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CHIEN CHOU and CHIN-CHUNG TSAI

The emergence and rapid growth of computer network technologies are changing the way we live and learn. Computer networks provide new alternatives for the design, development, storage and distribution of, as well as access to, learning materials. Therefore, they present new and formidable challenges for curriculum designers and teachers. Cornell (1999) states that faculty members may feel concern and anxiety about engaging in online teaching due to its unique status as the most-talked-about, but often least-experienced, pedagogical practice. Faculty members and curriculum designers may have experience using the Internet for social and even limited professional activities, but many of them still need to reconsider the use of the Internet and Web for curriculum and individual courses. Indeed, as Harrison and Bergen (2000) note, a substantial amount of planning and preparation must go into the design of an online curriculum, and, at the same time, the development of courses is an ongoing process as we become more knowledgeable and technologies continue to improve.

   This paper discusses those challenges, first by reviewing traditional curriculum development stages, and then by examining the issues,

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challenges and possible solutions presented by these stages when designers develop web-based curricula. The issues discussed in this paper are based on a review of relevant literature and our experiences in web-based curricula development.

Traditional curriculum development

There are numerous frameworks for curriculum development. Tyler's (1949) model, however, may be the most widely recognized. Tyler suggests four basic starting points for exploration in the course of curriculum development: purpose(s) of the school; educational experiences related to purposes; organization of experiences; and evaluation. Later, Taba (1962) proposed a more complex model that builds on Tyler's view of effective curriculum development.[1] Taba's model includes the following stages:[2]

- *Define target students and their needs*. Teachers and curriculum designers need to define those students for whom the curriculum is being developed. By first identifying particular groups of students and their needs, curricula will be both more efficient and more effective.
- *Identify instructional objectives*. After teachers and designers have defined the target students and their needs, they should state specific instructional objectives in the cognitive, affective and psychomotor domains.
- *Select the scope of subject content*. After objectives have been stated, teachers and designers must determine the subject matter, or the content of the curriculum.
- *Organize sequence and structure*. Teachers and designers cannot merely select subject content; they must also arrange content in a sequence or structure that will best accommodate the targeted students' academic levels and interests.
- *Select presentation methods and media*. Following the arrangement of content, teachers and designers should select suitable media in which to present the planned sequence or structure of course content. Effective presentation methods are more likely to engage students in the learning processes and, thus, to accomplish instructional objectives.
- *Design assessment activities*. Assessment is a crucial component of curriculum development; assessment of student learning, based on stated objectives, produces data with which to determine the overall success of curriculum design and implementation.
- *Implement formative evaluation*. Before implementing a new curriculum, a series of formative evaluations should be conducted in order to identify and assess any weaknesses in the proposed curriculum. This allows teachers and designers to improve the design before implementation and, thus, improve overall performance.

Developing web-based curricula: new problems require new methods

The seven stages of curriculum design, as outlined by Tyler (1949) and Taba (1962), become somewhat problematic when viewed in the context of designing web-based curricula. What follows is a discussion of the traditional curriculum development framework that accounts for the particularities of web-based distance learning.

Define target students and their needs

Defining target students and their needs is much more difficult for web-based distance learning than for formal classroom settings. Kearsley (2000) argues that the design of an online curriculum should start with a careful analysis of the students, not only to identify what they have already learned, i.e. their cognitive, affective and psychomotor skill levels, as traditional curriculum designers do, but also to understand the nature of their computing capabilities and learning environment. If the assumptions that are made about students' computer skills or accessibility are invalid, the success of an online curriculum will be limited. In addition to the students' learning environment, Willis and Dickinson (1997) contend that the challenge for web-based instructors includes the development of an understanding and appreciation for distant students' lifestyles, because students' realms of experience, living conditions, and cultures are often foreign to the instructor and other class participants. Therefore, teachers and curriculum designers must determine how to define remote target students and their needs, how to design web instruments to assess target students' prior knowledge, skills and computing capabilities, and how to gain a more thorough and effective understanding and appreciation of students' relevant living conditions and cultures.

Moreover, since the Web is basically an open system, any 'surfer' can potentially become a learner of a given curriculum. Teachers and curriculum designers must determine how to design a screen mechanism to block non-target users. For example, requirements for registration, online surveys and/or pre-tests can be used to screen out non-target users. Providing e-mail addresses to curriculum coordinators may help communications between target students and instructors. Providing some lesson examples will also help students to determine whether it is the right curriculum for them to explore. Further development of web-based curricula may try to provide different types of curricula to students with different levels of background knowledge, experiences and learning preferences, and then create a student-centred approach to instruction.

Identify instructional objectives

Traditionally, curriculum development is teacher-centred, and teachers themselves identify instructional goals and objectives. However, as Jones

(1997) notes, since the nature of the Internet promotes equal participation of all users, it nourishes a 'participatory democracy'. If we agree that this result of Internet use is a positive one, we need to reconsider the authorship of the curriculum: shifting authority from teacher to student may further advance such democratic ideals and practices.

French *et al.* (1999) contend that the figure of 'teacher' has traditionally been regarded as the 'sage on the stage', the individual who primarily determines the instructional objectives and provides most of the learning materials. However, in an Internet-based learning environment, the teacher is depicted more often as a 'guide on the side'. However, both the teacher and learner are simultaneously 'guides' and 'sages' because they become continual learners and peer-teachers who adapt rapidly to set learning objectives in the light of changing information.

Relan and Gillani (1997) explored the differences between traditional instruction and web-based instruction. They found that in a student-centred web-based curriculum the relative amount of time that students talk is equal to or greater than the amount of time that teachers talk. Students also help to choose the content to be organized and learned. French *et al.* (1999) also consider that web-based learning is suitable for self-directed learning in which students have more choice of, or control over, not only their learning time and pace but also the objectives or learning outcomes.

As a result, web-based curriculum designers and instructors must determine how to: (1) include students, especially adult students of non-traditional age and students undergoing on-the-job training, in the process of identifying instructional objectives; and (2) balance both teachers' and students' authorship in developing web-based curricula. For example, a forum in which both instructors and students discuss course direction and progress may shape instructional objectives as the course progresses. A distinct, identifiable area in the web-based curriculum can be allocated for students to contribute their learning materials (such as links to related websites and news groups); teachers can then screen students' contributions to determine which materials are suitable for the curriculum and course.

Select the scope of subject content

The Web is basically a hypertext system. Landow (1997) argues that hypertext is a fundamentally intertextual system, open, non-fixed and boundless rather than closed, fixed and bounded. The intertextual nature of hypertext makes it very different from page-bound text. Furthermore, Landow (1997) suggests that in producing and processing hypertext, we need to abandon the concepts of centre, margin, hierarchy and linearity upon which traditional text is based to replace them with concepts of multilinearity, nodes, links and networks, all of which are hallmarks of hypertext. Relan and Gillani (1997) support this in their claim that the predominant source of content in web-based learning shifts from the textbook and the teacher to more varied sources of information, and the

nature of content becomes dynamic rather than the static, limited to texts published on a certain date. In other words, teachers and designers must determine how to develop web curricula that are open, non-fixed and boundless and how to link web resources in such a way that curriculum content is enriched and students' attention is both captured and maintained.

When teachers and designers try to enrich their curricula by tapping the unlimited hypertextual information on the Internet, they ought to review and screen a large amount of information from many websites and make links in appropriate places during the 'course'. At the same time, Draves (2000) points to the necessity of providing some kind of guidance for students regarding these links. The simplest way is to divide those links into three teacher-assigned categories: 'Critical' (must read), 'Important' (should read), and 'Nice' (could read). By doing so, individual students can determine what linked materials to read, and when, depending on their schedules and learning paces.

In Chou and Lin's (1998) study, such guidance became a form of 'knowledge map', which was empirically evaluated. The study found that the map-type had a significant effect on students' processes in searching for particular pieces of information in web-based courseware, as well as their success in retrieving that information. Further, the map-type was a significant factor in students' development of cognitive maps within the course structure. The study demonstrated that presenting students with a global map, in which the entire hierarchical knowledge structure for the course is provided by means of a list of the concept names of all hypertext nodes, enabled them to more efficiently and effectively search for, locate and learn from curriculum content.

Organize sequence and structure

Unlike traditional linear text, hypertext organizes information in sets of informational units connected by means of associative links (Conklin 1987). For Landow (1997), hypertext also denotes text composed of blocks of text and the electronic links that join them. The concept of hypermedia simply extends the notion of the text in hypertext by including visual information, sound, animation and other forms of information.

Hypertext grants learners maximum freedom to navigate through hyperspace in a non-linear fashion—they can select, search and browse in an infinite number of sequential, and often recursive, patterns. Teachers and designers, therefore, must determine how to organize web curriculum sequences that best fit their students' prior knowledge and skills, but at the same time allow structural flexibility for individual navigation. Curriculum designers must also determine how to provide guidance so that students will not get lost in the web curriculum.

When authoring learning materials in hypertext format, Woodhead (1991) suggests three basic rhetorical techniques: *gradual disclosure*, i.e. a smooth progression into finer, richer, more specific levels of detail; *foreshadowing*, i.e. giving repeated references to forthcoming items to guide

audience needs; and *recapitulation*, i.e. prior topics are repeated for emphasis or to allow the audience to draw themes together. Beer (2000) also offers some guidelines for organizing web learning content, including providing a site overview, using consistent vocabulary across the whole learning site, explaining the content architecture, and using hyperlinks sparingly and carefully. Chou and Sun (1996) have suggested providing 'next' buttons at the end of each instructional node to indicate the designer's recommendation for the next node to visit. The 'prerequisites' for moves can also be set in a web curriculum. That is, students have to read one node before they jump to other, related nodes.

Chou (1999) suggested adopting elaboration theory to organize hyper-text-based curricula. The approach suggests, first, analysing content and selecting a few of the most fundamental concepts for presenting in the epitome node, and then linking each concept to its subordinate concept(s). In each subordinate-concept node, another epitome is provided describing the lower-level subordinate concepts. Information is, thus, fragmented in the nested nodes of a hypertext curriculum. This approach was empirically and formatively evaluated to establish its effectiveness.

Draves (2000) also offers some operational guidelines for web curriculum designers. First, the curriculum can be divided up into five to ten modules. Modules should lead somewhere—horizontally to the next module and/or vertically to a more intensive, advanced or detailed set of modules. Modules should also be able to stand alone. In this way, the combination of individual modules can be systematically organized and interrelated.

Select presentation methods and media

The Web is a multimedia system that incorporates text, graphics, audio, animation and video, and it provides teachers with more choices of presentation methods than are usual in traditional curricula. Indeed, the growing use of Internet technologies opens new possibilities that move well beyond the provision of more sophisticated delivery tools. In a study by Chou *et al.* (2001), a combined presentation in virtual reality modelling language (VRML) and hypertext markup language (HTML) was designed to demonstrate the human digestive system for university students who were not majoring in health or science. Three-dimensional graphics written in VRML allowed students not only to view the digestive system from any direction, but to enter the digestive organs themselves using navigation tools provided by VRML browsers. In addition, text and/or 2-D graphics were organized in HTML in order to offer detailed health science information.

Kearsley (2000) argues that most online curricular materials would benefit from graphics in the form of illustrations, diagrams, icons and backgrounds. Teachers or designers, however, may not have the graphic skills and knowledge of graphics software to incorporate these elements into their curriculum and courses. Moreover, some degree of background knowledge, understanding of, and skill in multimedia production are

necessary to produce audio and/or video elements in web-based learning sites.

Similarly, the creation of animations or simulations requires special programming skills and experience which teachers and designers may not have. Teachers and designers, therefore, need to be adept at preparing and organizing content-appropriate presentations in a digital multimedia form. If they do not have the necessary knowledge or skills themselves, they need technical support, as Kearsley (2000) suggests, either from others within the institution or from an outside vendor, and should work closely with technical support personnel. However, how much should curriculum designers and instructors know about the technology, and what skills ought they to possess to enable them to produce multimedia curricular components? In our opinion and experience, curriculum designers must be familiar with the technology (the terms, capability, feasibility, etc.) to the degree that they know what the technology can and cannot do, and to the point that they can communicate their ideas clearly to technical support staff.

Design assessment activities

As Bugbee (1996) contends, if learning is via a computer, then it is more appropriate to assess it by computer. This assertion is becoming a widely accepted fact, as web-based testing becomes more and more popular and available. Beer (2000) considers that the Internet in general and the Web in particular have unique contributions to make to a broader conception of assessment. He provides several new assessment ideas, such as inviting experts to evaluate online individual and collaborative work as well as the content of Web discussions, and argues for connecting assessments to learning resources and using the Web for individual self-assessment.

In response to such ideas, teachers and designers must be able to grasp the unique requirements and features of Web technology for implementing and maintaining web-based assessments, and to design effective web-based tests and assignments that accurately assess students' learning and provide useful data for further curriculum development. Chou (2000) contends that when analysing the use of a web-based test, the dimensions of time and location of testing can help developers conceptualize the use of any testing system. Noting whether time and location are specific or fixed, i.e. specific time/fixed location, flexible time/fixed location, specific time/non-fixed location, and flexible time/non-fixed location, testing types and situations can be characterized.[3]

When designing online assignments, in particular, Harrison and Bergen (2000) suggest preparing a detailed list of weekly assignments. The list should include the pages to read, questions to be answered and problems to be solved. It should also cover the material for online discussions. This will help to ensure progress in student discussions, and allow students to follow that progress easily.

Implement formative evaluation

Formative evaluation, a critical step in curriculum development, is the process of gathering information to advise design, production and implementation decisions (see Flagg 1990). Kearsley (2000) suggests that the biggest problem in developing online curricula may not be their initial creation, but rather subsequent revisions and updating: even if the content of a course does not require much change, many small details, such as links to other sites, need to be continually updated.[4]

Conducting a formative evaluation of web-based curricula requires experts in course content, curricula, media and administration to work together to develop evaluative methodologies that take into account students' and experts' presence at remote sites. Therefore, teachers and designers need to develop methods for conducting formative evaluations within complex, technology-dependent learning environments and curricula, to set up a reasonable work schedule for continual updating and revision, and to work closely with formative evaluation team members.

In Chou (1998), a formative evaluation system was developed especially for web-based distance learning. The computer logging of user entries (CLUE) system combined computer logging techniques to collect commentary during users' interactions with the learning materials, and was designed to be used to collect input from large numbers of users working in different remote locations. The inputs are automatically stored, calculated and then presented in a format that can be easily interpreted by curriculum designers and instructors. Innovative formative evaluation methods and systems such as CLUE are becoming increasingly necessary in order to ensure that more web-based learning materials can be effectively evaluated.

Other concerns about web-based curriculum and courses development

In addition to the above-mentioned seven major curriculum development stages, other factors relevant to developing web-based curricula and courses are also vitally important. The first factor is the degree of completion of a curriculum before the actual delivery of that curriculum (or course). Many instructional designers do not always have the entire curriculum organized and developed before the school semester begins; rather, they prepare the course material as the semester progresses. However, Harrison and Bergen (2000) suggest that it is far better to have the entire course organized into weekly modules before the students actually come online. They emphasize that, at a minimum, the underlying structure of the modules as well as the first three weeks should be prepared prior to student participation. As mentioned before, a substantial amount of planning and preparation must go into the design of an online curriculum and course (Harrison and Bergen 2000).[5]

The second major concern is the team approach. Kearsley (2000) claims that the major difference between developing online curricula and traditional curricula (as delivered by textbooks and lecture notes) is the need for a team approach. It is difficult for a single individual to have the range of

skills and time required to develop an entire online curriculum or course. Faculty members are usually subject-matter experts and familiar with how the content should be taught, but they typically have little experience developing curricular materials for online learning. An instructional designer, multimedia producer, systems analyst, network programmer, etc. should be invited to work with faculty members to develop various course components in the appropriate formats. Thus, Byun *et al.* (2000) call for the establishment of a 'web-course developer group'. They suggest that this group meet periodically, either in person or online, to share resources and experiences. A joint effort such as this encourages and offers material resources for those who are involved in online curriculum development, and those who are still curious or anxious about online teaching.

Summary

Since the advent of the Web, demands for online curriculum development have continued to increase. Teachers and curriculum developers are encountering both unprecedented opportunities and challenges in developing effective curricula. Our purpose here is to address these challenges and provide some possible solutions, as summarized in table 1. Although Kearsley (2000) notes that some issues in creating high-quality online curricula are really no different from those found in the development of traditional instructional materials, i.e. creativity, ambition, self-discipline and teamwork, there are distinct and important differences. These differences lie in the opportunities inherent in a technological world that seems to change exponentially, along with network technology itself, hypertext structure, and digital multimedia techniques. Each of these advances allows us to design more flexible, motivational and effective curricula. However, developing web-based curricula and courses is a complicated and time-consuming process, and requires a team approach. And the greatest challenge facing curriculum designers is often rethinking and adapting traditional curriculum development models.

It should also be noted that the features of web-based curricula are consistent with recent ideas about constructivist practice in education. Constructivist theories assert that knowledge is actively constructed by individuals, and that social interactions with others also play an important role in this process (von Glasersfeld 1993, Tsai 1998, 2001). Constructivist theory emphasizes that instruction needs to carefully consider learners' prior knowledge and encourage student-to-student as well as student-to-teacher interactions (Fosnot 1996, Tsai 2000).[6] Constructivist-oriented instruction also provides student–teacher shared control or student-centred learning environments (Taylor and Fraser 1991, Taylor *et al.* 1995). For example, as we have already suggested, web courses can ask students to complete online surveys or take online pre-tests to assess their prior knowledge, and can then offer the appropriate curriculum for each student. As they do this, web-based courses not only emphasize students' prior knowledge but also create student-centred instruction for students. The hypertextual nature of web courses offers higher flexibility for course

Table 1.   Contrasts between traditional and web-based curriculum development.

Traditional curriculum development issues	Web-based curriculum development challenges	What to do
(1) Define target students and their needs	• Defining target students and their needs is more difficult for web-based distance learning. • Block some 'surfers' who can potentially become learners of a given curriculum.	• Identify not only what they have already learned, what their cognitive, affective and psychomotor skills are, but also their computing capabilities, learning environments and life-styles. • Require students to register, complete online survey and/or take pre-test, and possibly give different curricula for different levels of students. • Require potential students to e-mail curriculum coordinator before registration. • Provide lesson examples.
(2) Identify instructional objectives	• Determine how to include students in the process of identifying instructional objectives. • Determine how to balance both teachers' and students' authorship in developing web-based curriculum.	• Set up a forum for both instructors and students to discuss the course directions and progress. • Allocate a separate area in the web curriculum for students to contribute their learning materials and for teachers to screen students' contributions.
(3) Select the scope of subject content	• Determine how to design an open, non-fixed, and boundless web curriculum. • Determine how to link web resources so that course content is enriched and students' attention is captured and maintained.	• Review and screen information in websites and make appropriate links. • Provide some guidance on linked information for students.
(4) Organize sequence and structure	• Determine how to organize a web curriculum sequence to best fit students' prior knowledge and skills; at the same time allow some degree of structural flexibility for their navigation. • Determine how to provide learning guidance to avoid students getting lost.	• Divide a course or a topic into stand-alone modules and make links among these modules. • Present information gradually from selected key concepts to finer, subordinate concepts. • Provide 'next' buttons indicating designer's recommendation for the next node to visit. • Set 'prerequisite node' before students jump to other nodes. • Always provide an overview on forthcoming information. • Provide a site overview, or epitome to explain content architecture.

(*continued*)

Table 1.   (continued)

Traditional curriculum development issues	Web-based curriculum development challenges	What to do
(5) Select presentation methods and media	• Determine how to present curriculum and course in different formats. • Prepare and organize content-appropriate presentations in a digital multimedia form.	• Be aware of the variety of options for presenting web-based learning materials. • Provide technical support to help prepare curriculum and course in digital multimedia forms.
(6) Design assessment activities	• Understand the unique requirements and features of web technology for implementing and maintaining web-based assessments. • Design effective web-based tests and assignments that accurately assess students' learning.	• Prepare innovative assessment methods for web-based learning, such as experts' evaluation of collaborative work, and individual self-assessment. • Prepare detailed listings of the assignment for students to follow.
(7) Implement formative evaluation	• Develop innovative methods for conducting formative evaluation for web-based learning. • Keep updating and revising course material.	• Develop formative evaluation system which can be used to collect evaluators' comments in remote locations. • Set up reasonable work schedule for continual updating and revision.
(8) Other concerns about curriculum development	• Determine the completion degree of curriculum design before putting it in use. • Require more time on web curriculum development. • Require a team approach.	• Have the entire curriculum organized into weekly modules, or prepare modules for at least three weeks in advance of their use. • Start planning and developing curriculum and course earlier. • Allow more time for continual updating and revising of courses, and dealing with other technical and/or administrative problems. • Organize a web course development team, including instructional designer, multimedia producer, systems analyst, network programmer, etc. • Set up team meeting dates to share resources and experiences.

structure, which may also better fit individual students' personal preferences. E-mail or web-based communications may also facilitate more student-to-student and student-to-teacher interactions. The concept of 'participatory democracy' proposed earlier is also consistent with the idea of student–teacher shared control. Indeed, Relan and Gillani (1997) have defined web-based instruction as 'the application of a repertoire of

cognitively oriented instructional strategies implemented within a *constructivist* and collaborative learning environment, utilizing the attributes and resources of the World Wide Web' (p. 43; emphasis added).

Finally, we argue that the time for researchers to ask whether or not web-based curricula should be created or used has passed. We must now work toward developing *effective* web-based curricula that will benefit all our students. The issues raised in this paper are perhaps a first step toward addressing these opportunities and challenges.

Acknowledgements

Notes

1. Other models of curriculum development are, for the purposes of this paper, less significant; the vast majority of educators who approach curriculum development from a technical perspective follow the models of Tyler (1949) and Taba (1962).
2. The final three stages are somewhat different from those originally proposed by Taba (1962). The original stages are 'selection of learning experiences', 'organization of learning activities', and 'evaluation'.
3. It is worth noting that in order to eliminate the possibility of students passing test information to others because of different testing times, different test sheets for individual students must be prepared by composing sheets of items selected at random from a test bank, which can be easily implemented on the Web. If test locations are not fixed, open-book-type tests or attendant supervisors at the test sites should be employed.
4. Similarly, Schifter (1999) considers that computer-mediated instruction allows materials to be continuously updated, thus making the curriculum always a work-in-progress. Therefore, web-based learning can bring the most up-to-date information into the curricula, and also into student discussion.
5. In the experience of Schweber *et al.* (1998), the development of online courses takes 2.5–3 times longer to complete than traditional courses, and faculty had to spend 2–5 hours more a week for class-related work. Therefore, designers or teachers should start planning and developing their curricula and courses earlier, so they give themselves more time to update and revise courses, and to deal with other technical and/or administrative problems.
6. Although constructivism is still a controversial topic in education (Phillips 1995), the position of this paper, following Perkins (1999) and Staver (1998), is that constructivism can help educators understand how students learn as well as explicate the practice of education.

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