

Learning With Handhelds: Findings From Classroom Research



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<http://www.palmgrants.sri.com/findings.html>

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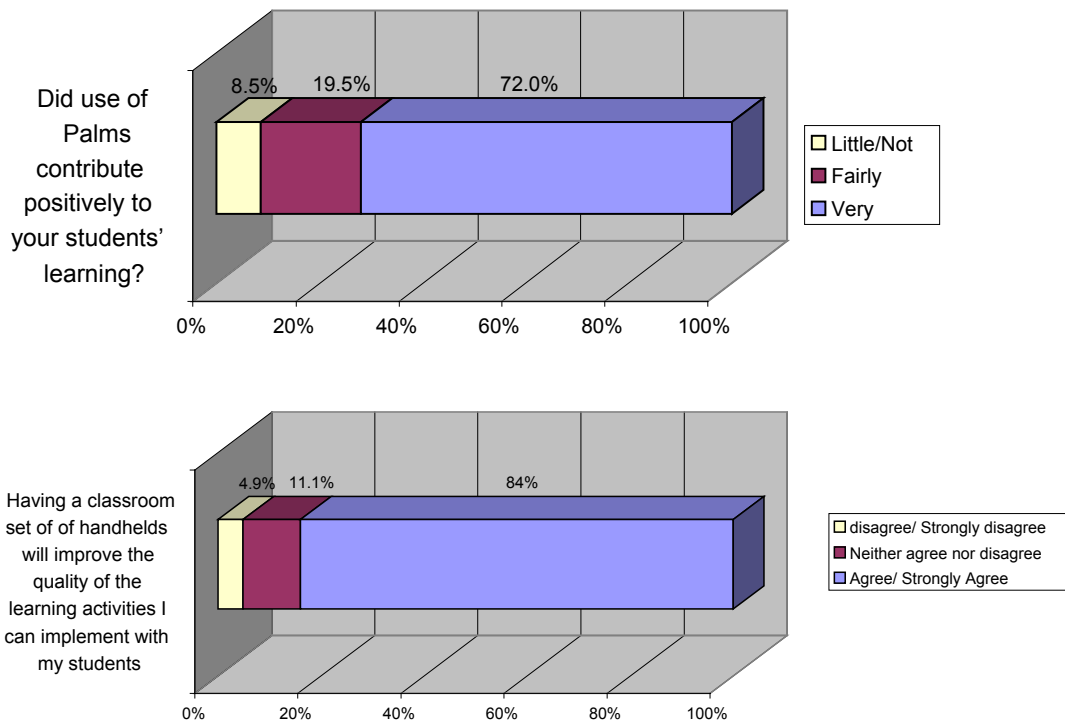
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Introduction and overview

Among nearly 100 teachers who used handhelds in their classrooms for a full school year:

- Over 90% stated that handhelds contributed positively to student learning.
- 84% stated that using handhelds would improve the quality of learning activities they implemented with their students.



Source: Palm Education Pioneers Final Report

Handheld computers are emerging as a promising technology for teaching and learning across all grade levels. With handheld computers we may finally fulfill the

promise of educational technology: providing low-cost interactive computers to every student to improve learning.

Most schools have a computer lab and/or a small number of desktop computers in each classroom, allowing students only intermittent access to technology during the school day. In comparison, handhelds are portable, inexpensive, and run many of the same programs as desktop and laptop computers. This allows each student to have a handheld computer wherever and whenever it makes sense. By providing a handheld computer to each student, technology can be integrated throughout the curriculum and used at the precise time and place that it can have the greatest impact on learning. In addition, a variety of peripherals are available for use with handheld computers, such as probes, sensors, portable keyboards, and digital cameras. Handheld computers can be used in a large variety of individual or collaborative learning activities, such as taking water quality measurements at a stream, beaming a spreadsheet with a data table to a fellow student in class, furthering work on an assignment while waiting to be picked up after soccer practice, or writing a report at home.

“I expect more of my students in the areas of organization and follow through. I find I can expect students to take more notes and organize them in the graphic organizers (and keep track of them for a longer period of time). New technology has led to higher expectations from the students and myself.”

A Palm Education Pioneers Teacher

Recently, SRI International conducted an evaluation study of teachers’ and students’ year-long use of handhelds for a wide range of activities in 100 K-12 classrooms around the country, as part of the Palm Education Pioneer (PEP) program (see <http://palmgrants.sri.com>). The PEP program showed that handheld technology has a beneficial impact on the classroom learning environment. PEP teachers reported greater student engagement, more effective collaboration, and increased student autonomy when handheld computers are thoughtfully integrated into the classroom. (To download the PEP report, please visit <http://palmgrants.sri.com>.)

This document summarizes the PEP evaluation study. It presents key features and possibilities of handheld computers, as well as key issues in integrating handheld technology in the classroom. Our goal in providing this document is to provide guidance to educators in determining the most productive use of handhelds in their classroom.

Portability

“The handheld computer is a truly personal computing device that is useful anywhere. The students can use the handheld anywhere, [and] with a [portable] keyboard, they have a powerful tool that they can use to get some serious work done in a wide variety of places”

A Palm Education Pioneers Teacher

Perhaps the most striking feature of handheld computers is their portability. Using handheld computers, students can easily bring their computer to the project, instead of having to bring their project to the computer. Students can truly have “anytime, anywhere” access to technology (a claim often made about Internet-based resources, which are available only “anytime” and “anywhere” students have a high-speed Internet connection), improving the quality and effectiveness of the learning task. Portability can make a difference in a wide variety of settings, such as the classroom, a field trip, or out of school.

In the classroom. Students don’t have to share the computers at the back of the room, nor do they need to go to the computer lab every time they want to use technology. This availability can have a significant impact on an activity as common as writing: handhelds, combined with external keyboards, allow all students to have their own word processors right at their desks. Additionally, handhelds allow teachers to move from whole-class to small-group to individual activities as naturally as if they were using no technology at all: students simply pick up their handhelds and move to the next activity. Because of this flexibility, teachers have found that handheld computers fit more easily into the flow of classroom activities than desktop or laptop computers.

On a field trip. Bringing handheld computers on a field trip allows students to have access to relevant technologies where they can have the most impact: at the learning site. For example, students can attach probes and sensors to their handhelds to analyze the health of a local stream. Students can use acceleration sensors at an amusement park to investigate the physics of a roller coaster. Some museums and aquariums provide handheld computers to patrons or set up beaming stations, allowing students to collect data directly from the exhibit they are viewing or interacting with. In all these cases, students can investigate—on the spot—what they see, raise important questions about unexpected findings, and continue their investigation while still in the field. Like scientists, students engage in *authentic investigations* when they are supported by handheld technologies, an occurrence that is all too infrequent in the typical classroom.

Out of school. Handheld computers allow students to take more responsibility for their own learning (see “Personal Learning Device”), and can allow more continuity between school and home. Students can continue their work at home, in the car, on the school bus, or while waiting to be picked up after soccer practice. All this can be done without having to transfer files or make sure that the latest version of their assignment was posted to the network. Additionally, handheld computers allow greater communication between home and school: whereas students often seem to lose paper notes between home and school, teachers have found that students are less likely to lose notes that are sent home on the handheld computer.

Personal Learning Device

“When students used handhelds, I saw greater student autonomy and accountability toward assignments and a greater sense of [student-teacher] partnership in learning together.”

“For students the biggest factor I see is motivation. They are motivated by the "coolness" factor of it, and after that wears off they are motivated by the fact that there are no papers to lose or get messed up. And if they do "lose it" another student can beam it to them instantly.”

Palm Education Pioneers Teachers

Teachers report that students using handheld computers demonstrate increased autonomy in learning. Students show increased self-directedness in learning and take initiative in finding ways to use the handheld computer for learning. Teachers said their students discovered and adopted handheld-based learning tools on their own, such as using self-quizzing programs, calculators, and dictionaries and other reference tools, sharing their discoveries with other students in the classroom—and the teacher. When students are allowed to take handhelds home, they continue and extend learning activities at their own initiative.

Many teachers value the greater opportunity for self-paced learning that students have with a handheld computer. Handhelds make it easier for students to work on tasks and assignments at their own pace, rather than as dictated by the computer lab schedule or the class period.

In addition to using handhelds as a learning device, students who are assigned a handheld computer to be used all day, and to take home, use it as a personal organizational tool. The scheduling and personal information management tools can make it easier for students to keep track of school work, due dates, and school events. Teachers report that students who take handheld computers home have an increased sense of personal responsibility and higher homework completion rates. For information on strategies for assigning and tracking handhelds, see the “Assigning Equipment” and “Class Management” sections.

Collaboration

Among nearly 100 teachers who used handhelds in their classrooms for a full school year, 94% observed increased cooperation and collaboration among their students when using handhelds in the classroom.

Source: Palm Education Pioneers Final Report

The infrared beaming function, available on handheld computers for easy transfer of electronic files, allows teachers and students to engage in collaborative learning activities more effectively than ever before. Learning groups can easily distribute, aggregate, and share information, resulting in more successful collaboration. When students can easily share their work and ideas, more on-task, learning-centered discussion can occur, and students can go deeper with their joint problem solving. Students also use beaming to assist each other, resulting in an increased sense of classroom cooperation and peer support.

Beaming also allows for completely new types of collaborative activities, such as participatory simulations. In traditional simulations, students watch, and occasionally act, on a computer-based simulation of some phenomenon. In *participatory simulations*, students don't watch the simulation—they *enact* the simulation. One such participatory simulation available for handhelds is "Cooties" (available at: <http://www.handheld.hice-dev.org/download.htm>). Parameters about disease propagation are set on the students' devices, and students walk around the room interacting with their classmates, beaming information to each other. As they interact, their handheld computers record their status and other relevant data. Learning applications such as Cooties can be used to change the way students learn about health and science issues by allowing them to *experience* instead of *watch*, and then *reflect* on their experiences.

One of the most interesting aspects of using handhelds in the classroom is how they can support *both* autonomous learning (see above) and collaborative activities. Because the handheld screens are small, they are relatively private. As a result, students are able to privately work, reflect, explore, and experiment, without concern that someone else will see their unfinished work. Then, once students have a final product they are proud of, they can easily share it, either by beaming to other students or by passing around their handheld for others to look at their work. This easy combination of private work and public sharing is one of the most compelling aspects of using handheld computers to support student learning.

"I loved seeing the students work cooperatively in teams and groups. They helped each other and shared information readily. This just wouldn't have happened if they were using pencil and paper or if they were seated in a permanent position in front of a PC."

A Palm Education Pioneers Teacher

Some teachers have found a downside to beaming. Students may attempt to use beaming to cheat on exams or beam inappropriate materials (similar to passing notes in class). Teachers can prevent such misuse by purchasing additional software that allows

the controlling of beaming, or by more traditional class management techniques, such as calling for “closed covers” on the handhelds. Just as with desktop computers, many teachers have found that “appropriate-use” policies help limit inappropriate use of the technology.

Teachers have also found the lack of “broadcast” beaming (beaming to the entire class at once) an inconvenience. Hardware and software solutions can be purchased that allow teachers to beam a document to the entire class. Alternatively, many teachers create “beam teams,” in which a number of students are chosen to accept beams from the teacher, and then each of these students beams to other students. Although less efficient than broadcast beaming, this method is at least as efficient as passing out papers, and some teachers even report that “beam teams” add to a sense of community in the classroom.

Putting It Together: Handhelds, Desktops, Peripherals, and Software

“I want more peripherals! I love them, my students love them, the parents love them, and my teachers love them. They make the Palms more useful than can be imagined.”

“Handhelds have their own requirements—software and hardware—to be effective, and that requires planning.”

Palm Education Pioneers Teachers

Although handheld computers can replace desktop computers for many uses, they do not eliminate the need for desktop computers. Instead, handhelds occupy a niche distinct from desktop computers, and teachers who use handhelds report that use of desktop computers does not decrease. In part, the reason is that handhelds are designed to be used in conjunction with desktop computers; files and data stored on handhelds are backed up to a desktop through synchronization. (Multiple handhelds can be synchronized to a single computer.) E-mail drafted on a handheld can be uploaded to a desktop for mailing. Text written on a handheld can be uploaded to a desktop for printing, or beamed, using infrared, directly to a printer with an infrared port. See Table 1 for a comparison of uses of handheld and desktop computers.

Table 1, comparison of desktop and handheld computers

Desktop Computer	Handheld Computer
Shared device	Personal Device
Large display	Small display
Greater processor power and memory	Less processor power and memory
Occasional use	Frequent use
Fixed place, used during school hours	Mobile, used whenever sensible

Simply having a set of handheld computers does not mean that they will be easily integrated into a teacher’s curriculum. To help ensure that handhelds are used as effectively as possible, it is important that teachers have time to research available software and peripherals, have the budget to purchase appropriate software and peripherals, take the time to learn how to use the software and peripherals, and understand how to integrate the handhelds, software, and peripherals into their learning activities. Although handheld computers don’t require significant additional infrastructure and may be useful in even the most basic configuration (one handheld per student, without any additional hardware or software), many teachers consider additional peripherals and software a “must have.”

The power of handhelds as a learning tool is greatly increased by peripherals. Appropriate peripherals and software transform the handheld computer from an electronic organizer into a truly productive learning device. Teachers have found that the most important peripherals are scientific probes (such as pH probes, dissolved oxygen probes, and acceleration probes), keyboards, and digital cameras. The most useful software for education includes productivity applications (such as word processors and spreadsheets), Internet applications, and education-specific applications.

Handheld probe systems combine a sensor interface and software for real-time data collection and analysis. This combination is a valuable addition to inquiry-based science curricula. The ability to take real-time readings using different probes and sensors can result in greater student engagement, and allow students to concentrate on the science rather than on logistics. For example, teachers report that when using pH strips, students spend a significant amount of time and effort color matching to determine pH. They contrast this to students standing knee-deep in a stream, collecting real-time data using handhelds and probes, instantaneously comparing data in different locations (often by shouting out their readings to others). It is when students are standing in the stream, asking questions about differences in pH readings, that teachers may find the most compelling teachable moments.

Digital cameras can be used to support inquiry, allowing students to take photographic records of field sites, or even of their experimental setups in the classroom. Back in the classroom, data from the handhelds can be uploaded to a desktop computer to analyze the data and create presentations of findings—tasks better suited to the greater processing power and larger display screen of a desktop computer.

Portable keyboards can also be invaluable, especially for projects that use handhelds for extended writing. When combined with general productivity applications, keyboards allow students to use their handheld instead of a desktop computer for many activities, giving students a truly portable personal computer.

Handhelds can also extend the use of Internet resources accessed with a desktop: using applications such as AvantGo or Fling It (from Hi-CE), students can do Web searches and then download relevant pages to their handheld for further analysis. This allows students to transport Internet-based resources from their home computer into the classroom. These applications also allow students to more effectively share the desktop computers found in the classroom: once a student downloads pages to her handheld, the desktop computer is freed up for another student.

A lot of education-specific software is now available for handheld computers. This software includes electronic flashcards, quizzing applications, concept map applications, reference applications like dictionaries, and much more.

The following resources contain useful information on integrating handheld computers into the classroom:

<http://palmgrants.sri.com/ideabank.html>

<http://www.k12handhelds.com>

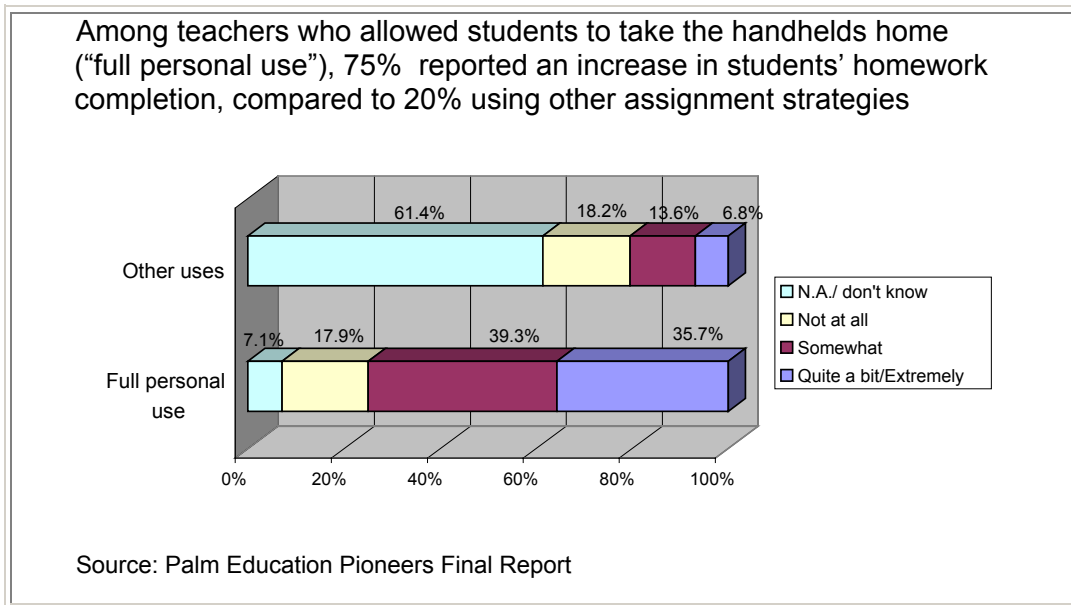
<http://www.handheld.hice-dev.org>
<http://www.handheldeducation.com>
<http://www.pdaed.com>
<http://pie.concord.org>
<http://www.handango.com>
<http://www.palm.com/education>

A note about compatibility

When determining how to integrate handheld computers with other technologies, it is important to be aware of potential compatibility issues. In considering the use of PalmOS™ or Pocket PC™ devices in the classroom, three particularly important issues are:

- *Compatibility with desktop computers.* Most handheld computers come with a cable that connects the handheld with a desktop computer. The widespread use of USB cables in current handheld and desktop computers minimizes cable compatibility issues, and in cases where the cables are incompatible it is possible to purchase adaptor kits. Most handheld computers also come with software that allows synchronization between the handheld and desktop. PalmOS devices come with software compatible with Macintosh™ and Windows™. Pocket PC™ devices come with Windows software, and Macintosh software may be purchased separately.
- *Compatibility with handheld software.* Software written for PalmOS devices and software written for Pocket PC devices are incompatible. It is important to ensure that any software you acquire is written for the appropriate handheld device.
- *Compatibility with peripheral devices.* Most peripheral devices (probes, keyboards, cameras, etc.) plug directly into the handheld computer. Because different models of handhelds may have different connectors, it is important to verify that the peripherals being acquired are compatible with the specific handheld computers you will be using.

Assigning Equipment: Ownership or “Loanership”?



Handhelds in the classroom can be assigned to students in two basic ways:

- As personal learning tools, with each student assigned her or his own handheld for continuous use.
- As a shared classroom set, with students checking out handhelds as needed or using assigned handhelds episodically for specific learning activities.

The first assignment strategy allows students to take ownership of the handhelds: they can store personal information, use them as learning tools at their own initiative, use them to organize their personal schedules and assignments, and have them ready at hand for genuine “anytime, anywhere” computing. The second assignment strategy is more like “loanership.” Students cannot store work and personal information on the handhelds because the handhelds are used by multiple students. Students’ access to the handhelds is limited, and they cannot adopt and customize the handhelds as truly personal learning tools. However, it is easier with this strategy for the teacher to prepare the handhelds for specific learning activities, such as science investigations.

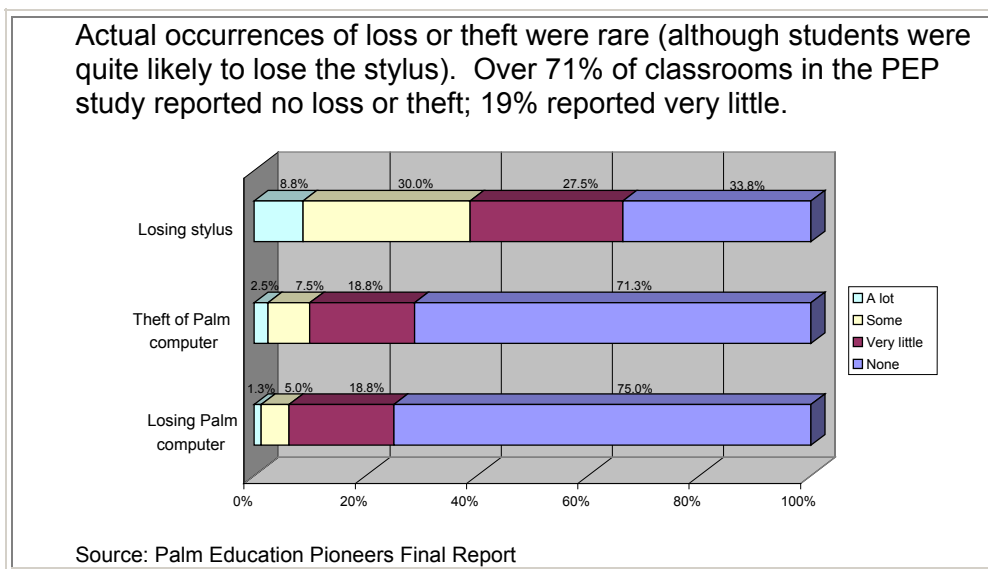
If the same set of handhelds are to be used by multiple classes, the shared-set assignment strategy is called for. If the handhelds are to be used frequently for various specific learning activities, such as using probes attached to the handhelds to collect data in a science inquiry activity or doing classroom-based labs, then it may be easier for the teacher to use the shared-set approach so that they are accessible for preparation (such as loading software or necessary files) and follow-through (for example, to synchronize the handhelds to classroom computers). Or, if the instructional purpose requires students’ all-day access to the devices (such as for projects that are cross-disciplinary, aim to promote students’ organizational skills, or have the goal of increasing home-school communication), the personal-use strategy is needed.

Teachers who allowed students to use handhelds all day and take them home did not report more loss or theft than teachers whose students used handhelds in class only.

Source: Palm Education Pioneers Final Report

With the shared-set assignment strategy, it seems to be more successful for teachers to assign specific handhelds to specific students—a student checks out the same handheld, rather than a different one each time. Teachers report that this approach results in greater accountability from students for the use and care of the handhelds and makes it easier for teachers to manage and track the devices and the work completed on them. Teachers who assigned handhelds as personal devices reported that establishing clear acceptable-use policies and parental agreements were important and effective in minimizing loss, theft, and inappropriate use of the devices.

Class Management



Adoption of handhelds in the classroom entails equipment management tasks—some similar to other classroom equipment management tasks and others unique to handheld computers. First, procedures are needed for assignment, storage, care, and repair of the handheld computers. These involve tagging or IDing the devices, storing the equipment in the classroom (secure storage may be desired), developing routines for charging the devices or charging or replacing batteries, and arrangements for transporting the devices (for taking a classroom set outside for an activity or for carrying home and back by individual students). In addition, making arrangements for repairs or replacement may be necessary. (PEP teachers found that it is useful to have a couple of backup devices for use in case a device needs to be returned to the manufacturer for repair.)

Second, teachers need to develop routines for handing out and collecting student work completed on the handhelds, as well as for tracking and storing student work. Assignments or other documents can be passed out through “beam teams.” Completed student work can be beamed to the teacher, or it can be uploaded to a desktop computer by synchronizing (or “synching”) the handheld to a desktop computer. Once on a desktop, it can be reviewed or printed. Students can be given the task of regularly synching handhelds to desktop computers. It may be helpful to assign each handheld to a specific computer for synching. If handhelds are shared by multiple classes, it is important to develop file-naming conventions so that student files are not lost or mixed up.

Third, it is usually helpful when teachers take active steps to minimize or prevent students’ off-task use of handhelds and to communicate policies and expectations to parents and other teachers. PEP teachers found that students are eager to use handhelds, and that the threat of having use privileges suspended for a time is an effective deterrent to off-task use. When students are given handhelds to take home, complications or surprises can be avoided if students and parents are given agreement forms ahead of time that specify acceptable use and replacement policies.

Conclusion

Clearly, successful integration of handheld technology into education is not effortless, but teachers have demonstrated that this low-cost, portable technology can make a difference. Handheld computers can enable new learning activities in and out of the classroom, allowing students to study problems at the time and place most relevant to learning.

Handheld technology supports teachers' efforts to individualize instruction, as well as to promote collaboration among students. It becomes easier for teachers to allow and manage students' self-paced work. At the same time, students can easily share their work, information, and ideas.

Handheld technology has the potential to transform teaching and learning. In some classrooms, it already has.