ELSEVIER

International Journal of Educational Development 24 (2004) 383–396

International Journal of EDUCATIONAL DEVELOPMENT

www.elsevier.com/locate/ijedudev

An approach to assisting teachers in building physical and network hybrid community-based learning environments: the Taiwanese experience

Li-Jie Chang [a,*], Chih-Yueh Chou [a], Zhi-Hong Chen [b], Tak-Wai Chan [a]

[a] *Center for Science and Technology of Learning, National Central University, Jhongli, 320, Taiwan*
[b] *Department of Computer Science and Information Engineering, National Central University, Jhongli, 320, Taiwan*

Abstract

Information technology (IT) is becoming increasingly important in K-12 (from kindergarten to senior high school) education. Teachers face growing pressure to interact with their students via networks. However, most teachers require IT assistance to establish a network learning environment. In this study, an approach named "Educational Applications Providers Platform" (EAPP), which clearly separates system developers and users, is designed to help teachers easily apply IT to build network learning communities based on existing physical learning communities, and designed to increase interaction frequency and quality both during and after class. Additionally, EAPP assists teachers in integrating physical and network learning communities to proceed with community-based learning. A system named "EduTowns" is implemented to realize the EAPP concept. The analytical results demonstrate that the EduTowns system is effective in Taiwanese schools, regardless of whether they are in urban or rural areas. Moreover, the survey results demonstrate that the EAPP is helpful to many teachers. Even teachers with low IT abilities can use the EduTowns system to build and organize hybrid physical and network community-based learning environments. The survey also indicates that teachers use the EduTowns system both at school and at home.

Keywords: K-12 distance education guides; Community relationships; Educational administration; Taiwan

1. Introduction

Recent developments in information technologies (IT) have facilitated the application of IT in education. Specifically, networks have significantly influenced teaching and learning. Network mechanisms facilitate "connectivity" for teachers and students (Chan, 2002). Notably, teachers and students can use networks to retrieve distant learning materials and resources, manage experimental tools in diverse places, and interact with other teachers and students without being constrained by distance. Networks enhance learning by supporting social learning communities of students and other related resource groups (alumni, volunteers, parents, and so on), and overcoming constraints of time and space. Moreover, networks stimulate learning through collaboration and communication among community members.

Chan and colleagues (2001) noted several network learning models to cope with issues related

* Corresponding author. Tel: +886-3-422715x7851; fax: +886-3-4261931.
E-mail address: jie@cl.ncu.edu.tw (L.-J. Chang).

0738-0593/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ijedudev.2004.02.001

to the applications of networks in education. One model was community-based learning, which deals with the issue of the emergence of network societies. Several virtual learning environments have been established to enable teachers and students to communicate via networks, such as WebCT (WebCT white paper, 2001), TopClass (Lenox, 2001) and CoSE (Roach and Stiles, 1998; Orsmond and Stiles, 2002). These environments are aimed at building and organizing learning communities for distance learning or for both on-campus and distance learners.

Network applications in education in Taiwan began with the establishment of the first Taiwanese Internet network, named TANet, in 1990. Subsequently, following the implementation of the Information Education Infrastructure Plan in 1997, all elementary and junior high schools in Taiwan now have at least one computer laboratory capable of connecting to the Internet. These computer laboratories are designed for teaching IT courses. Besides these computer laboratories, some regular classrooms in some schools are equipped with a computer, a large display screen or a single gun projector, and an Internet connection, allowing the teacher to use IT in teaching non-IT knowledge. Moreover, the Ministry of Education also encourages on-the-job IT training for teachers. Various IT training courses for teachers also have been held, as well as conferences on the application of IT in education. With the support of network infrastructure, computer hardware, and training courses, many Taiwanese teachers are trying to apply IT in education. Furthermore, some teachers build and operate their own online learning communities by using some tools, such as website or bulletin board system.

Schools and classes, the key learning communities in K-12 (from kindergarten to senior high school) education, basically are physical learning communities. Individuals in such physical communities generally share the same value systems and visions, and frequently interact with others face-to-face. Building network learning communities corresponding to these physical learning communities is an effective method of enhancing the quality and frequency of the interactions within physical communities, because networks provide teachers with an enhanced environment for managing learning communities and resources. While teachers are expert managers of school and class based learning communities, applying network technologies to education generally requires teachers to spend time not only on managing a network learning community, but also on implementing a system for supporting that network learning community. Therefore, teachers must learn how to maintain and even implement a network system, a requirement that becomes a barrier to proceeding with network community-based learning. Although various virtual learning environments have been developed to assist teachers in building network learning communities, most such environments are oriented towards distance learners. Little work has been done on supporting network learning communities based on existing physical learning communities. To help teachers construct network learning communities based on existing physical learning communities and interaction with students, this study proposes an approach named ''Educational Applications Providers Platform (EAPP)'' to separate system developers and system users. EAPP is carried out by the EduXs architecture, which provides multilayer network learning communities for mapping onto physical learning communities (Chang et al., 2003). EAPP developers implement network systems to support community-based learning while teachers are merely system users and do not need to implement the systems. Freeing teachers from system implementation allows them to focus on managing their hybrid physical and network community-based learning environments. Moreover, with the support of EAPP, even teachers with low IT abilities can establish hybrid physical and network community-based learning environments to enhance interaction quality and frequency both in and after class.

The remainder of this paper is organized as follows: Section 2 presents the EAPP approach to building a community-based learning environment. Next, Section 3 describes EduTowns, an instance system of EAPP. Section 4 then details the propagation and preliminary results of applying EduTowns in Taiwan. Finally, Section 5 presents some conclusions.

2. Approach to building community-based learning environments in school

2.1. Current status of the application of IT to education by Taiwanese teachers

Some curriculum revisions have been made in Taiwan to promote IT. Since 1998, computer courses have become a compulsory part of the junior high school curriculum. Moreover, the Nine-year Comprehensive Curriculum for elementary and junior high education, which plans to reform and integrate the elementary and junior curriculum in a stepwise fashion during 2001 to 2005, contains a strong focus on IT in education. Notably, the Nine-year Comprehensive Curriculum specifically requires the application of IT in teaching various subjects.

Teachers are essential to schools, and also are important in encouraging students to use IT whether at school or at home. Through involvement in conferences for training teachers and promoting the application of IT to education, the authors have sensed two phenomena. Firstly, although a lot of training courses on applying IT in education are provided for K-12 teachers, most teachers dealing with IT in education still require IT support. One reason for this problem is the inconvenient nature of computer and network technologies; therefore, teachers need to spend considerable time in learning these technologies. It causes additional workloads for teachers to applying IT in education (Ree, 2002). Second, teachers can roughly be classified into three categories, namely: (1) innovators, (2) followers, and (3) conservators. The categories resemble Roger's (1983) adopter categories on innovativeness, and assigning teachers to these three groups facilitates the understanding of user behavior (Moore, 1991). As shown in Fig. 1, innovators willingly accept new teaching strategies and technologies. Innovators can be divided into two further groups, namely those with high IT abilities and those with low IT abilities. Innovators with high IT abilities generally can apply IT effectively in education, but only a very small percentage of teachers fall into this category. In contrast, innovators with low IT abilities are willing to apply

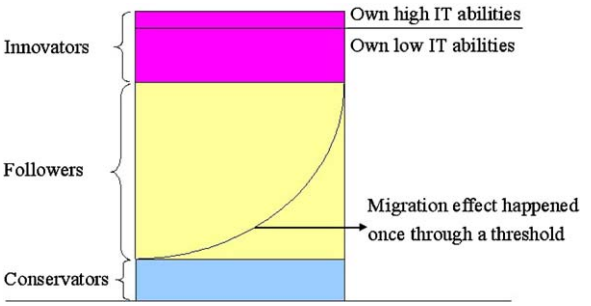

Fig. 1. IT in education assumption.

IT in education, but face challenges in doing so. Some teachers in this category spend considerable time enhancing their IT abilities, others seek assistance from or collaborate with colleagues, and others give up after a period of effort.

In reality, most teachers are "followers". Followers imitate innovators once they see them applying IT in education effectively, and are especially encouraged by the successes of innovators with low IT abilities. Theoretically, an event called the "migration effectiveness of IT in education" occurs once the percentage of followers applying IT in education in a particular environment exceeds a certain threshold. At the individual school level, this point is that at which most teachers in the school begin to apply IT in their teaching environment.

Notably, every school also contains a group of conservators. These teachers have become accustomed to their existing teaching style and are unable to easily adopt new teaching methods.

Based on the above schema, the authors hypothesize that the key to achieving the migratory effectiveness of IT in education is to assist those teachers who are innovators with low IT abilities.

2.2. Approach: separate system developers and system users

Teachers that adopt network technologies to enhance interactions in physical learning communities encounter several challenges in applying IT in education, such as caring for hardware, maintaining software and networks, designing learning courses and instruction methods, managing learning communities, and even implementing

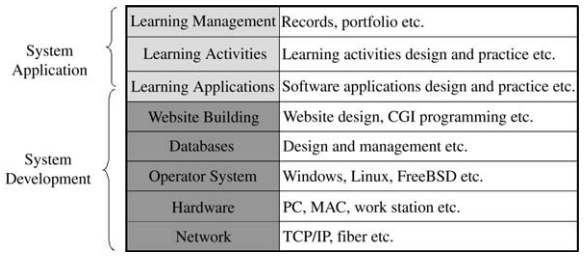

Fig. 2. Layers involved in building a community-based learning environment.

network learning environments. Fig. 2 demonstrates that teachers must overcome challenges in at least eight areas when applying network technologies to improve interactions in physical communities, as follows:

1. Network: teachers need an Internet connection at least. Furthermore, numerous network technologies exist, such as, fibre, ADSL (Asymmetric Digital Subscriber Line), cable modem, and so on, one of which must be chosen.
2. Hardware: teachers must decide which computer hardware is suitable for their needs. Teacher must choose from multiple types of computer hardware, including personal computers, Macintoshes, work stations, and so on.
3. Operating System: Once the hardware is in place, teachers must select an operating system. At this stage, teachers have a wide range of choices, such as Solaris, Linux, Windows, FreeBSD, and so on.
4. Databases: Teachers need databases to store website data, with possible choices including MySQL, SQL Server, Oracle, Sybase, and so on. Choices about database design and management must also be made at this stage.
5. Website Building: A web server is the minimal requirement if the teacher wants to interact with their students via a web-based environment. Consequently, a web server, HTML coding, and CGI programming are required at his stage.
6. Learning Applications: The website itself requires various learning applications, such as interactive content, voting systems, bulletin board systems, and so on, to enhance the interactions of the teachers and students.
7. Learning Activities: Learning activities must be designed and practiced based on the learning applications.
8. Learning Management: Finally, a management mechanism is needed for learning records, user portfolios, and so on.

Generally, teachers are unable to deal with all of the above issues satisfactorily and require support in at least some areas. The eight areas can be divided into two main groupings: system development and system application. Almost all K-12 teachers are expert in system application grouping, and have good abilities to apply learning applications, design learning activities, and mange learning activities in their classes. Conversely however, almost all of these teachers also are extremely weak in system development. On the other hand, system programmers and system administrators are expert in system development grouping. EAPP separates system developers and system users to allow programmers and teachers to work to their strengths and collaborate with others. In EAPP, system developers focus on building a high-usability system to help teachers build network community-based learning environments and interact with their students. Meanwhile, teachers concentrate on applying the system to establish a high-sociability learning environment and to interact with students.

2.3. *Supporting hybrid physical and network community-based learning*

Physical learning communities, such as families, classrooms, schools, and work places tend to have long lifetimes. Learners, especially K-12 students, spend most of their study time in these physical learning communities. Simultaneously, IT development recently has made network learning communities extremely successful (Oren et al., 2000; Preece, 2000; Wachter et al., 2000; Rheingold, 1993; Schuler, 1996; Preece and Ghozati, 1998). The development of network learning communities has been strongly influenced by that of physical learning communities. In some circumstances, network and physical learning communi-

ties are actually combining. Consequently, the boundary between physical and network learning communities is becoming blurred.

As described earlier, Taiwan has devoted considerable effort to establishing a network infrastructure in schools. TANet now contains numerous network communities, and both teachers and students are becoming increasingly interested in building network learning communities. Building network learning communities based on physical learning communities can enhance interaction between teachers and students both in and after class. EAPP assists teachers in building their own network learning communities based on the existing physical learning communities and, furthermore helps them to integrate network and physical learning communities.

3. EduTowns system: An instance of EAPP

3.1. EAPP: Educational applications providers platform

According to the above assumptions, innovators with low IT abilities are the keys to promoting IT in education. However, these teachers require support, particularly in computer and network technologies. Strategies thus must be developed to reduce the technological obstacles. EAPP offers one solution for supporting teachers in applying IT in education. In the EAPP concept, most technological problems are solved by a centralized group of programmers. These programmers provide educational application services on the EAPP. Consequently, teachers merely need to choose the required activity platform, and can then direct students in using that platform in their learning activities. A system named "EduTowns" is developed and implemented in Taiwan using EAPP concept. Currently, the EduTowns system services K-12 teachers and students in Taiwan (Chang et al., 2003).

In operating an online learning community, users should focus on community management rather than understanding the computer system architecture. In the EduTowns system case, the computer systems are provided by a group of educational application services providers. Until now, the service items have involved loose couple integration. The standard development of information technology software reveals that tight couple integration of service items is possible.

3.2. System concept and service items

The EduTowns system is a multilayer educational platform supporting hybrid physical and network community building. The EduTowns system provides three environments, namely EduTown, EduVillage, and EduCitizen to assist schools, classes, and individuals in constructing and managing corresponding network learning communities, as shown in Fig. 3. The EduTowns system is implemented under the guideline layer and relations. In the EduTowns system, each EduTown represents a school, while EduVillages represent classes, clubs or learning groups, and individual teachers or students can apply to become EduCitizen by filling in an on-line application form. Notably, each EduCitizen belongs to an EduTown. However, individual EduCitizens can belong to multiple EduVillages by participating in different learning activities.

The EduTowns system incorporates several scaffolding functions, named "service items," that allow management users to select and construct specific network learning community environment. A menu displays available service items, allowing managers belonging to each EduTown and EduVillage to select from these items and

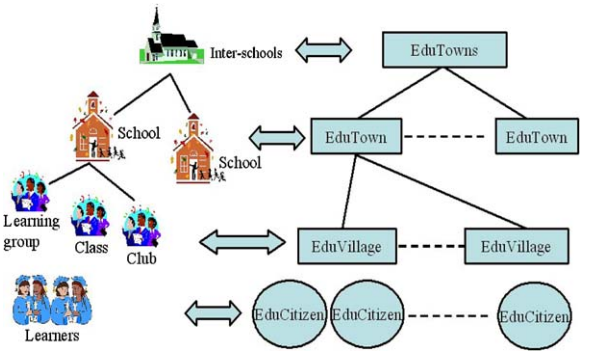

Fig. 3. Mapping the physical and network communities of EduTowns system.

include them in their environment to develop a learning community. Furthermore, each service item has both user and manager interfaces. For example, if a manager of an EduTown selects a "bulletin board" service item and adds it to their EduTown, then that manager can manage the bulletin board via the bulletin board management interface. Specifically, the manager can establish new boards, name them, assign a brief description to each, and establish user interfaces for these boards by selecting and adjusting various parameter options. Once the manager has established a board, EduTown users can post new messages and reply to other messages on the board via the user interface. The manager then can monitor board activity, make announcements, or delete messages deemed inappropriate via the manager interface.

Service items in the EduTowns system are classified into four categories: content service items, community service items, application service items, and other service items. Content service items provide mechanisms for users to create, share, modify, and utilize learning material. Meanwhile, community service items provide community members with a focal point for communicating with and learning from others. Moreover, community service items also provide channels for and facilitate communication among members. Finally, application service items comprise some environments for specific learning activities. The EduTowns system also provides another extension service item catalogue, named "Speciality", which enables managers to establish and manage links with other network-based content or systems in the EduTowns system. Different service items were provided to EduTown, EduVillage, and EduCitizen layers to fit the different requirements of school, class, and individual learning environments.

3.3. EduTown

EduTown is a school-based environment in which schools can organize their network learning communities. A teacher with a computer background can apply to construct a mapping EduTown on EduTowns system for his/her school. When the application is accepted by the system manager, an EduTown representing the school is created and a manager account is granted to the teacher for managing the EduTown of that school. Initially, an EduTown includes no service items and merely presents some default information. The manager of the EduTown must establish service items for the EduTown as appropriate. After constructing the EduTown, the manager can encourage students and teachers to apply for EduCitizen accounts and join the EduTown. The next step is for the manager to facilitate and supervise learning community development in the EduTown. EduTown managers are also responsible for managing applications for the establishment of EduVillages within their EduTowns. Any EduCitizen belonging to an EduTown can apply to establish an EduVillage under that EduTown. New EduVillages are created subject to approval by the EduTown manager, and then are managed by their applicants. The manager of the EduTown oversees the EduVillages and promotes activities within their EduTown.

3.4. EduVillage

Each EduVillage is a class-based environment in which a class can organize a network learning community. Individual EduCitizens can apply to create and manage EduVillages. Generally, the manager of an EduVillage is the teacher of a class. But students also can manage EduVillages. EduVillage managers first select appropriate service items to construct their EduVillages, and then encourage students to apply to become EduCitizens and join their EduVillages. Moreover, managers can facilitate and control learning activities in the EduVillages through their interaction with students in the physical world. Besides physical classes, other groups, such as parents, staffs, or clubs, in schools can also build their EduVillages.

3.5. EduCitizen

EduCitizens provide an environment to assist individual teachers or students to participate in network social learning communities. An EduCitizen account is created after an applicant fills

in an on-line application form, and after the data they enter passes a brief system safety check. Individual service items are supported with both individual and community-based learning scaffolding tools. For example, the user can use a "note" service item to record notes. Moreover, the user can employ a messaging system to communicate with other users of the EduTowns system. Individual EduCitizens can determine whether individual service items should to be public or private. For instance, if the users decide that their "note" service item should be private, their notes will only be visible to themselves after logging into the system. Alternatively, when a user decides that this service item should be public, other users also will be able to see the notes and communicate with the user. EduCitizens can join multiple EduVillages. For example, an EduCitizen can join an EduVillage representing their class and another EduVillage representing a club.

3.6. Diffusion strategy

In the EduTowns system, users must fill in an application form to apply for a layer, such as EduTown, EduVillage, or EduCitizen. All completed application forms then are sent to the managers of corresponding upper layer. The manager of the upper layer reviews the application forms and decides whether to accept or reject the applicant. Once the manager accepts the application form, a layer belonging to the applicant is created automatically, managed by the applicant, and supervised by the manager of upper layer.

In the EduTowns system, a layer can be created and assigned to a layer manager by the manager of upper layer conveniently. If individuals interested in being the layer manager can be found, then numerous layers can be created and managed. In our diffusive experiences, the layer manager is the key to helping diffuse the system. The authors held several workshops in Taiwan, introducing the system to the schools teachers with computer science backgrounds. These workshops attendees can act as layer managers, and can help to diffuse the system to their schools by enrolling managers of lower layers. Numerous layers are created conveniently and are supervised by the upper layer managers (Fig. 4).

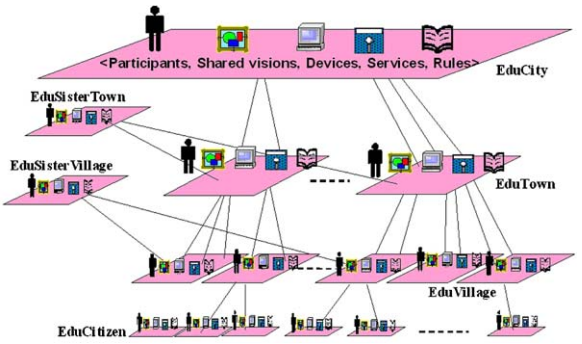

Fig. 4. Diffusion strategy.

4. Preliminary results and discussions

4.1. Propagation activities

The EduTowns system was announced on January 13, 2001. Promotional material and a user guide for the EduTowns system was placed on an educational website, named EduCities (Chan et al., 2001). The EduTowns system is a sub-system of the EduCities website, meaning users of EduCities easily can apply to use the EduTowns system. From March 2001 to May 2002, several workshops were held to promote the EduTowns system. These workshops were designed for teachers, especially teachers of computer courses in elementary and junior high school. These workshops were held in computer laboratories, where each teacher had a network-linked computer. During the workshop, the teachers were first told about the nature of the EduTowns system and its capabilities. Subsequently, the instructor demonstrated how to apply for an EduTown and each teacher applied for an EduTown for his/her school on the spot. Each teacher thus became the manager of an EduTown representing his/her school. Next, the teachers were told how to administer an EduTown, including constructing the EduTown, processing applications to create EduVillages under the EduTown, and managing the EduTown

and its EduVillages. Since the process of applying for and administering an EduVillage is similar to that for an EduTown, teachers who attended the workshop could instruct other teachers in applying for and constructing EduVillages after returning to their schools. Subsequently, these teachers could teach their students how to become EduCitizens.

4.2. Propagation results of the EduTowns system in Taiwan

The EduTowns system was announced to Taiwanese K-12 teachers and students via the Internet. Taiwan has a population of 22 million. Generally, IT levels in education correlate with level of urbanization, with urban governments controlling more educational IT resources than rural governments. Accordingly, this study uses population as an index of IT utilization in the Taiwanese education system. In this section, the authors investigate the usage of the EduTowns system in urban and rural areas. Taiwan includes a total of 25 cities and counties. The authors held several workshops to train teachers to apply for EduTowns and use the system. However, some of the newly established EduTowns remained silent after their registration. To distinguish the frequently visited and non-frequently visited EduTowns, the authors defined a frequently visited EduTown as one whose members login to the system at least once a week (Chang et al., 2003). The EduTowns system is a web-based system, and all Taiwanese teachers can apply to use it. The authors logged the system data from June 1, 2002 to October 31, 2003. Table 1 lists this data from a period after the release of the system.

Table 1 indicates that many schools in Taiwan applied to use the EduTowns system. One of the special cases listed in the Table is Changhua County. Changhua County is an agricultural county where farming is the major economic activity. However, 98% of schools in Changhua County have applied to use the EduTowns system. Among these schools, 23% are frequently visited and use the system to operate their hybrid physical and network community-based learning environments. The Bureau of Education (BOE) of Changhua County government is helpful in prompting the EduTowns system in the county because one of the officers of the Changhua County BOE considers the system helpful to rural schools. Besides Changhua County, the EduTowns system also widely accepted in other country areas in Taiwan. This is important because access to suitable resources can enhance teacher and student performance, and the Internet provides a rich source of such resources. From Table 1, a comparison of Taipei City and Taipei County, Hsinchu City and Hsinchu County, Taichung City and Taichung County, Chiayi City and Chiayi County, Tainan City and Tainan County, Kaohsiung City and Kaohsiung County, reveals little difference in system usage rates between urban and rural areas. The system thus seems useful to both urban and rural schools. Although it was noted earlier, that urban governments have more resources to apply IT in education, EduTowns system usage statistics display little difference between urban and rural areas. The strategy of separating system developers and users may be one reason for this phenomenon. Because of the separate design strategy, teachers do not need to spend much time on system design, and obtain good results for the effort they put into their network learning communities.

4.3. Online questionnaire survey

Online questionnaires frequently are used to gather basic user data and responses. Such questionnaires also represent an easy method of sampling the views of a large number of people. An online questionnaire was applied to survey users' feelings regarding the EduTowns system. The questionnaire was displayed on the website from 14 April to 28 April, 2003. Meanwhile, data validity was ensured by requiring that users who connected to the system answered the questionnaire no more than once. Only teachers could fill in the questionnaire. All user responses were stored in the system database. Some 992 questionnaire copies were filled in by teachers and collected. Although these respondents to the questionnaire are likely to be regular users and also fairly competent, the results provide their

Table 1
Statistics of EduTowns system by each Taiwanese city and county

No	City/County	Population[a]	Schools	Applied schools	Applied (%)	Freq. visited schools	Freq. visited (%)[b]
1	Taipei County	3,670,635	340	286	84%	42	15%
2	Taipei City	2,626,652	307	292	95%	57	20%
3	Taoyuan County	1,817,035	262	232	89%	19	8%
4	Taichung County	1,518,228	238	122	51%	29	24%
5	Kaohsiung City	1,508,637	158	139	88%	49	35%
6	Changhua County	1,315,877	236	232	98%	53	23%
7	Kaohsiung County	1,236,796	227	150	66%	18	12%
8	Tainan County	1,106,584	249	96	39%	29	30%
9	Taichung City	1,007,659	115	109	95%	28	26%
10	Pingtung County	903,803	236	61	26%	12	20%
11	Tainan City	748,805	86	75	87%	13	17%
12	Yunlin County	741,020	208	69	33%	13	19%
13	Miaoli County	560,753	167	88	53%	29	33%
14	Chiayi County	560,437	174	42	24%	13	31%
15	Nantou County	540,401	195	57	29%	12	21%
16	Eland County	463,310	113	72	64%	17	24%
17	Hsinchu County	458,135	119	60	50%	9	15%
18	Keelung City	392,052	69	41	59%	18	44%
19	Hsinchu City	382,154	57	39	68%	10	26%
20	Hualien County	351,232	149	46	31%	16	35%
21	Chiayi City	269,396	43	42	98%	6	14%
22	Taitung County	243,163	123	63	51%	10	16%
23	Penghu County	92,293	58	20	34%	7	35%
24	Kinmen County	60,482	26	21	81%	3	14%
25	Lianjiang County	8,742	14	12	86%	2	17%

[a] The population on the table is obtained from http://www.moi.gov.tw/.
[b] Active percentage is counted based on the number of applying schools.

perspective on EduTowns system. Table 2 lists the results of the online questionnaire.

Among the 992 copies of questionnaire respondents, 52.22% were male and 47.78% were female. Most were teachers who used the Internet every day (52.52%), and 89.01% of users had an Internet access point in their home. The questionnaire results also show that teachers used the EduTowns system in school and even at home. Notably, 79.03% of teachers in this survey agreed that the EduTowns system was helpful in building their online learning communities. However, 20.97% of teachers considered the system unhelpful, citing the reasons: ''The tools are too few'', ''Not enough service items'', and ''The interface is not good enough''. These negative feedbacks demonstrate that the EduTowns system still has room to improve. Teachers who answered ''I can construct the website by myself'' and ''I already have a website'' were those with higher IT abilities and were willing to build their website by themselves. Overall however, the EAPP approach was clearly helpful to most teachers.

To identify the relation between the EduTowns system and users' IT abilities, the authors roughly classify users into high and low IT abilities groups according to their responses regarding computer technology. Users who claim knowledge of programming language tools such as Java, C, and so on, and of database applications such as MySQL, SQL Server, and so on are classified as high IT abilities users. Meanwhile, other users were classified as low IT abilities users. Tables 3 and 4 list the statistical results.

Comparing Tables 3 and 4 demonstrates that teacher members with high IT abilities (345) are

Table 2
Statistics of the online questionnaire

Question?	Results (%)				
Copies of responses	992				
Are you male or female?	Male (52.22%)		Female (47.78%)		
How frequently do you access the Internet?	Every day (52.52%)	1–2 days (19.25%)	3–4 days (10.18%)	5–6 days (6.65%)	More than 7 days (11.39%)
How much time do you spend online when you access the Internet?	Less than 1 hour (26.51%)	1–3 hours (50.10%)	3–5 hours (12.40%)	5–7 hours (4.44%)	More than 7 hours (6.55%)
Do you have an Internet access point in your home?	Yes (89.01%)		No (10.99%)		
Where do you use the Internet? (multiple choices permitted)	Home (86.49%)		Classroom (23.69%)		Computer laboratory (38.71%)
	Library (5.24%)		Office (33.77%)		Others (11.19%)
What kinds of software usually used in your working time? (multiple choices permitted)	Programming language (19.76%)	Homepage editing tools (58.27%)	Word (80.24%)		Excel (60.69%)
	PowerPoint (64.31%)	Database (27.02%)	Photo tools (52.32%)		Others (5.75%)
When do you generally use the EduTowns system? (multiple choices permitted)	In the classroom (37.10%)	Break time in school (30.54%)	At home (61.79%)		Weekend (42.04%)
Is the EduTowns system helpful in building an online learning community?	Yes (79.03%)		No (20.97%)		
If so, why is the system helpful? (multiple choices permitted)	Easy to manage (69.26%)		Need not to coding (56.12%)		Personalize (46.05%)
	Service items supported (60.08%)		Can combine with the existed website (47.45%)		Others (2.55%)
If not, why is the system not helpful? (multiple choices permitted)	The tools are few (18.75%)		I can construct the website by myself (23.56%)		The interface is not good enough (12.98%)
	No enough service items (26.44%)		I already have a website (15.38%)		Others (33.17%)

outnumbered by those with low IT abilities teachers (647), as was originally assumed by the authors. From Table 3, male members with high IT abilities (61.15%) outnumber female teachers with equivalent abilities (38.84%), but the difference between the sexes is minimal in the low IT abilities group. Comparing Tables 3 and 4 also reveals that Internet use time, frequency, and place differ little between the high and low IT abilities teachers. Among the low IT abilities teachers, 77.43% agree that the EduTowns system is helpful in building their online learning community.

4.4. Observation: a real case study of the migration effect in a school

Observations can provide various types of information. In this case, the authors found Mrs. C., who did not have a computer background, but has had good experience of using the EduTowns system.

Mrs. C. teaches at Fu-Gang junior high school, which is located in a small town named Yang-Mei, in Taoyuan County, Taiwan. The school has around 560 students, and has 12 classrooms. The parents of most of the students are farmers or

work in factories. The staff of the school include a president, four chairmen, 10 management officers, and 24 teachers. Fu-Gang junior high school is a typical Taiwanese county school. The school has two teachers with computer science backgrounds who are in charge of computer science courses. There are two computer laboratories, but one is now rather old. The computer hardware is managed by a teacher with a computer science background. Mrs. C. was born in 1961. She graduated from the Department of English, National Kauhsiung Normal University, Taiwan. As of 2002, she had 18 years of teaching experience. She is a typical active teacher, but is not familiar with computer technology.

Mrs. C. attended the EduTowns system workshop, and applied to manage the EduTown for her school. After the workshop, she was very

Table 3
Results of high information technology abilities teachers

Question?	Results (%)				
Copies of responses	345				
Are you male or female?	Male (61.15%)		Female (38.84%)		
How frequently do you access the Internet?	Every day (55.07%)	1–2 days (15.07%)	3–4 days (9.28%)	5–6 days (7.54%)	More than 7 days (13.04%)
How much time do you spend online when you access the Internet?	Less than 1 hour (21.45%)	1–3 hours (48.12%)	3–5 hours (13.04%)	5–7 hours (5.80%)	More than 7 hours (11.59%)
Do you have an Internet access point in your home?	Yes (88.70%)		No (11.30%)		
Where do you use the Internet?	Home (86.09%)		Classroom (22.90%)		Computer laboratory (46.67%)
(multiple choices permitted)	Library (5.22%)		Office (30.43%)		Others (14.49%)
When do you generally use the EduTowns system? (multiple choices permitted)	In the classroom (42.32%)	Break time in school (31.30%)	At home (59.71%)	Weekend (44.06%)	
Is the EduTowns system helpful in building an online learning community?	Yes (82.03%)		No (17.97%)		
If so, why is the system helpful?	Easy to manage (78.09%)		Needn't to coding (59.36%)		Personalize (52.30%)
(multiple choices permitted)	Service items supported (62.54%)		Can combine with the existed website (53.00%)		Others (1.77%)
If not, why is the system not helpful? (multiple choices permitted)	The tools are few (17.74%)		I can construct the website by myself (25.81%)		The interface is not good enough (9.68%)
	No enough service items (35.48%)		I already have a website (14.52%)		Others (29.03%)

active in promoting EduVillages in her school. Mrs. C. personally produces the EduTown related handouts for Fu-Gang junior high school teachers and students. Furthermore, she has organized several workshops at her school. In the computer laboratory, Mrs. C. collaborates with teachers and students who are using the EduTowns system. Mrs. C. has also encouraged students to help each other to construct their own online learning communities. Mrs. C. mentioned that the EduTowns system is helpful in supporting learning on computer technologies, such as through notes, bulletin boards, recent news, and uploaded content. Mrs. C. also mentioned that these service items are very useful, especially for teachers who are unfamiliar with computers. Now, teachers in the school use the system to communicate with students, collect electronic homework, and so on.

Table 4
Results of low information technology abilities teachers

Question?	Results (%)				
Copies of responses	647				
Are you male or female?	Male (47.45%)		Female (52.55%)		
How frequently do you access the Internet?	Every day (51.16%)	1 – 2 days (21.48%)	3 – 4 days (10.66%)	5 – 6 days (6.18%)	More than 7 days (10.51%)
How much time do you spend online when you access the Internet?	Less than 1 hour (29.21%)	1 – 3 hours (51.16%)	3 – 5 hours (12.06%)	5 – 7 hours (3.71%)	More than 7 hours (3.86%)
Do you have an Internet access point in your home?	Yes (89.18%)		No (10.82%)		
Where do you use the Internet? (multiple choices permitted)	Home (86.71%)		Classroom (24.11%)		Computer laboratory (34.47%)
	Library (5.26%)		Office (35.55%)		Others (9.43%)
When do you generally use the EduTowns system? (multiple choices permitted)	In the Classroom (34.31%)	Break time in school (30.14%)	At home (62.91%)		Weekend (40.96%)
Is the EduTowns system helpful in building an online learning community?	Yes (77.43%)		No (22.57%)		
If so, why is the system helpful? (multiple choices permitted)	Easy to manage (64.27%)		Needn't to coding (54.29%)		Personalize (42.51%)
	Service items supported (58.68%)		Can combine with the existed website (44.31%)		Others (2.99%)
If not, why is the system not helpful? (multiple choices permitted)	The tools are few (19.18%)		I can construct the website by myself (22.60%)		The interface is not good enough (14.38%)
	No enough service items (22.60%)		I already have a website (15.75%)		Others (34.93%)

Mrs. C. has been using the EduTowns system for over a year. She successfully built the websites of each class using the EduVillage subsystem, and encouraged other teachers to use the system to interact with their students. Mrs. C. also helped students to construct individual learning environments using the EduCitizen subsystem. This case of Mrs. C. in Fu-Gang junior high school reveals that even teachers with low IT abilities can use the EduTowns system to build and organize their hybrid physical and network community-based learning environments. It also shows that assisting those teachers who are innovators with low IT abilities can cause the migratory effectiveness of IT in education.

5. Conclusions

Teachers face growing pressure to interact with their students via the Internet. However, most teachers require assistance in building an online learning environment and interacting with their students there. Hybrid network and physical learning communities offer one possible method of applying IT in education in schools. The Internet is a rich resource for increasing the quality and quantity of interaction between teachers and students and enabling teachers and students to collaborate effectively in developing hybrid learning environments.

In traditional online learning community building, teachers spend most of their time in coding and managing their network learning communities. However, unlike traditional methods of building network learning communities, EAPP approach, which separates system developers and users, allows teachers to focus on managing and operating their hybrid physical and network learning communities. The EduTowns system, which is based on the EAPP concept, was implemented and announced via the Internet. The preliminary surveys of the effectiveness of the EduTowns system, based on system logs, online questionnaire, and observation, indicate that the strategy of separating system developers and users is very effective in Taiwanese schools, including those in urban and rural areas. The online questionnaire survey reveals that the EAPP approach is helpful to many teachers. Even teachers with low IT abilities can use the EduTowns system to build and organize their hybrid physical and network community-based learning environments. These teachers use the system in school and even at home. The observation, which was conducted in a typical Taiwanese county school, demonstrates that even teachers with low IT abilities can use the EduTowns system effectively. Consequently, EAPP blurs the boundaries between physical and network communities (Lazar et al., 1999).

The EduTowns system is still a work in progress. Online statistics also indicate that the EduTowns system still has room to improve, for example in providing more service items and management tools, and a more user-friendly, flexible and personalized interface. Furthermore, more detailed evaluations should be performed, such as evaluations of the effects of the EduTowns system on teachers and students, and on facilitating community-based learning. It is also essential to examine the reasons why some EduTowns are not frequently visited. Extend the Fu-Gang junior high school observation, a widely survey based on structured interview is needed. To date, the EduTowns system primarily has been a web-based, centralized system. However, a more decentralized EduTowns system is developing due to teachers' demand. How to integrate this decentralized system with teaching and learning content is a work in progress.

Acknowledgements

The authors would like to thank the reviewers, who provide helpful opinions to revise this paper. The authors also thank the participants in the system development, and observation study for their kind cooperation. This project is funded by the Ministry of Education, Taiwan: Program for Promoting Academic Excellence of Universities, Project of "Learning Technology, Active Social Learning and its Applications, from Taiwan to the World" by National Central University. (Project No. 92-H-FA07-1-4).

References

Chan, T.W., 2002. Social design of network learning society. In: Proceedings of International Conference on Computers in Education 2002, Auckland, New Zealand, pp. 1–5.

Chan, T.W., Hue, C.W., Chou, C.Y., Tzeng, O.J.L., 2001. Four spaces of network learning models. Computers and Education 37 (2), 141–161.

Chang, L.J., Yang, J.C., Deng, Y.C., Chan, T.W., 2003. EduXs: Multilayer educational services platforms. Computers and Education 41 (1), 1–18.

Lazar, J., Tsao, R., Preece, J., 1999. One foot in cyberspace and the other on the ground: A case study of analysis and design issues in a hybrid virtual and physical community. WebNet Journal: Internet Technologies, Applications 1 (3), 49–57.

Lenox, D., 2001. A WBT System White Paper: Managing Knowledge with Learning Objects. http://www.wbtsystems.com/downloads/whitepapers/managing-knowledge.pdf

Moore, G.A., 1991. Crossing the Chasm. HarperBusiness, NY.

Oren, A., Nachmias, R., Mioduser, D., Lahav, O., 2000. Learnet: A model for virtual learning communities in the world wide web. International Journal of Educational Telecommunications 6 (2), 141–157.

Orsmond, P., Stiles, M., 2002. University teaching: A challenge to staff development. Innovations in Education and Teaching International 39 (4), 253–256.

Preece, J., 2000. Network communities, designing usability, supporting sociability. In: Preece, J. (Ed.), Community Tours. Wiley Publisher Press, New York, pp. 54–66.

Preece, J., Ghozati, K., 1998. In search of empathy network: A review of 100 network communities. In: Paper presented at the 1998 Associaton for Information Systems Americas Conference, Baltimore, MD.

Ree, R., 2002. Second year teacher candidates reflect on information technology in Ontario secondary schools: how it is being used and the challenges it presents. Journal of Information Technology for Teacher Education 11 (2), 143–160.

Rheingold, H., 1993. The Virtual Community: Homesteading on the Electronic Frontier. Addison Wesley Press, MA.

Roach, M.P., Stiles, M.J., 1998. COSE: A virtual learning environment founded on a holistic pedagogic approach. CTI: Software for Engineering Education 14, Available as: http://www.ltsneng.ac.uk/downloads/pdfs/news/nl14.pdf

Rogers, E., 1983. Diffusion of Innovation, third ed. Free Press, New York.

Schuler, D., 1996. New community networks: Wired for change. ACM and Addison-Wesley Press, MA.

Wachter, R.M., Gupta, J.N.D., Quaddus, M.A., 2000. IT takes a village: Virtual communities in support of education. International Journal of Information Management 20, 473–489.

WebCT white paper. 2001. Leveraging Technology to Transform the Educational Experience. http://www.webct.com/

Li-Jie Chang received his PhD degree in Computer Science and Information Engineering from the National Central University, Taiwan in 2003. He is a postdoctoral researcher in Center for Science and Technology of Learning of National Central University. His current research interests are network educational games, network learning communities, and network learning platform design.

Chih-Yueh Chou received his PhD degree in Computer Science and Information Engineering from the National Central University, Taiwan, in 2000. He is a postdoctoral researcher in Center for Science and Technology of Learning of National Central University. His current research interests are educational games, intelligent distance learning, social learning theory and systems, and intelligent educational agents.

Zhi-Hong Chen received his masters degree in Computer Science and Information Engineering from the National Central University, Taiwan, in 2002. He is a PhD student in the Department of Computer Science and Information Engineering at the National Central University. His current research interests are network educational games, network learning communities, and individual learning environment design.

Tak-Wai Chan received his PhD degree in Computer Science from University of Illinois at Urbana-Champaign in 1989. He proposed the concept of learning companion systems in his thesis. He is now the Chair of Graduate Institute of Network Learning Technology. His current research interests are mobile learning, active social learning models, and intelligent educational agents.