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# Developing e-learning environments that support knowledge construction in higher education

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## Abstract

*Much of the conventional development of Web-based learning environments the creation of electronic forms of existing print-based materials. In such instances the Web-based courses have tended to display limited evidence of an underpinning learning design and varying degrees of use of the opportunities and affordances of the new technologies. This paper provides an overview of instructional design principles that can guide the creation of Web-based learning materials that support learner engagement and knowledge construction. The paper describes the attributes of constructivist learning settings and provides some examples of explicit learning designs that can be applied in the design of Web-based learning environments. It describes strategies that are currently underway that are looking to provide ways to mainstream effective Web-based learning designs.*

*Keywords: instructional design, on-line, e-learning, higher education, constructivist*

## Introduction

The jury appears to still be out in relation to some of the benefits to higher education of contemporary e-learning projects and activities. E-learning has been mooted as the solution to many of the problems that face institutions of higher education. Many writers have argued the use of e-learning to attract new markets and new students, others have argued its capacity to increase levels of equity and access for existing students., while others see the new technologies as capable of reducing the costs of delivery of programs and courses. While many of these claims and potentials have yet to be verified the one thing we have learned from our activities in this domain is that e-learning, when done well, can improve learning and deliver enhanced learning outcomes. The intention of this paper is to explore strategies that can be used to assist in the design of effective e-learning environments. In essence, it attempts to provide a blueprint for design which academics can follow when they wish to create effective e-learning environments.

## Instructional Design for Web-based learning

In a previous paper, I described a framework for designing online learning settings (Table 1). The framework comprises three interconnecting elements which are presented as critical components for the design of learning settings. In particular, the framework highlights various distinctions between the elements involved in the design of online learning settings (Oliver, 1999).

**Table 1.** Framework describing critical elements of online learning settings

learning design elements	description
learning tasks	The activities, problems, interactions used to engage the learners and on which learning is based
learning resources	The content, information and resources with which the learners interact and upon which learning is based

learning supports	The scaffolds, structures, encouragements, motivations, assistances and connections used to support learning
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The framework provides a means to identify the various elements within learning settings and suggests emphases which can be made in the instructional design process. Contemporary learning theories posit that the forms of learning design most appropriate to higher education are those based on constructivist learning principles. The above framework takes on particular and discrete forms when applied this way.

### **Learning Tasks**

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. Contemporary thinking suggests that the activities must be active and engaging (eg. Wild & Quinn, 1997). They need to engender cooperative and collaborative activities among the cohort and in doing so must provide opportunities for reflection and articulation. The activities must provide the purpose and the context for learners to deal with the content and information (Duffy & Cunningham, 1996).

A synthesis of the pedagogical features for constructivist learning in on-line settings suggests the need for instructional design approaches which promote learning outcomes through learning processes and strategies employing various modes of communication (eg. Jonassen & Tessmer, 1996; Collis, 1998). Fundamental to the notion of knowledge construction is an active role for the learner in which there is encouragement and reason to act independently and in a self-directed fashion. Characteristic of these approaches to learning are settings and activities which see learners assuming much of the responsibility for themselves in terms of what is learned and how it is learned (eg. Duffy & Cunningham, 1996).

### **Learning Resources**

Choosing and developing content for flexible technology-based learning is seen by many teachers as the most important step in creating on-line learning environments. This is reflected in the resulting materials which often have a content-focus (eg. Dehoney & Reeves, 1998). It is sometimes estimated that on-line teachers spend 90% of their planning and development creating content and on-line learning resources. Contemporary thinking suggests that the content can, and should, assume a far lesser role in the design process. In constructivist learning environments learners need to be exposed to content that provides them with perspectives from a multitude of sources (eg. Herrington & Oliver, 1995). The materials need not all be on-line. The use of conventional materials along with electronic sources can provide the diversity often required. Previously designers created course materials where the content was rigidly organised and presented to the learners in a strict sequence. Today it is recognised that learners need to be able to access resources in a variety of ways and the absolute strictness and rigidity should be lessened (eg. Lebow, 1993).

Duschatel (1997) argues that content also needs to be chosen in a fashion which provides authentic examples and contexts. This argument is very much in line with situated learning principles. The move to outcomes-based and competency-based education is a reflection of this form of thinking. In such instances, the content is presented as a means to an end rather than an end in itself and it is the learner who must make most of the choices about which material to use and how to use it. There are many ways in which these principles and ideas can be implemented in on-line settings. Perhaps the best strategy to deal with this is to consider content as a resource for learning rather than the focus of learning.

### **Learning Supports**

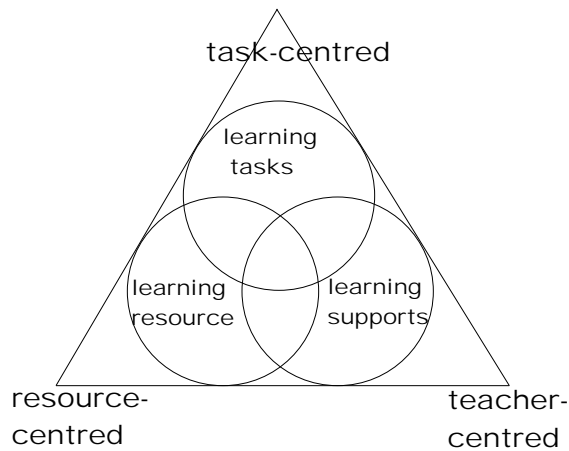
The third and final critical design element from the framework is that of learning supports. Flexible and on-line learning environments need learning supports to be designed as integral parts of the

which is responsive and sensitive to their individual needs (eg. McLoughlin & Oliver, 1998). In distance education contexts, learner support is a term that often embraces more extensive mechanisms such as academic support, library support and counseling. In this paper, the term is used in a much narrower context and limited to aspects of the on-line learning environment alone.

A number of writers have developed strong frameworks to describe the ideal forms of support required for on-line learning environment and in each case, there is usually a strong argument made for an active and involved teacher (eg. Laurillard, 1993). The role of the teacher however, tends to be defined as that of a coach and facilitator in place of the more didactic style often assumed. In contemporary settings, this form of learning support is called scaffolding in recognition of the way in which it helps to build knowledge and is then removed as the knowledge construction occurs.

### **Approaches to Instructional Design**

The framework described above discusses the various roles of each of the three elements. Often in the design process, designers emphasise one of the elements over others and in this way create an environment with particular attributes. Figure 1 below suggests differences in the nature of learning environments when one or more of the elements is emphasised in the design process.



**Figure 1:** Instructional design emphases

**Resource-based learning.** In the past, many forms of online learning setting have been based on the delivery of online content. When the online environment is based on online content delivery, the resulting products are resource-based environments. These environments are characterised by an emphasis on online content and typically tend not to make the most of the opportunities afforded by the online technologies. Many writers are critical of such on-line learning settings for the narrowness of the instructional approaches they use.

**Teacher-centred learning.** More contemporary online learning settings make strong use of the communications facilities of the Web. For example, many teachers support their online courses with discussion fora and online communications. In this way they create roles for themselves as supports for learning. When Web-based learning is used as a support for classroom learning, the prominence of the teacher role leads to a teacher-centred approach. In remote learning settings, use of the online facilities in supportive ways creates this form of environment.

**Task-centred learning.** The third type of learning suggested by the framework derives from settings where the learning activities are the underpinning elements. Task-based approaches stem from the use of learning activities as the contexts and anchors for student learning. In such instances students work in various ways to complete tasks, inquiries and projects etc. with access to resources and with forms of online support. In this paper I argue that task-based learning provides the best opportunities for learning environments that support active learning and knowledge construction.

### **Constructivist learning settings**

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. 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).

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). Technology-based approaches to learning provide many opportunities for constructivist learning through their provision and support for resource-based, student centred settings and by enabling learning to be related to context and to practice (eg. Berge, 1998; Barron, 1998).

Many writers have in the past provided guidance for the design of constructivist learning settings by articulating the underpinning characteristics. For example, Cunningham, Duffy & Knuth (1993) argue that constructivist learning environments are characterised by seven pedagogical goals. They suggest that constructivist learning settings are those which concurrently:

- provide experience in the knowledge construction process;
- provide experience in and appreciation for, multiple perspectives;

- embed learning in realistic and relevant contexts;
- encourage ownership and voice in the learning process;
- embed learning in social experience;
- encourage the use of multiple modes of representation;
- encourage self-awareness in the knowledge construction process.

Lebow (1993) presents five principles that he considers are needed to integrate the affective and cognitive domains of learning in ways that support constructivist principles of learning. He argues the need for learning environments to:

- maintain a buffer between the learner and the potentially damaging effects of instructional practices;
- provide a context for learning that supports both autonomy and relatedness
- embed the reasons for learning into the learning activity itself
- support self-regulated learning by promoting skills and attitudes that enable the learner to assume increasing responsibility for the developmental restructuring process
- strengthen the learner's tendency to engage in intentional learning processes, especially by encouraging the strategic exploration of errors

Savery & Duffy (1995) argue that there are four principles that necessarily underpin learning in constructivist settings:

- learning is an active and engaged process;
- learning is a process of constructing knowledge;
- learners function at a metacognitive level;
- learning involves social negotiation;

Grabinger (1996) provides a succinct list of the assumptions of learning that are aligned with contemporary constructivist views:

- People transfer learning with difficulty needing both content and context learning.
- Learners are active constructors of knowledge.
- Learning is cognitive and in a constant state of growth and evolution.
- Learners bring their own needs and experiences to learning situations.
- Skills and knowledge are best acquired within realistic contexts.
- Assessment must take more realistic and holistic forms.

The descriptions which authors provide of the elements required for constructivist learning settings can help designers to understand the forms of learning activity which are required but often fail to provide adequate guidance for the actual learning designs that can encapsulate such principles in cohesive and supportive ways. Hannafin, Hall, Land Hill (1994) suggest that appropriate forms of learning settings are what they call open-ended learning environments. These are characterised by learner engagement in cognitively complex tasks involving such activities as problem solving, critical thinking, collaboration and self-regulation.

There are however a number of discrete learning designs that support constructivist learning and whose forms can provide designers with guidance and structure in the design of actual constructivist learning settings. In the literature many of these designs remain ill-structured in their definitions and descriptions which can limit teachers in their choice and use of them.

### **Constructivist Learning Designs**

When these ideas are put into practice, the forms of learning setting that result are similar in many respects and quite different to conventional settings. The designs tend to be based on forms of learning that are based on learners undertaking various forms of activity that are open-ended and student-centred. The forms of environment tend to be those that require learners to work with others and to share the results of their work and to reflect on the outcomes. They tend to be settings where there are no fixed resources or content to be learned and where the emphasis is on learning how rather

than learning about. There are a number of discrete learning designs that accommodate these needs and some of these are discussed below.

**a. Problem-based learning (PBL)** is a learning design that found popularity in the mid 1980s in medical schools as an alternative to traditional forms of learning in this domain. Barrows (1992) describes a problem based setting where students work in small groups under the guidance of a facilitator in a problem-based setting where they are required to diagnose a patient's medical condition and to provide a rationale for their diagnosis and treatment. PBL involves presenting students with a real-life problem immersed in a context which is relevant to professional practice. Problem-based learning designs involve complex problems which provide a stimulus for learning. They provide students with the opportunity to immerse themselves into a context which requires more than memorisation and understanding of concepts and challenge them to apply their knowledge to determine the best outcome.

In PBL settings students apply their conceptual knowledge as well as processes and effective action learnt in solving the problem. Problem-based learning usually incorporates cooperative learning groups. Students work cooperatively in small groups identifying their prior knowledge and what they need to know to effectively solve the problem. Problems did not encourage simple, lower level solutions but demand that students pursue new knowledge through the process of solving the problem. The application of knowledge and skills is essential during the process of problem solving. The teacher's role is to facilitate a positive, encouraging cooperative learning environment and provide scaffolding at crucial times, as determined by the dynamic process of solving the problem.

**b. Case-based learning** is a form of problem-based learning but with unique characteristics. In case-based learning, students typically work through a problem setting which is usually a realistic case relevant to their course (medicine, business, etc). Students work through the case, either collaboratively or individually, and make decisions as to what would be the best course of action. A case is an abstract of an event and interpretations of experiences. It can either be a previously encountered and solved problem, or a typical way of solving a problem.

The characteristic feature of this type of learning activity is case-based reasoning. Case-based reasoning is a problem solving paradigm which utilizes the specific knowledge of previous experiences within concrete problem situations such as cases. A new problem is solved by finding a similar past case, and applying its solution to the new problem situation. Cases can have several components. If each component of the case is interpreted correctly the more useful it will be when it is necessary for the student to recall and apply similar knowledge and processes to another case (Kolodner & Guzdia, 2000).

**c. Project-based learning** engages students in the process of designing and creating products that meet authentic needs. It can focus on the central concepts and principles of a discipline through involving students in problem-solving investigations. Project-based learning lends itself to cooperative learning environments which enable students to discuss, explore, test ideas and concepts supported by a team environment. Even so, projects can be worked on autonomously. Project-based learning environments are considered authentic in nature and provide a learning environment which stimulates and encourages students to construct their own knowledge and pursue their own interests resulting in the creation of realistic products (Guzdia, 2000).

**d. Inquiry-based learning** describes a learning design where students are faced with an open-ended task for which they must formulate investigative questions, obtain factual information, and then build the knowledge that enables them to answer the original question. The form of learning is a hybrid of problem-based learning with its own idiosyncratic features. Students are often required to observe and question, present explanations, devise and conduct tests to test their theories; analyse data; draw conclusions, or design and build models. Inquiry-based learning emphasises research, critical thinking and multi-disciplined study to achieve course outcomes. Inquiry-based learning is sometimes discussed in conjunction with problem-based learning. Jakes, Pennington & Knodle (2001) describe

inquiry-based learning as a process where students formulate questions or the teacher provides questions to stimulate investigative processes to obtain information to help build knowledge to effectively determine a solution. Typically students are aided with questions or scaffolds provided by the teacher or other students.

Inquiry-based learning differs from problem-based learning by virtue of its use of a greater range of learning methods, high levels of teacher support and scaffolding, and an emphasis on an interdisciplinary approach to learning, critical thinking as well as students assuming responsibility for their own learning (Magnussen, Ishida & Itano, 2000). Inquiry-based learning can involve other forms of learning design including discussions, group exercises and role plays. The strategy makes strong use of student interactions, their previous knowledge and life experiences (Cerny, Amundson, Mueller & Waldron, 1996).

**e. Role playing** is a learning activity where students assume characters within a chosen context and carry out roles in the conduct of a predetermined scenario. Role playing is often used in educational contexts as a means to develop the affective components of a curriculum, for example students' beliefs and attitudes. In many business courses, role playing is used in such areas as counselling, negotiation training and learning about ethics (eg. Glass, 1999). Some instances of role playing take the form of games and are often referred to as simulations. In the context of this paper, we are principally concerned with the less structured forms of role playing.

Role playing is an open-ended learning environment and can involve the same high levels of learner activity and inquiry as other settings described earlier. Role plays are usually based around problem settings and in themselves tend to be problem-solving activities. Role plays are set within specific contexts and tend to follow a phased approach with learning occurring across a number of phases (Chesler and Fox, 1966).

### **Implications for Mainstream Teaching**

The learning designs that I have described above are discrete and recognisable entities. They represent forms for the design on any type of learning environment but are very well supported when used in online settings. There are many academics and teachers who are finding very effective ways to apply these design strategies in their classes in higher education. But for many the learning design is unknown and its potential for application in their classroom teaching is quite distant.

There are now a number of projects which are underway to make it possible for teachers to employ these forms of learning design in their own classes through online technologies. One particular project in which I am involved is an Australian Universities Teaching Committee Project which is exploring ways to create templates and generic designs for learning environments with learning designs of the forms I have described here. Many other agencies are now looking for ways to create reusable forms of learning designs and learning resources to foster and encourage the development of sustainable and effective online learning settings. Much of the research and development work in online learning is exploring issues associated with creating the means for mainstream teachers to seamlessly integrate new technologies in meaningful ways into the learning programs.

### **Summary and Conclusions**

This paper has discussed the nature of constructivist online learning environments and has presented a synthesis of contemporary thinking describing the attributes of settings that support knowledge construction. The paper has presented a model to inform the design of constructivist online learning settings and argues the needs for learning that is task-based and centred on open-ended and ill-structured activities.

A number of learning designs have been presented that have been found to support constructivist learning settings. These learning designs are being used more and more as the basis of the design for online learning. They provide a structure and framework for designers to follow which encourages the selection and creation of meaningful tasks as the basis for student activity. At the same time the



various designs support the notion of authenticity in the tasks in terms of the nature of the tasks and the contexts in which they are set.

Whereas in the past we have seen the proliferation of Web-based learning settings that have consisted mainly of on-line content and online interactions between teachers and students, we are now seeing increasing application of the forms of learning design described in this paper. Much of the research in instructional technologies today is focusing on exploring ways to refine and modify these settings to discover the optimal forms of learning activity and engagement to support the transfer of learning from the classroom setting to the workplace or the setting where its intended use will be.

*(word count 3,400)*

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