

When Teaching Meets Learning: Design Principles and Strategies for Web-based Learning Environments that Support Knowledge Construction

Ron Oliver

School of Communications and Multimedia
Edith Cowan University, AUSTRALIA
r.oliver@cowan.edu.au

Abstract

While many writers have produced comprehensive guidelines to assist developers of conventional print-based learning materials, few have produced similar sets for designers of technology-based resources supporting flexible delivery. This paper explores some of the issues surrounding the design and development of Web-based materials and provides some firm guidelines which have been used successfully in the past to help designers adopt design strategies more appropriate to contemporary learning using new technologies.

Introduction

Tertiary education throughout the world today is brimming with activity given to the design and development of on-line courses designed to support flexible learning. The Web pages of all universities proudly proclaim their preponderance of on-line courses and often the scope of a universities' on-line learning offerings is used as some measure of its quality and performance. But when one takes a close look at the offerings, one has to be slightly alarmed because a significant proportion of on-line material is not very good. While the materials give a favourable appearance and often use the full extent of the capabilities of modern technologies, when judged from a teaching and learning perspective, they fail badly (eg. Dehoney & Reeves, 1999; Mioduser, Nachmias, Oren, & Lahav, 1999; Burbules & Callister, 2000). The purpose of this paper is to explore some of the reasons behind this failure and to examine strategies that might enable us to address this significant problem. The need for a turn around is quite pressing. There appears a growing feeling among many of those who run universities and who have until energetically funded these developments, that the returns on investment have been too low and some are starting to question the real value of technology as a learning tool.

Designing Materials for Independent Learning

Much of the instructional design that has been applied to Web-based learning environments has been guided by the principles of instructional systems design, an

approach widely used for the development of learning materials prepared for correspondence and print-based forms of flexible delivery (eg. Gagne & Briggs, 1974; Dick & Carey, 1978; Gagne, Briggs and Wager, 1992). These approaches are based on the notions that learning occurs primarily through the consequences of internal and external conditions relating to the learner and the instruction (eg. Ragan & Smith, 1996). Models developed from the approaches identify discrete instructional events as a means for developers to create instructional materials to support teaching at a distance. In such materials, the instruction typically takes the form of a narrative, where learners are led through a learning sequence by a well choreographed story which seeks to impart knowledge in much the same way as teachers impart knowledge in lectures and classrooms.

With such design approaches, the resulting materials seek to provide a means to carry the knowledge from the minds of the experts (teachers) into the minds of the learners. The central figure in these learning settings is typically the teacher, the person from whom the knowledge is derived and with whose skills the knowledge is represented and translated into forms that enable and facilitate its path to the learners

Those of us who have been teachers know how seductive the sense of mastery and expertise can be when it comes to the teaching process. How many of us have spent countless hours telling students stories, describing processes, explaining theories, all with the expectation that such activities were effective and powerful ways to impart our knowledge to the learners? The systems approaches to instructional design provide a neat and efficient way to translate such forms of teaching into sequential classroom procedures and self-paced learning materials. The approaches provide a formula for taking what has to be learned and crafting it into a written form that can be carried by the appropriate media.

As print has given way to electronic media, and delivery means have moved from paper to the computer screen, the new forms of learning material have tended to retain the characteristic features of the old. Stories are told in sequential fashions, the content is carried with instructional messages and small tasks interspersed to create forms of engagement and reflection for the learners (eg. Herrington, Oliver, Herrington & Sparrow, in press).

New Learning Theories

The emergence of the new learning technologies appears to have coincided with a growing awareness and recognition of alternative theories for learning, theories that suggest many problems and inefficiencies with conventional forms of teaching. The theories of learning that hold the greatest sway today are those based on constructivist principles (eg. Wilson, 1996; Duffy & Cunningham, 1996). These principles posit that learning is achieved by the active construction of knowledge supported by various perspectives within meaningful contexts. In constructivist theories, social interactions are seen to play a critical role in the processes of learning and cognition (eg. Vygotsky, 1978). Grabinger (1996) provides a succinct comparison of the assumptions of learning that were typical of older views and those new assumptions that are aligned more with contemporary constructivist views (Table 1).

Old assumptions	New assumptions
• People transfer learning with ease by learning abstract and decontextualised concepts. • Learners are receivers of knowledge. • Learning is behaviouristic and involves the strengthening of stimulus and response. • <i>Learners are blank slates ready to be filled with knowledge.</i> • Skills and knowledge are best acquired independent of context.	1. <i>People transfer learning with difficulty needing both content and context learning.</i> 2. Learners are active constructors of knowledge. 3. Learning is cognitive and in a constant state of growth and evolution. 4. Learners bring their own needs and experiences to learning situations. 5. Skills and knowledge are best acquired within realistic contexts. 6. Assessment must take more realistic and holistic forms.

Table 1: Old versus new assumptions about learning (Grabinger, 1996: p. 667)

Theoretically, the strengths of constructivism lie in its emphasis on learning as a process of personal understanding and meaning making which is active and interpretative. In this domain learning is viewed as the construction of meaning rather than as the memorisation of facts (eg. Lebow, 1993; Jonassen & Reeves, 1996).

Student Responses to Changed Learning Settings

Teachers have been describing the outcomes from more student-centred learning settings for many years now and frequently explore students' responses to these enhanced environments. The results often reveal learner dissatisfaction with contemporary learning settings, especially in those where they are expected to assume control of their learning and to make decisions which previously may have been made for them. For example, Scott, Buchanan and Haigh (1997) discuss the diversity of opinion among a cohort in relation to their positive perceptions of student-centred learning approaches. In a study of student preferences in independent learning settings Jones and Jones (1996) report a strong preference among many learners for the retention of conventional presentation forms such as lectures.

Use of technology as a learning tool has the prospect to limit some of the difficulties and impediments faced by students in learning environments that support student-centred and constructivist learning. Our own inquiries with students' in on-line learning settings found students often expressing an initial desire to retain lectures and face-to-face contacts but changing their opinions as their experience and satisfaction with the alternative settings developed (eg. Oliver & Omari, 1999). In other inquiries of students' satisfaction with on-line courses, we found that many students accustomed only to conventional forms of teaching preferred more teacher contact when teachers changed

their roles from teachers to facilitators (eg. Oliver, 1998). Their apparent negative responses were aimed more at the apparent diminution of the teachers' involvement more than their acceptance of higher levels of learner control

Technology-based Learning Settings

Technology-based approaches to learning provide many opportunities for constructivist learning through their provision and support for resource-based, student centered settings and by enabling learning to be related to context and to practice (eg. Berge, 1998; Barron, 1998). The learning activities in technology-based environments play a fundamental role in determining learning outcomes (Wild & Quinn, 1997). They determine how the learners will engage with the course materials and the forms of knowledge construction that will take place. Socio-constructivist theories argue a need for communication and collaboration, activities that are well supported by technology-centred learning (eg. Collis, 1998). There have been many attempts by writers to provide guidelines for developers of on-line and technology-based learning environments to create settings that support constructivist learning. In some instances the guidelines have been based on the descriptions of the nature of the conversations and interactions needed (eg. Laurillard, 1993), while in other instances they have been based on descriptions of suggested forms of resources and activity. For example, Carr-Chellman and Duschatel, (2000) suggest the ideal on-line course is characterised by:

- A blend of appropriate delivery media including a study-guide and printed text-book;
- The use of assignments to provide contexts for learning;
- Provision for collections of student work and examples on-line;
- The use of all possible forms of communication to connect learners and their tutors;
- Activities that support interactive skill building, not simply information searching and acquisition; and
- Support for learner engagement capable of adaptation to suit the individual learners.

But there is still a large gap between these ideas and the actual design and development process. When one compares the nebulous nature of these guidelines compared to the extremely explicit guidelines that support instructional systems design, it is no wonder that the majority of developers prefer to use the latter. Especially when students are yet to fully support the contemporary settings.

Designing Online Learning Materials Supporting Constructivism

The question that is posed by this line of reasoning, becomes, is it possible to specify design guidelines from which instructional designers can generate Web-based learning settings that exemplify constructivist learning settings? This is a question on which we have been working for some time and we sense that it is possible to do so and to still leave the designer sufficient freedom to employ some form of creativity in the design process. The following guidelines are suggested as design strategies which can help designers by leading their thinking outside the constraints of conventional Web-design. Following these guidelines makes it impossible to end up with a static Web site

comprised of sequential pages. These guidelines help to promote the design beyond the traditional systems design approaches and into quite creative realms.

1. Choose meaningful contexts for the learning

We have been guided to a large extent in our research by the quest to create learning settings which provide a degree of authenticity in the nature of the learning outcomes being achieved (eg. Herrington & Oliver, 1999; Herrington & Oliver, in press). Our quest has been to create settings which provided a strong connection between the learning and the purpose for which the learning was intended. Such an aim tends to make the designer cognisant of the purpose of the learning and to strive for activities that reflect the real life setting. Seeking a connection between the classroom learning and the intended purpose of the learning generates restrictions on how the learning will be achieved but at the same time creates many opportunities for the contexts of the learning. When the design looks for meaningful contexts, the information becomes purposeful and the resources become artefacts of the learning setting. Most times when people generate meaningful Web contexts, their Web pages take on virtual settings that reflect a real life environment in which the learning can be cast. Some examples of this form of learning setting that we have described in the past have been Principles of Finance (eg. Stoney & Oliver, 1998) and Assessments in Mathematics (Herrington, Sparrow, Herrington, Sparrow & Oliver, 1997).



*Figure 1. A Web-based setting with an authentic context
(Principles Of Finance, Edith Cowan University)*

2. Choose the learning activities ahead of the content

When environments are designed to reflect meaningful contexts, it is virtually impossible to create settings that are not in some way driven by their learning activities. It is almost impossible to create a page-turning or transmissive delivery setting. The context demands a purpose and the purpose becomes a learning task. Choosing meaningful and

authentic learning tasks can be quite a difficult process but once you start it becomes easier (eg. Herrington, Sparrow & Herrington, 2000).

The way to do this is to consider how the learning is to be used in real life and to replicate this form of activity. Such an act requires you to consider the learning aims and the forms of competency that might reflect their achievement. From this point, it is then possible to decide what resources and content students will need to support the learning activities. The course content, which in traditional settings tends to be the desired end of the learning, becomes the means to an end. It serves to support the learning activity and its purpose is to provide information upon which the learner can call in completing the learning activity.

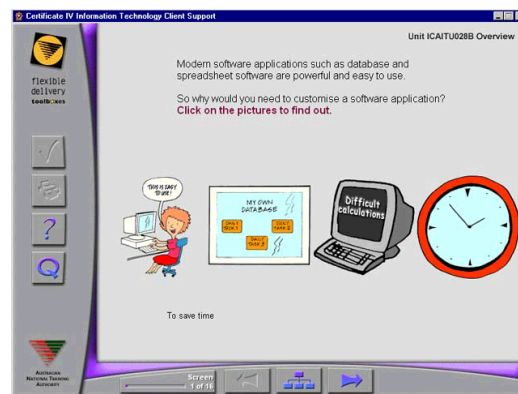


Figure 2. Conventional courses often use content as an end in itself.
(ANTA Flexible Toolbox)

3. Choose open-ended and ill-structured tasks

You are probably now getting the idea of the design process and the next stages should become a bit easier than the early stages. We now have a meaningful context for the learning and we are starting to assemble a range of resources to support the learning. The components of the course that drive the learning are the learning tasks. These must be designed with some care and some skill. The tasks have to provide the learners with the capacity to explore, inquire and reflect as means of generating some understanding of the context.

If the tasks are too straightforward, the students will be able to develop solutions and outcomes without overly stretching their mind and intellects. On the other hand if they are too difficult, many students will fail to complete them. If they are to be authentic, they need to have different interpretations and to have different solution processes and of course to have many acceptable outcomes. Often in task choice, you will be more interested in the processes involved in their solution than in the solution itself. Some exciting examples of this feature in Web design is evident in the ANTA Flexible Toolbox Project (eg. Oliver, Towers & Pearl, 2000)

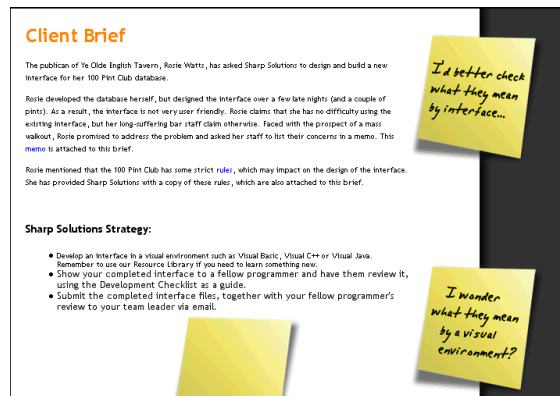


Figure 3: Using tasks to drive the learning helps focus on processes rather than products (ANTA Flexible Toolbox)

4. Make the resources plentiful

When courses are developed on the basis of authentic tasks and contexts, the resources that support the learning need to be extensive. Learners need to be able to explore and inquire and to derive their own meaning from these processes. It is important for them to see many different outlooks, to be able to view situations from a number of perspectives, to be able to disregard irrelevant information and to have to deal with the cognitive conflicts that occur as their ideas develop. This form of learning activity cannot be supported by scant resources. The idea of having a single text is simply insufficient for this form of learning.

The Web provides many assistances for designers and teachers looking to fill their sites with relevant information. The resources can take many forms and be of many types. Clever designer create opportunities for their sites to grow and for the learners to contribute to the knowledge base. It is not necessary for the teachers and designers to provide all the resources the learners will need but it helps if the environment is supportive of this need. Using an authentic context provides a place to put information that is easily located by the students.

5. Provide supports for the learning

Developing the tasks requires the designer to consider such things as providing some forms of scaffold and support for the learners. In Web-settings there are many strategies that can be used to support students. Perhaps the most effective support comes from peers. Creating collaborative and cooperative settings for learners provides many advantages for the designer and the learners. As learners collaborate they articulate their ideas and thinking and this contributes in large ways to developing their understandings. In Web-settings where learners are working remotely and at a distance, the technology provides many supports for collaborative learning including email, bulletin boards and chat rooms.

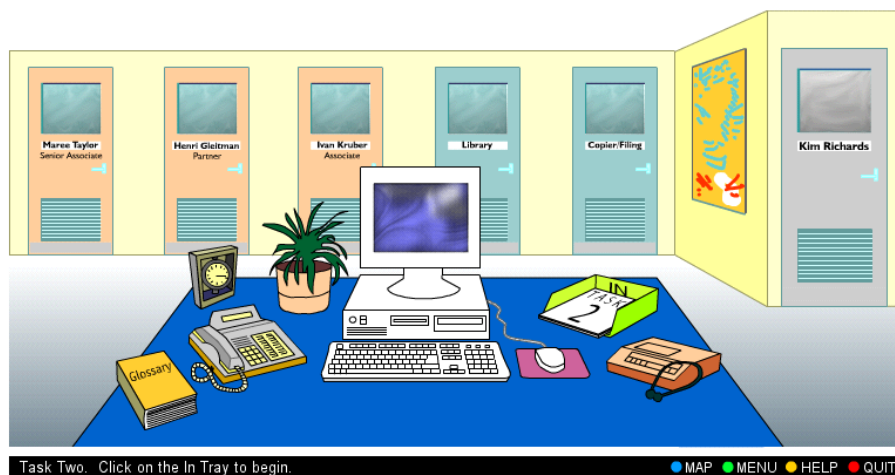


Figure 4: Virtual settings provide many opportunities to store vast arrays of meaningful information and resources for learners (ANTA Flexible Toolbox)

In some instances, designers will want to provide more structured supports and scaffolds and again these can take many forms. For example, in the first part of the course, the problems can be more highly structured and provide hints and strategies. As the course progresses the problem specifications can be reduced. Other forms of scaffold include FAQ sites, dynamic lists of URLs that students help to build, student work samples, links to external sites. There really is no end to the forms of scaffold and support that can be provided (eg. Oliver & McLoughlin, 1999).

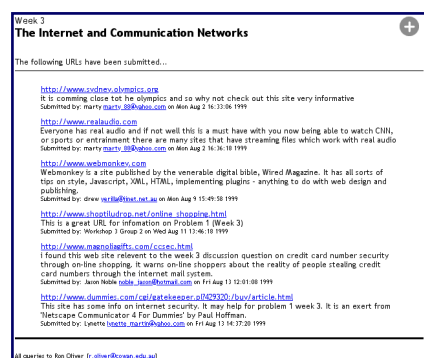


Figure 5. The design must include a raft of scaffolds and supports for the learners (Edith Cowan University)

6. Use authentic assessment activities

It is well known that the most motivating aspects of an tertiary learning environment are the assessment strategies which will be used to measure performance and achievement. Students show particular care about learning activities that are in some way related to the

planned assessment. Such an awareness and interest by the students provides a perfect opportunity for the designers of Web-based learning settings to motivate learners in their tasks and activities (eg. Reeves & Okey, 1996).

If all the guidelines from above have been followed, using the various activities as assessable elements of the course, serves to tie the course assessment to authentic tasks reflecting in some way the forms of use to which the learning will be placed when the student is a real practitioner. Using assessment with the learning activities provides an accurate measure of performance and achievement and is likely to accurately represent the capacities of the learner in the workplace setting. Tying the assessment to the authentic activities reduces the inclination to use those less meaningful (but convenient) forms of assessment such as exams and essays which we often see in tertiary teaching.

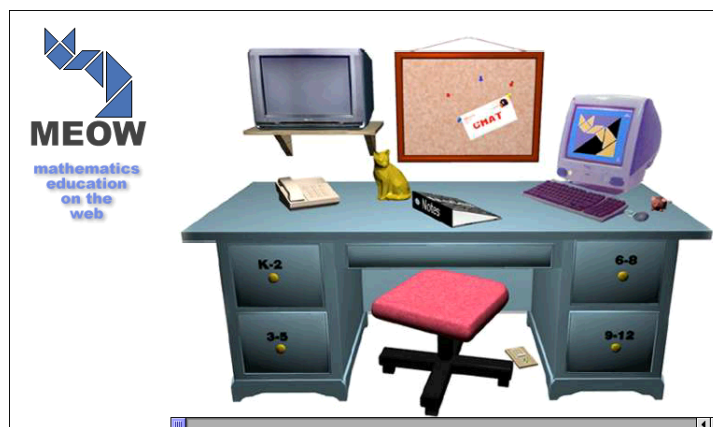


Figure 6. Authentic assessments help in many ways to support constructivist learning settings (Herrington, Herrington & Omari, 2000)

Summary and Conclusions

This paper has attempted an impossible task in that it has sought to provide a blueprint to guide designers looking to create Web-based learning environments that support constructivist modes of learning. There really is no prescriptive way to advise the design of constructivist learning settings but guidelines can help. This paper has suggested six guidelines as a possible starting point for those seeking to create Web-based learning settings that support constructivist forms of learning. We have used these guidelines in a number of projects and we can now point to a growing number of examples of Web sites that contain the various elements in a variety of forms. There will be many other guidelines that can also add to the learning quality of Web-based settings but this list provides a useful starting point for those who seek to use it.

From our experience, the most useful strategy for moving to constructivist Web settings from more traditional designs is to commence the design process by using the course objectives to drive consideration of the forms of learner activity and engagement that will be needed to lead to the planned learning outcomes. The focus on the learning activities ahead of the content opens so many doors to the designer. Immediately, the design can

consider contexts for learning and the rigid frameworks of sections of work and chapters which usually restrain design disappear. The environment can be built around a series of tasks and structured in ways to lead the learners to develop the required outcomes and to provide the forms of support needed to achieve this. The guidelines suggested above provide a practical means to achieve this aim.

An interesting feature of our work has been the discovery of the interest and enthusiasm which the adoption of these guidelines have provided for instructional designers and developers familiar only with conventional practices. While the change from the design of conventional forms of instruction to the constructivist forms suggested in this paper seem significant and perhaps difficult to achieve, once the principles are recognised and understood, designers have so many opportunities and their work can take on so many forms. Few of the designers with whom we have worked want ever to design conventional instructional materials again.

People develop Web environments for many purposes. Some teachers use Web sites as a means of delivering learning resources. Other teachers use the Web as a means of communication and organisation for their learning settings. Some teachers use Web sites to manage their learning programs. Much of what has been reported in this paper will be of little interest to many of these teachers. But for those teachers who want to use the Web to enhance students' learning, the guidelines presented in this paper provide some practical strategies that can be used to guide the design process of engaging and stimulating Web-courses across many fields of study.

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