The Major Drawbacks To The Use Of Wireless Communication Products In Education

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Abstract

This paper considers the use of wireless devices as an educational facilitator both in the classroom and in a business environment. There are many characteristics of such devices which are favourable to their use in such settings. But there are also problems. We identify the main problematic areas as being security, low speed and reliability, and the lack of interoperability. In our opinion, the use of wireless devices for educational purposes will grow quickly, and the problems of reliability, speed and standards will be overcome. However, the issue of security will remain a major problem into the distant future.

Keywords

Wireless communications, education, security.

INTRODUCTION

The emergence of wireless computing technology has effected a revolutionary change in our educational and business systems. Wireless computing devices are more portable, affordable and often more powerful than traditional computing devices such as desktop and office systems. Consequently, several recent papers have argued the case for the use of such devices to support learning and workplace activities. (Fung et al. 1998, Hennessy 2000, Sharples 2000, Soloway et al. 2001).

In this paper, we examine the use of wireless technologies as an educational tool both in a school or university setting, and in a business environment, looking at current and potential uses. We describe the many and varied attributes of wireless devices and communication methods which are capable of enhancing education in both settings.

We then analyse the drawbacks of wireless systems as used for educational and training purposes, pointing out that lack of security is most likely the biggest barrier to extended use of such systems, while poor reliability and lack of interoperability are not far behind. Problems which occur because of these last issues are irritating and so much attention is paid to them. This is not the case with the security problem. A lack of security is not usually identified until an incident happens which breaches legal or ethical boundaries. We argue that further use of portable devices in a learning environment needs to be cognizant of the security hazards inherent in these systems.

Conclusions, recommendations and opportunities for further investigation are presented in the final sections.

WIRELESS DEVICES

A wireless communications network is a network that transmits data through the air, instead of through cabling, to each device in the network. Radio waves in particular frequency ranges are relayed from transmission points. Receiving stations within a certain range of a transmission point can gather and interpret the transmitted signal.

Wireless devices can take several forms including laptop computers, palm-held devices and cell phones. Different, and often competing, standards for the operation of such devices diminish their functionality, and so the development of standards which apply to all types is of high priority.

To access the Internet wirelessly, a device uses radio signals to communicate with a wireless local area network (LAN) via baseband circuitry, a media access controller, and a radio.
“A wireless LAN operates with one of two IEEE standard protocols finalized in 1997 and differing in data rate and signal frequency. The two standards are the 802.11a and 802.11b, the latter often called WiFi. The 802.11a operates at 5 GHz and can transmit data at up to 54 Mb/s. The 802.11b operates at 2.4 GHz and transmits data at 11 Mb/s. The two protocols are not compatible: a laptop equipped with 802.11b circuitry alone cannot access the Internet at a hotspot running 802.11a. A newer protocol, IEEE 802.11g, is being finalized and should be out in 2003. It has the same data rate as 802.11a but operates on the same frequency as 802.11b and is compatible with it.” (Geppert 2003)

One other recent technology worth mentioning is the Bluetooth protocol (http://www.bluetooth.com). Bluetooth is a communication protocol which was launched in May 1998 and which utilises a short–range radio link to exchange information, enabling wireless connectivity between mobile phones, mobile PCs and handheld computers. It operates in the 2.4 GHz Industrial-Scientific-Medical (ISM) band and has a range up to 100m, which is projected to be improved up to 300m soon.

WHAT IS RIGHT ABOUT WIRELESS FOR EDUCATION

There are enormous benefits to the use of wireless-based hand-held computing devices in education, and particularly in the classroom. These include increased mobility for students and teachers allowing them to gather in any location (not necessarily in a computer laboratory), break into groups and move into other rooms. In a workplace setting, this mobility feature permits connections to people across a large business campus. The cost of wireless technology is also an important factor. It is greatly cheaper than wired technology, and supplies many of the same benefits, depending on the device on which it is implemented.

Gayeski (2002) argues that with a move to mobile learning, the foundation for a dynamic online learning and performance system can be built in several days by creating a framework for an intranet site containing a handful of key components, including case studies, job aids and discussion groups.

In addition to these benefits there are many applications of wireless e-learning which can be identified. Course scheduling and just-in-time course and assignment changes or clarifications enable the smooth functioning of the learning environment. On-line quizzes, learning games and interactive teacher assistance can provide regular and rapid feedback to students on how they are progressing with the course material. Use of handheld technology in a classroom setting permits and encourages real time collaboration among learners and provides real-time access to on-line resources.

Because assessment and feedback can be done on-site electronically, the management of related data can be allocated to the device used also. Thus, daily assessments of the class or of employees in training can be retained on the hand-held device and then downloaded onto a disc or transferred to another location at the end of the day (Stacey 2000).

WHO IS CURRENTLY USING WIRELESS FOR EDUCATION?

The rapid development of ‘personal digital assistant’ (PDA)-based wireless technology and the moderate cost of these devices has resulted in their adoption and trial by a number of institutions. A few of them are noted in this study.

Wireless Technology in the Classroom - Cases and Scenarios

Secondary Education

Mathematics teacher Barbara Hudgins of University High School in Irvine, California incorporated wireless based devices into her mathematics classroom (Hudgins 2003). She uses the technology to enhance instruction, motivate students’ interest in new technology and learning, and also to help students become comfortable with wireless devices.

Her experiment was run with a class size of 40 each of whom was assigned a PDA for the semester. Her intention was to give a class room quiz to the students: “After answering the questions on the PDA, they beam their answers to my computer, which scores it right away, and their score appears on their PDA as well as on my computer.” (Hudgins 2003).

The benefits to students and to the teacher are outlined in her article:

Benefits for the Students

The first thing they want to know after receiving their grade is how to solve the problems correctly. Learning takes place immediately. Some of the quieter students who used to get low quiz scores and never asked how to correct their mistakes appear more involved and inspired to get a better score on their PDA. The students have
responded very well to the system. They seem to be competing with themselves to improve their scores on the next PDA quiz, much like they would with a video or computer game - they want another chance to get a higher score. They are studying harder and taking more time to check their work before beaming it to my computer.

**Benefits for the Teacher**

The program has several types of analysis so the teacher can quickly see how the class did as a whole, view the item analysis, and check individual scores of the students. If the teacher chooses to use this as a quick classroom assessment that will not be graded, students can be rewarded for their performance by having fewer practice problems to do for homework that night. The system is easy to use, portable, as well as inexpensive, and it saves the time of grading and entering scores.

The Ballard High School team introduced “handheld computers” into their curriculum recently (pdaED.com 2003). The purpose of this initiative is to boost students’ learning opportunities and enhance their personal career profiles. Students will be encouraged to use the devices “to take notes in class, track homework assignments, create outlines and write reports, share information, and record their grades. They can also read novels and news, use an electronic dictionary and thesaurus, and study for tests.”

**Tertiary Education**

The University of South Dakota introduced the use of Palm Pilots for their law and medical students in 2001 (Harris 2001). The university outfitted their first year students with the devices. The plan is to use them as an organizational and e-learning tool. The University claims to be the first tertiary educational institute to provide students with this technology in the USA.

Several other universities have experimented with the use of handheld wireless communications devices in teaching. These include Stanford University Law School (Daniel and Cox 2002), and East Carolina University (DuVall 2003).

In summary, the highly interactive nature and ease of use of wireless devices seem to appeal to students, who can turn the learning experience into a game. They are challenged to raise their personal goal levels (increasing self-motivation) and induced to develop new ideas. Students can use the device as a personal organizational tool, to plan and store reports and tests, and also as a time management tool, to plan learning or studying schedules.

Teachers are able to perform a large part of their classroom management directly on the device. This includes student evaluations and comparisons as well as the development of quizzes, in-class tests and results.

**Wireless in the Workplace – use as an Educational Tool**

Job performance aids are a common item in the workplace. Many articles have been written in training journals on various types of such aids and their usefulness. They are designed to “provide procedural or factual guidance in the performance of tasks. They store essential details in a variety of functional forms for use just before or during task performance.” (Campbell 1999). Until recently, job aids took the form of instruction sheets, checklists and worksheets, usually in printed copy form. With the advent of mobile computing devices, such aids can be delivered and used electronically, speeding up the process and providing a breadth of information unavailable just a few years ago.

One instance of this is Factory Automation Support Technology (FAST), which has two primary objectives (Gayeski 2002): “(1) to improve human performance in manufacturing systems and (2) to link mobile personnel with plant-wide databases and experts in real time. Human performance is supported through the timely presentation of technical information or advice necessary to operate, adjust or repair advanced complex automation. Mobile personnel are able to continuously update and retrieve information from a central database while roaming throughout a large space.”

Wireless-based computing devices offer opportunities far beyond the traditional uses of job performance aids. According to Thibeault (2003), “corporations worldwide are looking for alternative training means to offset expensive travel…. As a result, many corporations have turned to distance and e-learning.” A second trend, according to Thibeault, is the propensity of employees to telecommute. “They use their phones and PDAs to manage their lives, their relationship with the office, and the enterprise data they access wirelessly.” Thibeault goes on to predict that, with video and sound gathered into one interactive device, the PDA of the future will become the ‘cornerstone of corporate training’.
THE PROBLEM WITH WIRELESS

It is likely that the greatest inhibitor to extended use of wireless systems in a formal educational environment is the poor data security associated with them.

Security built in by equipment manufacturers is now a standard feature, while additional security software and techniques are available from company sites and from the research literature. The IEEE 802.11b standard requires use of a Service Set ID (SSID) which plays the role of a password to enter and use a device. It also specifies use of the Wired Equivalent Privacy (WEP) protocol, encrypting data transmitted from the device. For those devices using a network card, a Media Access Code (MAC) filtering system can be set up to permit access to the system for certain users and forbid it to others.

So what can go wrong? Drew (2003) describes a number of the problems:

- There is software (some of it free) available on various websites which can enable an outsider to detect and enter the network from outside its physical boundary.
- Interference with the radio frequencies can jam the network, disabling the transmission of information.
- WEP uses a single key for encryption within a given network. Widespread dissemination of a key (for instance, within a class of 200 students) results in a greater opportunity for it to be recovered by an unauthorized party.
- A ‘dummy’ access point can be introduced into the network which has the potential to ‘capture’ data away from a valid access point, including usernames and passwords.

The Bluetooth technology described above has also been shown to have little security as the key is easy to obtain (Yean 2001).

Given that the objectives of security are to maintain confidence, access control and data integrity, what are the potential hazards of loss of security? These include:
- attempts to copy, steal or corrupt student or teacher files
- attempts to access and alter grade or evaluation material on the teacher’s or manager’s device
- attempts to gain unauthorized access to the general business system by means of the wireless network.

Thus, the management function of such devices must be carefully monitored – files should be transferred to a safe location on a daily basis to prevent loss or corruption of data. Plagiarism is an on-going problem in Australian schools, and the ability to develop an assignment or report completely electronically, and submit it electronically, is an open invitation to some to copy from multiple sources.

Gayeski (2002) notes that “As more information about people and more critical company information are stored and transmitted, there is the obvious threat to the integrity of the data. Is it possible for someone to hack data, jeopardizing individuals’ or the organization’s critical information? Can competitors intercept sensitive and confidential messages? Who has access to private messaging and personal information such as test scores, whereabouts, performance indicators, or even health, family and financial records?”

Access to evaluation material raises questions of privacy as well as security. In a work setting, authorized access levels need to be determined well in advance of maintaining a database of evaluative material. In a school setting, allowing a student read-only access to their own evaluations might be perceived to be beneficial. It might also be argued that their legal guardian or parents also be given such access. These issues remain to be debated.

Does the employer or teacher track your every move? Are all your communications recorded and available for review? Such a complete loss of privacy often results is a less obvious, though important, problem - that of stress. The pressures to be available at all hours of the day and night, in conjunction with constant monitoring, can lead to an unhealthy environment.

Low speed and poor coverage is also an issue when considering wireless devices for use in an educational setting. Part of the attraction is the real-time turnaround in obtaining data, so poor system performance is something to be avoided at all costs.

According to Margulius (2003), “Another challenge facing the industry is the immaturity of today’s mobile data networks, which suffer from bad coverage, low speeds, or both. Most of today’s wireless messaging devices run on a data-only network that is based on the so-called Mobitex protocol, which offers great coverage, in-building penetration, and power efficiency…. But this network is costly per kilobit, has high latency, and operates at speeds of single-digit kilobits per second. Momentum is instead shifting to emerging cellular-carrier-based 2.5G overlay networks, such as GSM (Global System for Mobile Communications), GPRS
(General Packet Radio Service) and CDMA (Code Division Multiple Access) – based 1×RTT. These overlay networks offer higher speeds but spottier coverage. Poor network performance, especially over-the-air synching, complicates the use of mobile enterprise devices. Another obstacle is that an open standard for intelligent synching across multiple mobile messaging platforms has yet to catch on. Middleware vendors must write to proprietary interfaces or else settle for least-common-denominator functionality, leaving enterprises with little choice but to purchase an overabundance of technology to get the functionality they need.”

This problem impacts on large scale projects where speed and stability of the system are important. Instantaneous feedback is a major selling point, and so, if the system malfunctions, the attention of the audience or class is lost. Moreover, the addition of video streaming, a useful educational tool, to the wireless capability is contingent upon improvements in current bandwidth.

A final problem that we mention here is that of system interoperability. Standards vary significantly, and so a geographically distributed project with a large group of participants working on different platforms may encounter difficulties interacting with each other.

Legal Issues

Many universities have partnership arrangements where education is supplied to groups of students based in various parts of the globe. In such a situation, it is conceivable that a student in one country obtains unauthorized access to data, changes grade results, or in some other way alters information in a teacher’s database. Hacking into business systems from outside the country is also possible, as indicated in the above reference to Gayeski. The legal position is then hazy. Governments have not yet developed workable protocols for dealing with such situations – determining liability and punishment – since the laws in these circumstances vary from country to country.

FUTURE WORK

The legal issues raised in the above paragraph leave many questions which need to be analysed at state, national and international levels. In addition, as more substantial privacy laws are developed by regions and nations, the legal aspects of the right to privacy of individuals also comes into play. Policies covering the use of decentralized wireless and mobile systems, especially ones which are highly mobile, operating outside of an intranet structure, just do not exist. This is a major area for work extending the current paper.

CONCLUSIONS

This paper has considered the characteristics of wireless devices which make them particularly appropriate for use in an educational environment. Such properties include their mobility and adaptability to different locations, and their ability to manage the learning environment for both the learner and the teacher. It is clear that wireless systems have much to contribute to the learning process.

However, there are problems associated with the use of wireless devices and we have analysed these problems in this context. One issue is the lower speed and reliability of wireless systems, both of which are expected to improve over time, as they will for wired devices. A second issue is that of interoperability of devices, which is exacerbated by the lack of standards across systems. This problem is more difficult to resolve as it involves collaboration across national boundaries; nevertheless, it is equally important in the wired context and so, we predict, will be given high priority.

We point out that security is a major concern and must be carefully monitored. This is especially true when an educational wireless network is being used within a business, and unauthorized access to confidential business material is therefore possible. Security and related privacy considerations are the most problematic of the issues for wireless systems as there are other means of security available to a wired network which are not available here. Thus, the authors believe that security for wireless systems will be a lower priority until these systems have experienced some major attacks.

REFERENCES


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