# The Palm Project: The Impact of handhelds on science learning in 7th grade

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## INTRODUCTION

There is mounting evidence that the use of computing technologies can lead to learning gains in K-12 (e.g., Honey et al., 1999; Krajcik & Starr, 2001; Krajcik et al., 2000; Schneider et al., 2001). However, to realize those gains, interacting "enabling conditions" need to simultaneously exist in the school and classroom, i.e.,

- Students must have access to the technology to support significant time on task
- The curriculum must be integrated with and leverage the technology
- Teachers need to be prepared and have an understanding of how to use the technology-infused curriculum
- Assessment must be appropriate to the technology-infused curriculum
- School administration and culture must support he use of learning technologies and curricular materials
- Parents/guardians and community members must support he school in attempting to use learning technologies, curricular materials and assessments.

While the hi-ce research group continues to make inroads in the areas of administrative and community support, for this study, we have determined that access, curriculum, and professional development are the modalities where the majority of the impact of innovation acts. This project in particular examines what happens when attempts are made to solve the issues of access, curriculum integration and professional development of teachers in the context of seventh grade science.

*Access*

A range of national and statewide studies is showing that the ratio of students to computers in K-12 schools is about 6 students to 1 computer (NCES, 1999; Anderson & Becker, 2001; Anderson & Ronnkvist, 1999). From the Snapshot Survey (Norris et al., 2001) of 4000 educators from four states, 45% of the teachers report that their student use a computer less than 15 minutes a week. Similarly, Becker (1999) reports that 70% of the teachers in his nationwide survey have their students use computers two or fewer times a week. Computers may be found in other parts of the school, but they are not being used by students.

We have chosen to solve the access problem by using more affordable handheld technology, specifically Palm computers. These cost approximately $100 as compared to a desktop computer's cost of upwards of $1000. Each student in the Palm condition of our study received a Palm m130 handheld and a keyboard, and the classrooms have desktop computers connected to the Internet, document cameras and digital projectors.

*Curriculum Integration*
Using a collaborative work circles model, Detroit Public Schools teachers and hi-ce researchers have developed curriculum materials that support urban students learning important science content and process skills via project-based learning.

To integrate the Palm computer into our existing curricula centered on air quality and communicable diseases, we also used a collaborative workcircle model with teachers and hi-ce researchers working together. During these meetings, we examined software and curricula to see where we could leverage the affordances of the technology to the student's advantage. What came out of these meetings was a new curriculum that incorporates the handheld in almost every lesson in some way.

*Professional Development*
Over the past 10 years, our research group has engaged in considerable professional development research (Soloway et al., 1996; Marx et al., 1998; Fishman et al., 2001). Our current approach is to focus our regular, biweekly professional development meetings on curricular goals and technology skills and integration, with the intent of being timely for the teachers as they enact curriculum. Embedded in the professional development is a long-term trajectory of those skills deemed important by teachers and/or researchers. Meetings include all the teachers and two hi-ce researchers, and while the meetings are facilitated by a researcher, most of the discourse involves teachers talking with teachers about the successes and challenges of using the technology in their classrooms and how they will enact future lessons.

During these meetings, teachers learn both how to use a suite of applications created by hi-ce and how to integrate their use into the curriculum. Palm computer use in each lesson is determined by the group. The core applications that get used by students are:

- **FreeWrite** is a word processing program. In addition to the basic word processor features, advanced features such as auto-capitalization, spell checking, and revision help make writing easier for any use.
- **PiCoMap** allows students to create, share, and explore concept maps on their Palm OS computer. This program allows users to create multiple nodes and relationships leading to elaborate concept maps for brainstorming, visual outlining or assessment purposes.
- **Sketchy** is an animation/drawing tool featuring many pen options, geometric objects, up to 999 frames, and an easy-to-use interface. Helpful features such as duplicate, insert and delete allow quick and clean animation creation.
- **FlingIt** allows users to instantaneously "fling" Web pages from the desktop computer to the Palm OS computer. Students can decide whether or not to include graphics and determine the link depth of the captured Web pages. Students can then view Web-based content at home, on the bus, or in their seats.
- **Chemation** is a chemistry-specific animation tool that allows for easy manipulation of ball-and-stick models of atoms and molecules to indicate chemical reactions. Students can build frames of reactants, draw some reaction and then build the products, creating an animation of the reaction at the molecular level.

## THE STUDY

The purpose of our study is to examine more closely than before how Palm computers are used to help students engage in project-based science curricula and to see if Palm use offers better achievement gains than the use of traditional pencil and paper. Our research questions are:

1. How does the use of handheld applications to create and revise science work influence students' science achievement compared to students who do the same work in traditional ways?
2. In what ways does the use of handheld devices change the work of teachers and students engaged in inquiry-based science curricula?

More specifically, what differences are there in scores on classroom pre/post tests, and on standardized state tests? What kinds of opportunities are presented to the students now that they have this new technology? What is the process of production of artifacts by students using the technology? What are the differences in the quality of the artifacts the students produce?

## METHODS

This study aims to show the results of a comparative examination of students using Palm computers on a daily basis to engage in scientific problem solving as opposed to students using traditional pencil and paper. The comparison is between classrooms of the same teacher, using the same curriculum. The only differences are the use of the handheld technology, and the manner in which the teacher chooses to enact that curriculum.

Four classroom teachers in four schools form the basis of our study that takes place in a large Midwestern city. Each teacher has two Palm and two no Palm classrooms and all four are teaching seventh-grade science. Over 200 students are using Palm computers as part of this study. The handhelds were given out near the beginning of the 2003-04 school year and used daily for everything from the warm up activity, to class projects, to their

| Data | Importance |
|---|---|
| Observational data from Palm/No Palm classrooms | Shows if classrooms are comparable and the kinds of activities and interactions that are happening |
| Artifacts | Check for quality of student products |
| Pre/Post tests | Comparing gain scores among Palm and no Palm classrooms |
| Student interviews | Probe student thinking about scientific concepts |
| Teacher interviews | Probe teacher enactment decisions |
| Standardized test scores | Comparing scores among Palm and no Palm classrooms |
| Attitude surveys | Understanding student's motivation for science and technology |
| Professional development meeting notes | Making connections from PD meetings to classroom enactment |

Table 1. Palm Project data collection.

homework. We used the personal model of handheld use, whereby students get to keep their handheld from the time we hand them out until the end of the year, taking full responsibility for its upkeep and safety. In much the same way that the no Palm students would use pencil and paper, the Palm students would use their handhelds.

The focus data of this study includes whole classroom observations, intended to examine how comparable the Palm/no Palm classrooms are in terms of teacher enactment of curriculum, while other observations will center on the group interactions as students work together to create artifacts. The artifacts will be examined and scored and curriculum pre/post tests will be used to determine achievement differences. Other contextual data will be collected as can be seen in Table 1.

## EARLY RESULTS

Students have had the Palm computers for about 5 months now and during that time, we have seen some successes and challenges in using them in the classrooms. We have noticed the following trends across classrooms:

*Teacher successes:*

- The Palm is showing itself to be motivation for teachers to reflect on their practice. Teachers are spending more time planning for class than before, in addition to the time needed to tend to the handhelds. In our professional development meetings and through email contact, teachers talk about how using the handheld has forced them to rethink how they teach.
- Professional development support is key. This is not a new finding where technological innovations are concerned. The continuous support that is provided in the biweekly meetings offers teachers the chance to discuss issues in enactment, get technical advice, and generally take part in a community of learners.
- One of the biggest concerns of teachers and administrators was that the time spent to learn the tool would drag down any gains that might be offered by its use. This has not been the case. Students were using the handheld to do their work on the same day they touched it for the first time. This might appear to contradict our explanation of our test data below, but this finding is considered over a five month period.

*Student successes:*

- Students using the Palm engage in more thoughtful conversation around tasks than pencil and paper. In our preliminary examination of small-group observations, it appears that the students in the Palm group talk more substantively about content, spending more time debating and critiquing others' work.
- We have yet to confirm this, but it appears that the first round of concept maps we are presently scoring are of higher quality in the Palm condition than the pencil & paper classes. It is yet to be seen whether these differences are due to a difference in what the Palm students know, or in affordances of PiCoMap.

*Student test data from the fall, 2003*

The Pretest to posttest gain for the Palm condition was 5.66, with a standard deviation of 3.94; the gain for the no Palm condition was 6.44, with a standard deviation of 4.02. Both gains were significant at the $p<.001$ level. However, the effect size of the differences in gain scores between the two conditions was 0.18, and was not significant (See Table 2.). One possible reason for why we did not see any difference between the Palm and no Palm conditions might be that the study began halfway through this unit, so the studetnts in the Palm condition did not receive their handhelds until that time. More time in the beginning of the study was spent in learning how to use the Palm computer in the classroom by both the teacher and students instead of using the Palm computer to learn content. In addition, this was the first time any of the students had used a Palm computer, and the first time three of the four teachers were using Palm computers with students.

Table 2. Air Quality pre/post test data, Fall 2003.

| | **Palm (SD) [Eff. Size] (n=167)** | **No Palm (SD) [Eff. Size] (n=143)** | **Difference [Effect size]** |
|---|---|---|---|
| **Total gain** | **5.66 (3.94)*****| **6.44 (4.02)***** | **0.78 [0.18]** |
| Pretest | 7.81 (2.81) | 6.76 (3.04) | 1.05 [0.39]** |
| Posttest | 13.47 (4.51) | 13.20 (4.67) | 0.27 [0.08] |

***$p<.001$, **$p<.01$

*Teacher challenges:*

- Teachers indicate that planning takes more time with the technology. Managing 70 Palm computers has been a challenge for the teachers. As time goes by, the teachers are offloading more of the responsibility to the students for syncing and beaming work to each other, but the time it takes is still an issue.
- Palm tasks take a little more time to complete (about 15%) than pencil and paper at this early time. Students are taking more time to type using the keyboard or take notes using the stylus than those using pencil & paper. This is not surprising. As students get better at inputting information, the time difference will decrease.

*Student challenges:*

More handhelds end up broken than should. This is a serious problem if we plan to scale Palm computer use to large numbers of students. Right now, we have about 12% of the Palms coming up broken. Some of this is student error (droppage, dog bites, etc.) but most of it is from the technology breaking down (i.e., digitizer errors).

## WHAT'S NEXT?

Our plan is to extend this study through the 2004-2005 school year, giving us two year's worth of data using the same teachers. We believe this replication will offer us a more detailed look at what is happening and how continued use by the teacher affects enactment. We are also planning on trying to understand how specific tasks and applications can be used to help students learn science.

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