Theoretical foundations of a Web-based learning environment pedagogy

1. Introduction

Emerging trends in tertiary education have seen a shift in focus from *teacher-centred* to *learner-centred* education and an increase in the use of Web-based learning environments in teaching programmes. These changes have provided impetus for the development of frameworks of teaching and learning that can be used to inform the design and use of these learning environments. These frameworks are based on learner-centred principles and reflect the need for appropriate use of the Web technology in tertiary teaching and learning settings. This report describes theories and models of learning and teaching, which are relevant to Web-based learning environments. As foreground to this discussion a brief overview of the theoretical foundations of current educational theories are provided. From this theoretical foundation, the CLC-Web Pedagogy is developed. It is proposed that this can be used as a framework to inform the design and use of Web-based learning environments.

2. Theoretical foundations of learning models

Many theories and models have been developed to describe the nature of learning. A number of these have been used in relation to Web-based learning to provide frameworks to explain student interactions within Web-based learning environments and to guide the design and use of these environments. The foundation for understanding the process of learning within these environments is provided by psychology. As Duchasel (1995) states (p.215):

> Applied learning psychology studies the interaction between learner and environment and the resulting internal processes that constitute learning. As such, learning psychology guides learning technology in the design of learning environments.

The two prominent theoretical positions that have influenced conceptions of learning are derived from *behavioural* and *cognitive* psychology. These provide quite different perspectives from which to understand the nature of learning. Behavioural psychologists view learning as directly observable behaviour that can be measured by behavioural responses in the learner. Learning is seen as a process of conditioning by instruction that can guide and shape the learning through sequences of *stimuli*, *responses*, *feedback*, and *reinforcement*. Behaviourists equate learning with observable behavioural outcomes and do not consider the role of mental operations in the learning process. In contrast, cognitive psychologists focus on the mind as the agent of learning. They are concerned with the internal mental constructions and activities of the learner rather than their external behaviour. Cognitive psychologists stress the importance of learning through a variety of learning strategies that depend on the type of learning outcomes desired. These strategies include *memorisation*, *drill* and *practice*, *deduction* and *induction* (Atkins, 1993; D. H. Jonassen, 1991; T. C. Reeves & Reeves, 1997).

Behaviourism and cognitive psychology are often presented as opposing philosophies in their explanations of learning. However, there are similarities in that both seek to effect learning through the design of specific tasks. The main differences are the foci on either external or internal activities of the learner and the epistemologies on which they are based (D. H. Jonassen, 1991). The behaviourist position draws on an *objectivist* view of knowledge. The central tenet of *objectivism* is that there exists a reality with a structure that can be assimilated by the learner. The role of the educator is to interpret, model and present this reality to their

students (D. H. Jonassen, 1991). From behaviourism and objectivism the *instructivist* approach to teaching and learning has evolved. This approach focuses on the structure and presentation of the learning material rather than the learners who are passive recipients of the instruction.

In contrast, cognitive psychology focuses on the cognitive activity of the learner. Cognitive psychology encompasses a broad range of views on the structure of knowledge and the processes involved in learning. These range in a continuum from a view that learning is effected and monitored by external stimuli and mediated by cognitive processes to a view that learning is a cognitive process initiated by the learner. The first view is linked to an objectivist epistemology and the second to a *constructivist* epistemology (Lowyck & Elen, 1993). The development of *constructivism*, which emphasises the cognitive activity of the learner through interaction with their environment, has been an important influence on educational technology. This is discussed in more detail in Section 4 and Section 4.2.

Until the beginning of the 1990s, the design and use of educational technology was strongly influenced by behaviourist principles (McKenna, 2004). Over the last couple of decades, with developments within cognitive psychology, there has been a move away from the objective view of knowledge as separate from the learner to a focus on the learner as the knower. This has shifted emphasis in research into learning from a behaviourist to a cognitive perspective (Herrington & Standen, 2000). However, both behaviourism and cognitive psychology are currently influential in developments and applications of educational technology (Atkins, 1993; McKenna, 2004). Although there is now little support for the objectivist view of knowledge — a key principle of behaviourism — there are also questions about the practical applicability of cognitive psychology research, which is often based on laboratory experiments. These bear little resemblance to normal learning tasks and as a consequence cognitive research tends to develop theories common to all learners rather than exploring individual differences or qualitative changes among the learners (Laurillard, 1987; Richardson, 1987). The position is further blurred when we consider that cognitive psychology focuses on the mental processes of the learner, but the models and theories developed by cognitive psychologists are typically tested using evidence of a behavioural nature.

More recently, a number of theories that have influenced the design of learning environments have drawn strongly from disciplines other than psychology. These have looked beyond the learning theories derived from behavioural and cognitive psychology — which focus on the external and internal events of the learner — to consider learning in a broader context. Perspectives from anthropology and sociology have broadened the view of learning to consider the social and cultural situations in which learning occurs (Lave & Wenger, 1991; Vygotsky, 1978). This has led to the development of learning theories from a *situative* perspective. According to situative principles, learning is viewed as "effective participation in practices of inquiry and discourse that include constructing meanings of concepts and uses of skills" (p.14) (Greeno, 1998). In an attempt to link the behaviourist, cognitive and situative positions, Greeno (1998) proposes an all-encompassing framework for the design of learning environments based on a situative perspective. He suggests that the situative position can subsume the behaviourist view of learning as acquisition of skill, and the cognitive view of learning as growth in perceptual understanding. By incorporating these under the situative umbrella they become complementary rather than orthogonal assets. As Greeno (1998) advises (p.17):

> We need to organise learning environments and activities that include opportunities for acquiring basic skills, knowledge, and conceptual understanding, not as isolated dimensions of intellectual activity, but as contributions to

> students' development of strong identities as individual learners and as more effective participants in the meaningful social practices of their learning communities in school and elsewhere in their lives.

Wilson and Myers (2000) cautiously support this view, claiming that the situative perspective accommodates rich and active environments and is well able to form the basis of an integrated framework which can incorporate the behaviourist and cognitive views. Synthesising the behaviourist and cognitive positions under the situative position has the potential for providing a broad framework for educational principles and practices providing a coherent foundation for the design of learning environments. Taking a similar stance, Hannafin and Reiber (1989) propose an overriding framework for the design of learning environments, which allows consideration of the learning process and instructional methods from the different perspectives. The strength of this inclusive approach, which considers multiple perspectives, is that it can provide a coherent and broad framework that is widely accepted. A similar approach will be used to develop a theoretical foundation for a Web pedagogy as discussed in Section 5.

3. Conceptions of learning

There are many definitions of learning in the literature. These describe the nature of learning, the processes involved in learning, and under what conditions learning may occur. The behavioural psychology view is that learning is a *change in behaviour* of the learner due to experience and may be shaped by selective reinforcement (D. H. Jonassen, 1991). More recent understandings of learning have evolved from developments in cognitive learning psychology. Within this domain learning is seen as the formation by the learner of *constructs of understanding* or *mental models*. Learning is viewed as involving "principally internal, learner-directed processes that can be supported, but not explicitly regulated, externally" (p.53) (M. J. Hannafin, 1992).

A more general definition from a constructivist perspective is provided by Biggs (1989) who states that: "Learning is a way of interpreting the world. Knowledge is progressively constructed by learners on the basis of what they already know …" (pp.8-9). In this context he views teaching as facilitation of learning. The teacher interacts with the student on the basis that learning involves the student actively constructing knowledge (J. B. Biggs, 1989).

Within the constructivist conception, learning involves events both internal and external to the learner and the learner is necessarily an active participant in the learning process. Although learners interact with and interpret information individually, Ewing, Dowling and Coutts (1998) maintain that: "There are clear links between what is presented outside the learner, the external events of a learning environment and how this is interpreted internally by the learner" (p.8). Accordingly, the environment in which the learning is situated and with which the learner interacts is critical to understanding the learning process.

A number of classification schemes have been developed to clarify understanding of the concept of learning. Two widely used schemes are *Bloom's taxonomy* and *deep and surface learning*. These are relevant to discussions of learning activities and theories and are described in the following sections.

3.1. Bloom's Taxonomy

A widely used classification scheme used in discussions of learning is the taxonomy developed by Bloom, Englehart, Furst, Hill and Krathwohl (1956). Over a period of six years

this group developed a *taxonomy of educational objectives*. The taxonomy was divided into three domains of *cognitive*, *affective* and *psychomotor*. The cognitive domain was categorised further into *knowledge*, *comprehension*, *application*, *analysis*, *synthesis*, and *evaluation*. These form a hierarchy of increasingly complex educational behaviours. These are also associated with increasingly higher levels of conscious behaviour on the part of the learner. They suggest that the higher level behaviours incorporate lower level behaviours. Each level is associated with a number of different learning behaviours. This forms a complex but comprehensive description of learning. Bloom's taxonomy is widely used as a tool for assessment and evaluation of educational objectives.

3.2. Deep and surface learning approaches

Foundational research into student learning conducted in Sweden by Marton and Säljö (1976) established that students adopt different *approaches* to learning. These were broadly categorised as *deep* and *surface* learning. Subsequent research introduced a third category – *strategic* learning (Entwistle, 1987). These categories provide general descriptions for the motivations and strategies that students use in conducting their learning (J.B. Biggs, 1999). Students who engage in a learning task with the intention of seeking understanding or meaning are said to be adopting a deep approach. Students who do the minimum essential work to meet assessment requirements are said to be using a surface approach. Students who focus on achieving a high grade with minimal engagement in a task are said to be using a strategic approach (Entwistle, 1987).

The importance of considering learning approaches has been shown by research studies that have linked these approaches to learning outcomes (J. B. Biggs, 1989). A number of studies have found that deep learning approaches are more likely than surface or strategic approaches to result in greater levels of retention and comprehension of learning material (Niederhauser, Reynolds, Salmen, & Skolmoski, 2000). The deep learning approach may be viewed as the ideal model of learning and most consistent with the aims of tertiary teaching (J. B. Biggs, 1989; Rogers, 2000).

Learning approaches describe the way students relate to their learning environment. They are orientations that influence how students approach a learning task and can be influenced by the learning tasks and the learning context (Entwistle, Entwistle, & Tait, 1993). A number of studies found that a Web-based learning environment both supported and encouraged deep learning approaches. Longitudinal studies of tertiary students have found that students become more sophisticated learners as a consequence of their experience using open-ended learning environments (Gibbs, 1992). Furthermore, the Web is valued as a learning environment by students who have deep learning approach orientation. A qualitative study of student use of the Web by Rosie (2000) found that students who used deep learning approaches valued the Web as a means to construct their own learning framework. In contrast, the students with a surface learning approach tended to devalue the Web medium. Another aspect to consider here is the access to a vast amount of information on the Web has influenced the way students approach learning tasks. The ready availability of information can lead to poor learning behaviours and in some cases plagiarism.

Biggs (1989) claims: "Good teaching should minimize those factors that lead to surface learning, and to maximize those leading to deep and achieving" (p.15). Based on findings from a number of studies, he proposes that teaching strategies that induce deep learning approaches embody four key elements:

1) appropriate motivational context — provision of a safe learning environment — encouragement of interest by involving students in planning and delivery of learning tasks;

2) learner activity — deep learning is associated with active rather than passive learning;
3) interaction with others — communication and collaborations with peers and educators; and
4) learning materials structured and presented in consideration of the knowledge and experience of the learners.

These provide general principles that can be applied to the design and use of Web-based learning environments.

4. Theories and models of learning

There are various theories and models of learning that have been discussed in relation to online learning. The following have been selected as having the most relevance to pedagogical considerations of Web-based learning environments. A brief overview of each is given below and key features applicable to the issues considered in this thesis are presented.

4.1. Constructivism

Constructivism describes a set of learning theories and pedagogical approaches which have their foundation in cognitive learning psychology. Modern constructivist learning theories have evolved largely from the work of Bruner (1966), Dewey (1933), Papert (1993), Piaget (1972) and Vygosky (1978).

Constructivism is founded on the epistemological belief that knowledge does not exist outside the mind of the learner. Constructivists view knowledge as individual to the learner with new knowledge constructed by the learner through building on their prior understanding and through interaction with their environment. Constructivists see the learner as active in the learning process rather than as a passive recipient of external inputs. They consider learning as a continual process of construction, interpretation, and modification of internal representations of knowledge based on external experiences and emphasise the importance of reflection within this process (Harper & Hedberg, 1997). As discussed in section 2, constructivism is based on different epistemological and pedagogical conceptions than the traditional *instructivist* approaches to teaching and learning (p.61) (D. H. Jonassen & Rohrer-Murphy, 1999b). Instructivists maintain an objectivist epistemology that separates knowledge from the concept of knowing. They consider learning as a discrete process. Knowledge is acquired by the learner passively receiving instruction (T. C. Reeves & Reeves, 1997).

The wealth of literature on constructivism shows there is no unified position on the meaning of this term. However, Duffy, Lowyck and Jonassen (1993) maintain there is general agreement about "the importance of the authenticity of the learning task and context in which the student works … and the importance of collaborative learning as a means of developing a richer understanding through considering alternative perspectives" (p.1). Duffy and Cunningham (1996) propose that two commonly agreed tenets of constructivism are (p.171):

- Learning is an active process of constructing rather than acquiring knowledge.
- Instruction is a process of supporting that construction rather than communicating knowledge.

Constructivism is often classified into two views providing related, but in some respects, complementary, perspectives (Duffy & Cunningham, 1996). One view is *cognitive constructivism* which is based on the work of Piaget (1972) and Papert (1993). This describes a theory of learning in which learners build their own knowledge by constructing schemas, or

mental models, from interactions with their environment. The other view is *sociocultural constructivism*, which emphasises the social and cultural contexts of learning. Sociocultural constructivism has been the basis of a number of learning theories and is discussed in more detail in Section 4.2. Both cognitive constructivism and sociocultural constructivism view learning as an active construction on the part of the learner. The major difference is that cognitive constructivism focuses on the individual mental construction of the learner whereas constructivism focuses on the social context of the learning environment (Ewing et al., 1998; Neo, 2003).

Constructivism, encompassing the cognitive and sociocultural perspectives, is currently the dominant influence in design of educational technology and has guided the development of many Web-based learning systems. Although there is much support for this position, some challenge the claims of constructivism. Fox (2001) contends that they differ little from common sense, otherwise providing misleading and incomplete views of human learning. He agrees, however, that learners need to interact with others to make sense of new ideas, and they can be helped in this by their teachers and appropriately designed instruction. Jonassen, Mayes and McAleese (1993) argue that the constructivist approach can lead to the design of effective learning environments. Cunningham, Duffy and Knuth (1993) devised the following seven pedagogical goals supporting constructivist principles:

1. provide experience with the knowledge construction process;
2. provide experience in and appreciation for multiple perspectives;
3. embed learning in realistic and relevant contexts;
4. encourage ownership and voice in the learning process;
5. embed learning in social experience;
6. encourage the use of multiple models of representation; and
7. encourage self-awareness of the knowledge construction process.

Web-based learning environments built using constructivist principles offer students a degree of control over their learning. This can present difficulties, as students need a complex set of skills to manage their learning (D. Jonassen et al., 1993). With increasing learner control the educator adopts more of a facilitory role. However, Westera (1999) cautions that the constructivist approach should not be seen as 'hands off' and it is still the responsibility of the educator to monitor the quality of learning. The issue of appropriate level of learner control is discussed in more detail in Section **Error! Reference source not found.**.

4.2. Sociocultural constructivism

Sociocultural constructivism emphasises that learning often happens in a social and cultural context and the process involves construction of understanding through sharing of multiple perspectives through interaction with peers and teachers. According to this view, learning can be considered a process of "acculturation into an established community of practice" (p.175) (Duffy & Cunningham, 1996). It is an important elaboration of constructivism resulting largely from the work of Vygotsky (1978) and Lave and Wenger (1991).

Vygotsky (1978) proposed the concept of a *zone of proximal development* which he defined as the distance between the level of actual development of the learner and the level that the learner can achieve with guidance or in collaboration with their educator or peers. He viewed learning as a profoundly social process and emphasised the importance of the learner-instructor and learner-learner dialogue in order to help the learner progress through their zone of proximal development. He maintained that this is more than just exposing the learner to new material through provision of resources or lectures; it is through dialogue with others that

the learner constructs their understanding. The essential point is that learning is a mediated process. Learners are able to challenge their thoughts, beliefs, perceptions and existing knowledge by collaborating with other students (Ewing et al., 1998).

Lave and Wenger (1991) moved away from an epistemological position that conceptualised knowledge as belonging to an individual, to consider knowledge as constructed through social and cultural interactions. Their work focused on the relationship between learning and the social situations in which learning occurs. They proposed that the learning process is facilitated by participation in communities. The participation is peripheral at first, but then increases in engagement and complexity as the learner gradually becomes more centrally involved in the practices of the community. They likened this to an apprenticeship model of learning. In their view learning takes place in a co-participatory framework, which they termed a *community of practice*.

A number of learning theories have been derived from the ideas presented by Vygotsky and Lave and Wenger. Two of the most widely discussed in relation to Web-based learning environments are *situated learning theory* (described in Section 4.4) and *distributed learning theory* (described in Section 4.5). Web-based learning environments can support sociocultural constructivist learning through provision of communication and collaborative work facilities (Bonk & Wisher, 2000).

4.3. Cognitive flexibility theory

Cognitive flexibility theory "is an integrated theory of learning, mental representation and instruction" (p.28) (Spiro, Feltovich, Jacobson, & Coulson, 1991),. The main tenet of cognitive flexibility theory is that objectivist instructional approaches, which deal with complexity by oversimplification, can lead to misconceptions through the compartmentalisation or decontextualisation of knowledge. Unidimensional representations of complex material may leave the learner with an inability to apply knowledge to new situations. Cognitive flexibility theory recognises the interconnectedness of knowledge and the importance of illustrating abstract concepts by using multiple case scenarios (Jacobson & Spiro, 1995) (Spiro et al., 1991).

Cognitive flexibility theory is based on cognitive learning theory and is situated within the constructivist paradigm. However, it extends the constructivist theory beyond the construction of knowledge structures to include the use of these knowledge structures in learning. This is a shift in emphasis from the development of knowledge based on pre-existing knowledge to the flexible adaptation of pre-existing knowledge to new situations (Fitzgerald, Wilson, & Semrau, 1997).

Cognitive flexibility refers to the ability to restructure knowledge in response to radically changing situational demands. This has led to a theory of instruction that proposes the design of learning environments that will encourage the development of flexible cognitive processing skills. The theory is based on five core principles: 1) use multiple representations of knowledge; 2) use case studies to demonstrate a variety of applications; 3) introduce conceptual complexity and domain complexity early; 4) stress the cross-associational, web-like nature of the context to demonstrate its flexibility in and applicability to a variety of settings; and 5) involve the learner in knowledge construction by providing them with tasks or applications to which they must apply the knowledge (Jacobson & Spiro, 1995). Environments designed according to these principles encourage active engagement of the learners and deeper levels of semantic processing, emphasising knowledge assembly from multiple contexts and perspectives rather than information gathering from a single representation (Spiro & Jehng, 1990). The outcome for the learner is a rich, multilayered

network of information and the ability spontaneously to restructure information (Rossner-Merrill, Parker, Mamchur, & Chu, 1998).

Cognitive flexibility theory provides a conceptual model particularly suited to the design of Web-based learning environments. These environments are characterised by their content complexity and irregularity, often with considerable variability in the way information is presented and interrelated. Typically, it is necessary to follow non-linear instruction sequences to avoid missing key concepts, gain mastery of concepts, and be able to apply the knowledge gained to new situations. It requires the learner to adopt new strategies to those used in a linearly ordered instructional environment (Spiro & Jehng, 1990).

Cognitive flexibility theory has been widely discussed in the literature. Jonassen, Dyer, Peters, Robinson, Harvey, King and Loughner, (1997) claim that cognitive flexibility theory is one of the richest and best-researched models for structuring hypertext. Although there are reports of the application of the principles in design of learning environments, there are few empirical studies upon which to evaluate its effectiveness and these have produced mixed results. In a small qualitative study of lower level secondary school students using an instructional media program, concept maps produced by the students showed that cross-linking had helped build up interconnected relationships of the content (MacGregor, 1999). However, another study of undergraduate students found that the students who navigated back and forth between concepts using hyperlinks tended to learn less than those who navigated in a sequential manner (Niederhauser et al., 2000). Jacobson, Maouri, Mishra and Kolar (1996) found that merely 'criss-crossing' the hypertext landscape is not enough to acquire an interconnected understanding of a complex topic but, with appropriate case-based instructional materials and scaffolding support, students were able to flexibly transfer knowledge. Demetriadis and Pombortsis (1999) also found that case based instruction in a hypermedia environment enhanced students ability to use knowledge flexibly.

4.4. Situated learning theory

Situated learning theory emphasises the importance of authentic learning experiences. This theory recognises the value of active participation in the learning process but focuses particularly on learning experiences that occur in authentic contexts. Authentic contexts are defined as situations that are meaningful and purposeful to the learners (Brown, Collins, & Duguid, 1989b). Situated learning theory is firmly placed in the sociocultural constructivist framework and is aligned with the work of Vygotsky (1978).

Situated learning as a model for instruction was developed by Brown, Collins and Duguid (1989b). However, it builds strongly upon the work of Lave and Wenger (1991) and their work on learning through social co-participation and apprenticeship. Rejecting the objectivist view of decompartmentalised knowledge that can be abstracted from the learning situation, Brown, Collins and Duguid (1989b) argue instead that learning and cognition are fundamentally situated within specific contexts and cultures. They propose that the activity in which knowledge is constructed is an integral component of what is learned. According to situated learning theory, effective learning can be fostered through social interaction and collaboration using ordinary and accessible activities that are embedded in realistic settings (Rossner-Merrill et al., 1998). These activities have authenticity in that they are closely aligned to real world tasks rather than decontextualised tasks.

Situated learning theory has the following implications for design of learning environments (Squires, 1999):

- learning environments should relate to personal experience of the real world;

- learning is best supported when technology augments learning rather than attempts to supplant it;
- collaborative learning in which peer group discussion and work is prominent is effective in helping students to learn; and
- the role of the teacher will change to a manager and facilitator of learning, rather than a director.

A search of the literature showed a scarcity of studies that had used this theory for the design of learning environments. However, a qualitative study by Herrington and Oliver (1999) of students using a multimedia program based on a situated learning framework found that the students gained substantial levels of higher-order thinking.

Some critics of situated learning theory question the premise of situated knowledge upon which the theory is based. Laurillard (2002) cautions that without decontextualisation knowledge can remain situated and uncommunicable. However, Brown, Collins and Duguid (1989a) contend that the difficulty in learning is not the abstraction, but learning the appropriate circumstances in which to apply the abstraction. A more reasonable view is presented by Merrill (1991) who suggests that learning should initially be situated but must eventually become decontextualised to assist the learner in abstracting knowledge to new situations. He suggests that to enable this, the learner should experience abstraction in a variety of contexts. This lends support to the concept of cognitive flexibility proposed in the cognitive flexibility theory and is inclusive of the cognitive and sociocultural constructivist based theories.

4.5. Distributed cognition theory

Distributed cognition theory in an educational context maintains that learning involves a broad range of cognitive events that do not necessarily occur within the learner. This theory is based on the concept that knowledge is distributed among individuals and artifacts within a system rather than residing with any one person. The literature shows a diversity of views on the exact meaning of distributed cognition and it is also referred to as *distributed learning* or *distributed intelligence* (Bell & Winn, 2000).

The origins of the concept of distributed cognition can be found in the work of people such as Dewey (1884). Recent developments in distributed cognition have been founded on anthropology and cognitive psychology and the cultural-historical theories of Vygotsky (1978) and Salomon(1993). Distributed cognition is aligned with the constructivist view of learning in its description of the construction of knowledge; however, it extends the constructivist view to include the socio-material context of learning (Bell & Winn, 2000). Additionally, it is compliant with the sociocultural constructivist perspective, differing, however, in that it also considers the interaction of the learner with the material world (Bell & Winn, 2000).

The successful functioning of a distributed cognition system depends on different components having access to the collective knowledge of the system. Furthermore, the components of the system are reliant on each other for completion of activities. This requires effective communication between components of the system (Bell & Winn, 2000). Hollan, Hutchins and Kirsh (2000) identified three types of distributed cognitive processes. These are cognitive processes which (p.3):

- are distributed across members of a social group;
- involve coordination between internal and external (material or environmental) structure; and

- are distributed through time in such a way that the products of earlier events influence later events.

Distributed cognition as a theory applied to the design of learning environments focuses on understanding the interactions between the learner and the technology. It shifts the focus of designers away from thinking of cognition as individual to the learner to considering the social and material contexts in which learning occurs. The sharing of cognitive activity within a distributed system has implications for the design of learner-centred Web-based learning environments. Within a distributed cognition system the learner has more autonomy in the learning process, with control shifting from the educator to the learner. The emphasis on use of interactive and network technologies has provided the interest in distributed cognition as a framework for the design of computer-supported collaborative learning systems and learning communities. These provide a means of scaffolding the learner (Bell & Winn, 2000).

4.6. Engagement theory

Engagement theory developed by Kearsley and Shneiderman (1998) emphasises the importance of the learner collaborating with peers in meaningful learning activities and focuses on the learner as a member of a *learning community*. Engagement theory emerged from the experiences of Kearsley and Shneiderman (1998) in using online learning environments. Although they claim that engagement theory is not derived from other theories, it is consistent with the constructivist view of active engagement of the learner in the learning process.

The foundational idea of engagement theory is that students should be "meaningfully engaged through interactions with others and worthwhile tasks" (p.20). They stress that engagement is necessary for effective learning to occur. This seems very similar to situated learning; however, the focus in engagement theory is on participating and contributing within group projects. Engagement theory proposes the creation of collaborative project teams that can work together outside face-to-face teaching environments. Three core principles of this theory are:

- encourage collaboration in teams though communication, planning, management and social skills;
- make learning a creative and purposeful activity; and
- a learning activity should involve making a useful contribution.

These principles imply that learning activities should be project based, occur in a group context and have an authentic focus.

Kearsley and Shneiderman propose engagement theory as a model particularly relevant for electronic learning environments. They claim that technology can enable interactions that are difficult or not possible otherwise. However, the theory shifts the focus from thinking of interaction with instructional content to interaction with humans. Although this theory has intuitive appeal and has particular relevance to Web-based learning environments, there is a lack of empirical studies to support its claims.

4.7. Conversational framework

The *conversational framework* by Laurillard (2002) presents a general model of learner and educator activities within a learning system. Laurillard derived this model from research studies of student learning using a phenomenographical approach. The model is based on an epistemology that emphasises the importance of communication between the learner and the educator. The model shows the learner as active and reflective in the learning process.

Laurillard views learning as a *conversation* between learner and educator, operating at the level required for the task and focusing on topics relevant to the task. The conversation is described as a series of interactions between the learner and educator. These may be conducted face to face or mediated through technology. The interactions define forms of communication necessary for deep learning and are classified as follows:

- *Discursive* – defining common understandings and goals;
- *Adaptive* – internal process of redefining actions to adapt to task;
- *Interactive* – activities related to achieving the task goal; and
- *Reflective* – reflections on the task goal to modify conceptions.

The recognition of the importance of the learner-instructor interaction is compliant with Vygotsky's (1978) view of an effective learning process and is compliant with the sociocultural constructivist view.

The conversational framework is a general model of a learning system but is readily applicable to Web-based learning environments. It presents a pedagogical model that views the learning environment from the student and educator perspective and focuses on the learner-instructor interactions within the environment.

4.8. Conditions of learning

The *conditions of learning* theory by Gagné (1985) has been a major influence on instructional design. The theory was originally grounded in behavioural psychology but was revised using cognitive psychology as its foundation. Gagné views learning as an internal process that is stimulated and directed by external factors. He identified five categories of learning outcomes: *verbal information*, *intellectual skills*, *cognitive strategies*, *motor skills,* and *attitudes*. He suggests that each entails different internal and external *conditions*, involving different phases that require different types of instruction. He proposed a set of nine instructional events, which provide the necessary conditions for learning. He termed these *events of learning*.

The events of learning can be used as a guide for courseware development. Using this framework, instructional transactions can be designed using appropriate events to achieve the learning goals (Overbaugh, 1994). The key principles of the theory are:

- learning is conceived as a set of processes, stimulated by events external to the learner;
- learning is cumulative in nature, with levels of learning forming a hierarchy of concrete to more abstract concepts;
- higher levels of learning involve higher levels of metacognition; and
- instructional activities can be designed as a sequences of events to activate, support and maintain the processes of learning.

Although widely used in instructional design, and with intuitive appeal, the conditions of learning theory has been criticised for being too mechanistic. Laurillard (2002) contends that the empirical basis for the theory is insufficient "to provide a holistic understanding of student learning". In contrast to Laurillard's conversation framework which emphasises the learner-instructor dialogue, Gagné emphasises the transmission of information. However, the emphasis on the enhancement of learner performance through the design of well-defined activities has a strong relevance to the design of Web-based learning environments (Coldwell, 2003).

4.9. Instructional transaction theory

Instructional transaction theory by Merrill and the ID2 Research Group (1996) is an instructional design theory for computer-based instruction development. The theory is founded on the ideas developed by Gagné (1985) and builds on previous work of the ID2 Research Group.

Instructional transaction theory describes a method for defining and generating instructional material using a concept of *instructional transactions*. Merrill, Li and Jones (1991) define an instructional transaction as "the complete sequence of presentations and reactions necessary for the student to acquire a specific type of instructional goal" (p.8). Transactions are organised into classes and subclasses to generalise the process of transaction development. Knowledge is defined in terms of *entities*, *activities* and *processes* (Merrill, 1996). Instructional transaction theory is based on the assumption that knowledge can be decomposed and treated independently of instructional strategies (Merrill et al., 1991). This conception of knowledge is strongly in agreement with the objectivist view.

Instructional transaction theory is an example of an instructional design theory. Merrill (1996) defines these as sets of "prescriptions for determining appropriate instructional strategies to enable learners to acquire instructional goals" (p.30). These theories are prescriptive in nature with an underlying assumption that the design can have an effect on the learning outcome and learning experience. The theoretical base of instructional design can be found in behaviourism. Lowyck and Elen (1993) claim that instructional design theory originates from the endeavours of behavioural learning psychologists "to make instruction more controllable, efficient and effective by applying behaviouristic learning principles" (p.213).

Instructional transaction theory as a pedagogical model for instructional design is focused on the learner-content interactions and contrasts with the conversational framework model by Laurillard (2002), with the focus on the learner-instructor interactions.

4.10. Activity theory

Activity theory is a framework for designing activity systems which focuses on the interaction of human activity and consciousness with the environment in which the activity occurs. Activity theory is founded in socio-cultural and socio-historical theories.

Activity theory is based on the idea that learning and action are interdependent and inseparable and are initiated by an intention. An activity must be interpreted within the context of the system in which it occurs. Jonassen (2000) defines an activity systems as "collective human constructions that are not reducible to discrete individual actions" (p.98). In analysis of these systems the smallest unit of analysis is an activity with further reduction not considered possible.

Jonassen and Rohrer-Murphy (1999a) state: "Activity theory provides a unique lens for analysing learning processes" (p.159). The theory provides a method for defining activity systems based on the particular activities in which people are engaged, the nature of the tools used in the activities, the context of the activities, and the goals, intentions and outcomes of the activities. These various components are organised into activity systems

Activity theory has been used in a broad range of domains. Jonassen and Rohrer-Murphy (1999b) propose that it provides a useful framework for the design of constructivist learning environments because the assumptions of the theory are consistent with those of constructivism. Activity theory considers the contexts in which the activities occur. This is in contrast to the traditional methods of task analysis, which are focused on the activity as a

decontextualised performance. Considering activities in their context leads to the design of learning environments that are ill-structured and complex, but are also relevant and meaningful to learners.

5. Reflecting upon the theories and models

Having outlined the main theories and models that are used to inform the design and use of educational technology, the relevance of these to Web-based learning environments will now be considered. The theories provide foundations for understanding the nature of learning and the processes of learning within Web-based learning environments. The models provide frameworks for determining how learning can be shaped and enhanced through the use of this technology. They cover a wide range of educational thinking, but can generally be aligned to three broad educational approaches that are founded in behaviourism, cognitive constructivism and sociocultural constructivism.

The evolutions in the foundational educational theories that have influenced models currently used for the design and use of learning environments were outlined in Section 2. From a long history of behaviourism, much of the recent effort in research and design of learning environments has been founded on constructivism (Harper & Hedberg, 1997). Constructivism, which is often classified into the two disciplines of cognitive and sociocultural constructivism, emphasises a learner-centred approach to education, in contrast to behaviourism which is based on an objectivist learning model and can be seen to promote an instructor-centred or instructivist approach (Lin & Hsieh, 2001). The constructivist principles, which state that the learner is responsible for constructing their own understanding and the role of the educator is a facilitator in this process, offer a close match with the fundamental changes in the learner and educator relationships and responsibilities that are apparent in tertiary education. There is widespread support for constructivism in the literature (Westera, 1999). Reeves (1999) suggests that the "constructivist approaches to applying media and technology may have more potential to enhance teaching and learning than instructivist models" (p.17). (Squires, 1999) claims: "For most educationalists, constructivism offers far more scope [than behaviourism] for realizing possible learning benefits of using educational technology" (p.49). This suggests that a constructivist approach is well suited to the use of the Web.

Constructivism is an umbrella for a number of epistemological theories and pedagogical models that have influenced the design of educational technology. These share some elements but take different perspectives of the learning process and provide overlapping but different sets of principles for the design of learning environments. The core tenet held by all constructivist-based or constructivist-related theories emphasises the active participation of the learner in the learning process. One of the most widely reported theories derived from constructivism is cognitive flexibility theory. This theory provides guidelines for the construction of knowledge from complex material. It emphasises active engagement of the learner through activities designed specifically to gain deep levels of semantic processing and develop flexible cognitive processing skills (D Jonassen et al., 1997). Sociocultural constructivism extends the cognitive constructivist ideas to consider the social and cultural context in which the learning occurs. In the sociocultural constructivist view, the learner and context are inseparable. According to this theory effective learning is embedded in social experiences and authentic problem-solving situations (M. J. Hannafin, 1992). The situated learning theory, distributed cognition theory and engagement theory are the examples of sociocultural constructivist theories. The conversational framework, derived from a phenomenographical approach, provides another perspective on the use of educational technology in learning environments. Although not directly related to, or derived from, constructivism, the conversational framework emphasises the interaction between the learner

and the educator and the importance of active engagement and reflection and is compliant with the constructivist theories.

Synthesising the principles from these theories provides a comprehensive, coherent and compliant set of principles for the design of a Web pedagogy. These theories provide descriptions that can be used to inform the design and use of learning environments that are learner-centred, encourage active participation in learning, provide meaningful learning activities and facilitate collaborative work practices within a learning community. This group of theories will provide the basis of a Web pedagogy.

At this point it is necessary to consider the three other theories that were presented: the conditions of learning, instructional transaction and activity theories. These are examples of instructional design theories, which provide frameworks for the design of instructional material, focusing on the design of instruction to effect specific learning outcomes. The role of instructional design theories in the design of learning environments based on the learner-centred, constructivist approaches will be discussed below, prior to further discussion of a Web pedagogy.

6. Role of instructional design

Theories of instructional design are prescriptive in nature, specifying how instruction can effect learning, in contrast to theories of learning which are descriptive, focusing on the behaviour and capabilities of the learner (Wagner, 1994). The shift in emphasis from behaviourism and cognitive psychology to constructivism has led to the questioning of the role of instructional design theory in informing the design and use of learning environments. The concept of instructional design, which depends on the belief of an objective reality for the specification of instructional sequences, is firmly based on behaviourism and on a branch of cognitive psychology. There are several critical ways in which the aims of instructional design can be seen to conflict with those of constructivism. These will now be considered to establish their relevance to this thesis.

Instruction can be defined as “purposeful interaction to increase learners’ knowledge or skills in specific, pre-determined ways” (p.135) (Ritchie & Hoffman, 1997). Instructional design is concerned with specifying how these interactions occur through the structuring and sequencing of teaching material and experiences. Instructional design theories provide postulates upon which to base these designs. The instructional designer uses information about learning context and objectives to design instructional methods. Instructional material is typically presented with predefined interrelationships and sequences. It is largely a reductionist process in which there is an assumption of a preferred learning model for the students that can be determined and achieved by the instructors (Winn, 1999). This is in direct contrast to constructivism, which emphasises learning as individually constructed by the student as a consequence of personal experience, activity and reflection.

Instructional design theories are premised upon the instructional designer being able to anticipate learning behaviour within the learning environment. A difficulty is that the nature of learning is idiosyncratic and dynamic (Lowyck & Elen, 1993). Learners are individual and complex, and are influenced by many factors (Winn, 1999). Furthermore, a learning environment designed according to constructivist principles will allow multiple ways of progressing to a learning goal. Learning behaviour within constructivist environments is unpredictable, suggesting that instructional design theories do not have a firm basis for application to the design of these environments.

An essential feature of instructional design models is their controlling rather than their enabling nature. This tends to promote passive rather than active learning (M. J. Hannafin,

1992). Designing instruction, therefore, appears to be in conflict with constructivism, which emphasises the importance of the learner as actively determining and regulating their own learning process (Lowyck & Elen, 1993). Within a Web-based learning environment, the provision of links can be viewed as allowing the learner access to the content in ways that the educational designer has permitted (Laurillard, 2002). Considering the basic hypermedia structures shown in Section **Error! Reference source not found.**, a learning environment designed with a network structure can be seen as following a constructivist approach; with the linear and hierarchical designs following an instructivist approach.

Considering these incompatibilities, it does not seem possible to integrate instructional design with constructivism. The formal instructional design approach does not accommodate the many informal ways in which learning can occur. As Squires (1999) argues (p.48):

> … we are left with a paradox if we accept a constructivist view of learning: In trying to design effective learning environments, we may at the same time constrain the levels of freedom necessary for learners to make decisions about their own learning.

A more reasonable view is presented by Winn (1999). Rather than seeing instructional design and constructivism as two extremes in opposition he accepts the constructivist position but proposes that sometimes a prescriptive approach is appropriate, the choice of approach depending on the instructional task (Winn, 1999). This rejects the extreme constructivist view and accepts a more moderate position. Adding support to this, Jonassen (1991) argues: "Since learning obviously entails constructivistic and objectivistic activities, the most realistic model of learning lies somewhere on the continuum between these positions" (p.13).

Considering this issue from a different perspective, Kozma (2000) proposes that a shift focus is needed (p.13):

> … from the design of instruction to the design of learning environments. This is not just a shift from content- to learner-focused instruction. It is an acknowledgement that learning outcomes are owned by learners … Learners are also in charge of arranging – of designing – the context for their learning that works for them.

This suggests that the focus in the design of learning environments should begin with a consideration of the needs of the learner and the appropriate pedagogy for the learning objectives. Rather than *providing instruction*, the focus should be on the *provision of learning resources and activities* to aid the learner in conducting their own learning. This is changing the emphasis from the learning material to the students and from the design and provision of instruction to the design of learning environments.

7. Implications for Web-based learning environments

The introduction of new educational technology requires an appropriate pedagogy to support its use. It is important that this is done with the consideration of a sound theoretical foundation. As Ewing, Dowling and Coutts (1998) remark (p.7):

> … any re-examination of learning linked with hypermedia environments should take account of the learning process involved. More precisely it means that some attention should

be directed at establishing the most appropriate theory of learning.

The theories and models outlined in section 0 were identified from the literature as currently the key influences on the design and use of tertiary Web-based learning environments. These theories provide descriptions that can be used to develop principles to address the practical issues of the design and integration of Web-based learning environments into teaching programmes. Each has a particular focus and addresses particular aspects of learning. Individually, they present a partial view of a Web-based learning environment. However, a theory providing an integrated view of the full context of learning in Web-based learning environments was not identified. It is proposed that synthesising the principles from these theories provides a comprehensive, coherent and compliant set of principles for the design of a Web pedagogy. This group of theories provides the basis of the Constructivist Learner-Centred Web Pedagogy — the CLC-Web Pedagogy.

In developing the CLC-Web Pedagogy, the aim was to use theories and models that are founded on currently reported and accepted conceptions of learning and sound educational practices. As discussed in section 0, the now widely accepted view of learning is that it requires active and conscious involvement of the learner. Learning is characterised as individual, idiosyncratic, participatory, situated, and socially negotiated. Effective learning is associated with engagement in higher levels of learning and use of metacognitive skills and reflective practices. The current educational focus is learner-centredness, in which students are provided with opportunities to initiate and direct their own learning. The learning environment in which the students work is a critical component in encouraging and supporting these aims.

The theories compliant with these views are generally based on, or aligned with, constructivist principles. Constructivism and related theories form a synthesis of ideas that can be used to establish contexts to promote good learning. The theories identified which satisfy these criteria are: the constructivist-based cognitive flexibility theory; the sociocultural constructivist theory of situated learning; the sociocultural constructivist related distributed cognition and engagement theories; and the sociocultural constructivist compliant conversational framework. The remaining theories presented provide frameworks for the design of instruction. The conditions of learning and instructional transaction theories focus on the design of instructional sequences, and are not generally aligned with the aims of a constructivist Web-based learning environment. Although activity theory is presented as a framework for the design of constructivist learning environments, this describes a way of supporting a constructivist pedagogy rather than informing how it can be achieved.

Having identified the most appropriate theories, models and practices to inform the design and use of Web-based learning environments, these are now used as the basis for the CLC-Web Pedagogy. In developing the Web pedagogy, the aim was to distil the key characteristics and practices, and show how these can be supported by the characteristics of Web-based learning environments presented in section **Error! Reference source not found.**. This inclusive approach provides a pedagogy that is theoretically-founded and practically-based.

The CLC-Web Pedagogy is described by six themes and 12 guiding principles as presented in Table 7-1 (p.17). These themes describe a pedagogy that is constructivist-based with a learner-centred focus. The themes provide principles to inform the way Web-based learning environments are designed and used and the facilities and resources they provide. These are used in an investigative framework for the studies reported in **Error! Reference source not found.** and **Error! Reference source not found.**.

Table 7-1 CLC-Web Pedagogy for Web-based Learning Environments

Theme	Guiding Principles	Enabling Features of Web Technology
Access	• Facilitate access to learning facilities and resources (Cunningham, Duffy & Knuth, 1993; Jonassen, Peck & Wilson, 1999b) • Provide a safe learning environment (Biggs, 1989)	Refer section **Error! Reference source not found.**
Engagement	• Encourage active engagement in learning activities (Biggs, 1989; Kearsley & Shneiderman, 1998; Laurillard, 2002; Spiro et al., 1991) • Provide multiple perspectives and representations (Cunningham et al., 1993; Spiro et al., 1991) • Provide meaningful learning experiences (Brown et al., 1989; Cunningham et al., 1993; Kearsley & Shneiderman, 1998)	Refer section **Error! Reference source not found.**
Enablement	• Allow flexibility and control over the learning process (Cunningham et al., 1993; Ramsden, 1984) • Encourage reflective practice (Laurillard, 2002; Schön, 1987) • Promote the use of metacognitive skills (Cunningham et al., 1993; Flavell, 1976; Gagné, 1985)	Refer section **Error! Reference source not found.**
Communication	• Facilitate communication with educators and other students (Bell & Winn, 2000; Biggs, 1989; Kearsley & Shneiderman, 1998; Laurillard, 2002; Vygotsky, 1978) • Provide appropriate levels of support and encouragement (Brown et al., 1989; Vygotsky, 1978)	Refer section **Error! Reference source not found.**
Collaboration	• Enable establishment of collaborative work practices (Biggs, 1989; Brown et al., 1989; Lave & Wenger, 1991)	Refer section **Error! Reference source not found.**
Diversity	• Consider the needs and preferences of individual or groups of students across a range of academic, social and cultural characteristics (Biggs, 1989)	Refer section **Error! Reference source not found.** Refer section **Error!**

		Reference source not found.

A description of the CLC-Web Pedagogy is now provided. The CLC-Web Pedagogy is intended to provide a learning environment that supports learner-centred education. Developed and emerging Web technologies can enable a number of learner-centred approaches in a variety of different contexts. These environments afford opportunities for learning, but do not direct or constrain learning. They allow the students to control their learning, but with appropriate levels of scaffolding. They facilitate individual constructions of understanding, while providing opportunities for learning in a collaborative environment. Underlying the design of these learning environments is the aim to support the students and maximise their learning opportunities. This is realised in a range of learner-content, learner-learner, learner-instructor and learner-interface interactions as described in section **Error! Reference source not found.**.

A Web-based learning environment is available at any time and any place. The learning environment can be accessed by a large, distributed and diverse group of students. The learning environment may be monitored by the educator to ensure a safe learning experience for the students. The students can be provided with many different resources in a variety of interactive and multimedia formats. These may be designed to allow active participation in learning and facilitate the individual construction of knowledge. The learning environment can provide meaningful learning experiences through authentic and relevant learning activities and resources. These encourage engagement in learning through exploration and experimentation. Within this environment, the students are able to control the sequence, pace and time of their learning. This enables and fosters the use of metacognitive skills and reflective practice. The rich and varied learning activities encourage deep learning approaches. These facilitate understanding of abstract concepts through concrete experiences and enable the development of flexible knowledge and thinking skills. Through communication facilities, the students can interact with their educator or other students on a one-to-one basis or through group forums. This provides the student with access to support and guidance as needed. Communication facilities can encourage collaborative work practices providing opportunities for the student to contribute to and participate in a learning community. Advanced implementations of Web-based learning environments allow for the diversity of learners through individualised learning through personalisation of the Web interface or through adaptive websites.

8. Conclusion

Emerging trends in tertiary education have seen a shift in focus from *teacher-centred* to *learner-centred* education and an increase in the use of Web-based learning environments in teaching programmes. The CLC-Web Pedagogy proposed in this paper forms a comprehensive and coherent set of principles to inform the design and use of Web-based learning environments. This pedagogy is based on currently accepted conceptions of learning and is compliant with widely used learning theories and models. A Web-based learning environment based on the CLC-Web Pedagogy presents a fundamentally different learning environment to a traditional learning environment. The synthesis of principles derived from theories provides a variety of different educational approaches, yielding a broader range of learning experiences than are possible in a traditional face-to face environment. The CLC-Web Pedagogy provides a pedagogical framework may be used to guide the design and evaluations of Web-based learning environments.

References

Atkins, M. J. (1993). Theories of learning and multimedia: an overview. ***Research Papers in Education, 8*****(2), 251-271.**

Bell, P., & Winn, W. (2000). Distributed cognitions, by nature and design. In D. Jonassen & S. M. Land (Eds.), ***Theoretical Foundations of Learning Environments*** **(pp. 123-145). Mahwah, New Jersey, USA: Lawrence Erlbaum Associates.**

Biggs, J. B. (1989). Approaches to the Enhancement of Tertiary Teaching. ***Higher Education Research and Development, 8*****, 7-25.**

Biggs, J. B. (1999). ***Teaching for Quality Learning at University*****. Buckingham, UK: Society for Research into Higher Education and Open University Press.**

Bloom, B., Englehart, M., Furst, E., Hill, W., & Krathwohl, D. (1956). ***Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain*****. New York, New York, USA: Longmans, Green.**

Bonk, C., & Wisher, R. A. (2000). ***Applying collaborative and e-learning tools to a military distance learning: A reseach framework*** **(Interim). Alexandria, Virginia, USA: United States Army Research Institute for the Behavioral and Social Sciences.**

Brown, J. S., Collins, A., & Duguid, P. (1989a). Debating the situation: A rejoinder to Palincsar and Wineburg. ***Educational Researcher, 18*****(4), 10-12.**

Brown, J. S., Collins, A., & Duguid, P. (1989b). Situated cognition and the culture of learning. ***Educational Researcher, 18*****(1), 32-42.**

Bruner, J. S. (1966). ***Toward a Theory of Instruction*****. Cambridge, Massachusetts, USA: Belknap Press of Harvard University Press.**

Coldwell, J. (2003). ***Mapping pedagogy to technology - A simple model.*** **Proceedings of the Advances in Web-based Learning (ICWL 2003), Melbourne, Australia, 180-191.**

Cunningham, D. J., Duffy, A., & Knuth, R. (1993). The textbook of the future. In C. McKnight, A. Dillon &J. Richardson (Eds.), ***HYPERTEXT: A Psychological Perspective*** **(pp. 19-49). Chichester, West Sussex, England: Ellis Horwood.**

Demetriadis, S., & Pombortsis, A. (1999). Novice student learning in case based hypermedia environment: A quantative study. ***Journal of Educational Multimedia and Hypermedia, 8*****(1), 241-269.**

Dewey, J. (1933). ***How We Think?*** **Chicago, Illinois, USA: Henry Regnery Company.**

Duchasel, P. (1995). Learning Interfaces. In T. Liao (Ed.), ***Advanced Educational Technology: Research Issues and Future Potential*** **(pp. 207-216). Berlin, Germany: Springer-Verlag.**

Duffy, T. M. (1993). ***Designing Environments for Constructive Learning*** **(Vol. 105). Berlin, Germany: Springer-Verlag.**

Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), ***Handbook of Research for Educational Communications and Technology*** **(pp. 170-198). New York, New York, USA: Macmillan.**

Entwistle, N. J. (1987). A model of the teaching-learning process. In J. T. E. Richardson, M. W. Eysenck &D. W. Piper (Eds.), ***Student Learning*** **(pp. 13-28). Milton Keynes, England: Open University Press.**

Entwistle, N. J., Entwistle, A., & Tait, H. (1993). Academic understanding and contexts to enhance it: A perspective from research on student learning. In T. M. Duffy, J. Lowyck &D. H. Jonassen (Eds.), ***Designing Environments for Constructive Learning*** **(Vol. 105, pp. 331-357). Berlin, Germany: Springer-Verlag.**

Ewing, J. M., Dowling, J. D., & Coutts, N. (1998). Learning using the World Wide Web: A collaborative learning event. ***Journal of Educational Multimedia and Hypermedia, 8*****(1), 3-22.**

Fitzgerald, G. E., Wilson, B., & Semrau, L. P. (1997). An interactive multimedia program to enhance teacher problem-solving skills based on cognitive flexibility theory: Design and outcomes. ***Journal of Educational Multimedia and Hypermedia, 6*****(1), 47-76.**

Fox, R. (2001). Constructivism examined. ***Oxford Review of Education, 27*****(1), 23-35.**

Gagné, R. M. (1985). ***The Conditions of Learning and Theory of Instruction*****. New York, New York, USA: Holt, Rinehart and Winston, Inc.**

Gibbs, G. (1992). The nature of quality in learning, ***Improving the Quality of Student Learning*** **(pp. 1-11). Bristol, UK: Technical and educational Services Ltd.**

Greeno, J. G. (1998). The situativity of knowing, learning, and research. ***American Psychologist, 53*****(1), 5-26.**

Hannafin, M., & Reiber, L. P. (1989). Psychological foundations of instructional design for emerging computer-based instructional technologies: Part I. ***Educational Technology Research and Development, 37*****(2), 91-101.**

Hannafin, M. J. (1992). Emerging technologies, ISD and learning environments, critical perspectives. ***Educational Technology Research & Development, 40*****(1), 49-63.**

Harper, B., & Hedberg, J. (1997). ***Creating motivating interactive learning environments: A constructivist view.*** **Proceedings of the Fourteenth Annual Conference of the Australian Society for Computers in Learning in Tertiary education (ASCILITE '97), Perth, Western Australia, Australia.**

Herrington, J., & Oliver, R. (1999). Using situated learning and multimedia to investigate higher-order thinking. ***Journal of Interactive Learning Research, 10*****(1), 3-24.**

Herrington, J., & Standen, P. (2000). Moving from an Instructivist to a Constructivist multimedia learning environment. ***Journal of Educational Multimedia and Hypermedia, 9*****(3), 195-205.**

Hollan, J. D., Hutchins, E., & Kirsh, D. (2000). Distributed cognition: Toward a new foundation for human-computer interaction research. ***ACM Transactions on Computer-Human Interaction, 7*****(2), 174-196.**

Jacobson, M. J., Maouri, C., Mishra, P., & Kolar, C. (1996). Learning with hypertext learning environments: Theory, design, and research. ***Journal of Educational Multimedia and Hypermedia, 5*****(3/4), 239-281.**

Jacobson, M. J., & Spiro, R. J. (1995). Hypertext learning environments, cognitive flexibility, and the transfer of complex knowledge: An empirical investigation. ***Journal of Educational Computing Research, 12*****(4), 301-333.**

Jonassen, D. (2000). Revisiting activity theory as a framework for designing student-centred learning environments. In D. Jonassen & S. M. Land (Eds.), ***Theoretical Foundations of Learning Environments*** **(pp. 89-121). Mahwah, New Jersey, USA: Lawrence Erlbaum Associates.**

Jonassen, D., Dyer, D., Peters, K., Robinson, T., Harvey, D. M., King, M., & Loughner, P. (1997). Cognitive flexibility hypertexts on the Web: Engaging learners in meaning making. In B. H. Khan (Ed.), ***Web-Based Instruction*** **(pp. 119-133). Englewood Cliffs, New Jersey, USA: Educational Technology Publications.**

Jonassen, D., Mayes, T., & McAleese, R. (1993). A manifesto for a constructivist approach to uses of technology in higher education. In T. M. Duffy, J. Lowyck &D. H. Jonassen (Eds.), ***Designing Environments for Constructive Learning*** **(Vol. 105, pp. 231--247). Berlin, Germany: Springer-Verlag.**

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? ***Educational Technology Research & Development, 39*****(3), 5-14.**

Jonassen, D. H., & Rohrer-Murphy, L. (1999a). Activity theory. In D. H. Jonassen, M. Tessmer &W. H. Hannum (Eds.), ***Task Analysis Methods for Instructional Design*** **(pp. 159-172). Mahwah, New Jersey, USA: Lawrence Erlbaum Associates, Inc.**

Jonassen, D. H., & Rohrer-Murphy, L. (1999b). Activity theory as a framework for designing constructivist learning environments. ***Educational Technology Research & Development, 47*****(1), 61-79.**

Kearsley, G., & Shneiderman, B. (1998). Engagement theory: A framework for technology-based teaching and learning. ***Educational Technology, 38*****(5), 20-23.**

Kozma, R. (2000). Reflections on the state of educational technology research and development. ***Educational Technology Research & Development, 48*****(1), 5-15, 16-18, 19-20.**

Laurillard, D. (1987). The different forms of learning in psychology and education. In J. T. E. Richardson, M. W. Eysenck &D. W. Piper (Eds.), ***Student Learning*** **(pp. 198-207). Milton Keynes, England: Open University Press.**

Laurillard, D. (2002). ***Rethinking University Teaching*****. London, UK: RoutledgeFalmer.**

Lave, J., & Wenger, E. (1991). ***Situated Learning: Legitimate Peripheral Participation*****. New York, New York, USA: Cambridge, University Press.**

Lin, B., & Hsieh, C.-t. (2001). Web-based teaching and learner control: A research review. ***Computers & Education, 37*****, 377-386.**

Lowyck, J., & Elen, J. (1993). Transitions in the theoretical foundation of instructional design. In T. M. Duffy, J. Lowyck &D. H. Jonassen (Eds.), ***Designing Environments for Constructive Learning*** **(Vol. 105, pp. 213-229). Berlin, Germany: Springer-Verlag.**

MacGregor, S. K. (1999). Hypermedia navigation profiles: Cognitive characteristics and information processing strategies. ***Journal of Educational Computing Research, 20*****(2), 189-206.**

Marton, F., & Säljö, R. (1976). On qualitative differences in learning I: Outcome and process. ***British Journal of Educational Psychology, 46*****, 4-11.**

McKenna, P. (2004). ***Constructivist or instructivist: Pedagogical concepts practically applied to a computer learning environment.*** **Proceedings of the Innovation and Technology in Computer Science Education, Leeds, UK, 166-170.**

Merrill, D. (1991). Constructivism and instructional design. ***Educational Technology, 31*****, 45-53.**

Merrill, D. (1996). Instructional transaction theory: Instructional design based on knowledge objects. ***Educational Technology, 36*****(3), 30-37.**

Merrill, D., Li, Z., & Jones, M. K. (1991). Instructional transaction theory: An introduction. ***Educational Technology, 31*****(6), 7-12.**

Neo, K.-K. (2003). Using multimedia in a constructivist learning environment in the Malaysian classroom. ***Australian Journal of Educational Technology, 19*****(3), 293-310.**

Niederhauser, D. S., Reynolds, R. E., Salmen, D. J., & Skolmoski, P. (2000). The influence of cognitive load on learning from hypertext. ***Journal of Educational Computing Research, 23*****(3), 237-255.**

Overbaugh, R. C. (1994). Research-based guidelines for computer based instruction development. ***Journal of Research on Computing in Education, 27*****(1), 29-47.**

Papert, S. (1993). ***Mindstorms: Children, Computers, and Powerful Ideas*****. New York, New York, USA: Basic Books.**

Piaget, J. (1972). ***Psychology and Epitemology: Towards a Theory of Knowledge*** **(Vol. 105). Middlesex, England: Penguin Books Ltd.**

Reeves, T. (1999). ***A research agenda for interactive learning in the new millennium.*** **Proceedings of the EdMedia 1999 conference, Seattle, Washington, USA.**

Reeves, T. C., & Reeves, P. M. (1997). Effective Dimensions of Interactive Learning on the World Wide Web. In B. H. Khan (Ed.), ***Web-Based Instruction*** **(pp. 59-66). Englewood Cliffs, New Jersey, USA: Educational Technology Publications.**

Richardson, J. T. E. (1987). Research in education and cognitive psychology. In J. T. E. Richardson, M. W. Eysenck &D. W. Piper (Eds.), ***Student Learning*** **(pp. 3-12). Milton Keynes, England: Open University Press.**

Ritchie, D. C., & Hoffman, B. (1997). Incorporating Instructional Design principles with the World Wide Web. In B. H. Khan (Ed.), ***Web-Based Instruction*** **(pp. 135-138). Englewood Cliffs, New Jersey, USA: Educational Technology Publications.**

Rogers, D. L. (2000). A paradigm shift: Technology integration for higher education in the new millennium. ***Educational Technology Review, 1*****(13), 19-33.**

Rosie, A. (2000). 'Deep learning': A dialectical approach drawing on tutor-led web resources. ***Active Learning in Higher Education, 1*****(1), 45-59.**

Rossner-Merrill, V., Parker, D., Mamchur, C., & Chu, S. (1998). Using constructivist instructional design featured in two online courses: Notes from the field. ***Educational Media International, 35*****(4), 282-288.**

Salomon, G. (1993). Editor's introduction. In G. Salomon (Ed.), ***Distributed Cognitions*** **(pp. xi-xxi): Cambridge University Press.**

Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1991). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. ***Educational Technology, 31*****(5), 24-33.**

Spiro, R. J., & Jehng, J.-C. (1990). Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix & R. Spiro (Eds.), ***Cognition, Education, Multimedia*** **(pp. 163-205). Hillsdale, New Jersey, USA: Lawrence Erlbaum Associates.**

Squires, D. (1999). Educational software for constructivist learning environments: Subversive use and volatile design. ***Educational Technology, 39*****(3), 48-54.**

Vygotsky, L. S. (1978). ***Mind in Society: The Development of Higher Psychological Processes*****. Cambridge, Massachusetts, USA: Harvard University Press.**

Wagner, E. D. (1994). In support of a functional definition of interaction. ***American Journal of Distance Education, 8*****(2), 6-29.**

Westera, W. (1999). Paradoxes in open, networked learning environments: Toward a pardigm shift. ***Educational Technology, 39*****(1), 17-23.**

Wilson, B. G., & Myers, K. M. (2000). Situated cognition in theoretical and practical context. In D. Jonassen & S. M. Land (Eds.), ***Theoretical Foundations of Learning Environments*** **(pp. 57-88). Mahwah, New Jersey, USA: Lawrence Erlbaum Associates.**

Winn, W. (1999). Learning in virtual environments: A theoretical framework and considerations for design. ***Educational Media International, 36*****(4), 271-279.**