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Teacher-oriented adaptive Web-based environment for supporting practical teaching models: a case study of "school for all"

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Abstract

Web-based learning systems, if designed appropriately, offer many advantages over the traditional learning environments. This study addresses the design and development of new approaches and network technologies based on the newly induced pedagogical models to support collaborative teaching, knowledge sharing, lifelong learning opportunities for anyone to offer or participate in courses free of charge. The authors propose and implement a Web-based learning environment called "School for All" in the Web-based Educities. To satisfy the needs of individual instructors, adaptive Web-based authoring tools and methods of teaching have been proposed, including five adaptive modules – Curriculum Setting, Co-teaching and Privileges Setting, Reward Setting, Assessment Setting and Information Sharing Setting. Thirty representative courses that used this adaptive School for All system were under close observations and investigation. An additional questionnaire was also used to collect online teachers' perceptions of this Web-based learning environment. Online teachers reported that these adaptive modules could support their online teaching effectively. More results were presented and more issues regarding online teaching were discussed in this paper.

Keywords: Lifelong learning; Authoring tools and methods; Cooperative/collaborative learning; Teaching strategies; Learning community

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1. Introduction

The demand for online learning is growing fast. However, most Web-based learning environments are designed and implemented for academic or professional purposes, and not for netizens (network citizens). As Pickering (1995) pointed out, people who could educate on the Internet might not necessarily be teachers in the traditional sense, but fellow navigators in cyberspace. Thus, this paper proposes practical and adjustable ways to support online teaching and learning through implementing a Web-based educational platform called "School for All" in tended for non-profit interest-driven learning community. A related study focusing on the learning community evaluation has been reported in the paper, "A Preliminary Evaluation of a Web-mediated School for All (Young, Chan, & Lin, 2002)." This paper aims to present the systemic conceptual framework of the platform and is composed of the following four sections: First, relevant theories and the origin of the "School for All" are presented. Second, six teaching models are proposed to support teaching on the Internet, with reference to the instructor and the curriculum. Third, the implementation of this adaptive system is described. Finally, the representative courses are analyzed and ideas for future research proposed.

1.1. Background

EduCities is an educational portal site that adopts the metaphor of a city to promote learning communities. It was established by several universities in Taiwan. All activities at the EduCities Website occur in the conceptual central space, which is the entry point to all of the various systems developed by different researchers (Chan, Hue, Chou, & Tzeng, 2001). The "School for All," an innovative learning environment, has been developed for large-scale Web-based active learning. It is the first virtual environment built on the Web-based EduCities (Young et al., 2002) and established as an online learning and teaching environment.

Information on the Web makes shared knowledge immediately available to anyone in the world with a suitable computer connection; anyone can publish such information (Kearsley, 2000). The motivation behind the "School for All" project is to challenge the tenet of traditional education that only teachers educate and only students learn. If anyone prepared to engage in Web education can be enabled to teach regardless of age or occupation, then information technology can be said to have provided an important benefit. The "School for All" takes advantage of the Internet and the mechanisms of social groups, and allows everyone to learn and acquire new knowledge openly, freely and interactively.

Through the "School for All," online learning can be without boundaries and everyone involved can share the relevant resources. The teaching profession knows well that the best way to learn something is to teach it. Online courses give everyone the opportunity to be a teacher. Getting online, everyone can offer or take courses free of charge. The authors hope that through the "School for All," we can realize our visions of education – from "instructing without discrimination" to "offering classes without discrimination," from "lifelong learning" to "lifelong teaching" and from "learning and then finding there is more to know" to "teaching and then finding there is more to learn." By disseminating the idea of "teaching and learning from one another," the authors hope to increase further the number of participants in the online learning community (Young et al., 2002).

1.2. Literature review

E-Learning represents a growing trend; it enables anyone in need of training involving information technology (IT) in a quick, accessible and affordable. E-Learning is becoming more popular as people come to appreciate the advantages of learning online. One of the pillars of E-learning is the course management system (CMS). Robson (1999) importantly defined a Web-based Course Management System (CMS) as acomprehensive software package (including email, discussions, real-time conferencing and other applications) that supports "courses that depend on the Web for some combination of delivery, testing, simulation, discussion, or other significant element." Such systems facilitate the work of students, instructors and course developers since all applications are accessed together with a common interface. Most existing CMSs provide similar tools for organizing instructional materials and enabling instructor-learner Web interactions. The underlying models of teaching and learning are similar. According to Robson (1999), the common features of course management systems include the following:

- *Computer-mediated communication.* CMS allows learners and instructors to communicate with each other publicly, privately, and in pre-set groups, such as discussion forums, email messaging systems, and chat rooms.
- *Navigational tools.* Navigation tools are used to organize a Web-based course into the equivalent of modules and lessons. The organizational structures tell students what to do next.
- *Course management.* CMS should help instructors keep track of students and their records to manage security and support a variety of user types such as instructors, students, and guests.
- *Assessment.* The most common form of Web-based assessment are the online quiz, Questions (true/false, multiple choice, fill-in-the-blank, matching questions, essay questions, and perhaps others), portfolio assessment, and so on.
- *Authoring tools.* Many CMS allow instructors to upload and organize material, create discussions, create and edit online quizzes, and otherwise control the features offered by the environment.

Examples of Web-based learning software include WebCT, Virtual-U, Click2learn, FirstClass and others. Numerous reports have addressed the technological features of some market leaders. These widely used CMSs provide various course management functions. Almost no CMS includes a full authoring environment. The differences among CMSs at these sites are significant only in relation to the general features listed above. However, they differ in how they organize and display course information. The functions may not always meet the needs of the online teacher. The large number of functions available to teachers for developing and managing online instruction can be confusing for some online teachers. They need to spend some time learning by trial-and-error. Accordingly an adaptive CMS must be provided for teachers with different needs.

Various researchers who have experimented with adaptive teaching over the WWW have applied techniques and principles derived from artificial intelligence (Brusilovsky, 1999). Carver and Lane (1999) developed a selection of Web-based tools to enhance learning. Others have applied adaptive Navigation Support of navigation using pages of hypertext and thus developed adaptive textbooks for, in particular, teaching software applications (Brusilovsky, 1996). An Adaptive Web site is one that can automatically improve organization and presentation by learning from visitor access patterns (Perkowitz & Etzioni, 1997).

The role of the online teacher is metamorphosing into that of a facilitator who guides and directs students to appropriate resources. Each instructor may have his or her own style of online

teaching. In this paper, the teacher-oriented adaptive CMS is defined as a system that provides various modules constituted of functions to support teaching by teachers with different characteristics or needs, and to calculate students' performance or execute the parameters that instructor specified automatically.

1.3. Motivation and goals

As described above, current learning and teaching systems are limited in the following ways:

(1) Few teaching models effectively and efficiently help instructors (Hong, Kinshuk, He, Patel, & Jesshope, 2001), and most of them have been designed and implemented only for academic or professional purposes;
(2) Many course management systems provide only a network of static hypertext pages (Brusilovsky, 1999) with static syllabuses and material;
(3) Complex functions are designed by IT engineers, with insufficient input from online instructors; the lack of flexibility in these complex functions make them not suitable for use by all instructors;
(4) Such systems are student-centered, but teachers and faculties still play the key role in creating and organizing a class. The systems do not support the role of teacher as controller.

Today's technology can be used to develop a Web learning environment easily. A CMS should be able to adapt to the needs of individual instructors, support interactions between teachers and students and be user-friendly to the instructors. Therefore, the authors have spent several years developing a system for learners and teachers to use over the network, to provide a flexible environment for various teaching and learning styles. This study focuses on adaptive function modules that help teachers construct courses online.

The primary aim of this study is to introduce a Web-based teaching and learning environment for people from all walks of life but who share the ideal of teaching and learning online. The individual aims of this study are:

- To provide adaptive tools with which teachers can easily manage learning resources;
- To facilitate cooperative teaching and learning;
- To extend knowledge and experience from one course to another.

The most important role of the instructor in online classes is to ensure a high degree of interaction and participation. A high level of comfort with the particular online tools/system used to deliver the course is very important. A challenging research goal is the development of advanced Web-based educational applications that exhibit some adaptability.

2. Teaching models (T-models) proposed

As well as providing materials as Web pages for students to browse, teachers in the"School for All"must actively engage the students. Certainly, online education supports collaboration among students and teachers. The "Instructor" can include a teaching team such as co-teacher, a consultant, or a teaching assistant. For each role, teachers can set particular level of privileges.

With reference to the relation between course and instructor, the authors observed courses individual and expanded upon six models of the use of the course-offering system to enhance

teaching efficiency. A related study is currently under way. The authors have called these six expansions, "Teaching Models (T-Models)," described as follows (Young, 2004).

2.1. SPM: Single-teacher-offering pedagogy model

A teacher can perform several tasks by himself. A teacher may prepare E-material, set the syllabus and monitor work progress, recruit students, specify topics for discussion and respond to questions, grade papers and evaluate assignments, make questionnaires, make announcements, keep daily journals, recommend Web sites and reading materials and manage students/classes, for example. In this model, the teacher can have full control of the course, but he has must spend a lot of time to exert this control.

2.2. GPM: Group pedagogy model – cooperative or collaborative

Online courses provide several opportunities for collaboration among teachers. Such collaboration typically hard in a traditional classroom setting but it is quite easy in an online class. Basically, group teaching can be performed in two ways – cooperative and collaborative. According to Panitz (1997), collaboration is a philosophy of interaction and personal lifestyle whereas cooperation is structured interaction designed to facilitate the achievement of a goal by people who work together in groups. Web-based teaching can include group teaching. The authors divided this general model into three teaching models according to the teaching team and division of duties, as follows.

2.2.1. C_PPM: Cooperative pedagogy model

Cooperation depends upon a supportive community of actors who agree to help one another in activities aimed at attaining the goals of each person involved (Lewis, 2002). In this model, courses are run by one primary teacher with co-teachers, teaching assistants, consultants and others. While the whole team may share workload, the "primary" teacher must be a very good coordinator to make the group function well.

2.2.2. C_LPM: Collaborative pedagogy model

Collaboration depends upon the understanding of common meaning and language related to a task, which enables the community to set a common goal (Lewis, 2002). As in the cooperation

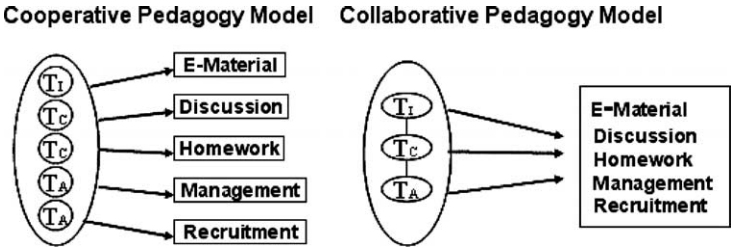

Fig. 1. Cooperative and collaborative pedagogy models.

model, each of the teaching team has a different role. However, in this model, team members have the same rights and no one single teacher dominates the course (Fig. 1).

2.2.3. C_OPM: Co-teaching pedagogy model

The course pedagogy consists of cooperation and collaborative models. Each teacher will be in charge of different topics at different times.

2.3. CPM: Cluster pedagogy model

Different course teachers can share a single discussion board, material or examination questions. Various teachers can integrate courses in the same domain. They can benefit from extensive interaction and share information/ideas among themselves. The clustering courses can attract more students and allow students to learn more. The general model includes two basic models – united teaching and central teaching (Fig. 2).

2.3.1. UPM: United pedagogy model

Teachers of courses in different domain may share discussion boards, examination questions, announcements and experience.

2.3.2. C_RPM: Central pedagogy model

One teacher or teaching team may teach several courses with different classes. However, they have the same material, schedule and homework but with students in different courses (Fig. 3).

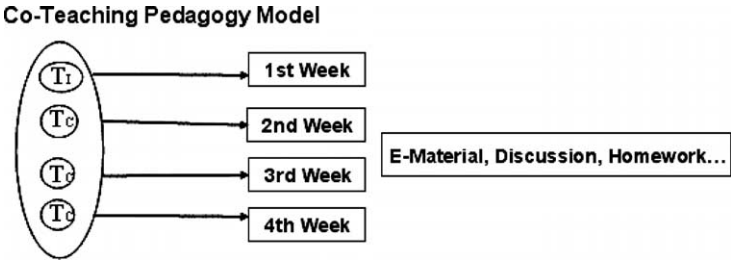

Fig. 2. Co-teaching pedagogy model.

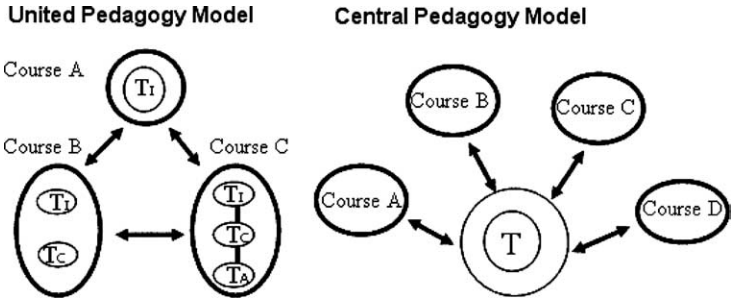

Fig. 3. Cluster pedagogy model.

3. Adaptive teaching environment

Since 1997, the authors have developed and adjusted the learning environment – "School for All." Users' feedback has helped to improve this environment. It comprises several different components, including Learning Resource Tools, Classroom Management Tools, Communication Tools, Assessment Tools and others (Lin, Chan, & Young, 2001). Fig. 4 shows the components of this Web-based system.

These tools may be used to perform 10 basic functions that are used in the "School for All," as shown in Table 1.

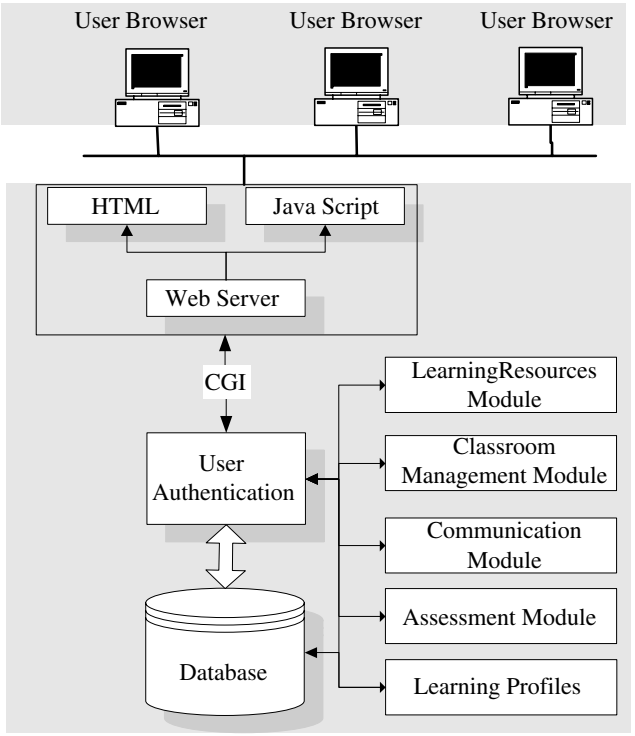

Fig. 4. System architecture of curriculum management.

Table 1
Six teaching models

Category	Teaching model	Description
Single teaching	SPM	Single-teacher-offering pedagogy model
Group teaching	C_PPM	Cooperative Pedagogy Model
	C_LPM	Collaborative pedagogy model
	C_OPM	Co-teaching pedagogy model
Cluster courses	UPM	United pedagogy model
	C_RPM	Central pedagogy model

Table 2
Functions of tools

Types	Functions
Learning resources	F1. Announcement F2. Instructional materials F3. Supplementary reading material
Classroom management	F4. Participants listing F5. Group management
Communication	F6. Guestbook F7. Discussion forum F8. Online participants and real-time messages exchange F9. Chat room
Assessment	F10. Assessment

This work proposes a practical and adaptive framework for a Web-based learning environment that comprises five Function Modules (F-Modules) – Adaptive Curriculum Setting, Adaptive Co-teaching and Privileges Setting, Adaptive Reward Setting, Adaptive Assessment Setting and Adaptive Information Sharing Setting. Such an environment with adjustable functions supports various kinds of teaching styles.

3.1. Adaptive curriculum setting module

A teacher with specific needs can tailor the functions accordingly. For example, he/she can adjust the properties of the course and expand functions integrated from other Web sites. The teacher can arrange course material, exercises, discussions and other resources. The teacher may rename, hide or integrate functions and decide who may use or seeing.

- FM1-1: The teacher can show/hide the 10 basic functions (as shown in Table 2).
- FM1-2: The teacher can rename the 10 basic functions.
- FM1-3: The teacher can set the privileges of each participant.
- FM1-4: The teacher can integrate more functions as needed or restore the default settings.

3.2. Adaptive co-teaching and privileges setting module

The online setting is bound to be more challenging to use than any traditional setting but also more flexible. The ''School for All'' supports participants in playing multiple roles, such as teacher, co-teacher, consultant and assistant. After authentication, those involved in instruction may have different roles and privileges.

- FM2-1: The instructor can add a teaching team and set roles as co-teacher, consultant or assistant.
- FM2-2: The instructor can assign different privileges to members of this teaching team, with reference to syllabus setting, bulletin board, discussion forum, evaluation and material management (Liao, Chan, & Lin, 2001).

3.3. Adaptive reward setting module

The system can generate records of what a student did when signed on including, for example, the number and type of responses to help to evaluate each student's performance. All activities can be converted into points as determined by the teacher. Furthermore, it provides an immediate record of the learning status and progress of the students, and accumulates points automatically to enable the teacher to reward participation. The teacher can also give additional points to outstanding students.

- FM3-1: The instructor can specifies the grading points that are used for automatic grading and scoring to help evaluate students' performance.
- FM3-2: Teachers can give additional points to encourage outstanding students.
- FM3-3: Teachers can determine the level of a student by the number of points granted to him or her.

3.4. Adaptive assessment setting module

Several tools exist online with which a teacher can track students' performance. They include online quizzes, online tests, learning portfolios and homework. A teacher may set the proportion of the contribution of each item to the student's final score.

- FM4-1: Teachers can set the percentage contribution of each item to students' score.
- FM4-2: Teachers can transfer scores of an exercise to an Excel file for convenience.

3.5. Adaptive information sharing setting module

Information sharing involves a forum for developing, sharing and floating new ideas, developing arguments and building a learning community (Salmon, 2000). The discussion forum provides enables the sharing of information: learners can post questions, issues and problems and obtained feedback from other participants of the "School for All." The forum enables learning community members to work together to share ideas and overcome challenges. Moreover, by exchange among different courses' discussion forums, participants of various courses can cover diverse issues and increase the visibility of their courses.

- FM5-1: The teacher may create, delete or move the discussion forum to the temp field.
- FM5-2: The teacher may open discussion forum to friend's courses, self courses or the same domain courses.

Table 3
Functional modules support six teaching models

F-Modules	T-Model					
	SPM	C_PPM	C_LPM	C_OPM	UPM	C_RPM
Curriculum setting	☐	☐	☐	☐	☐	☐
Co-teaching & Privileges Setting		☐	☐	☐		
Reward setting	☐	☐	☐	☐	☐	☐
Assessment setting	☐	☐	☐	☐	☐	☐
Information sharing setting					☐	☐

- FM5-3: The teacher may set different privileges for course students, Educitizen (citizens of Educities) or guests.
- FM5-4: The teacher may release the discussion forum and other teachers may freely use in his or her courses.

The authors believe that these adaptive function modules help teaching in the online environment. Table 3 shows how the Function Modules provided by the system support six Teaching Models.

4. Evaluation

This study analyzed representative 30 courses to find out what types of function modules are required by teachers. Using different adaptive modules, this study addresses different teaching models that are categorized from a system perspective.

4.1. Participants and sample course selected

The "School for All" includes more than 2,300 types of courses, and most of these were purely Web-based courses offered by instructors of any age and profession. Web-supported courses were very popular, and some classroom teachers have used this system as an extension of real-world teaching.

Five rounds of the course-offering contests held in the "School for All" to determine the potential of effective teaching online. The contests were held for several reasons. First, we hoped to identify the characteristics of online teachers, such as age and occupation, as well as the pedagogical strategies used by them attract remote learners. Second, we sought to identify outstanding online teachers by encouraging more active Web browsers to contribute their expertise through teaching. The third aim was to nurture active lifelong learners and learn more about their interests. Some teachers just want to share their expertise with others or to offer job-related, real-world teaching; others offer courses just for self-fulfillment (Young et al., 2002).

Courses were categorized into two major areas – computer/information technology related topics (IT) and general topics (GT). Due to the huge amount of data, for courses contest are 550 courses, not for course contest over 1600 courses and Web-supported courses over 150 courses. Not all of the 2300 courses were successfully offered. For details of the course evaluation criterion, please refer to the paper "A Preliminary Evaluation of a Web-mediated School for All (Young et al., 2002)." Therefore, 30 representative courses in each category are selected for analysis to determine the potential of teaching online. Data were collected from a course start dates for six weeks to identify discrepancies. The 30 online courses in each category can be categorized into five groups (G1, G2, G3, G4 and G5), as below (Table 4):

- G1 – Web-based IT courses for contest.
- G2 – Web-based GT courses for contest.
- G3 – Web-based IT courses not for contest.
- G4 – Web-based GT courses not for contest.
- G5 – Web-supported courses to extend real-world teaching and not for contest.

Table 4
Teachers' ages, course titles and class sizes, by groups

Groups				Courses				
	Contest or non-contest	IT/GT	Group	C-ID	Teacher login ID	Age	Course title	Class size
Web-supported courses	Contest	IT	G1	C1-1	Lii	29	NamoWebEditor	39
				C1-2	Hoasuma	20	Basis Digital Logic	79
				C1-3	Ikr	34	Teacher e-together	143
				C1-4	Wanting12	25	PhotoImpact	61
				C1-5	Finjonkiang	22	Use Notepad to Design Homepage	53
				C1-6	S6628714	16	Paint to much (PhotoImpact)	71
		GT	G2	C2-1	Amaumi	22	A foundation of Song and Dance Drama	29
				C2-2	Thclinic	32	Literacy Class of Chinese Medicine	86
				C2-3	Cyokaicity	38	Ease to Learn English	258
				C2-4	Hopi	34	Vagabond Memory by Hopi	66
				C2-5	Peter1986	17	Easy to Learn Recorder	63
				C2-6	Howtanwhytan	29	Science Games Special Area	94
	Non-contest	IT	G3	C3-1	Qiush	28	An introduction of Chinese TEX-chiTEX	28
				C3-2	Tenzoo	25	Hi-Flash MX	149
				C3-3	Sandy69495	12	Online Games	127
				C3-4	Ivantsai	26	Teaching on the Internet	148
				C3-5	Leuym	24	To Make Your Own Computer	113
				C3-6	Peteraby	12	Catch Flash	60
		GT	G4	C4-1	Jenjin	40	Life through Looking-Consciousness	21
				C4-2	Lydiachen	33	To Appreciate Children's Books	79
				C4-3	Roycelo	31	The Magic of Mutual Fund	69
				C4-4	Estherjn	15	Harry Potter	122
				C4-5	Pearl60	32	Swimming–Teaching online	38
				C4-6	Anita Su	32	Invited lectures on Investment & Finance (Sponsored by Citibank)	200
Web-supported courses			G5	C5-1	Cyokaicity	38	Multimedia – Medi@Show	97
				C5-2	Marklo	35	Physics (senior high school)	36
				C5-3	Iat751	37	Teacher's online Classroom	74
				C5-4	Kevin1081	35	Art (junior high school)	32
				C5-5	Jjtseng	34	English Writing (college)	29
				C5-6	Ctchen	32	IT Area (junior high school)	159
					Average	28	Average	87

4.2. Data analysis

The gathered data were analyzed by descriptive statistics and questionnaires to verify the research structure. Online data logs were obtained and directly analyzed to elucidate the status of these courses.

4.3. Function used evaluation

Data concerning the five groups of courses and the Web classes and observations indicate that the functions used in Web-based and Web-supported courses have specific characteristics in common. A detailed analysis is presented below.

4.3.1. Results

The results of this study show the functions used by outstanding teachers who offer courses in the "School for All." The results (Table 5) indicate that the system can practically and flexibly support online teaching.

Table 5
Total number of courses and percentage of adaptive functions used

Adaptive setting	FM-ID	Function name	G1 (6)	G2 (6)	G3 (6)	G4 (6)	G5 (6)	Used (%)
Curriculum	FM1-1	Use default setting	4	4	6	6	4	80%
	FM1-2	Use default functions name	4	2	5	6	3	67%
	FM1-3	Set privileges	4	1	2	1	2	33%
	FM1-4	Add additional functions	2	2	0	0	0	13%
Co-teaching	FM2-1	Add teaching team member	3	3	4	6	1	57%
	FM2-2	Set teaching team members' 9 privileges	2	2	2	4	0	33%
Awarding	FM3-1	Set points of 12 actions	2	4	3	5	6	67%
	FM3-2	Set student roles of each level (1–7 levels)	4	3	1	2	3	43%
	FM3-3	Add additional points	6	5	3	2	2	60%
Assessment	FM4-1	Set percentage of each Assessment	0	3	3	2	2	33%
	FM4-2	Add additional Assessment	0	2	1	2	1	20%
Information Sharing	FM5-1	Create new discussion forums	6	6	6	6	6	100%
	FM5-2	Open discussion forum to other courses	3	1	2	2	3	37%
	FM5-3	Set privileges of participants	6	6	6	6	6	100%
	FM5-4	Release discussion forum freely select	3	3	2	3	0	37%
	FM5-5	Material sharing	2	3	3	1	0	30%

4.3.2. Discussions

4.3.2.1. Curriculum setting. With reference to the use of adaptive curriculum functions, 80% of teachers used the system's designed default function and 67% used the default function name. Only about 13% of the teachers used external resources from the Internet. Course contest teachers G1 and G2 use the functions related to the Curriculum Setting to attract more students to their courses.

4.3.2.2. Co-teaching setting. Overall, more than half of the instructors (57%) like to organize a teaching team that includes the roles of instructor, co-teacher, consultant, or teaching assistant, to share the teaching load. The Co-teaching Setting enables co-teachers to implement their Web-related skills in producing digital courses, cooperation and to save time. Only one out of six Web-supported courses (G5) used these functions.

4.3.2.3. Reward setting. Sixty-seven percent of the teachers liked to specify the grading points for students' learning activities, such as discussion with 10 points. Moreover, in addition to the basic points, 60% of teachers used the additional point function to encourage students who performed outstandingly, and, for example, to indicate the excellence of achieving 100 points.

4.3.2.4. Assessment setting. One-third of the 30 courses used the assessment functions. Requiring students to do homework or taking online tests in an informal educational environment is difficult, particularly when courses are offered free for all. The data reveal that three out of six Web-supported courses (G5) may request students to submit coursework.

4.3.2.5. Information sharing setting. All of the 30 courses (100%) included new discussion forums and set participants' privileges. The instructors read and responded to all students' work and questions through the discussion forums. However, 37% of courses used the Information Sharing Setting module.

4.4. Courses evaluation

The authors would like to categorize teaching models from the system perspective. Methods for evaluating courses are described below.

4.4.1. Results

The authors extracted several rules (Table 6) by analyzing the characteristics of each course. Using the functions supported by the system, the authors divided the 30 courses into different teaching models. The rules can be categorized as follows:

- If the instructor uses function FM2-1 (add teaching team member), s/he is not adopting the single-teacher-offering pedagogy model, but maybe the GPM (Group Pedagogy Model) or the CPM (Cluster Pedagogy Model).
- If the instructor uses functions FM2-1 and FM2-2 (setting teaching team members' privileges), s/he is establishing a teaching team with different duties and adopting C_PPM (Cooperative Pedagogy Model) or C_OPM (Co-Teaching Pedagogy Model) must be further examined to distinguish C_OPM from C_PPM.

Table 6
Distinguishing among six teaching models by the functions used

T-Model	FM-ID				
	FM2-1	FM2-2	FM5-2	FM5-4	Other functions
SPM	NO	NO	NO	NO	X
C_PPM or C_OPM	YES	YES	X	X	X
C_LPM	YES	NO	X	X	X
UPM	X	X	YES	YES	X
C_RPM	X	X	YES	NO	X

(X implies indifference).

- If the instructor uses functions FM5-2 (open discussion forum to other courses) and FM5-4 (release discussion forum freely), s/he is cooperating with other courses and is adopting UPM (United Pedagogy Model).
- If the instructor uses function FM5-2 but not FM5-4, s/he is adopting C_RPM (Central Pedagogy Model).

In addition to functions FM2-1, FM2-2, FM5-2 and FM5-4, other functions may also support various teaching strategies.

According to these rules that concern the use of functions by instructors, the authors associated the 30 courses with corresponding teaching models, as follows (Table 7).

4.4.2. Discussions

According to the results and teaching models presented herein, the proposed design is helpful in supporting the construction of online courses. Some interesting findings follow.

4.4.2.1. Web-based courses vs. Web-supported courses. Teaching on the Internet differs from traditional teaching. Web-supported courses (G5), an extension of real-world teaching, manifest the characteristics of traditional education, in which one teacher teaches one course or one teacher teaches multiple courses. However, Web-based courses that are conducted purely on the network overcome the limits of space, time and classroom size, taking advantage of networks to facilitate cooperative teaching and share knowledge among courses.

Table 7
Teaching model of each course (30 courses)

Group	Model					
	SPM	C_PPM	C_LPM	C_OPM	UPM	C_RPM
G1-G4	*C1-1*	*C1-2*		C4-6	*C1-5*	*C1-3*
	C2-1	*C2-6*	*C2-4*		*C1-6*	C4-3
	C2-2	C3-6	C3-1		*C2-5*	
	C2-3	C4-2	C4-1		C3-3	
	C3-2		C4-4		C3-5	
	C3-4				C4-5	
G5	C5-2					C5-1
	C5-5					C5-3
	C5-6					C5-4

4.4.2.2. Contest courses vs. non-contest courses. Teachers highly motivated to participate in course contests would like to enrich their curricula and use multimedia presentations to attract students. They tend to use system-supported functions well. They also use the reward module and role-playing to encourage students' participation.

4.4.2.3. IT (Information Technology) courses vs. GT (general topics) courses. Teachers of IT courses make materials step by step or use tools such as Viewlets software for teaching. Such software allows teachers to demonstrate learning materials to students in an online real time mode, and supports courses that help students acquire computer skills. Thus, further interactions between the instructor and students become unnecessary. However, in GT courses on a network, the instructor must still interact with participants frequently.

4.4.2.4. Single teaching vs. team teaching. Courses for contests typically adopt the single teaching model (4/12, G1 plus G2 equals 12). Most of the competing teachers have strong technological skills and experience. Some teachers want full control of the courses to win the contest alone. However, a single individual is unlikely to have the wide range of computing skills and time required to develop online courses. Thus, most of the teachers of the Web-based courses would be more likely to adopt the group or cluster teaching model (75%). So, co-teaching is more popular and effective than individual teaching.

All of the teachers either participated in the course contests or were volunteers, except the course "Invited lectures on investment and finance," that adopted the Co-teaching pedagogy model and was sponsored by Citibank. Citibank not only donated money for the course contests but also supported 10 outstanding teachers to co-teach this course. Each teacher taught for one week, in charge of content, interacted with students, set homework, and undertook other responsibilities. Moreover, Citibank also sponsored a reward for outstanding students, by using the Adaptive Reward Setting, to encourage hardworking students.

4.5. Online teachers' perceptions of the use of the five modules

A questionnaire with multiple choices and open-ended questions was used to collect the online teachers' perceptions of the use of the 5 modules. It is hoped that the data collected would be helpful to improve the system in the future. Because it was an additional online survey, only 12 out of 29 instructors responded (note: among the 30 studied courses, two courses, C1-5 and C5-2, were offered by the same the teacher, Cyokaicity). Although the responding rate was 0.41%, those 12 teachers were active and highly engaged in the course contest and were familiar with the modules and system. Their responses, thus, were regarded useful and valuable to the researchers of this paper for usability reference. The questionnaire was administered to the teachers shortly after the 4th contest (held during 2002 Winter–2003 Spring) via the additional online survey, details of which were analyzed and described below.

4.5.1. Multiple choices

A five-point Likert scale (e.g. in question 2, the possible answers were: 1 = not at all, 2 = slightly, 3 = moderately, 4 = a lot, 5 = extremely) was used for the 5 questions in multiple

Table 8
Mean of each module perceived by the teachers Q: Did the 5 function modules help you improve your online course? (1 = not at all, 2 = slightly, 3 = moderately, 4 = a lot, 5 = extremely)

Questions	Mean ($n = 12$)
F-1 Curriculum setting	4.27
F-2 Co-teaching and privileges setting	4.18
F-3 Reward setting	4.18
F-4 Assessment setting	3.91
F-5 Information sharing setting	4.45

choices and 12 teachers' responses were taken into account to produce numerical results which are illustrated in Table 8.

Table 8 indicates that the teachers were highly agreed that these function modules helped their instruction on the Internet, particularly the "Information sharing setting (mean = 4.45)" function was perceived highly useful. "Assessment setting (mean = 3.91)" function relatively received low score. In the open-ended questions, the teachers expressed their opinions that not all of the learners would like to do the assignments so that "Assessment Setting" was less helpful to them in the given instructional/learning context.

4.5.2. Open-ended questions

Data collected from the open-ended questions can be concluded as follows. Overall, the teachers revealed that the convenient and useful adaptive platform significantly provided opportunities for anyone who was interested in Web-based education. Those teachers, with the use of this web-based adaptive learning/teaching system, could teach on the Internet regardless of his/her age and occupations. Some teachers reported that the web environment provided "suitable and satisfying functions to meet the teachers' various needs for running an on-line course (comments by the teachers of C2-3, C5-1 and C4-2 courses)." Therefore, they could put more efforts on handling other instructional matters such as producing course materials, interactions with learners, etc... (comments by the teachers of C1-1, C1-2, C2-3, C2-6, C5-1 courses). Although the adaptive environment might meet the teachers' various needs, one teacher made a good suggestion that "training courses should be required of all teachers before they offered an online course. Another teacher responded that "On the Internet, if you want to be a good online teacher, it's better to start as an online learner (comments by the teacher of C1-2 course)".

5. Conclusion and future research

A Web-mediated learning environment – "School for All," was designed to adapt to the needs of teachers. This study implemented five adaptive modules (Adaptive Curriculum Setting, Adaptive Co-teaching and Privileges Setting, Adaptive Reward Setting, Adaptive Assessment Setting, and Adaptive Information Sharing Setting) to support six online teaching models (SPM, C_PPM, C_LPM, C_OPM, UPM and C_RPM Models). The results help to elucidate the characteristics and needs of online teachers.

This study has addressed a few practical matters. Those who intend to embark on designing a CMS or to offer online courses should be aware a number of issues presented below:

- For the system designer: A good design involves achieving a balance between usability, aesthetics and adaptability. A user wants a program that is easy to use, and that is also visually interesting and highly motivating. Achieving such a combination is difficult, and this is one reason for the relatively low number of outstanding programs. System designers should always consider user-orientation and user-friendliness.
- For the Web administrator: Managing a nonprofit Web site to hold together a learning community is very challenging, it can only be achieved with an enthusiastic attitude toward serving the learning community. Maintaining an abundance of quality learning resources is a good way to attract students and teachers.
- For the teacher: It is suggested that an instructor should take an online course if s/he has no first-hand experience with this mode of Web-based teaching and learning. Co-teaching is better than individual teaching in terms of work-load sharing and time spending. A good online teacher should engage students' online interactions through pedagogical strategies, such as giving weekly theme for discussion.

So far, the "School for All" has over 60,000 enrolled learners and more than 2300 types of courses offered. Participants are growing in number daily. The authors will continue to observe and analyze the characteristics of other courses. With the assistance of the designed "School for All" system, the system will automatically detect the teaching pedagogy of the instructor used and provides an adaptable default curriculum setting. The authors also wish to provide a better functional environment for teachers and students. The potential of the use of the Internet via EduCities will continue to be explored in the future.

The authors will further associate the Web-based courses with another project entitled, "Fu-Tzu (Confucius) Learning Workshop." The "School for All" system and experience learned in this study will be applied to establish another learning environment in which online training courses for the in-service and pre-service teachers will be provided. More related research issues on how the teacher-based learning community perceives and uses the "School for All" system will continuous to be investigated.

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References

Brusilovsky, P. (1996). Methods and techniques of adaptive hypermedia. *User Modeling and User-Adapted Interaction, 6*(2–3), 87–129.

Brusilovsky, P. (1999). Adaptive and intelligent technologies for Web-based education. *Special Issue on Intelligent Systems and Teleteaching, Künstliche Intelligenz, 4*, 19–25.

Carver, C. A., Jr., & Lane, W. (1999). Enhancing student learning through hypermedia courseware and incorporation of student learning styles. *IEEE Transactions on Education, 42*, 33–38.

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

Hong, H., Kinshuk, He, X., Patel, A., & Jesshope, C. (2001). Trends in Web-based Learning Environments. Distance Education Report 5 (3), 6–7 (ISSN 1094-320X).

Kearsley, G. (2000). *Online education: Learning and teaching in cyberspace*. Belmont, CA: Wadsworth, ISBN: 0534506895.

Lewis, R. (2002). Learning communities – old and new. In *Keynote paper at the international conference on computers in education ICCE2002*. pp. 6–13.

Liao, C. J., Chan, T. W., & Lin, C. B. (2001). Support teaching teams and cooperative learning in "School for All". In *Global Chinese conference on computers in education GCCCE 2001*. pp. 47–54.

Lin, C. B., Chan, T. W., & Young, S. S. C. (2001). School for all: A Web-based teaching and learning community. *Computer & Learning CAL2001,* 04.2–5.

Panitz, T. (1997). Collaborative versus cooperative learning: Comparing the two definitions helps understand the nature of interactive learning. *Cooperative Learning and College Teaching 8*(2) Winter.

Perkowitz, M., & Etzioni, O. (1997). Adaptive Web Site: an AI Challenge, In *Proceedings of 15th international joint conference on artificial intelligence*. pp. 16–23.

Pickering, J. (1995). Teaching on the Internet is Learning. *Active Learning – Using the Internet for Teaching, 2*, 9–12.

Robson, R. (1999). Course support systems: The first generation. *International Journal of Telecommunications in Education, 5*(4), 271–282.

Salmon, G. (2000). *E-Moderating: The key to teaching and learning online*. London: Kogan Page.

Young, S. S. C., Chan, T. W., & Lin, C. B. (2002). A preliminary evaluation of a Web-mediated school for all. *Journal of Computer Assisted Learning, 18*(2), 211–220.

Young, S. S. C. (2004). In search of online pedagogical models through investigating a changing teaching paradigm in the school for all community. *Journal of Computer Assisted Learning*. In press.

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