the tension.

Roschelle & Pea [4] suggest that a wide range of early experiments with handheld beaming-enabled devices in education points to a new overarching metaphor of use. Originally we called this metaphor "augmented activity spaces" and then transitionally "collaborative activity spaces" and now "curricular activity spaces." We like the latest moniker because the augmented and collaborative aspects of these new places for learning activities are in the service and under the control of curricular regimens. In a curricular activity space, the teacher distributes assignments and aggregates results from students in real-time, punctuated by periods in which students work collaboratively in groups via peer exchanges. The technology enables the teacher to rapidly assemble an organized view of the whole classes state of understanding, to facilitate patterns of workflow that improve learning, to appropriately regulate the movement of personal learning objects into public spaces and visa versa, and to efficiently focus attention on the parts of tasks that maximize learning opportunities.

There is, however, a range of experience that students have with wireless and handheld devices which we did not consider in the previous article– students experience with cell phones (primarily outside the US) and with electronic organizers (like Palm computers, mostly in the US). In these uses, ownership of the device is a personal choice in which teachers and testing companies have little voice. Students like the devices because they can organize information about their busy lives in ways that are personally meaningful and connect socially with a network of friends and parents. On the Palm devices, which do not for the most part have telephone features, students still like to beam information peer to peer, to share with friends and parents. As personal organizers and communicators, students feel strongly that they should have control over whom they talk to and what they say, as how they use or do not use various organizational features. They use the devices for just-in-time information exchanges, maintaining social relationships over distance, coordinating and remembering events, and exchanging small media objects of mutual interest.

Stroup [10] calls the two contrasting designs "vertical" and "horizontal." Vertical refers to curricular activity spaces, for they are designed in response by subject matter curricular needs that are linked across several years in a similar course, e.g. high school mathematics. Horizontal refers to personal organizer/communicators for they are designed in response to an individual's needs across their day. He argues forcefully that these kinds of use will not converge, because they fundamentally pull in opposite directions. (See [11] for a related argument that the two primary devices will be a content-device organized around a cheap large hard-drive, and a communications device, organized around text and verbal communication needs).

Stroup notes, for example, that in curricular activity spaces, communication is under the teachers' control. With communicators, it is under the students' control. In the curricular design, content is specialized to particular subject matter and restricted (there is little chance of pornography on a graphing calculator); in the communicator case, content is quite general in format (text or graphics) and unrestricted (and students, in fact, routinely send each other very intimate messages). In the curricular design, the device packaging can be optimized for particular subject matter (to include a calculator keypad, for example) whereas in the communicator case it must be small, light, and general-purpose.

We summarize the tension between these two different kinds of design by noting that powerful curricular activity spaces work exactly because they take strong control over the kind of content (e.g., ensuring it is a powerful mathematical representation), the form of input and output that is allowable, and they regulate communication in line with curricular needs. The personal communicator designs work exactly because they do the opposite; allowing the owner to say whatever they want to friends of their choosing through forms of input and output that are quite general to everyday use. Teachers have little reason to make a strong push for students to buy a particular communicator, which undercuts the standardization of a learning platform in the classroom. Students will not be willing to put personal, private information on a device that is open to teacher control and snooping. So it appears likely that students will carry two devices.

If students will use two devices, how are they coupled? Clearly it would be useful to send assignments home on a personal organizer; equally clearly, cross platform incompatibilities could prevent an interesting curricular objects (e.g. a simulation program for exploring a mathematical concept) from migrating from single-platform curricular activity spaces to heterogeneous personal communicator spaces. Can these problems be solved technically? Probably. But it will be much too expensive to solve them in the general case, so a detailed analysis of what kinds of information need to traverse the curricular / personal device spaces is essential to progress. It may also be necessary to think very carefully about how hardware can be segregated efficiently between the two kinds of device-needs to optimize them for the relative purchasing power of classrooms vs. students, and for the design needs on each side.

3.2. Integrated vs. Synchronized Educational Databases

There is a tempting educational vision in which all the information that a student needs personally and all the school-based information relating to a one database student (at least conceptually), under the control of the school or its agent. This vision is usually conveyed through the idea of web portals which contain separate viewpoints for administrators, teachers, students, and parents, and through which all school relevant information exchanges take place. Often these portals use the word "my' copiously, to suggest that students will put their personal schedule, to do list, email communications, assignments, etc. in this large database, and it will be offered as a "service" to them on their handheld wireless access device.

While some version of this vision will no doubt continue to exist, we see very little reason to suspect that students will submit to enterprise control over their own personal data and communication capabilities; they will maintain a parallel device which gives them freedom to have data and communication without school surveillance. There are two obvious reasons for this. First, from the school side, if the database contains everything, then it contains sensitive information, like grades. Therefore it must be strictly administered under a security regime, and the school will have some legal responsibility to monitor what goes on there. If illegal music downloads are found, or undesirable texts, powerful stakeholders are likely to force removal of that content. Second, from the student side, individuals will not want to be limited in how they organize their lives, whom they communicate with, and how private that information is by what a portal service chooses to provide. Thus, the migration of personal organizer/communicator capabilities to services in an integrated database are unlikely.

Consequently, the coupling of issue of synchronization becomes interesting. What kinds of information are students and schools willing to have synchronized across the boundaries of their respective private spheres? How is a social contract maintained so that unauthorized use or surveillance cannot occur during synchronization?

3.3. Broad vs. Narrow Technological Mediation of Discourse

The fields of computer supported collaborative learning and the phenomena of distance learning encourage a view of technology in which all learning discourse is mediated by computers. This model, in which technology broadly mediates discourse, allows for some powerful and novel forms of communication, but it also runs the risk of eliminating much of what makes informal face-to-face classroom activity valuable.

An alternative success model, in which technology only mediates a very narrow slide of discourse, comes from much experience with the use of Classroom Response Systems, notably ClassTalk [12]. These systems collect simple multiple-choice responses from students, and plot a histogram that enables the class to quickly visualize the proportion of the class with various answers. Seen out of context, this is an absurdly simple and limiting use of handheld technology in the classroom. However, seen through the eyes of the most sophisticated users of such systems, this simple, reliable, inexpensive technology can have such far-reaching effects as creating a greater sense of community, a more learner-centered classroom, a more assessment-center classroom, and a more understanding-oriented classroom. This narrow mediation of discourse, with the right classroom practices, can enable such remarkable transformations because it makes possible a few key informatics properties (e.g. a public gestalt of all student's anonymous input) that are hard to achieve in teacher-student talk, while leaving all the nuance to normal discourse.

In general this points to difficult questions of the coupling of discourse that occurs through technological media and discourse that occurs outside of technological media. In general, we believe it will be too restricting to reproduce all social discourse in the technological medium when face to face communication is available; but if the technology medium does not respect the social context of use, it will be too disruptive for everyday use.

4. Conclusion

In this article, we have continued and expanded our contention that WILDs bring powerful new potentials to learning environments, but that our existing base of knowledge and software is insufficient to fully realize the potential of these environments. We worry that in our enthusiasm to embrace a technology that is affordable and personal, the field is not paying enough attention to the warning signs that the revolution may result in a backlash. We believe that WILDs in education can survive this threat, but to do so, we will have to break the hardware and software into parts, which are engineered to meet different social niches. Once broken apart, the issue of coupling comes to the fore as a way to preserve the potential of WILDs. Coupling is both among different technical parts, among different social spheres, and between social and technical spheres. Key areas requiring further design research are:

1. Curricular activity spaces vs. personal learning connections
2. Integrated vs. synchronization of educational databases
3. Strong vs. weak technological-mediation of discourse

5. Acknowledgements

This work has benefited from conversations with Walter Stroup and Corey Brady, as well as members of the Center for Technology in Learning at SRI International. This work in this paper was supported in part by the National Science Foundation (Award: REC- #0126197). The opinions presented are the authors, and may not reflect those of the funding agency.

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