



**Learning environments and
rapidly evolving handheld technologies**
by J. Evans Ochola, James R. Stachowiak,
John Achrazoglou, and David B. Bills

Abstract

More and more K–12 school teachers are using handheld devices in classrooms. The mobile nature of handheld technologies is often seen as an integral characteristic facilitating collaborative learning and flexible learning arrangements. Since both portable devices and ideas about the learning environment are rapidly evolving, teachers need to be aware of technologies and classroom arrangements that can help improve student performance and classroom experiences.

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Introduction

A growing number of K–12 school teachers have been using handheld devices in the classroom as an integral means of facilitating learning through flexibility and the mobile nature of handheld technologies. This paper focuses on collaborative and interactive handhelds that may be carried anywhere. Handheld technologies have initiated new ways to think about books, course packs, and problem based learning. A survey conducted by the Education Technology Center among students who take a “technology in the classroom” course at the University of Iowa showed that handheld technology, which students use during and after class, increases student engagement. This increase in student engagement is evident with the increased number of students who are engaged via Elluminate Live through the online ePortfolio support center. This course is on the cutting edge in terms of what students use in classrooms and in their day-to-day lives as they continue to address issues and the subjects covered in classrooms. When students and instructors are partners in the collaborative and informative assessment process of students’ success, research reveals that the result is profound involvement gains for all students (Stiggins, 2005). The handheld devices provide a unique way to connect the classroom with the class using connections and devices common to students. Within a short span of time, Internet usage has evolved from the traditional PCs and Macs to handheld mobile devices using fixed broadband. A fully mobile broadband Internet provides opportunities for innovation in networks and advantages for schools. Since both portable handheld technologies and the learning environment are evolving rapidly, teachers need to be aware of technology that may help students in class and out of class. Clickers and Turning’s mobile response solution allow all students to respond to the material covered in class in real time. Rather than having to wait for tabulated results after assessments are complete, results are immediately available. The purpose is to get current information about students’ progress to better meet students’ need. Research indicates that decisive assessment has a strong positive effect on student learning (Popham, 2007). With handheld devices instructors and learners are able to adjust quickly to what works. All of these handheld devices

have now become important to the growth and innovation of learning worldwide.

Handheld devices offer many different means that can be used on a day-to-day basis in different environments. At first, handheld devices were known as personal digit assistants (PDAs). Over time the devices developed and offered a wider range of applications. The newer devices offer calendars, clocks, address books, e-mail, weather, stock quotes, Google Maps, YouTube, and iTunes — all very rich interfaces and “to do” lists. Continually evolving, these devices are applicable for other purposes in the classroom, the world of work, and many other areas. According to the article entitled, “The new mobile scholar and the effective use of information and communication technology” (Bills, et al., 2006) the ability to use portable technologies outside of confined settings is a central characteristic of post-industrial work. The authors note that the continuously growing collaborative work in post-industrial societies mirrors an important task that students carry out. These devices range in size from those that fit into one hand and use a stylus for input to those with keyboards that are approximately one-half to one-third the size of a typical laptop. Handheld devices include SmartPen, cell phones with “smart” capabilities, PalmPilots, iPods, iPads, and other tablet devices. These devices are used by individual students or by groups to research and investigate topics in the classroom. Most of the devices are equipped with touch screens and are able to connect to the Internet quickly. These handheld devices are the wave of the future in education.



What are handheld devices?

Handheld devices are small, mobile devices that are considered “on-the-go” computers. They are much smaller and are easy to transport, they have less memory to store documents and files and they cost less. Conversely, the move to handheld platforms combines with the move toward cloud technology creates a sudden reversal in the pendulum. The mobility of these handheld devices allows them to offer the same guarantee that made browsers so popular with the users. They can normally retrieve wireless Internet signals and can be used to surf the Web, check e-mail messages and compose new ones. They can also double as a graphing calculator, word processor, and so on. In present time, mobile handheld technologies have increased in functionality within classrooms with the development of new software designed specifically for education, and therefore K–12 schools are utilizing these handheld computers as a teaching and learning tool. Handheld devices have almost limitless potential for in-school use, and can provide active engagement for students of all ages. Handhelds are the quickest and most economical devices available to present day learners. Most students possess and know how to use handheld devices. The handhelds do not require an onsite specialist in order for students to use them. Handhelds are accessible to students at all times, making it easy to collaborate, connect, and learn. Scholars and learners use handheld devices and embrace these devices because they are accessible learning tools.



Cost of handheld devices

While handheld devices are expanding to schools and colleges, what is lacking is an innovative educational framework to meet this new wave of technologies. With the right combination of learning strategies, handhelds can assist students in developing their critical thinking skills. In support of handheld usage, Boettcher (2006) posits that the key benefit of learner-generated content lies in the knowledge construction, and sharing as opposed to the end product itself. What distinguishes the use of handheld technology from traditional classroom settings is that students engage deeply with peers, subject matter experts, and the public. This aspect is particularly pursued by Lee, et al. (2006), describing how podcasts improve student-centered approaches by allowing students to express themselves through different modalities and exercise a greater degree of personal autonomy. Usage of handheld portable devices differs from characteristic of traditional pedagogies because they allow personalization. Students use the tools to choose and create content by collaborating with peers and to connect their learning to a broader audience. Handheld devices adds another element to student-centered approaches by increasing the level of collaboration with experts and peers and by connecting students to an emerging business network which transcends the walls of a classroom (Barsky and Purdon, 2006). The model for the teacher to be a “guide on the side” as contrasting to a “sage on the stage” (Doolittle, 2003) has been in educational systems for many years, but handheld portable devices brings pedagogical shift with new ways in which to realize goals while continuing to recognize the role of the teacher as an expert.

A handheld device can be extremely costly which could be a reason for the handheld technology not being used as much in schools, depending on the type and model of technology. The smartphones, MP3 players, and digital cameras have lower end options starting at US\$20–30. However, in the more classroom-based technologies like handheld computers, A+ interactive software's, e-readers or handheld projectors price tags of anywhere between US\$150 and US\$600 are common. Prices vary from device to device depending on quality and specifications of the device. Some of the more well-known handheld devices and their

prices are pictured in [Figure 1](#). A popular smartphone that made the iSight camera in iPhone 4S the world's favorite is now on iPhone 5, which costs between US\$400 to US\$600 and iPod Touch cost around US\$200–350. These gadgets offer a wide range of applications (“apps”) that offer educational use. They also provide the capability to store lectures and podcasts for distance learning, watch instructional videos and browse the Internet. Young people consider their use of technology as the greatest difference between them and previous generations. It is more and more evident that instructors and students do their work on handheld devices, probably during the majority of the day. Equally it reduces the amount of paper that is consumed by eliminating the need for notebooks and textbooks (these are purchased in an electronic version). The “apps” that can be purchased for these devices supplement any standard textbooks that are being used in the classroom. As a technologist, Achrazoglou (2010) posits that “Technology can help integrate different viewpoints, beliefs and lifestyles. As a nation, we may becoming a place where people are judged not by the color of their skin but by the content of their tweets.”



Figure 1: Handheld technologies.

As a result of evolving handheld technologies and learning environments, we are witnessing a blurring of the distinctions between learning, work, and play. New models for teaching and learning are needed to replace traditional models that place emphasis on the institution and instructor.



Impact of handheld devices in the classroom

With the rise of handheld devices prevalence in youth, it is important to understand the effect that adopting handhelds as study tools can have in the learning environment. According to the study that looked at the impact of handheld technology on students studying mathematics, "Analysis of observational data confirmed that students in the TechPALS condition participated socially in questioning, explaining, and discussing disagreements, whereas students in the individual condition did not. The study concludes that an integration of technology, cooperative activity designs and broader educational practices can lead to impact on students' mathematics learning." (Roschelle, 2010) They found a positive correlation between the group that used the handheld technology and their success in learning, whereas the control group that did not use the technology did not learn as much. Although this focused just on math, it is widely agreed upon that handheld technologies can increase communication and cooperativeness among students within the classroom, thereby creating an atmosphere of discussion and paralleled growth and having a positive impact on education. A survey conducted at the University of Iowa, College of Education and Pew (Horrigan, 2009) reported that most students (85 percent) have these handheld devices already.

Table 1: Survey responses.				
		Fall 2010 (N=90)	Fall 2011 (N=102)	Spring 2013 (N=88)
Do you own a Smart phone that can browse the Internet?	Yes	55%	59%	76%
	No	45%	41%	24%
Do you own a handheld touch device such as an iPod, iPad, android, etc.?	Yes	76%	89%	84%
	No	24%	11%	16%
Does your handheld device or smart phone let you capture video?	Yes	68%	62%	84%
	No	29%	34%	10%
	I do not have.	3%	4%	6%
Have you ever installed an app?	Yes	66%	72%	92%
	No	23%	24%	6%
	I do not have.	11%	4%	2%
How many text messages do you send in a day?	0	5%	2%	2%
	1–10	43%	31%	13%
	20–50	27%	35%	48%
	50+	25%	32%	38%
Which did you first check today?	Text messages	55%	61%	59%
	E-mail	26%	20%	18%
	Facebook	17%	14%	13%
	Nothing	2%	4%	1%
Do you sleep with your cell phone?	Yes	76%	79%	85%
	No	24%	21%	15%

Handhelds are the thing of this generation; laptops and desktop computers are old news. Handhelds are excellent means to help students organize their projects, express themselves in creative ways, and collaborate with their peers. They are also a great way to enhance communication with students as well as motivate students to want to learn. Using handhelds helps students and teachers integrate and make connections in diverse ways with all the various features handhelds have to offer. Sara Davis (2003) demonstrates in her paper that handheld devices give both teachers and students the ability to instantly see their data displayed in the group space, the ability for the teacher to instantly assess how all students are doing at any time during a lesson, and that the ability of the network to let all students answer all questions may have an impact upon student engagement in the classroom. Davis draws from four years of observations of classes using two early network prototypes. The handheld technology she refers to has been implemented in a variety of classrooms from elementary to college level. Even though the major focus of Davis' emphasis is clicker technology, it is clear that handheld technology can make lessons more interactive and provide the teacher with immediate results.

Digital cameras, iPods, laptops, etc. are becoming regular objects in certain classrooms. These handheld devices can be utilized to improve basic reading and writing skills, such as students recording themselves reading. The teacher and/or student can then listen to their recording via iPod. Some handheld devices, such as SmartPen, tablets or laptops, have the capabilities of downloading content and games. This gives teachers and students access to a wide array of interesting content that has the potential to make lessons, projects, etc. more interesting. Handheld devices offer both teachers and students unlimited possibilities, and may be utilized in a variety of classrooms settings thereby creating an exciting educational atmosphere.

Handheld technologies have been a growing presence in the classroom ever since the first calculators came on the scene. Today not only do students have very advanced graphical computing devices but now they also have many other new sensor laden devices that can collect and analyze data in ways not seen before. Wilson, et al. (2001) found that students who own and therefore have regular access to handheld technologies tend to be more cognizant of its capacities. In some cases, authors found students used the technology to investigate and explore, but on tasks that did not require graphing, their use of a handheld device was minimal. The impact of handheld technologies on the classroom is ongoing and will probably be a strong component of future learning and classroom environments. Students will have faster and more accessible ways of retrieving information and analyzing and collecting data. These will hopefully have a positive impact on learning and will not lead to either information overload or become so digitally connected that students lose the human component of the classroom setting.

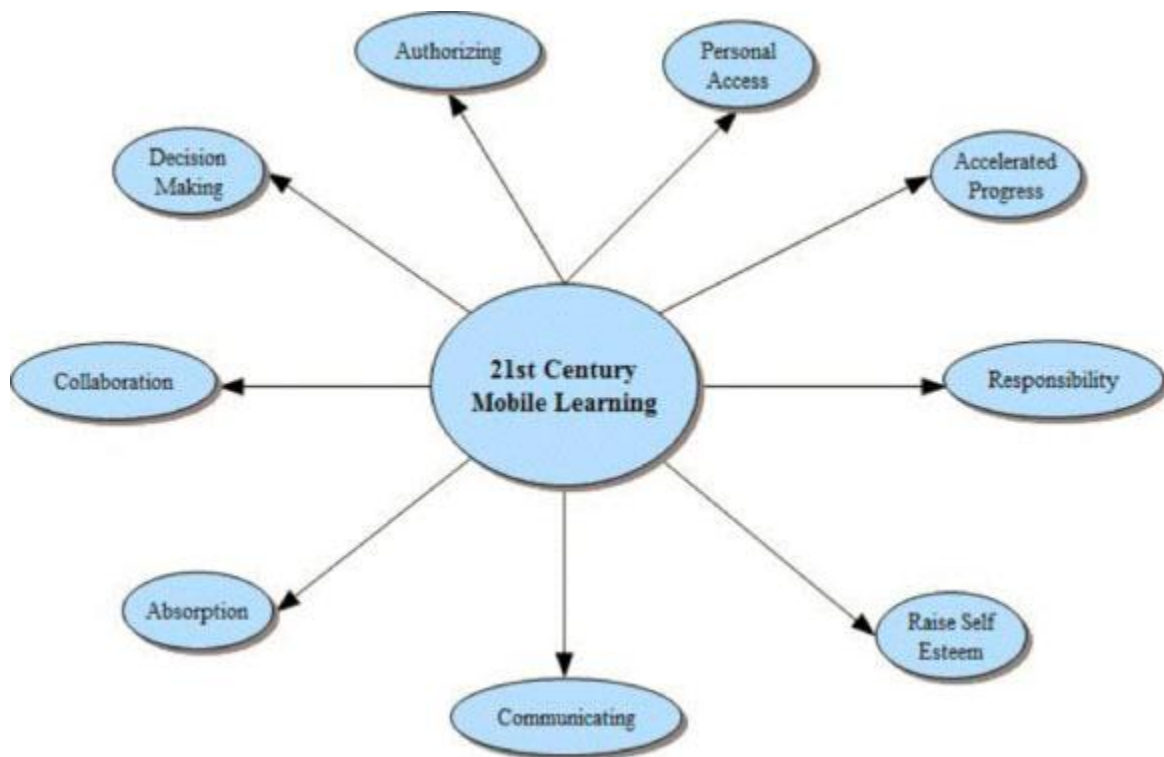


Figure 2: How handheld technologies benefit students.

Handheld technologies like personal digital assistants (PDAs), iPads, wireless laptop, e-reader and smart phones are causing a paradigm shift in education. A review of some empirical literature shows that universities face exponential growth in demand for higher education and global competition (Olsevicova, 2006). Many libraries are transforming themselves into digital resources and in some instances schools are starting to provide their students with e-readers to cut back on the cost of textbooks. Handheld technology is found almost everywhere and is used for class projects, daily activities and business networking. Almost everyone these days has a phone that can access the Internet or an iPod. Students depend on these handheld devices to get through their days. Handheld technology offers new ways to engage students in the classroom by connecting to them on their level. This generation of students is more familiar with technology than any before, so it would behoove teachers to reach out to their students through this medium. Caution must be taken, however, for while there are many advantages to using handheld technology, there can be some risk as well.

Specific rewards include students feeling empowered by the responsibility of being trusted with a device, leading to improved relations with the teacher and productivity in and outside the classroom. Accessibility, engagement, and mobility are very important to both student and teachers. Handheld devices can be taken by the students and do not require relocation to a computer lab. Mobile technology replaces books, as students can download free books and articles instantly. Both students and teachers are able to create calendars to keep track of, and receive reminders for, assignments and tests.

Given the shift from a wire centric Internet it is vital that teachers incorporate handheld technologies in the classroom. There are so many opportunities for students to learn and gain knowledge from the different technologies. Applications and other programs continue to develop and become more advanced and they can greatly benefit students. Also, teachers can explore different teaching strategies to enhance student learning by using these handheld technologies in accordance with other technologies, such as Smartboards. These new technologies will begin to change the learning environment, but they will also strengthen it as well. Handheld technologies are a definite asset to the classroom. They provide so much more opportunities for students to learn and discover new things.



Impact on students with disabilities

The use of mobile devices in the classroom is beginning, and has great potential, to benefit students with disabilities. Assistive technology for reading, writing, communicating and understanding social stories have been used in classrooms for quite some time. Now assistive technology applications that read text aloud while highlighting, print dictated text, produce speech from typed text, and link recorded audio to written notes are available on mobile devices. Computer-based assistive technology has been successful, but has had drawbacks as well. The introduction of assistive technology on mobile devices has been able to address and potentially offer a solution to many of these issues including cost, stigma, startup time, and mobility.

Cost has long been one of the deterrents to the use of AT in the classroom. Communication devices are often expensive, costing thousands of dollars. Reading and writing software, although recently more affordable, is also often more expensive than most families can afford on their own and school districts have to stretch their budgets to afford them. Mobile devices make similar tools more affordable. In general, applications for mobile devices range from free to US\$10. A great example of the lower cost of tools through mobile devices would be communication software. The most popular communication tool for mobile devices, Proloquo2Go, uses a symbol based grid to allow users to create sentences that are then spoken aloud for improved communication for students that struggle with speaking. This application is more expensive than most, retailing for US\$189, but compared to similar stand-alone devices that cost anywhere from US\$4,000 to US\$7,000, this is much more affordable and produces similar results.

Another issue causing students to avoid using assistive technology in the classroom could be the stigma it places on them. Many AT tools look different from the tools used by the rest of the students. Students with disabilities do not like standing out using them, and thus often don't. That does not seem to be the case with mobile devices. Most all students would like to be able to use a mobile device in the classroom, so a student using one in the classroom does not stand out as different, but gets to use a "cool" device. The effect of removing the stigma often associated with special technology goes a long way to improving usage in the classroom.

When doing a statewide needs assessment in Iowa during the 2008–2009 school year, the Iowa Center for Assistive Technology Education and Research (ICATER) found that one of the primary reasons for limited use of AT in the classroom is start up time of the computer. Computers used in the classroom are often older and take valuable class time to start up. Mobiles start up almost immediately, allowing students to access needed tools as soon as class starts. Another aspect of this tool that benefits students with disabilities is the mobility of these devices. Being small and light, it is very easy to transport these devices from one class to another, meaning that students that might have only been able to use AT in one

class in the past are able to easily move with their assistive technology from class to class for better overall access.

There are downsides to using these devices as well. Although they are mobile, many mobile devices are fragile and do not react well to being dropped. This can be a significant problem for students with physical disabilities. Another issue for students with physical disabilities is that there are currently limited options for access if one cannot use a touch screen. Also, depending on the level of need of the student, mobile applications may not be appropriate. For those that need significant help, computer-based software and similar hardware is still often the best answer. That being said, the positives for mobile devices in the classroom outweigh the negatives and since we are just on the brink of this mobile revolution, the expectation is that these options will continue to improve for both the general and disabled populations.



Pros and cons

In group work, all can take their own notes then forward the information to one tablet to compile. This can be a huge help in health and physical education, serving as stopwatches, calculators, data collectors (students can monitor their nutritional intake and physical activity). This can replace calculators in math classes through various available applications and may be helpful in ESL classes with word recognition apps to assist with unfamiliar vocabulary. In social studies classes, there is instant access to more information for both students and teachers. Grades may be downloaded to the tablet and made accessible to parents. If a student misses a day of class, they can download notes when they get back without worrying about misspellings or disorganization. It may also drastically reduce the amount of paperwork in a classroom.

On the other hand, technology can be very distracting, especially with personal devices that feature games and other Web sites. Students who multi-task can lower their own productivity while simultaneously distracting other students. Restrictive measures to limit distraction can also be problematic, promoting a "Teacher vs. Technology" mentality that students will not respond well to. Cameras on handhelds can involve privacy issues, plagiarism, and may be broken by the student. Because of the expense of handheld devices, many classrooms across the nation do not have access to them.



Policies affecting use of handhelds

Policy issues are always complicated and striking a balance can be very delicate given the speed at which technology evolves. Thus, it is imperative that policies address ownership, curriculum goals, integration plans, implementation models, classroom rules, professional development, and set-up and on-going management. Ownership is the first policy that decides who owns the handhelds and who is responsible in case of misuse. Handhelds come with a one-year warranty that covers most hardware issues related to damage, theft, or if loss of handhelds accrues. Written policies are financial responsibility agreements that are used in schools or with individuals that own the handhelds. It is important for each student to be responsible for their personal handheld technologies, such as cell phones, palm pilots, etc. It is also important to establish that any school-sanctioned event must follow school policy, therefore the handheld technology policies apply even if students are on a field trip. Schools should recognize that parents give their children cell phones as a safety feature to contact them at any time. However, in case of emergencies within school grounds, students must still defer to authorities to contact parents rather than using their own personal devices. Schools should also recognize that handheld technology may be of use and aid in the classroom. However, as stated above, students must follow school-set policies. Acceptable uses of technology are those such as only using handheld devices when permission is allowed by an authority, otherwise keeping devices out of sight and silent. On school grounds or at school sanctioned events, handheld devices must be on settings of silent or vibrate so as not to disturb others. Handheld technologies should not be used to disrupt every day routines, such as texting or taking a call during class lessons. Students must be aware and are responsible for giving out their personal numbers. They should take caution who they share their number with; this may help prevent cyber bullying.



Future classroom concepts

Classrooms for the Future is about recognizing and embracing rapidly evolving handheld devices, enabling teachers to use technology as an effective tool for educating students, and preparing students to enter and successfully compete in the ever-expanding, high-tech global marketplace. The concept of Classroom

for the Future resourcefulness has changed the way students and teachers learn. In the Technology in the Classroom course students are participating in assignments that not only use technology, but offer students opportunities to develop twenty-first century skills such as collaboration, problem solving, creativity and innovation. Creativity and innovations with handheld devices is moving instruction from Education Technology Center learning activities to twenty-first century learning environments.


According to www.apple.com, with handheld devices, the classroom is always at your fingertips. At the App Store, there are thousands of apps available to download. Students can track their assignments, take notes, and study for finals. Instructors can give lessons, monitor progress, and stay organized. This is just the beginning of the nature of the Classroom of the Future. Students may use iMovie in a film production class and GarageBand in a music class. iTunes U "is home to more than 350,000 free lectures, videos, books, and podcasts from learning institutions all over the world".

Handheld technologies also offer the potential for a more student-centered project oriented based approach to education. Cathleen Norris, Elliot Soloway, and Terry Sullivan (2002) argue that "while appropriate as an initial focus, it is time that the educational community move beyond an emphasis on 1:1 computing to a vision of a handheld-centric classroom, where each child not only has his/her own personal, handheld computer, but also has access to networked PCs, probeware, digital cameras, etc. Such a classroom digital infrastructure, we argue, uniquely supports project-based learning, where children can engage in multi-week, multimedia, multi-subject, collaborative efforts." By using the handheld devices discussed in this article, instructors can be more efficient and education has the possibility of becoming more student-centered.

Norris, et al. are clearly arguing that handheld devices provide beneficial opportunities to teachers. However, this is not always the case. Utilizing handheld devices, instructors have the ability to expand their lesson plans and, as Norris, et al. suggest, make the lesson more student-centered. Despite the diversions that handheld devices cause, they do belong in classrooms and should be used by teachers and students. Due to handheld mobile capability and interactive learning potentialities, handheld devices will become a realistic alternative for integrating technologies into the curriculum in K-12 settings.



Conclusions

Within a short span of time, Internet usage has evolved from the traditional PCs and Macs to handheld devices using fixed broadband. A fully mobile broadband Internet provides opportunities for innovation in networks and advantages for schools. Since both portable handheld technologies and the learning environment are evolving rapidly, teachers need to be aware of technology that may help students in class and out of class. Newer devices offer calendars, clocks, address books, e-mail, weather, stock quotes, Google Maps, YouTube, and iTunes, all very rich interfaces. The use of handhelds is beginning, and has great potential, to benefit students with disabilities. Continually evolving, these devices are applicable for many other purposes in the classroom, the business world, and many other areas. 

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