Applying wireless information technology in field trips - A Hong Kong experience

ABSTRACT

In 2002, the Hong Kong government launched a pilot scheme "e-school bag" promoting the use of wireless technology in ten primary and ten secondary schools for classroom teaching and learning. In 2003, a secondary school successfully received a grant from the Quality Education Fund (QEF) to implement a wireless network for outdoor field trips. This paper shares the experience generated from one school in Hong Kong using wireless technology, blue tooth, notebook computers, and Pocket PCs in increasing the interactivity of teaching and learning in outdoor education. Benefits, limitations, solutions, and future developments are presented. It is hoped that the experience gained from this project is beneficial to other schools experimenting the use of wireless technology in teaching and learning activities.

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INTRODUCTION

Before 1998, Computer Studies was taught in Hong Kong secondary schools as a subject in its own right with the focus on programming techniques. There were about 20 – 40 stand alone computers installed in an average secondary school with no connection to either network or the Internet. The use of information technology in teaching and learning was rare. In response to the rapidly changing world, Hong Kong started its first five-year educational IT strategic plan from 1998 to 2003. In this period of time all schools in Hong Kong set up computer networks (from fast Ethernet to Gigabyte networking) and broadband (from 1.5 to 10 Mbps) Internet connection. On average there were 91 and 247 networked computers installed in primary and secondary schools in Hong Kong respectively (Education and Manpower Bureau, 2004). In 2002, the Hong Kong government sponsored an experiment called "e-school bag". Ten primary and secondary schools participated in this experimental project. Although the title of this project was related to school bags, its main focus was not on reducing the weight of school bags, rather, it intended to explore the use of wireless LAN and custom made courseware in enhancing teaching and learning in classrooms. The Quality Education Fund (QEF), established by the government, also sponsored the experimental project by applying wireless technology in schools.

The purpose of this paper is to present the use of the latest technology in enhancing teaching and learning activities in outdoor field trips in a school of Hong Kong. It aims to describe the benefits bought by applying the wireless technology, the problems faced by the school, and the possible solutions to the problems. It is hoped that the experience gained from this project is beneficial to other schools exploring the use of wireless technology in teaching and learning activities.

The wireless technologies

Today, mobile access is becoming increasingly important in the business world. Many daily business transactions are completed by handheld devices already. Wireless technology is based on the IEEE (Institute of Electronics and Electrical Engineers) 802.11 standard, which is one of the many standards of the IEEE 802 LAN/WAN standards (Embrey, 2002). 802.11 used to be currently the most affordable and available specification (McKimmy, 2003), but as technology keeps on evolving, now the most affordable standard is 802.11b. The most important factor here is the bandwidth provided by the standard. When wireless network was first introduced into schools, the 802.11 standard could only provide 1 – 2 Mbps connection speed. Later, the 802.11b provided 11 Mbps bandwidth. Both 802.11a and 802.11g standards provide 54 Mbps connection speed between the wireless device and the access point. All bandwidths of different standards mentioned here refer to the total bandwidth which has to be shared among different users. From practical experiences, a typical user is satisfied with a network speed of about 1 – 1.5 Mbps (Horn, 2001). Of course it might not be sufficient to transmit huge movie files but in general this speed is good enough to browse the Internet/Intranet. For better result, 802.11g standard is recommended.

In general, the advantages of applying wireless network include:

- flexibility to support previously excluded applications and users
- ease of installation
- ease of modification
- mobility
- portability
- inter-connectability
- expandability
- ease of segmentation
- being economical
- transparency
- reusability
- having broad range of coverage and options (Wenig, 1996)

The uses of technologies in education

Nowadays there is no doubt about integrating information technology in education. More and more educators are of the opinion that the potential of computers in education will realize critical changes in curriculum, schools and classroom learning environments (Newhouse, 2001).

For schools that already have highly developed infrastructures, including fully wired school buildings with data ports in classrooms, a wireless network can extend the access range of the existing network. On the other hand, for schools that are in the beginning or middle of developing their wired infrastructures, wireless technology can offer an affordable solution that gives students and others immediate access to data (Roach, 2000). The emergence of compact, portable, and increasingly powerful, yet price-decreasing laptop computers and the wireless network makes wireless classrooms possible and affordable to schools. Wireless technology allows the seamless use of technology throughout the school buildings and creates a model of anytime, anywhere technology integration (Robertson et. al., 1997; Zardoya, 2001). More than that, mobile computers (wireless laptops) can extend the fixed computer facilities into areas that lack network and electrical wiring for desktop systems – including outdoors (McKimmy, 2003). The second motivating factor for wireless classrooms is the expense of retrofitting older classrooms with wired network connections. Wireless classrooms can give network access in every classroom with little or no renovation cost (Griffioen, Seales, and Lumpp, 1999).

The compactness and portability of laptops and emerging sub-notebooks/palmtops make them a suitable replacement for pen and paper, while the computing power and network connectivity open up whole new instructional opportunities (Griffioen, Seales, and Lumpp, 1999). Garfunkel (2001 in Embrey, 2002) examines how students use the devices, which vary from using a variety of software programs to record pH and temperature for science experiments, to looking up words in Spanish/English dictionaries that they have downloaded. The handhelds turn out to be so essential that the University of South Dakota now requires the purchase of handhelds for all incoming first year medical and law students (Dean, 2001 in Embrey, 2002). In the medical field, nurses and doctors are using handhelds to make entries into patients' charts, verify dosages of medications, and perform patient related research. The Arizona Health Sciences Library has used Avantgo and iSiloWeb to optimize some of its electronic journal titles for viewing on Palms and other PDAs. With wireless applications expanding at a ferocious pace, hopefully educators can incorporate the uses into the information literacy classes and the curriculum in general (Embrey, 2002).

Perhaps the greatest benefit wireless technology brings to education is the interactive online note taking (Griffioen, Seales, and Lumpp, 1999). Their study showed that students quickly embraced online note taking and many pointed out that it helped them understand the materials better because:

- All the instructor's notes were transmitted immediately to the students' machines and displayed on their screens so that students would no longer waste time in copying things the instructor wrote as they would in a conventional classroom using paper notes. Freedom from recopying - the marking of instructor's notes allowed them to focus on what the instructor was saying and doing; thus they found they learned more during the initial presentation of the material.
- By adding their own private annotations, they ended up with multimedia notes including the instructor's pre-written materials, the instructor's in-class marking, and their own annotations.
- Online course materials mean that students can access them anywhere, exchange or modify notes, correct them and add cross-references, etc. Online note taking was very effective because the focus of attention could be centered exclusively on the laptop screen (ibid).

Besides bringing benefits to students' learning, wireless technology is also beneficial to teachers. Robertson et. al. (1997) found that most teachers felt that the Pocket Books were extremely useful. For teachers, the use of palmtop technology means that information on all students is potentially available at all times, that students can access the materials anywhere they want. Lewis and Neil (2002) found that the strengths of

portables also included the potential for integrating the computer into teachers' personal and professional development. There was a substantial increase in teachers' IT skills and extended professional development in non-working hours. It involved teachers in doing considerable amount of independent training, development and work related activities in their own time at home.

However, a considerable amount of effort has to do with teacher training to make teachers understand the potential of IT and change their attitudes. The amount and the nature of the training teachers have had on using IT in the classroom will obviously impact on how effective computers are likely to be used in schools (Moss, 1992). Therefore, teachers have to be convinced first that the time spent on learning to use new technology is likely to yield benefits in terms of saving time and improving student learning (Cumming, 1988; Thompson, 1991). Without adequate training they are unlikely to make fruitful use of computers in the classroom (Hammond, 1994; Underwood and Underwood, 1990).

Data collection

This research employs document analysis and interviews to collect data. The information presented here is gathered from government documents, school plans and reports, summary of interviews, and reports of computer and educational magazines.

Background of the pilot scheme in Hong Kong

Approaching the end of the five year IT strategic plan (1998 – 2003) the Hong Kong government started encouraging schools to experiment the possibilities of using wireless technology in teaching and learning as an extension of the newly established wired network. In 2002, the Hong Kong government launched a pilot scheme "e-school bag" promoting the use of wireless technology in ten primary and ten secondary schools for classroom teaching and learning. Later in 2003, a secondary school in Hong Kong launched a pilot project called "Outdoor Wall-less Classroom". The project was funded by the Quality Education Fund (QEF) organized by the Hong Kong Government with HK$230,000 (about US$30,000). It was intended to set up a wireless network to enhance the teaching and learning activities in an outdoor setting.

The technical set up of the project "Outdoor Wall-less Classroom" includes:

Hardware

- 23 sets of Pocket PC (Intel PXA255 400 MHz)
- 3 sets of Centrino P-M Notebook computers
- 3 sets of wireless access point/base (802.11g)

Software

- Apache
- PHP
- MySQL
- Online Forum
- Voting Forum
- Chatroom
- FTP
- ClearVue

In Hong Kong, the maximum number of students per class in secondary school is 45. Due to the limitation in the budget, 23 sets of Pocket PCs were purchased and every two students shared one Pocket PC. The notebook computers today are already powerful enough to function as servers. Therefore, the notebook computers in this project were configured to serve as web servers and FTP servers. Before leaving the school, teachers would store all multimedia materials into the notebook computers first so that students could access these materials through the wireless network when they arrived at the field trip location. Since multiple computers attached to a single station shared the same bandwidth, the more computers were attached, the slower the connections were. Roughly there were about ten computers per base station (Horn, 2001). Therefore, in order to connect 23 Pocket PCs, the wireless system needed three wireless access bases.

Benefits identified through practical experiences

So far the school has conducted several successful field trips which enhanced students' learning interests greatly. Students expressed that it was no longer necessary to bring a lot of stationery with them when they went for field trips. In the past, they had to bring pens, paper, maps, and worksheets, etc. Now they could do the observation on one hand, and watch the multimedia movie through their shared Pocket PC on the other. During the field trips, students could do some online exercises and knew the results instantly. The chatroom facility enabled them to conduct online discussion in groups in real time.

In a geography field trip, students uploaded data collected to the server through the wireless LAN. After the data was transferred to the notebook server and processed, statistical analysis and charts were sent back to students' Pocket PCs. Moreover, teachers took pictures and uploaded them by the blue tooth technology to the server. The pictures were also sent to all students subsequently by the wireless LAN. Through the technologies, the interactivity between teachers and students, and students and students was greatly increased. With one Pocket PC, students could write notes on the device, view maps on the screen, do online exercises and get the results, chat and communicate with other groups of students and teachers, and do worksheets on the screen. Another by-product this project bought to students was enhancing the collaboration among them, as they had to share the Pocket PCs. It was a good chance for teenagers to cooperate with others. Sharing the same device and solving problems together is a good opportunity for them to practise their interpersonal skills.

The range of the movement depends on the power of the access point. Roughly, the effective range of communication between the Pocket PC and wire access point is about 60 – 100 metres, depending on the weather and terrain. With the help of wireless technology, students can conduct observation and other learning activities in an area of about 11,000 square metres. Although groups of students were scattered within the effective range, they can all conduct their own activity yet communicate with others and teachers at the same time. If any one group discovered anything, or the teachers would like to update anything, they could exchange information through the wireless network instantly.

In a bird watching field trip, during the forty minute ride to the destination, teachers first downloaded the movies and related information to students' pocket PCs from the notebook server. After arriving at the destination, students started their observations and learning activities. One of the learning objectives was to identify different birds and fish. A graphical software had been installed in the Pocket PCs that students would draw what they observed and insert their own descriptions in their handheld devices. Periodically, students had to upload their work to the server so that teachers knew what their progress was.

In a field trip regarding local Chinese custom and culture which young students were not familiar with, the teachers would first prepare multimedia learning materials such as movies, pictures, and sound clips. Students would then conduct their own tour. Whenever they encountered anything they were not familiar with, they would turn to their Pocket PC and watch the movies or listen to the sound clips illustrating the history and other relevant information to them. By doing so, different groups of students could control their own learning pace. Or students could communicate with teachers directly to get instant interaction. In the traditional way, teachers could not cater for students' learning needs as they were scattered around. In the new innovative way, teachers could answer students' questions from different groups at different locations. Teachers might even set up a chat-room instantly and let students discuss and exchange ideas if they found that the queries of some groups of students were common or similar.

Problems encountered and the solutions

Three major technical problems were observed in this project. The first one was the power supply to the access bases. The second was the weather, and the third was taking pictures.

The first problem was the power supply to the wireless access bases. Up to the year 2003, all wireless access bases available in the commercial market were powered by AC only, unlike notebook computers and PDAs. In order to solve this vital problem, the teacher-in-charge came up with a solution by inventing a tailor-made power supply. He constructed a DC power supply system by some rechargeable Nickel Metal Hydride Batteries (NiMH) available in local Hong Kong market with as high as 7,000mAh. Compared to normal rechargeable batteries (1,200 – 2,200mAh), these high power rechargeable batteries were so powerful they could provide power to the wireless access bases up to six hours continuously. However, it took more than ten hours to recharge the batteries. Therefore, he needed to ensure there were enough rechargeable batteries ready to be used.

Another alternative supplementary solution was the use of tailor-made solar cell pads. As using solar energy is environmental friendly and there is enough sunlight in Hong Kong around the year, using solar energy as the backup power supply is a very practical strategy. After a series of trial and error, the school concluded that they would utilize both power sources at the same time in one field trip. If the weather was cloudy or the 802.11g wireless connection was used (which required more power yet offered more bandwidth), the rechargeable batteries would be used. On the other hand, if the weather was sunny or the 802.11b wireless connection was used (which required less power but offered smaller bandwidth), the solar cell energy would be used.

As electronic devices cannot be utilized in humid conditions, the teacher-in-charge stated that no matter how advanced the technology was, once the weather was not conducive, the learning activity had to move back to indoor venues.

Since the Pocket PC purchased at that time had only one expansion slot which was occupied by the network card already, it was very inconvenient to expand other functions in the Pocket PC. When the teacher-in-charge of the field trip wanted to take any pictures and share with students through the wireless network, he had to plug and unplug different cards with different functions. The school finally came up with a solution that teachers could take pictures by a mobile phone first, and then the mobile phone could transmit the pictures to the Pocket PC through the blue tooth wireless technology. Once the pictures were uploaded to any Pocket PC, they could be shared by all students through the notebook web server and the wireless network. They also found that the use of mobile phone was better than normal digital camera because the digital camera was too advanced, having a big size photo with large file size. Images taken by the 100,000 pixels lenses of the mobile phone just fitted to the 320 x 240 pixels screen size of the Pocket PC. If images were taken by digital camera, the sizes of the images would be so large that students had to scroll left and right, and up and down to view the images. Of course in the standard today, we could consider buying a Pocket PC with built-in camera function to resolve this problem.

Finally, the school had to face a problem which was common to any other schools using information technologies – technical support. Since the outdoor activities involved a lot of custom made learning materials, some support from teaching assistants was required. Moreover, it would be better to have a technician accompanying the field trip so as to solve any sudden technical problems with the notebook computers, wireless access bases, the power supply system, or the Pocket PC.

Evaluation of the project

In general, all stakeholders seem to be satisfied with the implementation of this project and the benefits it bought. The school had utilised the wireless technology in the right place that maximized the strength of wireless network in outdoor activities. Both teachers and students appreciated the use of technology. They all held positive attitudes towards the use of the latest

technology. Teachers of other subjects were thinking of applying the wireless technology in their own teaching and learning. On the other hand, together with other innovative changes, parents were very satisfied with the performance of the school that they all want their kids to go into this school. As a matter of fact, in the period of three years, this school had turned itself from a band three school to almost a band one school, which is a very rare case in Hong Kong.

Further development

It is hoped that in the year 2005 or 2006, the school could employ the 802.11n standard wireless network with 108 – 320 MHz bandwidth so that the multimedia learning materials could be transmitted faster and the technical limitation will be relaxed more.

Due to the current limitation of the technology, there is no provision for interoperability between 802.11a and 802.11b standards. It is hoped that the industrial products providing such flexibility will be available soon.

The success of this project relies on individual teacher's innovation and technical expertise of assembling tailor-made DC power supply to the wireless access point. Again it is hoped that the demand of wireless devices with such handy features will create a market to draw the attention of the telecommunication companies. If the access point with such unique feature is available in the market, many schools are willing to consider implementing the wireless network for their teaching and learning.

Conclusion

With the financial support from the government, the school has successfully extended their wired network in the school campus to a wireless network reaching beyond the four walls of the classroom. In different field trips the wireless network showed its effectiveness in enhancing the teaching and learning activities. It greatly helped in improving communication between teachers and students, and between students in different groups. It also increased the interactivity between teachers and students, and collaboration among students. Moreover, the wireless technology enhanced the varieties of teaching materials from pencil and worksheet to multi-media materials such as pictures, sound and movie clips.

However, before implementing the wireless technology in full scale we have to solve several matters first. In-house IT personnel, technical support, teacher training, and financial support are crucial factors that contributed to the success of this project. Before expanding this small-scale project to cover all subjects, we have to make sure there is enough technical support. For example, do we have enough technicians to go out with teachers and students on different field trips? Do we have appropriate IT personnel to support other teachers to integrate IT into the curriculum? Is every family able to buy a handheld wireless device (Pocket PC, PDA, etc.) for their children? Are we narrowing down the digital divide, or widening it? Once the scale is large, some unforeseeable problems may arise. We have to be prepared to cope with the doubts or even negative attitudes from teachers and parents about the application of IT in teaching and learning.

REFERENCES

Cumming, A. (1988). Change, organization and achievement: Teachers' concerns in implementing a computer learning environment. *Journal of Educational Technology Systems*, 17, 141-163.

Education and Manpower Bureau (2004). Consultation document: *Way forward*. Hong Kong Government of the Special Administrative Region.

Embrey, T. (2002). Working with wireless devices: Library applications in support of the needs of students and teachers. Teacher Librarian, 29(5), 24.

Griffioen, J., Seales, W., and Lumpp, J. (1999). Teaching in real-time wireless classrooms. *Journal of Engineering Education*, 88(4), 397.

Hammond, M. (1994). Measuring the impact of IT on learning. *Journal of Computer Assisted Learning*, 10, 251-260.

Horn, R. (2001). Home and school technology: Wired versus wireless. *Phi Delta Kappan*, 28(8), 571-573.

Lewis, A. and Neil, S. (2002). Portable computers for teachers and support services working with pupils with special educational needs: An evaluation of the 1999 United Kingdom Department for Education and Employment Scheme. *British Journal of Educational Technology*, 32(3), 301-315.

McKimmy, P. (2003). Wireless mobile instructional labs: Issues and opportunities. *International Journal of Instructional Media*, 30(1), 111.

Moss, G. (1992). Comparing awareness and use of content-free software in comprehensive schools. *Computers Education*, 18(4), 283-291.

Newhouse, P. (2001). A follow-up study of students using portable computers at a secondary school. *British Journal of Educational Technology*, 32(2), 209-219.

Roach, R. (2000). Campus move toward wireless computing. *Black Issues in Higher Education*, 17(14), 24.

Robertson, S., Calder, J., Fung, P., Jones, A., and O'Shea, T. (1997). The use and effectiveness of palmtop computers in education. *British Journal of Educational Technology*, 28(3), 177-189.

Thompson, N. (1991). Computers, curriculum and the learning environment. *Computers Education*, 16(1), 1-5.

Underwood, J. and Underwood, G. (eds) (1990). *Computers and learning: Helping children acquire thinking skills*. Blackwell, Oxford.

Wenig, R. (1996). *Wireless LANs*. Boston: AP Professional.

Zardoya I. (2001). Urban students cross the digital divide through laptop leasing program. *Education*, 122(2), 262.