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Cyber Schooling Framework: Improving Mobility and Situated Learning*

NIAN-SHING CHEN
Department of Information Management, National Sun Yat-sen University, Taiwan.
E-mail: nschen@cc.nsysu.edu.tw

KINSHUK
School of Computing and Information Systems, Athabasca University, Canada

YI-HUNG WANG
Department of Information Management, National Sun Yat-sen University, Taiwan

E-learning has enabled a variety of ways for teachers to give instruction and students to learn that were not possible in a traditional education environment. This paper describes the Cyber Schooling framework that enhances the familiar traditional school paradigm by identifying different modes in which technology is able to serve the learning process. The Cyber Schooling framework includes four elements: Cyber School, Cyber Classroom, Cyber Teacher Desk (teacher's WiFi laptop) and Cyber Student Desk (student's WiFi laptop). The paper describes the principle of the Cyber Schooling framework and provides case studies for various possible modes.

Keywords: international education; cyber schooling; mobile learning; educational administration; distance education; e-learning

INTRODUCTION

THE GROWTH in the use of computers and the Internet in recent years has brought many conveniences to human life. The educational sector has also been significantly influenced [6, 21, 22, 31]. However, traditional school environments are not suitably geared up for exploiting all the advantages that the current technology has the potential to offer [11, 17, 18, 19].

Traditionally, the location of the school is fixed, restricting various teaching activities. Such an environment is less accessible to those who live far from the school. The infrastructure does not support situated learning due to its lack of mobility. Without the use of suitable information technology, traditional schools do not have access to the vast amount of digital resources that are now available [14]. The limited access to IT and the fixed location also mean that there is a lack of interaction with experts from other geographical locations. In addition, traditional schools require students and teachers to be present at the same time and in the same place, imposing rather rigid restrictions on the learning process [11, 17, 23, 24]. Traditional schools are also limited in terms of some pedagogical aspects. For example, they may not provide adequate support for peer-learning outside of the classroom. They also fail to retain context in out-of-class learning situations [25, 26].

This paper describes a Cyber Schooling framework based on various methods of using information technology in the context of traditional schooling. The framework aims to provide the following benefits.

- It enhances the traditional schooling environment with the help of information technology (as opposed to trying to replace the familiar schooling methods); and
- it adds additional modes to the traditional schooling methods to provide education for students who are unable to attend traditional schools.

The research in this paper focuses on identifying ways in which e-learning approaches could enhance the familiar traditional school system. The aim is to extend the well-established educational infrastructure and make it more accessible, flexible and cheaper for students who seek to benefit from it.

The next section discusses various characteristics of traditional schools that have the potential for technological enhancement. The elements of Cyber School are then described. This is followed by a description of the Cyber Schooling framework. The paper then discusses each mode within the framework using real-life examples. Finally, the paper concludes by summarizing the benefits of the framework in enhancing the traditional school system and improving the potential for new situated learning opportunities.

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CHARACTERISTICS OF TRADITIONAL SCHOOL ENVIRONMENTS

The traditional school environment typically has a fixed location with several classrooms. Each classroom contains a teacher's desk and several student desks. In such a school environment, the teaching and learning process is conducted in face-to-face mode [3, 23, 24]. Various restrictions have significant effects in such an environment.

The first issue is 'cost restriction'. With the cost of Internet access falling significantly in recent years and improvements in the availability of high bandwidth, the issue of 'travel cost' vs. 'Internet access cost' is becoming a critical issue. This is particularly true for those who have to travel a long way to attend school, those who have special needs, and those who are away from the fixed school's location due to job demands and other commitments. The same applies to students who live in rural areas and those who want to make use of certain school facilities in another city but cannot afford to, due to the long distance. Similarly, teachers may also have to travel away from school for certain reasons during teaching hours (conferences, sabbaticals and so on).

In an environment where teleworking is becoming increasingly popular, it may also be more convenient for many students and teachers to learn and teach from home, while performing other duties, such as child care.

The second issue is 'time restriction'. In traditional school environments, teachers and students are required to attend school during a particular period of time, even if they do not feel well for any physical, emotional or other similar reason. In such situations, the quality of teaching and learning activities is significantly influenced. For instance, if during the school time, the teacher's situation is not satisfactory, this will decrease the quality of their teaching. On the other hand, if a students has to be absent during school time, he or she may suffer a set-back in their progress. E-learning technologies, such as recorded lectures and asynchronous discussion boards, could circumvent these problems.

The third issue is 'the difference in the availabilities of teaching resources between city and rural areas'. School teaching facilities and resources, such as hardware, software and teaching staff are much more readily available in the cities than in rural communities [3]. For example, a large number of teachers prefer to teach in a city rather than in the countryside. This results in poor quality education in rural areas and lack of equality of teaching resources between urban and country schools. The only way that this problem can be solved is to enable access to quality teachers and quality curriculum in rural areas.

The fourth issue is 'the lack of teaching aids for teachers'. When lecturing in the classroom, the majority of teachers use a blackboard (or whiteboard), and bring their own notes and teaching aids. This is less effective than using digital notes and electronic teaching aids. Course content that has been previously-created by the teachers can also be easily reused by students.

The fifth issue is the 'lack of learning aids for students'. In traditional classrooms, the majority of students have to bring their own textbooks and related materials. The weight of school bags has been an issue of concern in many countries [12, 13, 27, 30]. Therefore, if students' study materials could be digitalized, they would not have to carry heavy school bags. Since technology is getting cheaper day by day and many countries already have education masterplans to deploy computer technology in the classroom, access to digitized material inside the classroom is becoming a real possibility [9]. For example, the Department of Education in the United States announced their National Education Technology Plan in 2004, which says:

> Over the past five years there has been an explosive growth in online and multimedia instruction (e-learning) and 'virtual schools'. At least fifteen states now provide some form of virtual schooling to supplement regular classes or provide for special needs. Hundreds of thousands of students are taking advantage of e-learning this school year. About 25 per cent of all K-12 public schools now offer some form of e-learning or virtual school instruction. Within the next decade every state and most schools will be doing so. E-learning offers flexibility in the time, place, and pace of instruction. It provides teachers the opportunity to create an instructional environment that adapts to students wherever and however they need to learn, at home or in school. It gives parents a significant choice of providers and educators an alternative means of meeting their student's academic needs. A good example of the impact of virtual schooling is the Florida Virtual School (FLVS). Founded in 1997, the FLVS is a national leader in providing online, distance education solutions for K-12 students. Most of its 13 000 students in the 2003–2004 school year enrolled for only 1 or 2 courses for a total of 21 270 course enrolments. In addition to designing and monitoring the online instruction, FLVS teachers communicate with students and parents on a regular basis by phone, e-mail, online chats, instant messaging and discussion forums. A full 90 per cent of its enrolees complete and pass FLVS classes. [29].

The limits of the traditional school system can be largely overcome by the effective use of emerging and existing technologies, but this requires a systematic approach [32, 33].

The next section describes the elements of Cyber School. This is followed by a description of Cyber Schooling framework.

CYBER SCHOOL

Cyber School is an environment where the instruction and learning processes are enabled through the use of information and communication technologies. It integrates various Cyber Classrooms,

in a way similar to traditional school structures. Cyber School is built using a computer server for storing digitized resources and for hosting a learning management system to provide content access and interaction between teachers and students without any temporal or spatial restrictions. The server provides excellent information processing capability and adequate hard disk space, and is ideally accessible through a high bandwidth network to the teachers and students. In addition, the server also facilitates access to other associated material, such as administrative information, academic data, teaching materials, teachers' handouts, and students' assignments.

Cyber School is a cyber environment that includes hardware, software and pedagogy. It adds the two new dimensions of mobility and situated learning to the traditional schooling concept, particularly when it uses information and communication technologies associated with distance learning.

There are three-layers of architecture in the setting up and running a Cyber School (Fig. 1):

1. the *hardware setup*, where computer hardware and networking devices are put together to create system infrastructure;
2. the *software setup,* where an e-learning system is installed by using appropriate software tools like Blackboard™ and WebCT™; and
3. the *course setup,* where online courses are designed and teachers and students undertake teaching and learning activities facilitated by the e-learning system.

The aim of the Cyber Schooling framework is to provide an educational environment to improve the learning process and generate opportunities that did not exist before. The lower levels in Fig. 1 facilitate the environment and the upper levels provide opportunities. The lower levels can be seen as building blocks and the upper levels as a variety of scenarios giving educational possibilities. The upper levels can provide methods for creative and innovative instruction, if the lower levels have adequate facilities. The Cyber Schooling framework identifies various ways in which the adoption of technology has the potential to provide more of those facilities, compared with traditional educational environments, hence it generates more opportunities.

Cyber School includes three elements: Cyber Classrooms, Cyber Teacher Desk, and Cyber Student Desk. The Cyber School is not limited by geographical or temporal boundaries. In the Cyber School, there are many Cyber Classrooms. In each Cyber Classroom, there is a Cyber Teacher Desk (or many desks in the case of team-teaching) and Cyber Student Desks. Fig. 2 shows the three elements of the Cyber School.

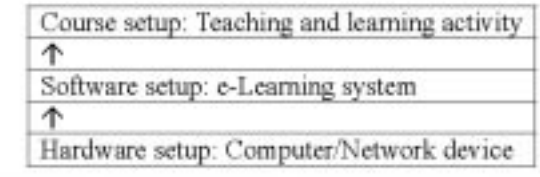


Fig. 1. Architecture for setting up and running a Cyber School.

Cyber Classroom

In the traditional sense, a classroom is a common area that enables teachers and students to carry out teaching and learning activities. The Cyber Classroom facilitates an environment that is similar to the traditional classroom, but is enhanced by technology. The benefits of technology in such a classroom include: mobility; two-way collaboration with the possibility of archiving the interactions; the ability to access the classroom in a situated learning environment; anonymity that helps to increase student participation, and immediate access to the vast resources that are available in digital format.

The Cyber Classroom has many distinct advantages over the computer rooms that are typically found in traditional schools. Traditional schools generally have one computer room where teachers can take their students for some computer related activities. Such computer rooms remain fixed and therefore cannot be used for situated learning. They require students and teachers to move from room to room, leaving behind all the classroom resources, such as reference books, demonstration material, and other teaching aids. Basically, traditional computer rooms separate reality from the virtual, whereas Cyber Classrooms merge them together.

Cyber Classrooms are constructed within the Cyber School. Teachers can provide different courses in different Cyber Classrooms. The resources of these courses can be digitalized and stored in the Cyber School. In the Cyber Classroom, teachers can manage various activities and materials, such as student interaction, teaching resources, assignments, students' tests, and students' results. On the other hand, students can interact with their teachers in online synchronous or asynchronous teaching, have online synchronous or asynchronous discussions with classmates, submit their assignments, take online tests, and engage in other learning activities [2].

Cyber Classroom can be constructed in three different settings.

- *Fully distributed setting*: In this setting, teachers and students form the Cyber Classroom by accessing the Cyber School server from locations far from the physical location of the server. The access in this setting is via the Internet. This setting support high mobility and therefore has high Internet bandwidth requirements.
- *Fully centralized setting*: In this setting, teachers and students form the Cyber Classroom by accessing the Cyber School server from the

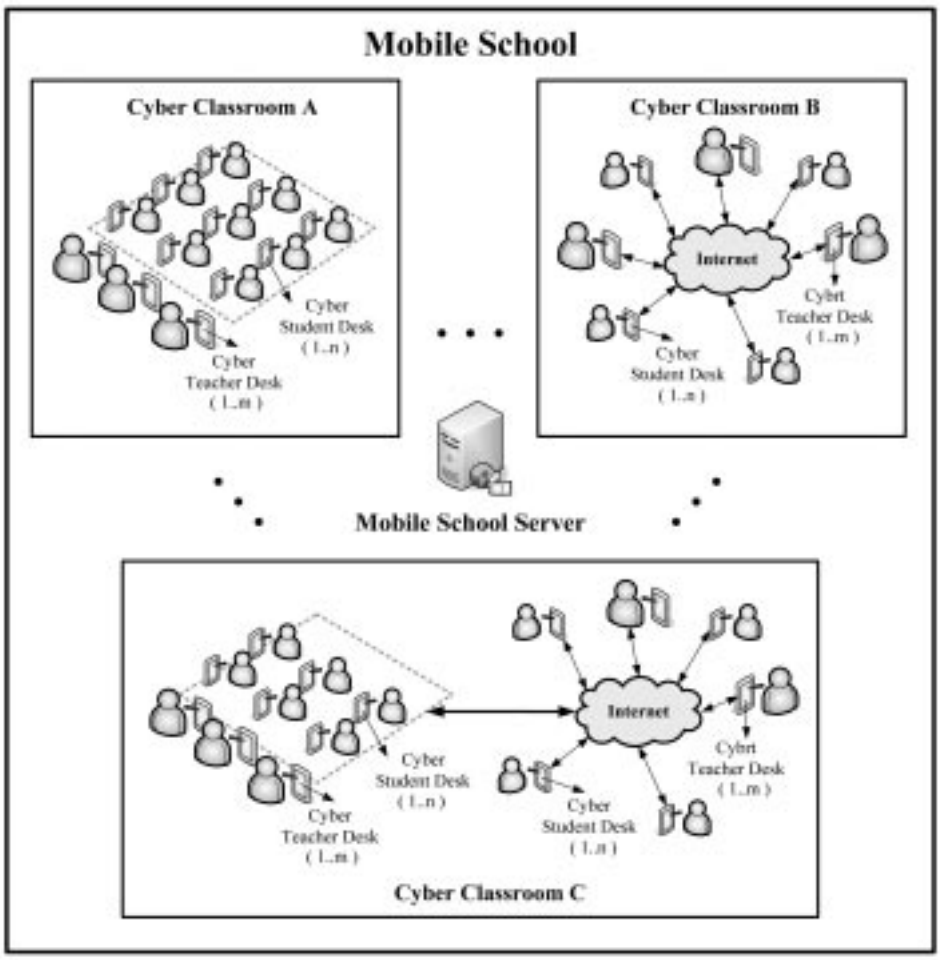


Fig. 2. Elements of a Cyber School.

same physical location as the server. The access in this setting is via a local area network. This setting, in its purest form, does not support mobility and therefore has the least Internet bandwidth requirements (Internet is used only to access resources outside of the Cyber School server).

- *Mixed setting*: In a mixed setting, some participants access Cyber Classrooms from locations far from the physical location of the server and some from the same location as the server. Depending on the number of participants accessing the Cyber Classroom from distant locations, the amount of mobility and the Internet bandwidth requirements vary.

Figure 3 shows various settings of a Cyber Classroom. Figure 3 also depicts the extent of the mobility supported by each setting and the Internet bandwidth requirements needed to support that mobility.

Cyber Teacher Desk

Cyber Teacher Desk is generally made up of a Tablet PC or notebook computer, combined with a wireless network connection and Web camera. In addition to teaching-aid software, it also contains a writing facility similar to that of a whiteboard, an immediate telecast function, and video recording facility. In using Cyber Teacher Desk, teachers do not have to have many teaching materials and tools. In addition, Cyber Teacher Desk does not restrict teachers in either time or space; it also enhances the teaching quality.

Cyber Teacher Desk is applied in Cyber Classrooms. There are two settings for Cyber Teacher Desk: 'Within walls' and 'Without walls'.

Within walls

In the 'Within walls' situation, teachers use the Cyber Teacher Desk in a real classroom. Use of the technology allows students to attend the class either physically or via remote access. Teachers can download teaching resources on Cyber Teacher Desk from Cyber School without bringing teaching resources and tools to the actual classroom. Using the Cyber Teacher Desk's whiteboard writing function and a projector, the teaching contents can be projected on to a large screen in a real classroom. In this situation, teachers can move around the classroom while writing on the Cyber Teacher Desk's whiteboard, unlike in a traditional classroom environment where the teachers' movements are restricted because of the

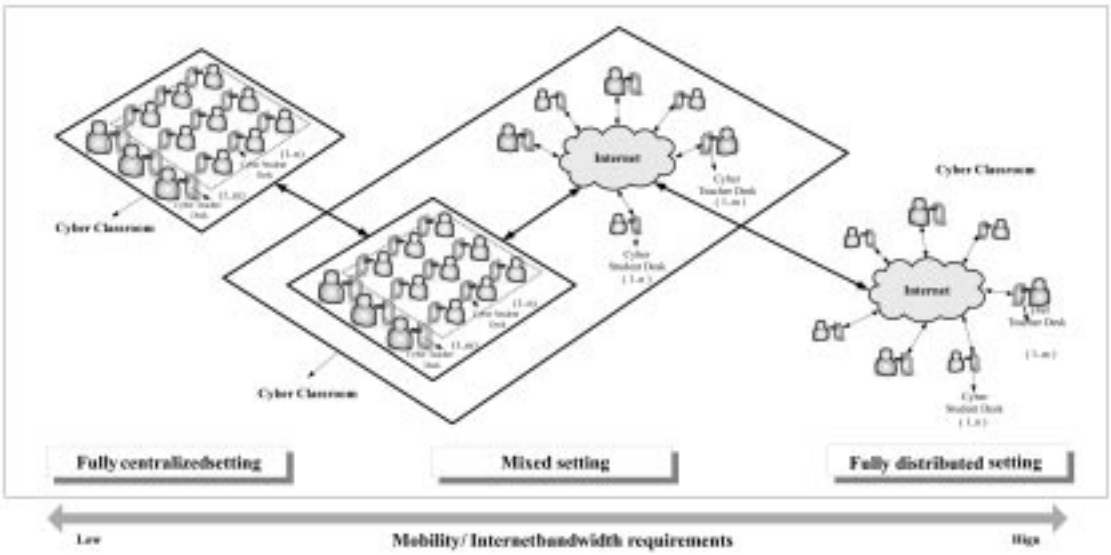


Fig. 3. Settings of Cyber Classrooms.

fixed position of the whiteboard. In addition, by using a function of Cyber Teacher Desk, the whole teaching contents can be recorded both visually and aurally and uploaded on to the Cyber School server. Students who are absent from the class can review the recording online and even download it later from the server and review it from their own local computer.

Without walls

In the 'Without walls' situation, teachers can provide lessons from anywhere in the world using Cyber Teacher Desk. Since Cyber Teacher Desk contains wireless Internet access, teaching-aid software and the function of immediate telecast, teachers can access the Cyber Classroom from anywhere to provide lessons for their students. Even if a teacher cannot teach their students face to face, the students can still acquire adequate instruction from the teachers because of the multitude of teaching activities that are available. Through the video recording function, teachers can also record the teaching material in advance and show it to students during lecture hours [2].

Chen and Zimitat (2003) describe a real-life Cyber Teacher Desk implemented using a laptop with Microsoft Windows operating system and wireless network access. The laptops ran Microsoft Internet Explorer Web browser, which is usually installed on machines that run Microsoft Windows 2000 or XP. Anicam-Live (http://anicam.elearn.-com.tw/) was installed on the Cyber Teacher Desk to provide a video streaming source to the media server. Jointnet video-conferencing client software (http://www.homemeeting.com/) was installed to facilitate a shared electronic whiteboard with two-way audio/video interaction. The laptops were equipped with three devices:

- *Video camera*: Webcam with zoom in/out features;
- *Audio in/out*: Microphone and ear phone; and
- *Handwriting*: Digital pad and digital pen.

Cyber Student Desk

The concept of Cyber Student Desk is similar to the electronic school bag. It not only reduces the heaviness of the students' school bag, but also enhances the quality of learning with the help of the vast array of resources. The constitution of the Cyber Student Desk is similar to the Cyber Teacher Desk. It can be constructed using a Tablet PC or a notebook computer. In addition, it includes the ability to connect to wireless Internet, Web camera, and the learning-aid software, which includes functions such as electronic note making, a dictionary and calculator. By using Cyber Student Desk, students can access the Cyber Classroom to download teaching materials, interact with teachers for online teaching, make digitized notes, discuss with classmates, or reflect on their own understanding.

Cyber Student Desk enables students to take part in the Cyber Classroom whether they are in a real classroom or attending virtually from a remote location. There is no real difference between the situations. The technology enhanced interaction and the possibility of retaining anonymity during the question–answer sessions means neither physically attending a lecture nor remotely taking part in it has any reduction in the quality of learning process.

A real-life implementation of Cyber Student Desk [5] included laptops with wireless network access using a Microsoft Windows operating system. Microsoft Media Player was installed on all Cyber Student Desks to receive the streaming

video broadcast from the media server. Jointnet video-conferencing client software was installed to facilitate a shared electronic whiteboard with two-way audio/video interaction. The laptops were equipped with three devices:

- *Video camera*: Webcam with zoom in/out features;
- *Audio in/out*: Microphone and ear phone; and
- *Handwriting*: Digital pad and digital pen.

THE CYBER SCHOOLING FRAMEWORK

The Cyber Schooling Framework is based on using information technology in various forms with e-learning to enhance the traditional school paradigm. It broadens the scope of the educational environment to include those who are unable to participate in the learning process in the traditional school environment, and extends the learning process to more contextual learning by including those modes where learning takes place in a location that can provide context for the subject content.

There are eight modes in the Cyber Schooling Framework depending on the location, mobility, accessibility and the extent of situatedness in learning process:

1. Stationary school—stationary people—within close proximity

In this mode, Cyber School server and participants (teachers and students) are at the same geographical location. Participants access the Cyber School server from any stationary computer within the School's local network area through wired access. The Internet is used only to access external resources; it is not for accessing Cyber School. Users have a high bandwidth available for accessing the Cyber School server. This mode is very similar to the traditional school environment. The only difference is the use of technology to supplement traditional teaching and learning methods. Information technology helps by providing facilities that would otherwise be time-consuming and that can be automated. For example, assignments can be uploaded into the Cyber School and various interactions can be shared while maintaining anonymity. In terms of accessibility, this mode does not improve accessibility to additional users. The users are the same as those in the traditional environment.

2. Stationary school—mobile people—within close proximity

The Cyber School server in this mode remains stationary at one location and participants access it wirelessly while moving within the school's local area network. The access to the server is via a wireless hotspot (access point). Internet is used only for accessing external resources; it is not used for accessing Cyber School. Users have a high bandwidth available to access the Cyber School server.

3. Stationary school—stationary people—no proximity

The Cyber School server in this mode is stationary at one geographical location and participants access it from other geographical locations that can be far from the Cyber School's local area network. The access to the server in this mode is via the Internet using wired computers or wireless hotspots. Users have a high bandwidth or low bandwidth available to access the Cyber School server, depending on the type of their last mile Internet access.

4. Stationary school—mobile people—no proximity

In this mode, the Cyber School server is stationary at one geographical location and participants access the Cyber School's server while they are mobile and at any geographical location that is far from the Cyber School's local area network. The access to the School's server in this mode is typically via mobile phone Internet access with a low bandwidth, but recent technological advances have made it possible to provide wireless hotspot access in trains and airplanes, enabling users to use a high bandwidth.

5. Mobile school—stationary people—close proximity

The Cyber School server in this mode is at a different geographical location from the real schoolrooms and participants access the Cyber School's server within the School's local network through the wired local area network. Users have a high bandwidth available for accessing the Cyber School server.

The main purpose of this mode is to bridge the digital divide. In rural areas, it is generally difficult to get Internet access. Even if Internet access is available, it may not be cost effective. In many rural areas, Internet infrastructure is not even available. On the other hand, the infrastructure in cities is improving rapidly, hence increasing the digital divide. In addition, in urban areas, many good teachers are available. Most of these teachers do not want to go to rural areas. This creates a lack of good teaching resources in rural areas. Moving the Cyber School to rural areas, where people can get high bandwidth access without the Internet, aims to help to reduce these problems.

This mode enables teachers and students to access the same high-quality content that is available at resource-rich locations (such as in cities) without requiring remote Internet access. It not only solves the problem of differences in the quality of digitalized information but also eliminates the problem of lack of teachers in rural areas. A school with a small number of local teachers is able to draw on the explanations and perspectives of a variety of experts for different areas of subject matter, hence significantly improving the quality of their instruction.

Table 1. Characteristics of Cyber Schooling framework modes

	Moving Cyber School server	Local access to Cyber School server	Internet access to Cyber School server	Increased mobility	Situated learning
1. Stationary school Stationary people Close proximity	No	Yes	No	No	No
2. Stationary school Mobile people Close proximity	No	Yes	No	Low	No
3. Stationary school Stationary people Close proximity	No	No	Yes	Medium	Low
4. Stationary school Mobile people No proximity	No	No	Yes	High	Medium
5. Mobile school Stationary people Close proximity	Yes	Yes	No	No	No
6. Mobile school Stationary people No proximity	Yes	No	Yes	High	Low
7. Mobile school Mobile people Close proximity	Yes	Yes	No	Medium	High
8. Mobile school Mobile people No proximity	Yes	No	Yes	Very high	Very high

6. Mobile school—stationary people—no proximity

The Cyber School server in this mode remains mobile and can be moved to different geographical locations. Participants access it from stationary physical locations far from the School's local area network. The access to the server in this mode is via wired or wireless hotspot Internet access. Users have a high bandwidth or low bandwidth available to access the server, depending on the type of their last mile Internet access.

7. Mobile school—mobile people—close proximity

In this mode, the Cyber School server and participants can both move to a different geographical location, but remain together, and access Cyber School's server within the environment to which they have moved. The access to the server is via a wireless hotspot local area network. Users have a high bandwidth available for accessing the Cyber School server.

8. Mobile school—mobile people—no proximity

The Cyber School server in this mode can move to different geographical locations and participants access it via the Internet while they are mobile and are at any geographical location that is far from School's local area network. The server is generally connected to the Internet by satellite. The users access the server typically via mobile phone Internet access with low bandwidth, but recent technological advances have made it possible to provide wireless hotspot access in trains and airplanes, enabling users to have a high bandwidth.

Various modes of the Cyber Schooling framework extend the accessibility of the learning process. The learning process is no longer restricted to traditional school buildings; it not only benefits from the possibilities of remote access but also enables high bandwidth access to those who have been severely disadvantaged in the traditional school system. An important aspect of the Cyber Schooling framework is the identification of the extent of situated learning that has been made possible by the use of advances in information and communication technologies.

Table 1 summarizes various characteristics of the Cyber Schooling Framework modes. Mode 1 is a technological improvement over traditional schooling but it does not add anything in terms of increased mobility or incorporation of situated learning (learning still takes place within the boundaries of a real classroom). Mode 2 provides little mobility within the proximity of Cyber School server (typically a traditional school campus). Modes 3 and 4 start to provide better mobility and they also contribute towards situated learning, though to a limited extent.

Mode 5 is an interesting mode. Although it does not improve the mobility of those involved per se, it is the best suited mode for those who are in remote areas with the least facilities. In this mode, the Cyber School itself moves to the location of these users.

Modes 7 and 8 contribute the most towards providing mobility and also situated learning, and perhaps these two modes are the product of the latest development of technologies for mobile learning (M-Learning).

Table 2 depicts the relationships of various characteristics of the Cyber Schooling Framework modes with appropriate Cyber Classroom modes.

Table 2. Cyber Classroom modes within Cyber Schooling framework

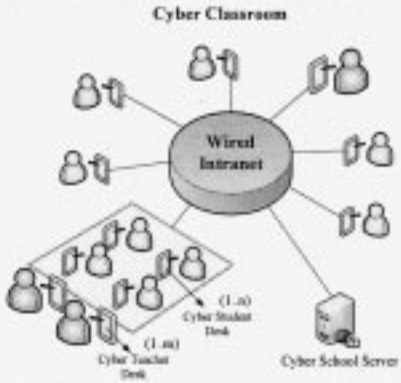
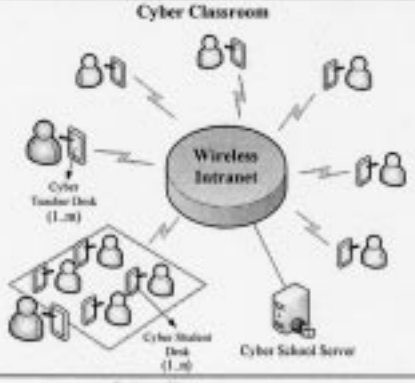
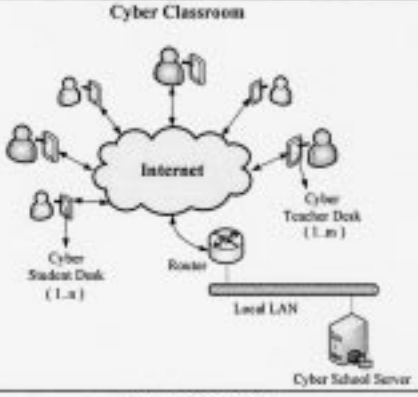
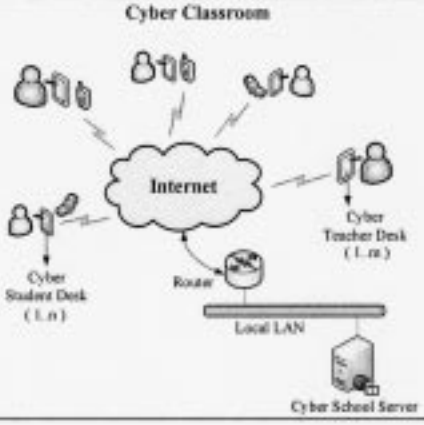
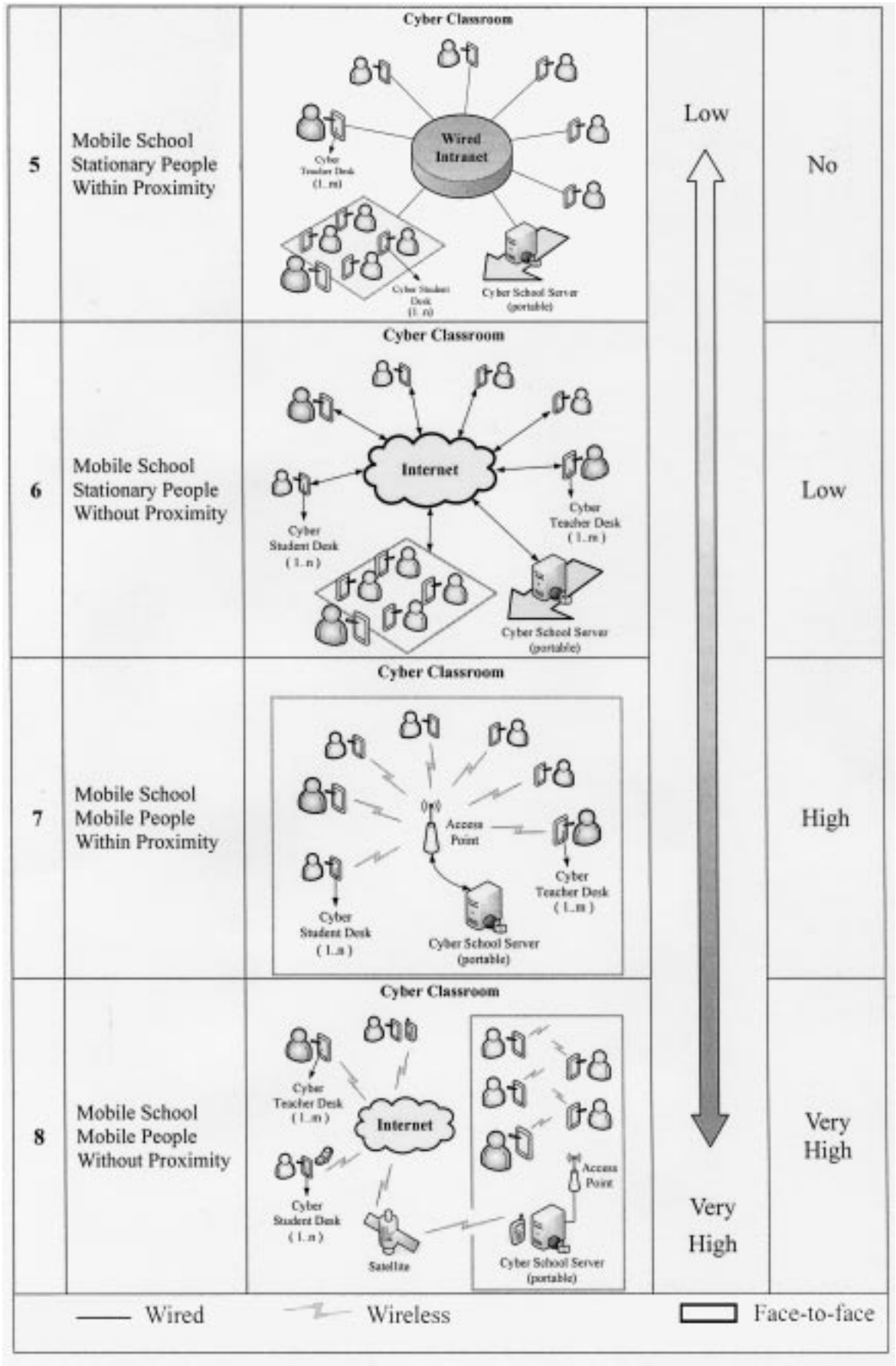
No	School/People/ Geographic	Cyber Classroom Mode	Mobility	Situated Learning
1	Stationary School Stationary People Within Proximity		Low ↓ High	No
2	Stationary School Mobile People Within Proximity			No
3	Stationary School Stationary People Without Proximity			Low
4	Stationary School Mobile People Without Proximity			Medium

Table 2. (*cont.*)


5
Mobile School
Stationary People
Within Proximity
Cyber Classroom
Wired
Intranet
Cyber
Teacher Desk
(1..m)
Cyber School Server
(portable)
6
Mobile School
Stationary People
Without Proximity
Cyber Classroom
Internet
Cyber
Student Desk
(1..n)
Cyber
Teacher Desk
(1..m)
Cyber School Server
(portable)
7
Mobile School
Mobile People
Within Proximity
Cyber Classroom
Access
Point
Cyber
Teacher Desk
(1..m)
Cyber
Student Desk
(1..n)
Cyber School Server
(portable)
8
Mobile School
Mobile People
Without Proximity
Cyber Classroom
Cyber
Teacher Desk
(1..m)
Internet
Access
Point
Cyber
Student Desk
(1..n)
Satellite
Cyber School Server
(portable)
Low
Very
High
No
Low
High
Very
High
Wired
Wireless
Face-to-face

The Cyber Classroom modes in the table describe examples of practical implementations for teachers to enable implementation in their own organizations.

REAL USE CASES OF THE CYBER SCHOOLING FRAMEWORK

The Cyber Schooling framework has been implemented in various real-life applications for different cases. This section discusses these applications, providing examples of each mode of the framework.

Stationary school—stationary people—close proximity

Mode: In this mode, teachers and students remain in their own physical school and use desktop computers with wired network connection to access the Cyber School server from the real classrooms. In certain cases, they may also access the server from their department, computer laboratories, dormitory, or from any available computer on the campus.

Real use case: A number of traditional credit courses have been conducted on the NSYSU Cyber University (http://cu.nsysu.edu.tw) every semester since 1999. In these courses, teachers and students all meet on the university campus; however they used Cyber Classroom as a supplement to traditional teaching methods. In addition, many other higher education institutions have been running Cyber Schools in this mode [1, 7, 8, 10, 15, 20].

Stationary school—mobile people—close proximity

Mode: In this mode, teachers and students remain in their own physical school and use portable laptop computers, Tablet PCs or PDAs with wireless network connections to access the Cyber School server from anywhere within the local area network of the Cyber School server. Even within the classroom teachers could use wireless laptops for better interaction with their students. At a micro level, the nature of the classrooms themselves can be transformed because students and teachers no longer have to be co-located. In a traditional lecture setting where a teacher and students have wireless-enabled laptops, teachers can quiz students and, based on the results, make an immediate assessment of their level of understanding. They can then decide whether to recap or continue. Alternatively, students could search the course materials or the Web to seek a range of sources of information for discussion.

Real use case: This mode has been used by one of the professors of the Department of Information Management at National Sun-yat Sen University in Taiwan where, for the last five years, he has used Cyber Teacher Desk and Cyber Student Desks in a traditional classroom for a Computer Networks course. The professor and the students access their Cyber Classroom for lectures using all course materials that have been published in the Cyber School. Students interact with the professor and other students via Cyber Student Desks. The teacher can move around the classroom while conducting the class due to the flexibility of using wireless-enabled laptop computer (Cyber Teacher Desk) to access the Cyber School server.

Stationary school—stationary people—no proximity

Mode: In this mode, teachers and students can be anywhere in the world and can use desktop computers with wired Internet connection to access the Cyber School server from locations such as a cyber-cafe, hotel, conference venue, public library, or wherever they can get access to a computer with Internet connection at their current location.

Real use case: This mode was used when a teacher, while attending the ICEIS2004 conference at Porto, Portugal, managed to conduct a live lecture from Portugal to Taiwan using the NSYSU Cyber University server running at the computer centre of the University in Kaohsiung city of Taiwan. The teacher used his Cyber Teacher Desk to access the Internet using the wired Ethernet connection from the conference venue. After he finished talking on the topic of 'virtual organization', he responded to a student's question. The student was using Cyber Student Desk to access the Cyber Classroom from Taipei.

Another example of this mode is the research seminars that were conducted in January 2005 during the visit of one of the authors from Taiwan to Massey University, New Zealand. During these seminars, PhD students and professors used three laptops to create a wireless network through a wireless access point to access the Cyber School server in Taiwan and to conduct synchronous discussions using JoinNet video conferencing software.

Stationary school—mobile people—no proximity

Mode: Teachers and students can be anywhere in the world using portable laptop computers, Tablet PCs or PDAs with a mobile phone Internet connection to access the Cyber School server from any location where mobile phone coverage is available. Users might be actually on the move, such as sitting in a train.

Real use case: This mode has been frequently used by a professor who uses the Cyber Classroom at NSYSU Cyber University to conduct live three hour lectures for his Computer Networks course over the whole semester. One of his students was

travelling one day on a train journey from Taichung to Taipei during the live session. The student used his laptop, connecting to the NSYSU Cyber School, and attended the live class via his PHS mobile phone internet connection.

Mobile school—stationary people—close proximity

Mode: For rural areas where an Internet connection is generally unavailable, unreliable or very expensive, making it unfeasible to access a Cyber School server via the Internet, a well established Cyber School server can be moved from a city to that rural area. There are many initiatives to donate computing equipment to rural schools [16] and these initiatives serve well in this mode. Teachers and students remain at their own school (in the rural area) and access the Cyber School server from their computer labs or wherever there is computer available in the real school.

Real use case: This mode was used in a graduation ceremony of the K12 Digital School (http://ds.k12.edu.tw) that took place in the school auditorium, which is on the first underground floor of San Ming Junior High School in Kaohsiung. The first underground floor is a place which does not have Internet access. The host school wanted to demonstrate a real scenario of how a variety of teaching and learning activities can be conducted in an online course and provide a hand-on session for the participants. Teachers and students attending this ceremony could not access the original K12 Cyber School to carry out the demo and hand-on session. Therefore, a copy the Cyber School server was installed on a portable computer and two wireless access points were assembled around the auditorium to create an Intranet environment. There were 40 Tablet PCs in that auditorium. In this situation, if teachers and students wanted access to the K12 Cyber School, they needed only to use a Tablet PC to connect to the copy of the Cyber School server on the portable computer using a wireless network connection via a wireless access point. In this mode, the Cyber School was moved to the required location. Teachers and students did not have to move; they could use the Tablet PCs through the Intranet to access their original online course from the copy of K12 Cyber School.

Mobile school—stationary people—no proximity

Mode: A field trip to a remote place away from the real school will require the server to be located at the remote place for instant local access to a vast amount of data. People from other places (such as research labs) will access the server from their own locations for collaborative learning processes.

Real use case: An example of this mode is the discussion among four researchers, one from Taiwan (Laurence Quinlivan), one from United States (C. M. Chen) and two from Australia (Craig Zimitat and Nian-Shing Chen). The discussion took place in order to complete a joint paper in the Cyber Classroom supported by a Cyber School which was a copy of NSYSU Cyber University in Taiwan and was moved by Nian-Shing Chen to Australia during his sabbatical at Griffith University. It was more efficient for the two main researchers, Craig and Nian-Shing, to upload and download vast amounts of audio/video recordings directly from the nearby portable Cyber School server than to access the original server in Taiwan.

Mobile school—mobile people—close proximity

Mode: This mode is basically for realizing the emerging new educational trends towards 'classrooms without walls' and to provide situated learning. Teachers and students can go anywhere in the world with a portable Cyber School server. They can then use a portable laptop computer, Tablet PC or PDA to access the Cyber School server. Users in this mode might be on the move, such as on a ship exploring the South Antarctica.

This mode enables teachers to convert any place into a classroom and provide situated learning. For example, a field trip requires the preparation of a variety of tools in order to have a successful learning environment during the trip. This mode of Cyber School provides one such tool. When students need to access relevant information in order to learn something in a situated context, they can access the stored knowledge without requiring remote Internet access. For example, in a trip to zoo, students can first observe real animals and then obtain more information about them from the Cyber School. They can also undertake comparative studies with animals of other geographical regions. Therefore, this mode enables students to learn in a way that was not possible in traditional classroom.

Real use case: This mode has been successfully used in running an Environmental Science class at the EcoCentre of Griffith University, Australia, with 16 school students. The teacher began the class within the classroom and, after providing an overview of what is to be done in the class, required groups of students to move into the adjacent Toohey Forest area to begin their data collection in different microhabitats and record information on their WiFi laptops. One group ran a continuous streaming video footage of their activities, so that two classmates in wheelchairs could participate in the exercise even though they remained back in the classroom. After an interval, students discussed their interim findings with the teacher and their classmates using video and the shared whiteboard. After discussion and some redirection students completed their task, and sent data to the teacher. The class then reconvened in the classroom to interpret and discuss the results. All data were compiled and uploaded to

the Cyber Classroom. Students returned to their school and used the collected information of the different activities for report writing.

This mode enabled greater preparation and coordination, and the technology was used effectively to engage students in collaborative activity, to enable communication between groups and as a means of archiving an experience for later (re)use.

Mobile school—mobile people—no proximity

Mode: This mode is for extremely situated learning, in areas that are very remote or in places where typical Internet infrastructure does not exist. Teachers and students can go anywhere in the world with a portable Cyber School server that can be connected to the Internet using a satellite modem. Other participants, from anywhere in the world, can then access the Cyber School server using portable laptop computers, Tablet PCs or PDAs to interact with people who are located with the server or to access the data collected by them on a portable laptop computer-based Cyber School server.

Real use case: As yet, there has been no real implementation of this mode, but the mode explained in 'Mobile school—mobile people—close proximity' can be extended to those places where Internet infrastructure does not exist (such as a study at the Pyramids in Egypt, or a study of creatures in the Amazon forests), where a few participants would actually be at the site using a portable laptop computer-based Cyber School server and a satellite-based Internet connection; others would communicate with them from afar.

CONCLUSION AND DIRECTION OF FUTURE RESEARCH

The use of technology in e-learning requires a systematic and effective approach to ensure that learning actually takes place and the technology acts as a catalyst not only to improve the learning process but also to engage those students who were not able to pursue this in the traditional school environment. The concept of Cyber School extends the traditional school while providing additional functions that have become available due to advances in the technology in recent years. This includes anytime and anywhere access to teaching resources, better teacher–students and student–student interaction, and a much more contextualized learning environment.

The Cyber Classroom circumvents the restriction of space and time, and provides teachers and students with a common study environment well beyond the physical classroom of traditional schooling. The Cyber Teacher Desk provides teachers with enhanced teaching aids and just-in-time access to students both within the real classroom and outside of it. Cyber Student Desk provides students with multifarious learning tools. The Cyber Schooling framework provides a clear classification of the modes in which Cyber School can be used, along with the bandwidth requirements, mobility of network access and the extent of situated learning that can be achieved. The real-life examples of various modes illustrates the practical utility of the framework.

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Nian-Shing Chen is Professor of the Department of Information Management, National Sun Yat-sen University, Taiwan. He is currently the Chairman of MIS department, NSYSU and Adjunct Professor of the Griffith Institute for Higher Education, Griffith University, Australia. He has published over 170 research papers in international refereed journals, conferences and book chapters. His research areas include e-learning, knowledge management and the use and development of online synchronous learning and wireless technologies to enhance learning.

Kinshuk is Professor and Director of School of Computing and Information Systems at Athabasca University, Canada. He has been involved in large-scale research projects on adaptive educational environments and has published over 200 research papers in international refereed journals, conferences and book chapters. He is Chair of IEEE Technical Committee on Learning Technology and Editor of the SSCI indexed *Journal of Educational Technology & Society* (ISSN 1436-4522).

Yi-Hung Wang is currently a master's student with the Information Management Department of the National Sun Yat-sen University, Taiwan. His research interests include e-Learning, knowledge management and the cyber learning community.