Contextualisation of Learning Objects to Derive Meaning

Dr Stephen R Quinton
Curtin University of Technology
Perth. Western Australia.
s.quinton@curtin.edu.au (email)

> One's thinking becomes different when exposed to new and unfamiliar worlds. Certain common ideas become inexpressible, whereas other previously unimagined ones spring into life, finding miraculous new articulation. In some instances, that which cannot be adequately articulated in one context may in another, become fully comprehensible. It is at the juncture of prior and new understandings that the potential for creativity arises (Quinton, 2005).

Learning Objectives

This chapter presents an analysis of systems theory, information theory, and current theories of learning that is aimed at determining how context influences conceptual understanding, metacognitive thinking, and knowledge building. A range of principles and strategies will be drawn from the theoretical concepts that are explained during the course of discussions with a view to furthering our understanding on how learning object technology may support the contextualisation of meaning in online learning environments. The learning objectives that shape the key arguments underpinning this chapter stem from an emerging need to:

- understand the relationships that connect data, information and knowledge and lead to the realisation of meaning, understanding, and learning
- explain how a networked systems approach to understanding connectedness, electronic content can be structured to form multidimensional, multi-levelled, interconnected and interrelated webs of data, information and knowledge
- explore (a) current perceptions of learning objects, and (b) determine the opportunities that learning object technology presents for enhancing educational design as applied to electronic learning environments
- conceptualise and apply learning objects in a way that enhances the learning process and supports sound pedagogical practice
- describe how a contextual object approach to content classification may assist to preserve contextual relevance and meaning without compromising object integrity and thereby comply with the notion of reusability
- enhance learning outcomes by devising strategies to link content in various ways and to multiple contexts to facilitate the meaningful and efficient processing of information
- devise strategies to improve the learning process though the provision of dynamically generated electronic environments that enable individualised learning experiences
- develop deeper insight into how current technologies may underpin innovative learning processes and ultimately encourage the creative construction of knowledge
- identify the learning potential and design considerations that arise when implementing of new types of learning experiences
- explore the implementation issues that may arise when applying new ideas and technologies to educational practice.

Executive Summary

The speed of change in the economic and educational sectors of many countries throughout the world necessitates a continuous search for more effective and innovative strategies to address the learning requirements of future university graduates. If students are to cope with future skill demands and work practices, they must understand that knowledge is constantly subject to change. The only constant is change itself. It is also vital that teachers encourage students to develop advanced levels of proficiency in problem-solving and critical analysis. Otherwise, their ability to derive new or useful knowledge from information (knowledge construction) is adversely restricted. However, it is argued that to have any chance of success in achieving complex levels of critical awareness, not only must learners apply higher order cognitive skills that enable the efficient collection, management, and analysis of data and information (information processing), but systems thinking and meta-cognition skills must also be mastered in ways that enhance the creative construction of knowledge. Such skills are necessitated by the fact that learners must gain an awareness of the many divergent and multi-faceted issues that will be encountered during the course of their lives. A systems approach to online content design with its underpinnings of interconnected systems, sub-systems, and interrelationships among systems is presented as a useful model for assisting learners to master the complex levels of thinking that will be required in a world in which the predominate means of production will be the creative application of information and knowledge.

It is further argued that to be effective as an aid to learning, teaching content must be contextual, implied and experiential. Whereas such attributes are well established in traditional teaching resources, in the case of learning objects this assumption no longer holds true. If the aim is to conform to the notions of accessibility, adaptability, reusability and durability, then an alternative means of unifying meaning with learning object content is required. That is, object-based teaching resources must be contextualised in a way that ensures the intended relevance and meaning is inherently clear. As an example of what may be possible, this chapter explores the suitability of learning object technology to improving the learning effectiveness of online environments through the strategic manipulation of context to alter or add meaning. This chapter outlines the methods developed to date to overcome the issues outlined above and explains the advantages learning objects afford in enhancing the learning experience by adapting to the needs and preferences of individual learners.

Introduction

As individuals encounter information, each from different perspectives and backgrounds, and for different purposes, so too will the interpreted meaning vary from individual to individual. The initial meaning of a picture, a report, or a graph is continually defined according to the individual's pre-existing knowledge and experiences and influenced by their unique intentions and perceptions. Once meaning has been derived, information then becomes organised as knowledge operating in a larger context of meaning that encompasses community accepted biases and interpretations (Hill and Hannafin, 2001, p 2). The ambiguities of knowledge construction raise the perplexing question of how learning can be managed in complex online environments given that the meaning of the information provided will change from user to user and in relation to individual and community needs and goals.

Current learning management systems (LMS) are designed to deliver static, hard coded data and information in ways that facilitate ease of access from anywhere and at anytime. They may display pre-structured information or provide the learner a limited capacity to re-organise the same information using predefined classification criteria. In common with most online learning environments, explicit links (hyperlinks) to other (usually external) resources and information are predetermined by the content author to be relevant to the lesson outcomes. This approach provides a means of structuring and connecting the resources contained within a defined learning environment by directing or cueing learners to related information. While this method is useful for assisting the majority of learners to achieve the required learning outcomes, it does not permit the flexibility needed to make sense to all learners. This problem arises because the information that is provided by the content expert will not always match the unique understandings and experiences of every learner.

To render meaning, information must comprise two or more data types that when connected cognitively may reveal discernable patterns of organisation or meaning. Most common data types apply to dates, events, locations, numbers, and names. Without some indication of relationship, data are isolated facts that possess no meaning or value and represent little more than a reference point. Whenever the learner observes a fact (or segment of data) that is regularly embedded within a relatively stable context, patterns of meaning form within the learner's mind. Data that is abstracted and associated with meaning in some way is then becomes information. We are so accustomed to this process that the tendency is to assume the derived meaning is embedded within the data itself. The same meaning may then be transferred to other contexts without realising it remains directly related to the original context (Capra, 1996, p 265). To overcome this limitation, we must learn to not only discern the differences between data, information and knowledge, but also to develop and refine the thinking skills required to accurately judge the relationships that connect data and thus give rise to meaningful information. Only then is it fitting to engage in the task of constructing knowledge from information.

The capacity to connect two or more data types to construct mental patterns of meaning opens the potential for unique application and interpretation that discrete datum do not possess. For learning purposes, the connection may be furnished by the educational designers, or if permissible, constructed by learners. Conversely, whenever information and data are interrelated in unfamiliar ways, new patterns of understanding and knowledge may be revealed. Furthermore, the strategy of applying selected teaching resources to varying contexts affords an effective pedagogical strategy for influencing learner understanding. Although in one context a resource may appear meaningless, the act of embedding the same resource in an alternative context exposes the learner to new insights that may accentuate otherwise unknown or unfamiliar aspects of the whole. That is, for learning to be more comprehensive, teaching resources must be contextualised in ways that govern the intended relevance and meaning. Thus, it is important the learner is encouraged to seek out and explore the more obscure aspects of the object or topic under discussion. It is in this sense that the purpose of learning and the development of understanding extends not just from active involvement but is also the result of good design. In other words, situational relevance and meaning should be pre-planned. Moreover, it is useful to be aware that application and meaning can be managed and manipulated for different learning outcomes. The design aims can be intentional, or the learner can be permitted to construct their own understandings according to their individual learning needs (Hannafin, 1997, pp 255 - 8). Whilst on the surface such flexibility may seem pedagogically useful, nonetheless where learning objects are concerned there are a number of additional factors to consider.

Learning objects introduce the notion of reusability where resources designed for one purpose are used to support other purposes, some of which may contradict or be inconsistent with the original intent. In keeping with the defined attributes of a learning object, it is a requirement that content be broken down into reusable, non-contextualised segments of information and data. However, as learning content is converted into smaller, reusable objects, there is an increased risk of unintentional fragmentation of the anticipated logic. The reason this problem may occur is relatively simple. On the one hand, the higher the proportion of contextual content contained within a given object, the less reusable it will be in other contexts (thus, more difficult to recontextualise). On the other hand, as the amount of contextual information is decreased, the greater the level of flexibility afforded in adapting the underlying object (and its content) to other teaching contexts. For many educationalists, reducing content down to context neutral content may prove unacceptable if in the final analysis the effectiveness of the pedagogical strategies and the quality of the educational outcomes are diminished in some way. This brings us to the primary focus of this chapter, which is to explore a number of approaches and techniques that may assist to reduce the loss of contextual meaning in the application of learning objects to online learning environments. The eventual aim of this exercise is to devise a method for contextualising learning objects that will provide meaningful learning experiences whilst ensuring learners' needs are not compromised. In my view, the most favoured approach is to derive an effective method for creating learning objects that permits high levels of object granularity and enables maximum extraction of contextual content from teaching resources to produce highly flexible, adaptable, and reusable content. The set of strategies for resolving these complexities will be referred to as the contextual object approach to content aggregation.

In practice, it is not always possible to remove all contextual information from any given learning resource. Without due diligence to detail, the quality and coherence of the delivered teaching material may reduce the effectiveness of the applied pedagogical approach as evidenced by lower than expected educational outcomes. To counteract such problems, a range of design techniques must be employed to:

- prevent the loss of contextual meaning in the design of object-based learning environments
- enhance the required learning outcomes by devising strategies to link object content in ways that enable the meaningful and efficient processing of information.

This chapter will explain the theoretical principles that support the design of a contextual object approach and outlines the methods developed to date to overcome the problems and issues described thus far. The advantages the concept of contextual objects affords in enhancing the learning experience will also be made apparent by observing a parallel, supplementary aim of this chapter, which is to describe how the many elements that comprise object-based online courses and units can be interrelated to form a multi-levelled, conceptual framework for learning design. The practical value of this systems-based approach lies in the potential to underpin the design of highly flexible online learning environments and thereby assist to structure content in ways that enhance the educational value of the assembled learning components. What follows is not in any way intended to provide a definitive model for online learning design. That is, it is a way of exploring the potentials and possibilities given what is known, and what one day may prove feasible to implement.

The Building Blocks of Learning

Data, Information and Knowledge and Context Dependence

Ackoff (1974, p 17 and pp 75 - 6) proposed that the human mind can be classified into five conceptual categories of content. The first four categories relate to the past in that they apply to what has been or what is already known. Wisdom, the fifth category, requires vision and design and therefore relates to the determination of future potential outcomes. To achieve wisdom, the individual must progressively work through the first four categories:

1	Data:	symbols
2	Information:	data that are processed to be useful; provides answers to the 'who', 'what', 'where', and 'when' questions
3	Knowledge:	The application of data and information that answers the 'how' questions
4	Understanding:	an appreciation of 'why'
5	Wisdom:	evaluated understanding

Figure 1 below illustrates the transitional sequence from data through to information, then to knowledge, and finally to wisdom (Bellinger, 1997, p 1):

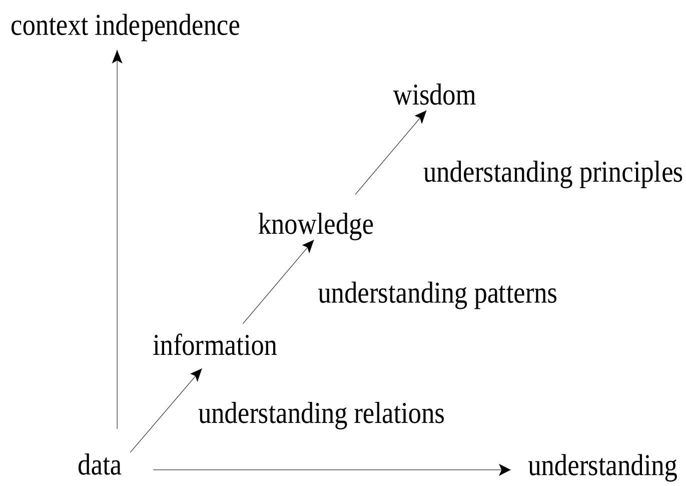


Figure 1 - The Transition from Data to Wisdom

The above diagram is underpinned by the notion that the whole represents more than the sum of the parts. Compare this diagram with the traditional view of learning that is often depicted as a hierarchical, linear progression from data (the raw materials), to information, to knowledge construction (the first layer of adding value), to insight/foresight (the next layer of adding value), and ultimately, to wisdom. Instead, what is presented above in Figure 1 is an interdependent, fully interrelated, holistic structure in which data, information, knowledge and wisdom are combined to form a complete, integrated whole while the cognitive process of understanding progressively underpins the transition from one stage to the next. An additional factor, the degree of context independency also increases as learning and understanding are refined in the pursuit of wisdom. Of further interest is that insight, foresight, understanding, and wisdom require systems thinking skills that are described later in this chapter as the ability to understand the interconnectedness of different areas of knowledge (Employment and Skills Council, 1996, p 77).

It is possible to abstract information by identifying patterns of relationships among data without being aware of the component parts or even the purpose of the object or event under examination (Rucker, 1988, p 25). Whenever we encounter a collection of data, we attempt to attribute meaning by mentally forming associations with other objects or concepts. Take as an instance, the number '5'. We can immediately associate it with other cardinal numbers and determine that it is greater than '4' and less than '6' regardless of whether this understanding was implied or not. Alternatively, we might consider the word 'time'. Again, there will be a tendency to construct mental associations with previously known contexts where the word 'time' has been found to be meaningful. In itself, the word time provides no clues as to the intended meaning. This might take the form of 'a period of time', 'the time of year', 'take time to smell the roses', or 'he or she tried several times'. The point is that in the absence of context, little or no discernable meaning exists. To compensate, we create context that in some circumstances may prove to be invalid. The mistake often made is to call it information even though a valid context has not been established (no relationship to other data) and therefore by definition, it is still data. However, there are also occasions when our attempts to create context amounts to little more than conjecture which nevertheless, may assist to establish new or previously unknown meanings.

The extent to which a collection of data can be defined as information is dependent on the associations that are discernable within the collection (Bellinger, 1997, p 2). This statement implies that a collection of data for which there are no obvious relationships connecting the data segments is not information. That is to say, information is quite simply the identification and interpretation of the relationships that connect data, or data and other information. In effect, information represents an abstraction of ideas. A relational database for example, generates information from the data stored within it. Once deciphered in accordance with predefined rules, a simple message or a complex pattern of data becomes information. Hence, information is in fact data that is given meaning by way of relational connections. Because information is dependent on the relationships between a given set of data it requires context to give it meaning. That is, information is context dependent. As indicated earlier, we must remain mindful that not all relationships assist to construct useful meaning. The 'meaning' may be of some use, but the depth of that meaning is dependent on the individual's prior knowledge. Thus, while information entails an understanding of the relationships among data, it generally does not provide a foundation for understanding why the data is what it is, nor will it provide clues as to how the data may change over time. Whereas information may remain relatively static, the data form which meaning has been derived will be constantly subject to further refinement and modification. By identifying the connections and relationships, a second level of information emerges. Information organised according to some form of logical relationship that is interpreted through systematic exposure or study and then leads to conceptual understanding, will result in the construction of knowledge. In other words, knowledge arises as the result of how information is applied, absorbed, or communicated.

While information represents an abstraction of ideas, information itself does not create ideas. Ideas are not inherent within information but are instead the integrating patterns derived through human experience and knowledge. The human mind thinks with ideas, not with information. As Capra (1996, p 70) explains, information is derived through ideas, not vice versa. The acts of dialogue, observation, questioning, and research result in the retention of information, ideas, and concepts, in turn giving rise to learning as new information is generated and combined to produce new understanding (Daniel, 1996, p 2; Brown & Thompson, 1997, p 75). The type of learning that assists in the creation of knowledge involves two important processes. First, information from the world around us is processed in the human mind, and second, new information is generated by asking questions, forming memory impressions, and through the physical act of writing. Learning is communicated by transmitting and receiving information, as well as by generating and absorbing knowledge (Rucker, 1988, p 26).

The second important factor relates to how knowledge is constructed and the crucial role of understanding. As Burbules and Callister (1996, p 2) write, “knowing depends upon the meaningful organisation of information, new methods of organisation imply changing forms of knowledge.” In contrast, understanding involves recognition of the implications of one’s knowledge as derived through an innate capacity to reason, analyse, interpret, and think critically. In other words, deep understanding encompasses the need to comprehend varied perspectives, the ability to explain, and the capacity to reason using one’s individual knowledge construct. Thus, it can be argued that understanding involves a transformation of meaning based upon associations with personal experience and prior knowledge. Again, Burbules and Callister (1996, p 7) provide a more precise definition of what these notions infer by explaining that ‘learning’ and ‘understanding’ arise through the formation of cognitive connections. They point out that humans do not learn information as discrete, isolated facts, but instead integrate new information with the knowledge they already possess.

Beyond relationships, there are patterns where the term pattern refers to more than just relationships and embodies a consistency and completeness of relations that to some extent, creates its own context relation of relationships (Bateson, 1988, pp 9 – 11, and p 29). The potential for deriving meaning increases whenever a pattern is discerned amidst a collection of data and information. New knowledge is constructed when recognised meanings are analysed in order to interpret the implications that are inherent within each perceived connection (Bellinger, 1997, p 2). The act of deriving meaning therefore can be described as an interpolative and probabilistic process (Bellinger, Castro & Mills, 1997, p 2). Understanding and knowledge emerge through the acts of dialogue, observation, questioning, research, and how information is applied, absorbed, or communicated. That is, the process by which data and information is synthesised into new knowledge requires the application of cognitive, analytical, and language skills. New information is generated through the retention of information, ideas, and concepts which when combined, produces new understandings (Daniel, 1996, p 2; Brown & Thompson, 1997, p 75). It is this process, albeit stated in simple terms that results in learning. The distinction between understanding and knowledge can be compared to the difference between ‘learning’ and ‘memorising’. From Rucker’s (1988, p 26) perspective, the learning that assists in the creation of knowledge involves several important processes. The first applies to the input of information through each of our senses that is then processed by the human mind. The act of processing involves the generation of new information by posing questions, synthesising new understandings that are then assimilated into the individual's existing cognitive framework and stored as new knowledge. The learning process becomes internalised (memorised) within the individual's mind. Once memorised, it is then possible to 'transfer' the learned knowledge from one individual to another (or to a group). The following extract from the work of Megarry (1989, p 50) builds on the preceding views by providing further insight into the relationship between data, information and knowledge:

> Knowledge is not merely a collection of facts. Although we may be able to memorise isolated undigested facts for short while at least, meaningful learning demands that we internalise the information: we break it down, digest it and locate it in our pre-existing, highly complex web of interconnected knowledge and ideas, building fresh links and restructuring old ones.

As implied in the above extract, the notion that knowledge is represented as a set of facts to be memorised is problematic. Although there may be a need to know certain facts, it is not just the knowing of facts that is important. The empirical (reductionist) approach to deriving knowledge typically involves the removal of the object of study (whether it be an organism, a process, or a concept) from its usual context in order to render it the exclusive focus of study and to analyse its constituent components in isolation from the whole. While it is acknowledged there is and has been great value in this approach, it is important to recognise its limitations. Any contextual change alters the intrinsic function and meaning of an object or concept by removing part of the network of interrelationships that generate, interact, and contribute to its overall definition (Burbules, 1999, p 12). Therefore, learners must not only be motivated to learn new knowledge, but should also understand how that knowledge was derived and the connections that were formed, whilst remaining cognisant of what was learned in the process. Otherwise, all that has been achieved is little more than a meaningless collection of unrelated facts.

Individuals who develop understanding can carry out useful actions because they have gained the capacity to synthesise new knowledge, or at least new information, from what was previously known (and hence understood). In other words, understanding builds upon currently held information, knowledge and understanding itself. In terms of learning, the acquisition of knowledge can be viewed as a deterministic process. When someone 'memorises' information (preparing for a test for example), they amass a specific amount of knowledge. This knowledge has useful meaning to them, but in and of itself does not provide for a level of cognitive integration that would enable the capacity to infer further knowledge. Take for instance, the situation where elementary school children are required to memorise, or retain knowledge of the multiplication table. While they may be able to repeat the equation '2 x 2 = 4', their success is due more to an ability to memorise that knowledge and recall the fact that it is included in the table. Nevertheless, when requested to calculate the equation '1064 x 250', many students will fail to respond correctly because the entry was not provided in the table. To answer such a question correctly requires a level of cognitive and analytical ability that is only acquired through genuine understanding.

If our graduates are to be proficient in the construction of new knowledge, then a clear understanding of the relationship between data, information and knowledge is critical. An examination of how relationships are derived reveals a useful theoretical framework for describing the process of converting data into information and then to knowledge (knowledge construction). This framework comprises three distinct stages of a knowledge creation process:

- data that is collected and stored
- information that is extracted from organised data
- knowledge that is construed from information (knowledge construction) - by implication, this latter stage involves the cognitive processes of learning and conceptual understanding.

In attempting to derive and articulate a personal understanding of new ideas and concepts, learners must be actively engaged in the process of knowledge construction. One noteworthy advocate of this view was Bruner who asserted that the final goal of teaching is to promote the 'general understanding of the structure of a subject matter' (Sprinthall & Sprinthall, 1981, p 281). Bruner reasoned that for learning to be of genuine value it is important for the student to actively form global concepts, build coherent generalisations, and to create what he termed 'cognitive gestalts'. As he explained, for learning to be meaningful, students should be encouraged to search for solutions by exploring alternatives and discovering new relationships. By first understanding the structure of a object or concept it becomes possible to perceive this same structure as an integral part of a greater whole that has meaningful connections to other areas of knowledge. The role of teacher is to create the conditions in which the student can discern the structure of a given subject. Once such conditions are established, Bruner insisted this type of 'discovery learning' provides a far more permanent and useful understanding of the subject matter than learning based on memorisation and conditioning. When an individual actively seeks to construct knowledge, incoming information is matched with existing cognitive structures. In this way new meaning is given to existing patterns of organisation and experience and assists the individual to think beyond the information given (Bruner & Anglin, 1973, p 397). Patterns of relationships that lead to the creation of knowledge have a tendency to self-contextualise. That is, the pattern creates its own context, a factor that contrasts with the context dependency that in part, defines information. It is here we begin to unearth the basics of 'systems thinking'.

The most productive learning occurs when new material is readily connected with what are often 'complex and multiple links of association'. The capacity to act intentionally and purposefully on the accumulated understanding of existing personal knowledge enables the construction of new knowledge. Through this grounded process, knowledge and understanding catalyse, yielding something that previously did not exist or was not part of the individual's prior experience. Such cognitive action may involve forming an inference, solving problems, responding differentially to complex circumstances, forming new connections, or articulating new ideas and perspectives. In effect, generating knowledge is what learners do with the information resources provided or located as they define their personal learning needs, generate hypotheses, and acquire new understandings. The question for now is how to underpin the knowledge construction process with the theoretical principles required to model a design approach that will provide for the efficient yet effective conversion of information into knowledge and in so doing, enhance/reflect/mirror the way in which our natural minds function. A potentially useful hypothesis to be explored later in this chapter is to propose that the goal of learning is to assist the student to develop 'holistic understanding' through active participation in learning environments modelled on a networked ‘system of learning systems’. To ensure effectiveness in terms of deriving enhanced learning outcomes it will be argued that such a model should be composed of multidimensional, multi-levelled, interconnected and interrelated webs of data, information and knowledge.

For learners to understand the educational purpose of the content as provided requires consensus by both designer and students on the distinctions to be made between data, information and knowledge, and in so doing identify the various relationships. Without meaning, data does not equate to information, which in turn does not equate to knowledge. The implications raised in this statement for contextualising learning objects are critical to understanding how context may influence the creation of new knowledge. As will be argued, to derive complete knowledge or understanding from a given body of information requires a holistic, systems approach to learning where insights into discerning contextual relationships are essential for making meaningful, valid connections. To paraphrase Bruner, “you cannot study learning in the abstract and ignore the broader context – the environment in which that learning took place.” As Laurillard (1993, p 268) puts it, the term ‘holistic’ can be applied to describe “an integrated knowledge structure, or an approach to learning that recognises knowledge must be integrated.” Thus, it is more appropriate to view the process of knowledge acquisition as an integrated system of distinct sub-processes each of which are fully dependent upon one another (Shank, 1996, p 173). It is at this point that a more holistic, systems perspective on learning design takes shape.

A Systems Approach to Understanding Connectedness

The Complexity of Information

Much of our understanding of the world has been derived using a reductionist, empirical approach to observation and analysis. In effect, simple forms are extracted from the physical world even though it is generally accepted that greater complexity provides a more reasonable approximation of reality. The use of simplified models to understanding the complexity of the world is considered essential due to one inescapable fact. Notwithstanding what part or aspect of the world that is studied, ultimately the quantity and complexity of information is impossible to manage. The universe (including the world we live in), is far more complex than we imagine. One has only to compare the amount of knowledge derived using unaided human senses with the enormous increase in information provided by artificial devices such as telescopes, microscopes, radio receivers and x-ray machines. As the technologies designed to enhance our senses are refined or replaced, we are better equipped to understand the inherent complexity of the world around us. The fact is, there are numerous physical structures and events that display patterns of information which are far too complex for the human mind to process. Regardless of whether they exist in nature or the result of human activity, all systems are complex and generate information. The information to be derived at all systems levels is dynamic, multidimensional, and invariably generated in an infinite number of permutations. It constantly changes, exhibiting unpredictable, random patterns (chaotic), as well as predictable, organised patterns (order) (Gleick, 1987, pp 259 - 262; Sheldrake, 1988, p 113; Rucker, 1988, p 26, 113; and Kosko, 1994, pp 21 - 3). The key factor to note here is that all systems are composed of inconceivable quantities of information (Rucker, 1988, pp 290 - 1).

Where learning is concerned, there is a need to apply the available knowledge to deriving practical solutions. For the process to be of genuine educative value, a broad range of problem solving and analysis strategies are required that direct the learner's attention to the entire task at hand replete with its especial difficulties and complexities. The reductionist approach to subdividing a problem into manageable subsets provides one means of simplifying the task and understanding the complexities involved. However, ignoring those factors for which there are no apparent solutions will inevitably result in explanations that on the surface, will make little sense. In such circumstances, there is a need to recognise that there are many complex, interdependent issues to be addressed, which if not taken into account will lead to further complications. As Toulmin (1972, pp 400 - 01) puts it: "Where practical outcomes are required, 'actions and choices are meshed together into a complex spider's web of interacting sequences, in which the consequences are equally complex."

If the task of deriving complete understanding seems difficult enough, then consider that it is also contingent upon how the individual views objects or events and the context in which they are examined. By their very nature, the acts of observation and analysis are subjective experiences and accordingly, most individuals do not interpret and understand things in the same way as the 'perceived' context will vary from individual to individual. Even where traditional scientific inquiry is concerned, the empirical approach to deriving knowledge relies on an objective examination of the facts, not interpretations, and as a result, context is viewed as irrelevant to the process. As will be made clear, by applying an object or event to different contexts, otherwise unknown aspects of the whole are revealed, thus rendering context as crucial to the derivation of meaning,

Without doubt, it is legitimate to analyse complex phenomena by breaking it down into its constituent components provided it is acknowledged that some aspect of the whole will be lost. A reduced expectation is necessary because the attributes of the whole are far more complex than the relatively simpler attributes of its parts (Koestler, 1978, p 25). Any attempt to reduce and thus decontextualise an object, a concept, or a system to its fundamental components loses part of that which serves to define the whole within which it belongs. Whereas the reductionist approach argues that the behaviour of the whole can be analysed and explained in terms of the properties of its parts, a systems approach (and related systems thinking) to deriving knowledge reverses this approach and demonstrates how living systems cannot be fully understood through reductionist analysis alone. Although the properties of the parts can be studied in isolation, their combined effect can only be understood in the context of the larger whole. Thus, systems based thinking can be likened to 'contextual' thinking, a way of explaining things in terms of their associated context as opposed to their innate structure or substance. In this sense, a shift in the focus of inquiry from the parts to the whole is parallelled by a shift from independent objects to the relationships that connect objects. Hence, the multidimensional relationships between the parts are viewed as more important than the parts themselves.

The application of a systems model to educational design and practice has profound implications for enhancing the cognitive processes of thinking and learning (Bawden, 1998, pp 46 - 7). As touched on already, our individual perceptions or views of the world around us are inherently grounded in cultural and personal semantics. That is, our understanding of how knowledge is derived varies considerably from culture to culture and from individual to individual. In other words, every individual views the world and construes meaning through unique personal perspectives or what Bawden terms 'worldviews', which he defines as "integrations of intellectual, normative and emotional positions".

Several possibilities exist to incorporate systemic principles into the learning process (Bawden, 1997, p 4). He cites the example of where the learner and the experience of learning could represent one systemic whole. Then, given that the context through which knowledge is acquired is also influenced by cultural worldviews, the inquiry process could embrace several coexistent 'levels' of learning. Accordingly, while participating in the learning process (level one), the student can be encouraged to learn about how that learning occurs (meta-learning) (level two). At the same time, whilst engaged in two levels of inquiry, the learner may be exposed to the philosophical foundations of many different worldviews (third level - epistemic learning) from which we can understand the process of learning and how these worldviews influence learning at the other two levels. Next, given that social discourse is essential to learning, collaborative discussions that focus on how objects or ideas are defined can be viewed as a fourth level which in turn amounts to a multi-component system of inquiry made up of interacting individuals and groups. In this model, a complex, interrelated, dynamic learning system is made possible, which at its most optimum level, will be self-reflexive and self-regulating. At the same time, new knowledge is created as new ways of knowing are generated and new philosophical contexts for knowing emerge, all interrelating with, and influencing each other. Taken as a whole, the learning system is constantly using the knowledge generated at one level to inform and critique the knowledge generated at every other level. Likewise, knowledge created by the individual informs and critiques the knowledge being created by other individuals or groups that comprise the larger learning system. In essence, Bawden provides a unique insight into how systemic design may assist learners to construct meaningful, contextually relevant connections among data, information and knowledge and thereby expose learners to a broader understanding of the whole.

To illustrate the relevance of applying a systems approach to the contextualisation of teaching resources, I refer to the work of Wicklein and Schell (1995, p 1) who observed how traditional school curricula are largely based on the separation of instruction and content into distinct subject areas to facilitate ease of understanding. Underpinning the notion of a 'separate subject areas' approach is the assumption that the learner will readily reconnect their school knowledge in an applied real-world context. As Wicklein and Schell note, (referring to the work of Crohn, 1983, and Hawkins, 1982) research does not substantiate such an assumption. A typical example of the failure of students to 'connect' school knowledge with contextual practice is provided by Tam, Wedd, and McKerchar (1997, pp 54 - 55) in the following observation:

> ... accounting principles are usually taught in a compartmentalised way with emphasis on technical mastery of skills through a linear-structured curriculum. This problem is further aggravated by specialised teaching of accounting content by individual accounting lecturers. While students may have learned some specific accounting principles very well in isolation, they are not able to see how different concepts are linked to each other and how changes in some parts of the accounting system may impact on the system as a whole.

Again, what is alluded to is the limiting effect of applying a reductionist approach to learning. The classroom is not the only environment where the principles of reductionism prevail. Where learning objects are concerned, the use of segmented, non-contextualised teaching resources may inadvertently reduce the final learning outcomes. As noted earlier, without reference to context, information will not have meaning, in turn, influencing learners' perceptions and understandings. To derive meaning requires an ability to connect information in a wide variety of ways combined with a capacity to form relationships among what at first may appear to be multiple, unrelated contexts. In other words, systemic insights into discerning contextual relationships are essential for ensuring the learner is afforded the ability to make meaningful, valid connections. The need to identify and create meaningful connections amounts to a consolidation of the theoretical underpinnings of systems thinking with its notions of integrated wholes, systemic properties and organising relations all of which provide further insight in relation to the design of meaningful, contextualised learning environments. To summarise thus far, the key principles most relevant to a systems model of learning as distilled from the work of several authors are outlined below:

- all systems are integrated wholes whose properties cannot be reduced to those of the smaller parts. Systemic properties are destroyed when a system is reduced to its component parts.
- nature does not reveal the existence of independent components, but instead appears as a complex web of relationships between the various parts of a unified whole
- the essential or 'systemic' properties of the whole arise from the 'organising relations' of the parts (Sheldrake, 1988, p 314)
- all systems are nested within other systems and interact in a network fashion with other networked systems, or put more simply, networks within networks. There is no hierarchical structure, only larger or smaller systems nested within other networked systems.
- the simple laws that govern the various elements of a system also act to generate behaviour that extends far beyond their individual capacities (Holland, 1998, p 5)
- all system levels represent differing levels of complexity where each level exhibits unique phenomena known as 'emergent' properties
- properties of emergence displayed at one level, do not exist at lower system levels (Capra, 1996, p 37).

This brief introduction to systems theory principles serves to introduce the notion of systems thinking and highlights the complexity of the world and the information that describes it.

Systems Thinking

The implications for the effective management and critical inquiry of vast repositories of information are profound. Whenever the intent is to derive meaning across disparate areas of information and knowledge, an eclectic mix of new possibilities and unforeseen problems can manifest in many unpredictable ways. To mange such complexities requires the ability to collect, manage and analyse information, skills that are generally described as 'information processing'. It is the notion of processing and generating information that underpins the current emergence of the information age and its closely aligned derivative, the knowledge economy. This line of thought naturally begs the question of what is information processing? If we look to the Encyclopaedia Britannica online, the term information processing is defined as:

> … the acquisition, recording, organisation, retrieval, display, and dissemination of information. In recent years, the term has often been applied specifically to computer-based operations.

There are times when we believe that our understandings and knowledge are factual and overlook the need to question or re-examine it further. For example, there are times when we perceive a situation without considering other possibilities. The depth of understanding that has been acquired is at best superficial. At other times, when confronted with the unexpected or anomalous, we are forced to make a judgement or deliberate on what has been presented. The depth of understanding would be much greater than in the first instance. In both instances, meaning is added and then construed as information. However, each instance would be 'viewed' from different perspectives and as a result, different levels of meaning have been added. Thus, regardless of how often or how well it is manipulated, information is at best an abstract representation of ideas. In order to derive knowledge, it is necessary to judge or to have previously judged the value of the information at hand. In addition, learners must possess the capacity to discern inaccurate, unproven information and knowledge (Tiffin & Rajasingham, 1995, p 44). A common requirement for all these processes is the application of thinking strategies that aid in the cognitive activities of organisation, encoding and retention. Learning and understanding follows as a result of how these cognitive processes are applied and used to engage higher order thinking skills such as analysis, problem solving and critical thinking. Such skills extend our cognitive abilities to construct abstract concepts that emerge from the application of formal and informal logic, conceptual analysis, critical interrogation and evaluation, all of which underwrite the construction of knowledge and understanding. However, for such skills to be effective, it is essential the learner be exposed to the many complex and multi-faceted issues to be dealt with when managing information. A summary of the main issues to be addressed is provided by the Employment and Skills Council (1996, pp 74 - 75):

- the difficulty of interpreting interconnectedness or interdependency in complex systems such as within organisms or organisations
- the problem of deriving meaning or the loss of meaning from a surfeit of information; tracking patterns of connection across divergent systems, and
- recognising properties of emergence in complex systems that are difficult if not impossible to imagine or predict.

In light of the complexities and issues raised thus far, it is useful to summarise the key information processing competencies promoted by proponents of systems thinking skills (Employment and Skills Council, 1996, p 75):

- the ability to see parts/wholes in relationship to each other and to work dialectically with the relationship to clarify both similarities and differences. That is, the ability to balance the cognitive processes of analysis and synthesis.
- the ability to abstract complexity so that the organising structures (visual, mathematical, conceptual patterns) are revealed rather than imposed
- the ability to balance the need for flexibility and to manage real world change against the conceptual need for stable system boundaries and parameters
- a command of multiple methods for problem solving as opposed to applying a limited range of algorithms to a wide variety of situations
- an awareness that the map is not the territory
- the ability to act appropriately in relation to the use of systems models,

In attempting to develop a successful model for dealing with the complexities of processing divergent sources of information, systems thinking offers distinct advantages. In terms of learning design, the real value of systems thinking is that it is based on the notion that meaning cannot be derived from information through analysis alone. The properties of the parts are not simply intrinsic to the part, but can only be understood within the context of the broader system level and the relationships of the parts to the larger whole. This contextual approach to deriving meaning focuses not just on the individual component parts but also on the systems principles of organisation, interconnectedness, and properties of emergence. The strength of a systems approach to learning can be found in the way it interrogates and contextualises the system(s) it encompasses. The student learns to inquire into the methods and contexts that are inherent within the various levels of a defined learning activity. Each level of inquiry is open to the influence of other system levels that occur as a response to the properties that emerge at other levels (emergent properties). Thus, the effective conversion of information into knowledge requires a systemic understanding of what information is, how it is generated, structured, patterned, then analysed, and ultimately, converted into knowledge.

It should be apparent buy now that managing and understanding the diversity and interconnectedness of data, information and knowledge with a view to determining their contextual relationships is a highly complex and difficult task. The complexities of applying a systems thinking model must not be reduced to a simple model for deriving competence in information processing skills or formal problem solving operations. The application of systems thinking principles to learning design should only be made be in recognition of the need to apply more than just formal operation and information processing skills.

The Value of Context in Knowledge Construction

So far it has been explained that data is little more than a representation of facts. On its own, data has no value or meaning inasmuch as it is context free, meaningless, and disorganised. Data becomes meaningful when it is connected and applied in some way. Without meaning there is no value, but with meaning, data becomes information. In other words, the selected data reveal a pattern of relationships that aide in the formation of new meanings within the learner's mind. Because it can be generated and processed in a multitude of ways, information exhibits properties that can be characterised as dynamic, multidimensional, and context dependent. At first glance, information may appear to be simple, but on closer examination, can be highly complex. Whenever information is processed, that is reordered, reorganised, or re-categorised, new relationships and new meanings are formed, which may transform simplicity into complexity or order into chaos. Furthermore, when relational connections amongst data and information are identified, the pattern that is revealed holds the potential to represent knowledge. However, before knowledge can be derived, the individual must recognise and understand the contextual implications of each identified pattern. To further our understanding of the contextual dependency of relationship and meaning, we know from the discussions to this stage that the components that make up every system (which comprise data and information) are interrelated through networked connections that preserve the integrity of each component while simultaneously provide the crucial interdependencies that make up the whole. As noted beforehand, the properties of the parts must be determined in the context of the broader system level and the relationships of the parts to the larger whole. The key stages of a systems based knowledge construction process can be summarised as follows:

- a unit of data is the symbolic representation of a fact, value, or a result
- information emerges from an understanding of the relationships among data that give rise to meaning
- for information to have meaning it must be contextual, an attribute data does not possess
- information represents an abstraction of ideas; information itself does not create ideas
- ideas are integrating patterns that are not derived directly from information but instead, through experience and cognitive action
- the human mind thinks with ideas, not with information
- humans learn by connecting new information to patterns that are already understood. In so doing, the patterns discerned in the process are extended and refined.
- patterns of relationships among data and information and other conceptual patterns have the potential to represent knowledge
- knowledge arises when sufficient data and information have been accumulated to form a complete, discernable pattern
- pattern embodies both a consistency and completeness of relations which, to some extent, creates its own context
- a pattern only becomes knowledge once its implications are recognised and understood, and
- patterns that represent knowledge tend to be self-contextualising.

Connections, Context, and the Derivation of Meaning

The Relationships that Induce Meaning, Understanding, and Learning

Learning should not be viewed as something that is separate from the learner's experience. Nor should it be assumed that knowledge and understanding can be transferred to the learner along with a guarantee that learning will naturally follow. It was established in the early stages of this chapter that the terms 'understanding' and 'knowledge' are interrelated in the sense that both are derived as a direct result of how information is applied, absorbed and communicated. The acts of observation, questioning and research all facilitate the cognitive processing of information resulting in the formation and retention of ideas and concepts. As information is processed, new data and information are absorbed and combined with existing knowledge in a process that leads to the realisation of new understandings. Given the strong interconnectedness of understanding and knowledge, as our understandings grow so too does our knowledge. This cognitive process is further enhanced through the exchange of ideas and concepts acquired through ongoing discourse with other individuals and groups, which in turn generates new understandings and new knowledge. Thus, a pattern of cognitive activity is apparent. The processes of dialogue, observation, questioning and research that lead to the synthesis and assimilation of new insights into pre-existing knowledge is then reiterated in a cumulative pattern to construct knowledge. This cyclic process describes the essence of learning. Moreover, it is also important to make a clear distinction between the learning of information and the learning of knowledge. The tasks of memorising information and understanding information (knowledge) often result in distinctly different outcomes (Koppi & Chaloupka, 1997, p 350). On the one hand, the learning of information requires little more than the ability to memorise and recall (rote learning), whereas the learning of knowledge requires the cognitive skills of synthesis and analysis to derive new understandings and thereby, to construct new knowledge.

Rote learning is often associated with superficial understanding and can be viewed as a surface approach to learning in that it amounts to little more than the retention of unrelated, meaningless facts (Laurillard, 1993, pp 51 - 2). It is known for example, that students can perform well in examinations without understanding the underlying concepts. However, when compared to the learning effects of memorisation and recall, active participation in the learning process can produce deeper levels of understanding and meaning. A deep approach to learning is necessary to comprehend the structure of information and to identify the relationships that assist to determine meaning (Atherton, 2002, p 1). In addition, students who are encouraged to seek understanding or meaning for themselves tend to demonstrate higher levels of learning. That is, higher-order thinking skills are not acquired through traditional didactic approaches, but through the learner's active involvement with information (Harper and Hedberg, 1997, p 13). Learning is enhanced when the learner is provided an opportunity to experiment, reflect, and construct meaning through direct, personal interaction with data and information. Active engagement in the learning process can be encouraged in several ways. For example, discovery learning involving active experimentation is a natural (experiential) way to derive meaning through trial and error (heuristic) and encourages self-learning (Koppi & Chaloupka, 1997, pp 119 and 350). Problem-based learning also provides an effective strategy to motivate learners and promote higher order thinking skills. Students must analyse the available information to identify the connections that give rise to meaning and thereby the knowledge required to resolve the problem at hand. Thus, learning can be viewed as a function of actively interpreting and understanding the underlying structures and relationships that provide meaning to information.

In order to understand how learning occurs, the individual should be perceived as much more than a passive recipient of information. Instead, genuine understanding of the learning process is derived by encouraging the learner to: actively participate in the process of knowledge acquisition; engage in the selection and transformation of information; and, construct hypotheses and modify those hypotheses in the light of new or inconsistent information. To have any lasting effect, the cognitive activities of perception and learning are not simply about the passive storage of data and information, but result from the interpretation and elaboration of information in response to changing hypotheses. The act of reading for example, relies on the assumption that when a page is read, learners will actively engage in the construction of meaning. Although the ubiquitous book may be viewed as old technology, the author's original intentions and perceptions are usually embedded within the covers. To understand its origins we must first be conscious of the context in which it was initially grounded. As occurs with the derivation of meaning, the author's purposes may differ from that of the reader's. Nevertheless, in the process, serendipitous ideas may be stimulated which may pave the way for further discourse and understanding.

Learners also need to reflect on new material, discuss their tentative understandings with others, actively search for additional information in ways that may further illuminate or strengthen their understanding, and ultimately assist in building conceptual connections to their existing knowledge base (Brown & Thompson, 1997, p 75). This view parallels that of Bruner who argued that learning involves three almost simultaneous processes (Bruner & Anglin, 1973, p 397). In the first instance, the learner must be exposed to new or contradictory information (out of context). Next, for learning to occur, the learner must process or transform the newly acquired information through analysis, reordering it so that it is possible to extrapolate, interpolate or convert it into new knowledge. This transformation can be viewed as the process in which new information is manipulated in order to derive the relationships (connections) and insights that will lead to new knowledge or understanding. Thus, new discoveries (knowledge) do not occur by producing something out of nothing. Knowledge arises by combining, connecting, and integrating the known with what were once disparate ideas, facts, and associative contexts. In essence, the goal is to synthesise prior knowledge in an open feedback loop that adds new levels of understandings to the existing knowledge structure. At times, the synthesis of previously unrelated knowledge may result in what is commonly referred to as the 'aha' effect where apparently discrepant bits of information suddenly click into place. At this point, there is a realisation new knowledge has emerged, and in the process, higher levels of cognitive understanding are attained (Koestler, 1978, pp 131 - 33).

It is useful to view the acts of creativity and the discovery of knowledge as cognitive processes in which the abstraction and synthesis of previously unrelated mental structures or ideas leads to the formation of new emergent understandings. Anyone who has experienced that moment where a novel idea arises without apparent connection to previous knowledge would agree that the resultant outcome is often much more than the simple sum of a collection of disjointed ideas and thoughts. However, it is not the sum of the parts that is important, but of equal significance is the notion of the creative process as an expression of the relationships between various abstract components. Where the extent of learning and the depth of that learning are concerned, the focus of activity is a significant factor. When analysing an object, event or a concept, we first attempt to understand it by focussing on the parts. The problem with this approach is that the parts only make complete sense when the focus is shifted to the whole in which all parts belong. What is now being described is the very essence of a systems approach to deriving knowledge. The synthesis of data and the subsequent formation of information at different 'system levels' gives rise to the emergence of new patterns of relationships, each more complex than the previous, all extending to higher and higher cognitive levels of a mental hierarchy and thinking skills.

The Relevance of Learning Theory to Deriving Contextual Meaning

The applied theory of learning will also influence the type of context that is presented to the learner. An objectivist model for example, assumes learning occurs using abstract representations of reality thus there is no requirement for the learning context to be real (Leidner & Jarvenpaa, 1995, pp 270 - 1). Cognitive information processing theories emphasise learning as the formation of abstract concepts that represent reality and therefore the context provided need not fully represent the information or knowledge to be learned. In an environment structured on collaborative learning principles, context plays a substantial role in that the individual's prior experiences are accepted as real, but become less real to others as these same experiences are shared through discourse. The constructivist approach to deriving knowledge promotes a view of the learner as an active maker or 'constructor' of meaning and places contextualised problem solving at the centre of the learning process (Glatthorn, 1994, pp 449 - 55). The latter point naturally applies to the derivation of meaning. Constructivist learning theories have assisted educators to understand how learners apply self-directed and collaborative strategies to create meaning by exploring, experimenting, testing, and applying knowledge to real contexts. Then there are the active learning theories such as social constructivist theory and connectivist theory that have assisted educators to understand how learners apply self-directed and collaborative strategies to derive meaning by exploring, experimenting, testing, and applying knowledge (as opposed to pre-sequenced, instructivist-based courses of study) (Leidner & Jarvenpaa, 1995, p 270). The underlying assumptions made most often are that the learner is permitted control of the learning process, that experiential activity promotes learning, and that learning best occurs in the context in which it is applied. Consider for example, other pedagogical approaches such as anchored instruction that emphasises embedding the skills and knowledge to be learned in authentic or if possible, realistic contexts. Anchored contexts promote the use of complex and ill-structured problems where learners are required to define sub-problems and generate new knowledge as they determine how and when to apply that knowledge. This approach is consistent with the situated cognition perspective in which knowledge and the conditions under which it is applied are inextricably linked. The social cognitivist position extends this view to include an emphasis upon learning as a goal-directed activity that is connected to the social contexts in which it occurs. Of significance, is that learning is promoted in realistically complex contexts that do not decontextualise knowledge and skills from the circumstances in which they are applied. The apprenticeship models are similarly aligned in that they promote the scaffolding of knowledge, heuristics, and coaching strategies while students actively engage in authentic tasks.

Siemans (2004, p 4) explores an unorthodox alternative to traditional learning theory that he refers to as ‘connectivism’, a concept derived from an analysis of how individuals gain understanding and meaning by recognising or forming connections. From a learning perspective, the concept of connectivism relates to the integration of the key principles that support the theories of chaos, networked systems, and complexity to explain how newly acquired information is assimilated with the learner’s existing cognitive framework. Unlike constructivism, chaos theory states that meaning exists amongst all data and information and therefore, the challenge for the learner is to recognise the patterns that lead to the realisation of new meanings. As each individual engages in learning, he or she is continually exposed to new information. In processing this information, the ability to draw distinctions between important and unimportant information is vital, as is the ability to recognise when new information conflicts with existing understandings that are drawn from past experiences and decisions. By referring to the connectionist model, learning can be described as an internal process that occurs whenever individuals encounter vaguely defined environments comprised of shifting core factors that may not always be under their control. The focus of learning (defined as actionable knowledge) could also be external, such as within an organisation or stored in a database, and directed toward discerning the patterns of connected relationships that exist among what at first appears to be dissimilar collections of information. In this model, the connections that enable learning are viewed as more important than the learner’s existing knowledge.

The effective application of connectivist principles to learning design should begin with the learner. First, personal knowledge is viewed as an integral part of a network that interconnects with external organisations and institutions, which in turn feeds back into the network and thus, continues to provide the individual with new learning experiences. Then, by directing the focus of learning towards recognising the patterns of connections that individuals that have formed over time, a cycle of knowledge development (personal to network to organisation) occurs that enables learners to remain current in their chosen area of interest. The key principles of connectionist theory that are most relevant to the aims of this chapter are summarised to include:

- learning and knowledge rests in the diversity of available opinions
- learning is a process of connecting specialised nodes or information sources

- learning may be assisted by technology
- the capacity to increase knowledge is more critical than what is currently known
- nurturing and maintaining connections are needed to facilitate lifelong learning
- the ability to see connections between fields, ideas, and concepts is viewed as a core skill
- the goal of all connectivist related learning activities is to determine the currency and accuracy of knowledge
- decision-making is in itself a learning process. Choosing what to learn and the meaning of new information is viewed through the lens of a shifting reality. While a given answer may be correct for the moment, it may be incorrect tomorrow due to unforseen changes in the understanding that affected the decision in the first instance.

The Value of Contextualised Learning

Proficiency in applying high order cognitive competencies to the creative construction of knowledge extends well beyond the transmission of prescribed knowledge and related prerequisite skills. This in turn, raises the many latent and complex problems of how to model and structure knowledge and how to predetermine the relationships that connect knowledge structures to selected teaching content while taking into account their contextual relevance and semantic biases. Resolving such complex issues requires an unreserved commitment to: identifying the key properties and relationships that serve to model the structure of targeted knowledge domains to provide effective navigational strategies; devising ‘intelligent’ methods for managing and transferring knowledge skills; and, the strategic deployment of teaching resources through the dynamic generation and contextualisation of the content to be displayed in a given learning environment.

Contextualised learning applies to teaching environments where the learner engages in theoretical learning and competency development relative to divergent contexts through direct participation in real life learning environments, simulations and action learning. As a design model, it enables students to integrate propositional knowledge with experiential knowledge, that is, to link theory to action. This type of learning experience is highly valued by students as it enables them to discover new understandings and meanings through involvement in research, data collection and analysis tasks while observing how each of these processes actually transpired. Thus, students are able to extend their learning competencies from the mastery of theoretical knowledge to include experiential praxis. Without these skills, deep learning and higher order thinking skills cannot develop. In explaining the importance of context, Hannafin (1997, p 7) argues that when attempting to apply established teaching, learning, and technology strategies to the design of situated learning environments:

> Context, in this example, is critical to influencing how information is processed, negotiated, and used, and how understanding evolves. It is assumed that lesson content and heuristics for performance are best embedded in the task itself and represented and determined by the learner, not by an external agent (Brown & Palincsar, 1989). Errors and limitations in understanding form the unique basis for establishing relevance and the need to reconcile prior beliefs with current observations (Papert, 1993); they are encouraged rather than avoided. Consequently, learners are expected to assume additional control over the learning process. It is also assumed that, with the help of teachers, students, or technology to “scaffold” performance, complex tasks are made more manageable without simplifying the task itself (Glaser, 1990; Vygotsky, 1978).

An interesting example of how information can be restructured to form new and unimagined associations is provided by Burbules and Callister (1996, p 8) who explore the merits (and drawbacks) of the application of hypertext within electronic media. They consider the possibility of all nodes of information being viewed as equal at all levels, without a hierarchical structure, where none are more central or more important than other nodes. In this open, more flexible, systems model, new and hitherto unimagined associations may be formed; opening up the potential for creativity and novelty in ways that otherwise would not be possible. Equally possible however, is the potential for chaos, arbitrariness, as well as the counterproductive and time-consuming exposure to permutations and juxtapositions that are without purpose or application. This is because the meaning of data and information will vary from individual to individual due to the innate influences of divergent backgrounds and perspectives further compounded by the unique intentions of every individual. The key to successful design they suggest, is to determine when it is appropriate to free up and decontextualise each node of information and hence provide an effective means of determining useful and novel 'lateral' connections. It is only then thet argue, that the juxtaposition and contradiction of concepts and ideas provide the conditions needed to create new knowledge.

Whereas the traditional 'linear' mode of connecting ideas of facts is limited to a 'manageable' subset, the notion of levelling out and equalising all nodes of information effectively allows for the number of nodes to be boundless. This is because virtually anything can be assumed to be relevant, interesting or important. By drawing on a larger number of sources, the quantum of potentially useful connective data points is enhanced considerably, in turn diversifying redirection towards otherwise unknown yet meaningful associations. Non-sequentially linked data and information provide an educationally viable alternative because they highlight the possibilities that are inherent to the processes of reading and thinking. For example, there is the possibility of constructing a unique, personally meaningful, and useful interpretation of the displayed learning materials, or equally, the potential exists to derive several associations from amongst the given data and information. The benefit is in learning to discern the associations that assist to support meaningful and useful interpretations. Thus, learning environments that allow a degree of unstructured and idiosyncratic exploration can prove to be an indispensable aid to learning (Burbules & Callister, 1996, p 15).

To summarise to this point, data and information are fundamental to enhancing human intelligence in that comprehension can never occur without reference to the context in which they occur (Dreyfus, 1992, p 156). Whereas it may be assumed that context is preset and does not change, in reality, context is related to all that we experience. Herein is the crucial difference between humans and machines that is found in the way meaning is attributed to both sensory and digitised data. Data represented in digital form does not possess semantic meaning until it is externally attributed by humans. Within the human mind, semantics emerge without external attribution. As noted earlier, digitised data is no more than simplified electronic signals. No meaning is attached. Meaning is added to data (whether it is stored in a book, on video tape, or on a computer) only when a human intervenes and transforms it into information. The same applies to sensory data as it too is without meaning until acted upon in some way. Once contextualised and applied in new or even similar ways, sensory data can be viewed as information. It is at this point that a systems approach to designing object based learning environments takes on greater significance. A number of systems thinking strategies for contextualising learning objects will be described in due course. The key point to observe at this stage is that a systems approach to structuring conceptual understanding can also be viewed as ‘contextual thinking’.

Learning Objects and their Ideal Educational Attributes

What are Learning Objects?

In terms of educational application, the concept of learning objects is a relatively recent development that may hold the key to understanding how learning content could be matched to the learning needs of individuals. This technology introduces a ‘building block’ approach where content is broken down into manageable, self contained ‘components’ that can be stored in networked repositories and manipulated using sophisticated database management systems. The main advantages of these new objects of learning (commonly referred to as learning objects) include the removal of unnecessary duplication, the sharing of resources (objects) across units, courses and even institutions, and of direct relevance to this chapter, the capacity to generate webpage content dynamically to assist in the creation of knowledge.

An agreed definition of a learning object is not only difficult to source but appears to be subject to considerable variation. This is because most definitions are based on the idiosyncratic preconceptions of the originating institution or individual. An examination of the available literature suggests that the simplest level, a learning object is a self-contained, discrete piece of instruction or resource material that is designed for viewing on the web. In practice, objects can be as small as a single paragraph containing a few lines of text, or an image, a diagram, an animation, or a movie. Alternatively, a learning object may be as large as an entire lesson. Most developers however, would consider this to be outside accepted practice (Schatz, 2001, p 2). In determining what might be regarded as a suitable size (the question of granularity), and to afford maximum opportunity for reuse (reusability), the accepted rule is to reduce the object’s design parameters down to its smallest, most useful function. Thus, learning objects can be viewed more precisely as independent entities that are assembled to form a larger, more comprehensive, teaching activity.

Where my research has been concerned, learning objects are indeterminately described as autonomous segments of content or resource material that can be applied to an online delivery environment in many different ways and for a diverse range of reasons. In their most basic form (metatagged), I refer to such learning materials as tagged assets. Learning objects can be derived from many types of resources such as concepts theory, study notes, learning exercises, assessment activities, case studies, problem solving exercises, reports, self-test quizzes, and discussion groups. Objects can be made up of Microsoft word, hypertext or Acrobat (pdf) documents, photographs (graphics/animations etc.), audio or multimedia files, and hyperlinks. Learning objects are stored in a content repository (CR) and managed, stored and retrieved using a database driven content management system (CMS) so that they can be shared or reused as required for multiple applications. The task of managing objects is controlled using a manifest document (or instruction file) that is interpreted and acted upon by the CMS.

For educational designers, understanding the concept of learning objects in some ways requires a minimal, yet in other respects, a radical change in thinking. Instead of viewing the teaching process as a linear sequence with a defined beginning, middle and end, learning objects can be viewed as independent, stand-alone segments of data and information. While certain learning objects may be interrelated to form a conceptual group (or sub-group), at the same time they can be applied as discrete, unconnected entities to divergent contexts. In other words, it is possible to combine or recombine learning objects in many different ways to form for example, a topic, a lesson or a module. Alternatively, it is conceivable to nest a single object or a group of objects within an object, topic or module to as many levels as required. A systemic perspective on how learning objects can be organised and applied introduces the potential for interconnecting and contextualising content is without limit.

There is a sense in which the concept of learning objects is not new. Many lecturers and teachers are familiar with the practice of sharing and reapplying instructional resource materials to their teaching programmes. The material may include text extracts, photographs, video segments, or even parts of existing lesson plans. Each teaching resource is combined and recombined with other resources in a process designed to support and enhance student understanding during lesson delivery. These learning resources can be viewed as generic pieces of knowledge (or 'knowledge bits ') that the educator can pass onto others, modify, or reuse in varying levels of granularity – as small as a single picture or a block of text, or as large as an entire teaching programme. However, once digitised, tagged, and saved to a database-managed repository, these same resources can be quickly located and accessed using a computer, be updated or modified without affecting the overall integrity of the structure, or seamlessly connected to other objects to create a more comprehensive and unique learning experience.

An educational designer who has access to a digitised learning object repository is empowered to reuse an existing image, procure a video sequence from another repository, write a series of related assessment objects, and then combine it all to create a learning solution that is contextualised and tailored to the specific learning outcomes of a new teaching programme (Downes, 2000, pp 3 - 4). Thus, learning objects may be used in many different ways, applied to different contexts, and even customised for different audiences. However, the difficulty that arises is that most digitised content is developed for a specific purpose such as a degree course for example, and not with a view to building an object repository. First, the materials to be delivered must be converted to independent, reusable segments or objects. Ideally, this process requires the removal of any reference to context. Then, to have any degree of success in terms of producing quality learning outcomes, educational designers must first recognise the need to develop clear, explicit instructional goals, assemble selected learning objects based on those goals, and devise coherent navigational procedures. From the outset, this means that greater emphasis must be placed on developing sound educational goals, as it is these goals that ultimately guide the selection and co-ordination of the content to be presented to learners. Moreover, detailed navigational strategies are crucial to the success of the intended learning outcomes. Online teaching resources must be designed not only to assist the learner to move to the correct location, but the strategies employed should also assist them to learn and understand the information as it is presented (Schatz, 2001, p 2).

Why Develop Content as Learning Objects?

The concept of learning objects has become a contentious and topical issue in education as researchers seek to understand the issues arising from the use of this technology in teaching (Barrett and Lewis, 2000, p 6). Alongside these challenges, learning objects also provide real opportunities and benefits for content developers and educators. The primary benefit for developers is the capacity to repurpose existing content. With appropriate tagging and information management practices, learning objects can assist to reduce the time spent researching and accessing content and thus facilitate the rapid reuse of teaching content. An unexpected, yet positive outcome of the learning object approach is that an emphasis on prior planning and modularity requires that the purpose and central idea of all content is made explicit before development is initiated (Longmire, 2001, p 4). Another significant benefit of learning objects is the notion of shareability that requires the use of content repositories, which shift the focus of design from locally produced resources to externally stored, digital resources that can be manipulated and adapted to match a range of learning needs. From an educational perspective, an even more interesting prospect is the development of advanced content management systems (CMS) that can locate, assemble, and reorder learning content adapted to individual learning needs. Such adaptations might apply to individual learning styles, choice of learning materials, tailored study plans, continuous assessment accompanied by instantaneous feedback, and varying levels of teacher/student or student/student interaction. In an environment where content is reusable and adaptive, the ideal learning object attributes apply to properties that are (Longmire, 2001, p 2):

- modular, free-standing, and transferable to other applications and environments
- non-sequential
- capable of satisfying a single learning objective
- accessible to broad variations in learner needs and are readily adaptable to other audiences
- not embedded within the content format so that it can be re-purposed within a different visual schema without losing the essential value or meaning of the text, data, or images.

As will be made apparent in the pages to follow, the preceding attributes can be extended to include learning material that is not context specific and therefore, can be used to reveal alternative meanings through the selective application of alternative contexts. Taken as a whole, these attributes afford considerable pedagogical flexibility and ensure adaptability of learning object content to a broad range of educational purposes. For most educators however, the immediate attraction for utilising object technology is to provide a 'value-added' factor that in most cases will produce a return several times over in terms of learning effectiveness, development time, and costs. To summarise, there are compelling arguments for designing and developing reusable learning objects as paraphrased from the work of Longmire (2001, pp 1 - 2) the most relevant of which include:

Argument	Explanation
F**lexibility**	If material is designed for use in multiple contexts, it can be adapted more easily than material that is rewritten each time it is applied to a new context. However, it is often difficult to recontextualise an object written or designed for a specific context.
Ease of updates,	Metadata tags facilitate rapid updating, searching, and management

Argument	Explanation
searches, and content management	of content by filtering and selecting only the relevant content for a given purpose.
Customisation	When individual or organisational needs require customised content, the learning object approach facilitates a just-in-time solution. Modular learning objects permit the delivery and recombination of material at the desired level of functionality and purpose.
Interoperability	The object approach allows organisations to set standards and specifications in relation to the design, development, and presentation of learning objects based on identified institutional needs, while retaining interoperability with other learning delivery systems and applied contexts.
Facilitation of competency-based learning	A perennial challenge in implementing online learning results from a lack of appropriate content that is modular enough to enable genuine adaptation. The tagging of discrete learning objects allows for a flexible and adaptive teaching approach by matching the learning object description (the metadata) with the individual learner's requirements.
Increased value of content	From an economic standpoint, the value of content increases every time it is reused. This is reflected not just in the costs saved by avoiding new design and development time, but also in the potential for on selling content (objects) or sharing them with colleagues or partner institutions for use in other contexts.

Table 1 - Arguments for Designing and Developing Reusable Learning Objects

A Systems Approach to Learning Object Design

In practice, developing teaching content for the online environment goes against good technical or expository writing regarded as standard by many writers and content developers. By design, learning object content may not logically or even naturally, connect with other objects. To compensate, it may be necessary to change the inherent meaning of the content to accord with the surrounding content. Alternatively, if it is assumed the content is fixed and only the connections require adjustment then we move to a connectionist design approach. Where complex conceptual content is concerned, the designer may consider it necessary to reference information in other objects (without violating object modularity), to avoid creating confusion in learners' minds (Longmire, 2001, p 3). Regardless of the chosen technology and design strategies, sound educational design is critical to ensuring learning object content is accompanied by relevant, meaningful context.

It is useful to imagine learning objects as nodes of non-contextual content that can be interconnected to form a networked system of information or learning material. In a similar way, we can equate a typical lesson, topic or teaching module to a networked system of interconnected learning objects. With this model in mind, a number of educational design approaches merit further investigation. An object-based lesson or topic could be sequentially structured around a central narrative or discussion that is displayed and read in a predefined order. Opportunities to branch out to other learning object material at strategic points can be permitted. This network approach to object design can be extended to consider linking to single objects, or to groups of objects that are assembled for example: to provide alternative perspectives or responses to student input; to enable the learner to jump forward or backward to other sections along a central sequence; to provide extended commentary that may be tangential or parallel to the main topic; and finally, to allow learners to input annotations as they proceed through the learning material. We can further imagine that every supplemental object or group of objects is interconnected with other subject areas through a complex system of networked relationships. Thus, it can be argued, establishing connections between learning objects in effect transforms the notion of a discrete topic or module into a complex, interrelated array or system of independent, yet separable nodes. This model supports Burbules' and Callister's (1996, p 8) concept of an 'equal playing field' where all information, whether central to the aims of the lesson or linked to form a multi-dimensional teaching framework, are equal in terms of relevance and value at all levels of the learning environment.

The notion of an equal playing field paves the way for exploring alternative views and consider new design options. To this end, I refer to the key principles of a systems-based model of learning as outlined beforehand. By discarding the tendency to apply a linear or a hierarchical structure, it is feasible to design a networked system interconnected learning objects comprised of concepts, information, and other resources that interconnect with other sub-systems and systems of objects. In this way, selected learning objects can be assigned to provide a single learning activity, or be interconnected with other objects to form additional learning activities. Networked learning objects can incorporate unlimited multidimensional interrelationships and thereby expose the learner to richer and more productive learning experiences than is attainable using other design models. This is because the information provided by each learning object becomes part of a larger whole, to be explored and analysed in a multitude of ways. A single learning object may be combined with other learning objects to create structured learning activities according to need. A degree course for example, may comprise several units each of which may be made up a number of modules. A module may comprise a tutorial lesson, an assignment, and a test for example. If each of these levels of a traditional course structure were redesigned using learning objects, then this same arrangement could also be viewed as nested systems containing objects and sub-systems of objects. In effect, there are several nested systems made up of learning objects housed within other learning object systems, yet at every level, all learning objects remain intact and are therefore independent of each other. Potentially, each learning object may interact with or be interrelated with other objects positioned within its own level, or to objects that are contained within other levels throughout the entire learning environment. In other words, it is possible to combine or recombine learning objects in many different ways to represent the familiar unit, module, or lesson. For example, in a teaching unit that contains a test and an assignment, the unit test may also interact with a grade table held in a database assessment object. Or a unit may contain a learning activity that is also programmed to interact with a video object stored in a separate database repository. In effect, the video resource could be used as a navigational tool to assist the leaner to progress through the displayed learning activity. Alternatively, the same video object (or parts thereof) could be reused in another context to support a separate learning activity. As a second alternative, an incorrect response to a question could be programmed to trigger a supplementary learning object to illustrate a complex concept from another perspective. Provision may also be made for what could be loosely described as ‘intelligent’ response procedures. For example, sub-groups of learning objects could be dynamically assembled to form customised responses based on progress, areas of difficulty, student input, and the need for revision. A number of techniques that could be applied include a capacity to:

- alert the student to the need for revision and present appropriate alternative material
- require the student to repeat a certain sequence or even work with alternative material a set number of times
- force the student to repeat the learning sequence until successful
- dynamically generate quizzes, assignments, or activities that are customised to match the student’s needs and competence levels.

The most optimal design is to create objects that have a high degree of interrelatedness and context independence (context dependent) while providing a sound basis for enhancing the learner’s understanding. However, the degree of complexity versus the learner’s ease of understanding will be dependent upon the extent of interrelatedness and context independence that is built into the design. As the degree of interrelatedness increases, the higher the likelihood the content will be more context dependent (Bellinger, 1997, p 2). Herein lies a number of crucial design issues to consider. A learning object with a high degree of interrelatedness may convey too much information and therefore prove difficult for the learner to comprehend the intended purpose. Conversely, an object that contains an inadequate amount of information with little interrelatedness (context independent) may fail to provide a rewarding learning experience. Consistent with the notion of reusability, the contextual neutrality of reusable learning objects is in itself a barrier to pedagogical flexibility. The higher the level of contextualisation contained within a given learning object, the greater the difficulty in repurposing or reusing that object for other educational purposes.

The level of understanding expected of the learner is contingent upon the relative quantities of data, information and knowledge provided and the interrelationships established by the content designer to support the development of metacognitive thinking skills. The deeper the level of understanding required, the greater the complexity of design and difficulty that will be experienced by the learner. A large concentration of facts for example, may provide little learning value if the amount of information provided is inadequate. Equally, the provision of too much information without the provision of basic facts and opportunity for understanding, may cause unnecessary confusion or even prove to be overwhelming. Ideally, an object-based learning activity should provide the correct blend of interrelated data, information, knowledge considered essential to achieving the expected learning outcomes. The interconnectedness of the various components is such that they should form a highly structured, interrelated set of data, information, and knowledge that match the intended learning outcomes. Consider Figure 2 for example, where the grey area indicates a learning object made up of three nested systems levels (data, information and knowledge) all interrelated to form successively higher levels of understanding. In this example, the learning pathway leads to wisdom. Moreover, it should be noted that properties of emergence exist at each successive level as indicated by:

- data interrelated with other data, information, and knowledge leads to new information
- data and information analysed to discern patterns of information leads to knowledge

- knowledge combined with meta-cognition or holistic understanding leads to wisdom and truth.

If the example provided in Figure 2 is extended to include a learning object made up of smaller (sub) objects, then the above configuration still applies. However, what has been now been included is the complexity of forming relationships between selected sub-objects, and the need to ensure each object interrelates with the broader systems levels that as a whole combine to facilitate the intended learning outcomes. In theory, there are no limits to the number of 'system' levels and hence, the degree of flexibility that can be built into this type of learning environment. The limits, if any, will be due to everyday practical teaching needs and time constraints. Notwithstanding the complexities involved, the educational benefit of a more natural (systems) learning approach is highly appealing given the potential for designing highly complex and dynamically adaptable learning experiences.

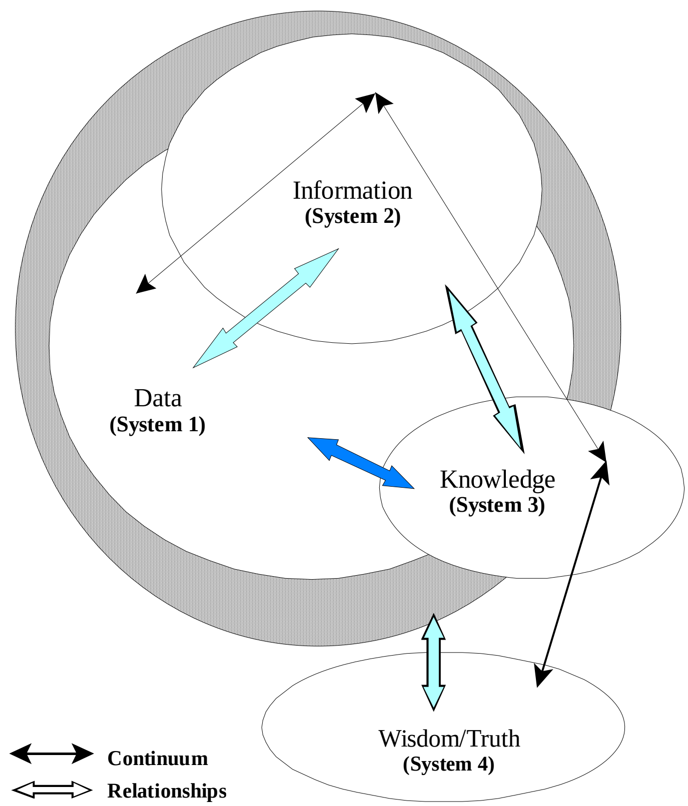


Figure 2: Nested Systems Learning Object Model

Learning object technology may also enable the design of learning structures that permit the learner to explore the given material in a manner best suited to their preferred style of learning. Technology can now readily cope with the demands of high storage capacities at a low cost. In addition, database systems are capable of managing huge quantities of data while delivering rapid response times. Standard personal computers process data bits at the rate of four gigahertz per second. With such processing power, technology is no longer a limitation. It is feasible therefore, to assemble several ‘parallel’ groups of learning objects that are matched to different learning styles and preferences. Furthermore, it is also feasible to monitor student activities as they work through a learning activity. Their choice of responses, navigational preferences, and even mouse movements may be recorded and analysed with the aim of generating a personal ‘learning profile”. A customised profile may also comprise information on the learner’s credentials, learning habits, and grades (Jafari, 2002, p 33). Once established, this profile can be matched against pre-identified learning style criteria. By determining which learning style format (or combination thereof) best approximates the student’s preferred learning approach, it would be possible to dynamically modify navigational procedures by creating new connections and displaying more appropriate learning object content. This ‘intelligent’ monitoring process may also permit ‘on-the-fly’ modification of the content to be displayed by analysing the student’s responses. Monitoring student progress in this way may yield important information about individual differences in learning approaches or how learning in general, could be improved in online settings. To this point, I have described a systems approach to the design of learning object-based online learning environments that may assist to enhance the quality and effectiveness of student learning. At this stage, the second aim as stated at the commencement of this chapter has been met. I will now move onto the primary aim, which is to outline a series of strategies designed to encapsulate contextual meaning and ensure coherent, meaningful connections are made possible in the development of object-based learning environments. Whilst it is not intended to devise a definitive model for enabling meaningful contextualisation, the following exploration of a number of potentially viable models will is referred to as the contextual approach to learning object aggregation.

Contextualising Learning Objects

For learning to be effective, content must be contextual, implied and experiential. Whilst in the traditional sense such aspects are intrinsic to most learning resources, they are rarely authored with modularity in mind. Thus, it often proves difficult to re-purpose (reuse) traditional teaching materials. In the case of context neutral learning objects, these assumptions can no longer be made. If the notion of reusability is to be observed without compromise, then an alternative means of contextualising learning objects to provide meaning is essential. However, in order to gain higher levels of content purity and thus increase the potential level of adaptability, contextual information must first be separated (as much as possible) from the reusable material. One approach to be described later in this chapter, defines several object type classifications that support a contextual object approach, each of which conform to the Sharable Content Object Reference Model (SCORM) metadata schema.

The act of breaking down content to reusable objects introduces the issue of size or granularity. Current assumptions on learning object granularity centre mainly on entire documents and other large bodies of text. One of the aims of the contextual object approach is to refine the creation of learning objects so that the target object size may be as small as a single word or line of text. Other resource types such as Flash files are inherently composite and therefore difficult to reduce without affecting their overall integrity and function. Regardless of size considerations, a contextual approach should focus on refining teaching content to form constituent reusable and contextual objects small enough to afford high levels of granularity and thereby, the flexibility required to meet the needs of learners.

For the most part, size (or granularity) is not an issue as the choice can be made to design a learning object as small as a single sentence, or a graphic image, or as large as a complete document. The guiding rule is that the smaller and more specific the object content, the greater the flexibility it affords. As noted beforehand, learning objects can be used in any number of ways, reused in any context, tailored to suit the visual and informational preferences of divergent audiences, and even customised to match individual needs. Observing these criteria provides for greater flexibility and thereby ensures adaptability to a broad range of educational design models. The drawback of high levels of granularity is a concomitant increase in complexity due to the need to manage a larger number of objects and their associated interrelationships. Conversely, the larger the object, the more difficult it becomes to recontextualise the content. Given the continued emphasis on sound pedagogical practice and quality educational outcomes, the most favoured approach is to develop a method for managing learning objects regardless of the degree of granularity. Whilst cognizant of the complexity involved, my research priorities have been directed toward understanding the inherent advantages of what are referred to as generic, reusable learning resources. By this, I refer to learning material that is not context specific, and can be used to ascribe different meanings when applied to divergent contexts. However, without context, learning objects are confusing, misleading, and even meaningless. After the adaptive selection of appropriate objects to match individual needs, context is the most crucial factor to observe when considering the application of learning objects. Any retention of the original context within the object content will often be inappropriate (and in many cases defeats the adaptive purposes of breaking educational material down into smaller objects). Yet how much context is enough? Perhaps a more apt question is put forward by (Longmire, 2001, p 3):

> How can context be scalable in expanse and type, so that the learner can decide how much is needed?

The key to the effective deployment of learning objects is to provide practical methods to contextualise reusable content. There are many ways to facilitate the contextualisation of learning objects depending on the design strategies applied, the available technologies, and the extent to which the learning content requires adaptation to individual needs and learning outcomes. Once again, a number of useful approaches are provided by Longmire (2001, p 3):

Strategy	Description
Tailored wrappers	Context wrappers consist of information that is associated with a learning object. One object can have multiple wrappers, each providing a different way of contextualising the object. In a learning environment, an instructional designer might generate multiple context wrappers (some using audience-specific data for example). When a learner accesses the learning object, the context of the object can be a function of the correlation between learner attributes and the content object attributes (as described using metadata tags).
Tailored context	Ideal learning object content does not always address the diverse needs

Strategy	Description
frames	of an intended target audience. However, in terms of context, an object can be personalised using such techniques as humour, visual or linguistic themes, or explanations that relate it to a specific body of knowledge. Object-framing and instructional activities can be specific to an organisation or group of people provided they are distinguishable from the object. Context frames can be designed to match learner profile characteristics such as individual interests, needs, level, knowledge, and performance gaps.
Adding context links to objects	If a development environment permits the editing of learning objects (not just metadata wrappers or context frames), then hyperlinked connections can be incorporated into the learning object that point to an external context. This way, developers may spend very little time changing the object and provide links to context that the learner may or may not choose to activate. The linked context can be updated at any time and may be used to provide context for multiple objects.
Pattern templates	Pattern templates incorporate a data structure based on metadata attributes defined by users. For learners (and instructional designers), these templates provide opportunities to contextualise information in a variety of meaningful ways according to variables defined by users. One application of pattern templates is the use of competency models to contextualise learning objects in relation to the abilities, knowledge, and attributes of excellent performers in an organisation (in effect a performance-based approach to using learning objects).

Table 2 - Learning Object Contextualisation Strategies

We must remain mindful of the fact that reducing content to manageable objects inevitably results in some loss of the overall coherence and logic. This concern is especially relevant to learning activities that demand high levels of complex, conceptual understanding. As noted in Table 2, there are a number of approaches and techniques may assist to limit the reduction of contextual meaning in the design of object-based learning environments. In what follows, I will examine how the many elements that comprise object-based online courses and units can be contextualised at the individual component level without any loss of overall meaning while preserving the key interrelations that will enable learners to explore a multi-dimensional, conceptual framework.

A Contextual Object Model

As previously indicated, to be truly reusable, a learning object must be generic or non-contextualised. Therefore, by design, object content should not contain context, and preferably, not include any reference to other contexts by way of hyperlinks. If this rule is adhered to in the strictest sense, a context neutral object will not logically, or naturally, connect with other objects. The problem with this approach is that in some instances, connecting several learning objects will not necessarily result in a coherent, well-structured sequence. Even if some context is included, it is not always the case that existing resources will be consistent with the anticipated learning outcomes (Hill and Hannafin, 2001, p 2). Thus, to ensure situational relevance and meaning is not lost or diminished, we must remain mindful of the need to contextualise learning objects in a way that:

- makes sense to the student, and
- ultimately, fulfils the desired learning outcomes.

For these two reasons, I have devised the concept of a 'pseudo-object' (referred to as a contextual object) as a method for assembling selected learning objects within a logical or conceptually connected framework. The approach that is proposed here is relatively simple. For the academic, current instructional design practice is to prepare the topic or module to be delivered in a common document format (usually Microsoft Word). In partnership with an instructional designer, the document is examined to identify sections of content that may be suitable either for substitution with an existing learning object (downloaded from a content repository), or if not possible, conversion to a learning object. All learning object content is then referenced within the original document using a set of macro scripts designed specifically for this purpose. Any sections that remain (not identified as reusable) will for the most part, be descriptive, explanatory, or instructive in nature and in effect, serve to connect and add meaning to the identified learning objects. In this way, all reusable object content (whether new or existing) are provided new meaning and assume greater significance in relation to the overall logic and the required learning outcomes. Whilst not essential, in terms of ensuring consistency and meaning, it is often preferable to prepare the document before any attempt is made to locate suitable learning objects. It is just as feasible however, to list out all identified learning objects (once selected) and then insert the connecting text into a document. On completion, this document provides the framework for co-ordinating both learning object and contextual object content in readiness for online delivery.

A distinct feature of the design approach described above has been to 'evolve' the original document into an instructional 'map' that defines which objects are to be accessed and how those objects will be connected to form a coherent learning structure. In a sense, the approach described here is consistent with Longmire's 'tailored wrappers' (see Table 2). The next step is to convert the document into a web aware format (either hypertext markup language – html, or extensible markup language – xml). On completion of the conversion process, the web document is then referred to as a master contextual framework. The choice of html or xml code as an output option is dependent upon the available learning management system (LMS) or content management system (CMS). Whilst at first the steps as outlined above may appear somewhat complex and time consuming, a set of software utilities have been developed to automate the essential conversion procedures. For those readers interested in knowing more about the software components developed to demonstrate and implement the contextual approach to learning object technology, the following extract explains in part the key conceptual underpinnings of what is known as the ADONIS project:

Data Definition: Under the classic definition of data versus information, context (or meaning) is the key to converting data into information. For example:

Data		**Context**		**Information**
91234567	+	Bob's phone number.	=	Bob's phone number is 91234567.

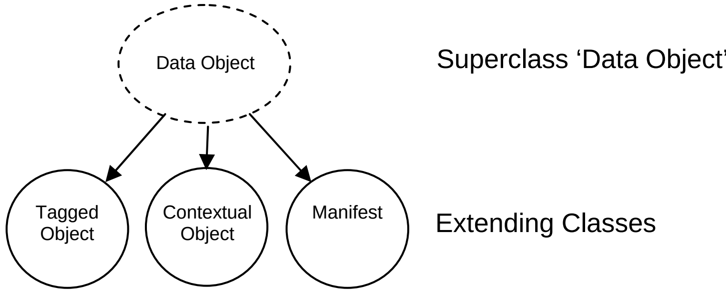
In this definition, data is context neutral.

Tagged Object: A discrete unit of data or teaching resource selected to describe or explain a fact, idea, or concept that is intended for single purpose application. In this definition, data that is tagged using an accepted metatag schema is termed a tagged object. For example, a tagged object could be a collection of facts about an historic event, or a graph that may be accompanied by a written explanation, or a single non-text resource (for example a movie file). By default, tagged objects must be free of any reference to context (context neutral) and may comprise any manner of data types. In actual practice, context neutrality is not always feasible. The aim however, should be to ensure that when created, the tagged object is as context free as possible to enable its reuse in other teaching contexts.

Contextual Object: A segment or collection of data that links tagged objects to give meaning and provide interpretation relevant to the intended context of a specific content aggregation. Contextual objects represent the 'glue' that binds neutral tagged objects together, converting them into information that in turn should conform with the required learning outcomes and support other content aggregations. In effect, contextual objects bridge the sequential transition from one tagged object to another. In general use, contextual objects are unique to a particular content aggregation and therefore are (generally) not reusable in other content aggregations (unless the initial aggregation has been included as a complete component). Once a tagged object has been combined with a contextual object, it is referred to as a learning object.

Manifest File: A document that describes a collection of tagged objects and contextual objects will be selected and assembled by a content management system to form learning objects that for example, may be intended to make up a larger informational unit such as a topic or a lesson. A manifest may comprise a collection of tagged /contextual/learning objects, a collection of other manifest files or a combination of the two. A manifest may describe not only a collection of objects and sub-manifests but also a structure or several structures made up of different combinations of these elements. Manifest files are also re-usable resources.

Superclass Data Object: For the purposes of enabling the management and assembly of tagged objects and contextual objects that ultimately, are required to form learning objects, the term Data Object refers to a super class definition (an object-oriented base class) or resource object made up of tagged objects, contextual objects, learning objects, and manifest files. Data objects are so named because internally (in themselves) they are inherently free of context (neutral). Data objects may be used to add context to other data objects.



Thus, in reference to the data versus information diagram, it is useful to describe the relationships between tagged objects, contextual objects, and learning objects in a similar manner:

Data (tagged object)		**Context (contextual object)**		**Information (learning object)**
91234567	+	Bob’s phone number.	=	Bob’s phone number is 91234567.

The explanation of the tem ‘data object’ may at first, be a source of confusion. Data can be viewed as a data object in that it is used to describe an artefact that is extracted from another source such as a written document. A tagged object is also a type of data object and is the most valuable in terms of re-use. A contextual object is another type of data object, which is less re-usable but necessary to add meaning to a tagged object and therefore viewed as a learning object. A manifest is a plan for tying together tagged objects and contextual objects, and in itself, can be extracted from a document as an artefact. Thus, for each of the preceding object types, the term data object is used to describe a single specialised artefact.

Tagged objects, contextual objects and manifest files have no intrinsic value until they are combined and managed as a whole. As noted, without context data is meaningless. In effect, meaning is provided through the combination of all object types. Hence, the term ‘Data Object’ is applied as the encompassing superclass name for all object types. Within this definition, a data object does not actually contain tagged and contextual objects; it is simply the type of object that they both extend to form a ‘superclass’ object for content management purposes.

Although similar in concept and application, the main technical distinction to be made between learning objects and contextual objects rests with their respective search capabilities. Whereas both types may be stored in the same object repository, a reduced tagset is attached to contextual objects as it is considered unlikely the material it provides will be reapplied to another context. Typical examples of contextual objects include:

- structural content (explanations, observations, summaries, outlines, abstracts, opinions)
- instructions, procedures, overviews
- textbook and reference lists
- aims, objectives, outcomes
- assignment and/or assessment details.

In the approach just described, the focus is on how to contextualise learning object content. The assembly of learning objects is underpinned by the notion of taking discrete segments of content, each meaningless and without context (thus can be likened to data), and positioning them in a context that will assist to produce a desired learning outcome. From the content designer's perspective, the aim is to determine ways of providing an 'environment' in which the learner is assisted to 'derive' meaning and understanding based on the unit/module outcomes by examining ways to 'connect' objects to different contexts and engaging in various learning activities using the available features as required. In this type of learning approach, the learner is afforded the opportunity to impose patterns or organisation on existing content and is encouraged to imagine and create new patterns of organisation. Learners can be cued either directly or indirectly to begin with the broader 'system' unit outcomes and then work their way through the 'sub-system' levels as appropriate. Whilst engaged in the task of solving complex problems, students should be encouraged to seek out and explore new connections and to test the validity of the connections they have made. However, it is important to note that the higher the level of abstraction and conceptualisation required the greater the amount of control that must be given to the learner in choosing the content that best suits their learning needs. Whenever data and information are selected and processed so that they are reordered, reorganised, or re-categorised, new relationships and meanings will emerge as a natural outcome. To the intelligent reader, the original meaning associated with each object no longer applies, as it is understood that meaning changes once it is positioned within a new context. Based on the systems notion that the sum of the parts is greater than the whole, each new context manipulation will expose another aspect of the whole. The underlying assumption (by implication, the aim of learning) is that exposure to different aspects and to varying constructs will reveal new meanings that when combined, lead to more comprehensive understandings and ultimately, knowledge.

As an example of the type of design approaches advocated here, consider a 'snakes and ladders' model where learners can 'jump' to other information sources embedded in multiple contexts and so provide opportunities to view abstract concepts from several perspectives. Alternatively, a multi-pathway or parallel delivery approach could be adopted where learners can traverse one or many pathways at will. Regardless of the how data and information are connected, context should be the deciding design factor. Often, a focus on context as a learning strategy creates the need for multiple pathways to a single node supported through the provision of nonlinear organisations of information (Ayersman, 1996, pp 508 - 9). The content expert might also consider a design approach where the student is permitted to determine their own methods and strategies for achieving an agreed set of learning goals. The outcomes are determined by the student who must demonstrate not only what has been achieved, but also how the goals were actually derived in the process. The learning outcomes could also be determined in collaboration with the lecturer in a way that favours contextualised learning. A learning object / contextual object approach could facilitate the preceding model by providing predefined pathways (with descriptions) to be selected by students, or they could be encouraged to design their own learning pathways.

The strategic use of learning objects in conjunction with contextual objects can empower learners in unprecedented ways by enabling them to participate in the contextualisation of data and information. In this instance, context is not something that is simply provided to the learner. Instead, contextual information has two functions: first to orient context-neutral objects to their intended meanings, and second, to prompt learners to derive their own meanings from the contexts in which the learning content is displayed. Regardless of the available delivery environment, these two factors should always be viewed as essential components of all good educational design practice. In this way, learners come to understand that principles, just like information, gain their meaning from their associated context and application. Thus, where learning objects and context application are concerned, several questions require further exploration. For example: how does the content author ensure the new context is relevant to the learner's understanding and will contribute to the attainment of the required learning outcomes?; what are the rules the learner should apply to enable understanding of the relevance and purpose of the new context?; how can contextual flexibility be used as an effective pedagogical strategy to teach students the rules that will assist them to forge new links between what at first may appear to be divergent segments of data and information? Some of the answers could lie in the tacit rules we all learn through experience. That is, the inductive rules we construct each time we are exposed to something new. In a sense, this type of 'education' could be referred to as 'flexible constructivism'. For now, these questions extend the current line inquiry beyond the aims of this chapter, and as such will be set aside as part of a later study. In terms of the potential to provide a useful educational tool, the advantages of devising a contextual object approach to online design can be summarised to include:

- complete preservation of the author's intended context is essential to ensuring learners will derive the correct meaning and relevance of the displayed learning object content without compromising its integrity and adaptability to other contexts
- by 'recontextualising' reusable learning objects, previously unknown aspects of the whole (subject, topic, concept) are revealed, thereby exposing learners to a more complete understanding
- alternative contexts can be substituted as required to encourage learners to apply multiple strategies according to the explicit presence or absence of context
- by altering the context, new and previously unimagined associations can be identified, opening up the potential for creativity and innovation
- the learning possibilities that are inherent to the processes of reading and thinking can be emphasised and reinforced through the strategic use of contextual and non-contextual content
- learners could be encouraged to explore and create more personally relevant organisations of the available content by providing their own context
- the use of context-neutral objects means that the traditional distinctions between bodies of knowledge can be overcome in that the capacity to impose patterns of organisation on existing information and to facilitate the learner's ability to imagine and create new patterns of organisation is made possible.

Exploring the Issues and Possibilities

I will now describe a conceptual framework that incorporates the concepts and principles described thus far to the design of learning object based delivery environments. To begin, the task of determining how best to apply learning object technology to learning presents an opportunity to draw on our understanding of the theoretical principles and strategies raised throughout this chapter. For example, a 'systems' model for learning object design could be described using interrelated sub-systems of data, information, and knowledge, each requiring deeper levels of understanding and meta-cognition. Regardless of the design approach, the use of learning objects provides unique opportunities to explore models of learning that aim to remove the boundaries that limit many courses and units to little more than stand-alone packages. That is, greater connectivity and resource sharing between courses and units is now a feasible option.

The viability and usefulness of a database driven model for the management and provision of reusable learning objects is incalculable. Learning objects stored in a database managed repository permit multi-levelled relationships to be embedded throughout all elements of the defined learning environment. Thus, the potential exists for a multi-faceted systems approach to the integration and delivery of online teaching and learning based on the dynamic allocation of new relationships amongst existing resources. In other words, if learning content is configured to form multi-dimensional (non-linear), multi-levelled, interrelated webs of data, information and knowledge, it is feasible the many components and elements that comprise online courses and units can be realigned to produce educational outcomes which in effect, are greater than the sum of the individual parts. Whether applied separately or combined in varying degrees, these suggested design models provide for a holistic approach to the delivery of a more comprehensive, interconnected, and interdisciplinary learning environment. Once again, the notion of connectedness introduces the issue of context dependency. As the level of interrelatedness increases, both within the defined boundary of a single learning object and with regard to other learning objects, the greater the probability the object will need to be contextualised in some way. The dilemma here of course, is that in attempting to contextualise a learning object, designers must ensure that learners are not deprived of the opportunity to 'connect' their own understanding with other subject or discipline areas.

In addition to the issue of contextualisation, is the difficulty in determining the optimal object size or as referred to earlier, 'granularity'. Whilst the need for determining a suitable size for a learning object may at first appear to be a return to reductionist principles, it nevertheless is consistent with a systems approach to design. As noted several times, a learning object can be a small as a single word or as large as a document selected for a specific learning activity. However, the more abstract the concept to be absorbed, the more granular the objects that are needed to facilitate dynamic interaction between the learner and the content to be presented. Thus, the level of granularity is dependent upon the aims or outcomes defined to fulfil an identified learning need. With these factors in mind, it is the relationship to the broader 'system' purpose as well as the level of flexibility the learner is permitted that should ultimately determine the size of a learning object. This leads naturally to the question of the type of anticipated learning outcomes. The higher the level of cognitive understanding required, the greater the flexibility needed to accommodate a diverse range of learning needs. Therefore, from a design perspective, the greater the complexity that will be encountered both in terms of design, and for the learner in accomplishing the learning outcomes. Resolving this dilemma means that the level of understanding is contingent upon the relative quantities of data, information and knowledge provided and the interrelationships established to assist in the development of metacognitive understanding.

In designing an online learning environment, it may prove beneficial to directly connect learning objects that support the lesson objectives and/or the concept to be mastered in ways that facilitate navigation, learner control, and hence the learner's progression through the learning process. If such an approach is adopted, a three-dimensional navigational tool or perhaps even a concept map may prove useful as an aid for communicating the sequence and the arrangement of objectives and concepts. For example, objects could be designed to provide connections that are relevant to teaching a single concept. Here, the connections may be confined to the required concept and the learner is therefore not permitted to diverge from the required learning task. Alternatively, objects associated with, but not directly related to the required concept development task could be incorporated into the design. This approach would permit the learner to develop alternative pathways as a way of seeking out and establishing personal associations and understandings. With thoughtful planning, students could also be encouraged to construct new conceptual understandings by identifying strategies for exploring information based on their individual framework of logic and experience. When considered as an aide to deriving understanding, abstract concepts may also be perceived as nodes in an interconnected or networked system. Representing knowledge as an integrated network of concepts and ideas as opposed to a linear, structured sequence of facts or information permits students to discover the relationships and work through the connections in their own way. Learners can be given the opportunity to reconstruct the network (or part of it) so that it aligns more closely with their own cognitive schema. While there may be a need to impose a more sequential or hierarchical structure to comply with predefined teaching criteria, some allowance can be given to providing flexibility in terms of individual learning preferences. Moreover, a networked structure of concepts permits students to conduct critical interrogations in order to form new conceptual understandings as requisite concepts are mastered. It is possible for example, to provide a networked structure of information in which predefined sections are connected within a website and/or interconnected across many separate websites. An interesting prospect is that connected information and related media could prompt students to conceptualise and formulate a non-linear or multidimensional exploration of the presented learning content (Harris, 2000, pp 36 - 7). Of particular relevance here, are the various theories of learning outlined beforehand that are suited to the design of contextually relevant learning systems. It should be noted, that even though the previous example focussed on potential relationships between concept-related learning objects, all learning object types could be associated with any other type. In effect, the number of potential combinations and connections are endless. With a little ingenuity and creativity, it is not difficult to imagine how a systems model permits genuine multi-purpose flexibility in learning design.

Toward a New Perspective on Learning Design

Striking a Balance between Technology and Learning

Even the most abstract questions are rarely asked in a factual vacuity. When required to rationalise how experience is possible or what knowledge is, or how something can be a symbol or have meaning, the natural tendency is to refer to a body of known facts that will serve to anchor what we mean by ‘experience’, ‘symbol’, and knowledge. Many philosophers of mind, knowledge and language have found it useful to seek out more data often for the reason that the issues at the less general (empirical) levels seem more fascinating, manipulable, and ostensibly useful in illuminating the more abstract level (Dennett, 1978, p 162). Nonetheless, sole reliance on a reductionist (linear) approach to learning (and research) is no longer adequate for deriving complete knowledge and understanding. In light of the discussions thus far, I argue that technology has created a level of complexity that extends well beyond the explanatory scope of the reductionist approach. I further submit that to understand, interpret, synthesise, and derive new knowledge requires a holistic, systems approach to managing the vast, complex quantities of information that will be generated over the coming decades. In dealing with these issues, we are forced to confront one crucial question, that is, how can such complexities be managed.

The design of online environments using learning object technology provides much more than just a new way of organising content and the information it contains, it also holds the potential to influence the meaning of the information provided. As new data and information are presented to the learner, the relationships that had been formed in their minds can be realigned, revealing new insights and unknown aspects that previously were not apparent. It is in this sense, that context and content are interdependent. This of course raises deeper questions about knowledge for as noted, the act of knowing depends upon the meaningful organisation of data and information. Thus, new methods of organisation imply existing forms of knowledge must change in the process. Furthermore, to the extent that learning objects incorporate the capacity to impose patterns of organisation on existing information and to facilitate the learner's ability to imagine new patterns of organisation through the formation of meaningful relationships, it is further argued that the distinctions between accessing and creating new knowledge are becoming unclear.

By manipulating context, it is not difficult to imagine learning activities where the right technology could assist students to be critical users of information. Learning objects could also be used to teach students multiple strategies for problem solving and information retrieval. Alternatively, learning objects may be programmed to assemble dynamically in ways that assist lecturers and students alike to focus on the critical processes of interpreting and organising information as opposed to the traditional tasks of acquiring and memorising facts. Lecturers therefore, can encourage learners to explore the interconnections between theory, content, and context. As made clear, whenever information is processed in some way, and reordered, reorganised, or re-categorised, new relationships and new meanings are formed. Regardless of the learning activity, there will always remain a crucial role for the lecturer or tutor to provide continual guidance and support.

An understanding of how information is organised or structured can be derived by determining existing associations and/or interrelationships between collections and patterns of information (using principles of systems theory as applied to systems, sub-systems, and networked interrelationships). The application of systems principles to learning design provides the means to determine and define conceptual relationships, which in turn has the effect of fostering deeper insights into the information that is presented to the learner. These principles therefore, represent a plausible theoretical foundation upon which a new, technologically driven model of learning may be established. Each principle holds the key to devising a range of strategies for recontextualising learning objects that may assist learners to develop a broader, more holistic perspective as they work on their given course content. Whether applied separately or integrated as appropriate, all principles present new opportunities to design online teaching environments that connect with other subject areas and even disciplines in ways learners may otherwise not have considered. The benefit of course, is to provide the student increased exposure to new knowledge relationships and in so doing, gradually expand their conceptual schema into wider, more diverse cognitive perspectives. Thus, the significance of learning object technology is further underscored by the fact that it affords considerable flexibility in the design of electronic learning environments.

Given the potential for enabling a more holistic, systems design approach, the educational implications for networked learning objects are profound. Beyond allowing students to proceed through an electronic document by taking prescribed routes in a linear, well regulated pace (the once-heralded attributes of computer-aided instruction), instead students can focus their investigations on the questions that are informed by their own unique interests and experiences. They are able to organise and progress through the learning materials in ways that make sense to them while developing and comprehending their own heuristics. As new understandings emerge, they discuss their findings with their lecturer/tutor and/or their fellow peers. This flexible 'connectivist' approach to inquiry and discussion has many advantages, not the least of which is a capacity to accommodate diverse personal or cultural learning styles. Notwithstanding the merits of this approach, it is imperative to consider the learner's capacity to undertake independent learning. That is, in order to manage high levels of autonomy and faculty, learners must be experienced in identifying the relationships that connect the available data and information and to apply the insights gained to the construction of models and strategies that will assist them to become adept, independent learners.

Technology, Learning and Reality

It is worth considering that the act of processing information to create new knowledge may not only explain the nature of what we perceive as reality, but could also yield the key to manipulating 'reality' by altering the context of discrete information components. By this, I refer to the strategy of 'contextualisation'. To illustrate my point, the following extract from Duncan (2001, p 8) presents a model of reality that challenges our accepted view of the world:

> ... for any individual in the universe, reality is represented by those elements of information which have a probability of trueness that exceeds the threshold of conscious/awareness for them. To some degree it can be argued that reality also includes those elements of information that have reached the centre portion of this model, having crossed the threshold of existence in the subconscious mind, but having not reached the threshold of conscious awareness.

As we move from the world of 'physical reality' to the realm of 'subjective reality' where the individual's perception of events is defined in terms of relationships, it is important to question our assumptions about the relationships between technology, learning and reality. When we take into account the potential for technology to alter our perspectives on teaching and learning, combine it with the constructivist position as applied to the individual's interpretation of reality, and then add the value of current learning theory in providing a useful framework for deriving an accurate representation of knowledge, it is apparent there are many complex factors to consider. For example, if data and information are indeed the fundamental 'element' for deriving new knowledge, then what we presently understand as 'an information system' and 'information technology' will change as we come to grips with the essential nature of information and how it can be applied to learning. Consider for a moment, Russell's (1997, p 7) notion of an Internet that is evolving into a 'planetary nervous system' in which he speculates a 'global brain' is emerging out of the expanding network of computers connected to the World Wide Web. As he explains, the web is becoming a vast, globally networked repository for all human knowledge where data and information is no longer stored in libraries and inside human minds but is also distributed amongst tens of millions of host computers located across the world. A link displayed on any of the billions of pages made available on the web enables instant access to any number of interrelated pages. In the same way that human recall can take the form of a thought, a visual image, a sound, or a memory, a link on the web may call up text, images, sounds, video, virtual reality, or any combination of media. Not only does the web afford an unprecedented capacity to deliver information on demand to a worldwide population, one day it will facilitate the movement of elements of information between the 'real' and the 'not real'. Thus, in an informationdominated age, an issue many learners will need to come to terms with will be the accuracy or the 'reality' of information. Projecting further into the future, it is also conceivable the software engines that drive the web will eventually be given the capacity to form new associations, synthesise information to create new knowledge, and solve problems on demand. In effect, the web will evolve into a 'living' system that can learn and think for itself, a notion consistent with Sheldrake's (1988, p 36) claim that a fundamental feature of the evolutionary process is that new organised systems come into being, along with patterns of organisation that never existed beforehand. If, and when this scenario occurs, such a system will display properties similar to human consciousness. Moreover, as the level of complexity and sophistication in global communications increases, the associative links to all human knowledge will in essence, resemble a planetary nervous system. At that point, we will no longer perceive ourselves as isolated individuals, but instead we will become an integral component of a complex, fully integrated global network system. Russell's view of a globally connected web of computers that learns and solves problems, brings to mind the 'connectionist' viewpoint described earlier; a position that is further strengthened by the notion of emergent properties. The overall effect is that the systemic properties of the Internet at any level are greater than the aggregation of the distinct properties evident within each sub-part. Taken as a whole, the preceding concepts hold useful insights for determining how our current understandings of teaching and learning may encompass the unrealised potential of 'organic' information systems such as the Internet.

Finally, the risk in attempting to describe any one aspect of a systems-based theory of learning without reference to the contextual flexibility and adaptability it affords is to limit its potential to a one-dimensional model. By opting for a design approach without first considering all possible alternatives may restrict the focus of design to one theory, one strategy, or one method, and ultimately limits the quality of the intended learning outcomes. In itself, the risk indicated here provides a clue as to the various strengths of applying object technology to learning design. The first is that due to their inherent dynamic properties and the emphasis placed in this chapter on forming new connections at any given reference point, it should not be assumed that any model of learning which incorporates systemic principles will remain static, but instead, it will dynamically respond to the evolving needs and purposes of not just the teacher and the learner, but also to unforseen possibilities. In other words, the dynamic attributes of learning objects are such that the structure of the teaching content may be configured to change in direct response to the circumstances that exist at any given moment. This leads to a second, equally important strength, which is the capacity to permit different types of learning to take place in many ways, at any point during the learning process. That is, learning objects provide for dynamic modification and adjustment of how learning occurs without preference for any one theoretical construct or pedagogical model. By monitoring student progress for example, it is feasible to deliver any type of learning environment ranging from a highly structured sequence of learning tasks based on the behaviourist model, through to an unstructured, unrestricted, highly individualised constructivist environment. There are no absolute rules, only needs and the possibilities that can be imagined to fulfil these needs. All possibilities interact without favour, and with only one goal in mind – to facilitate learning in a way that best matches individual learner's preferences, values, and needs. The focus of learning is to constantly monitor and accommodate the student's changing learning requirements. Thirdly, the learning environment should allow for self-organisation, properties of emergence, and networked systems of knowledge, all of which interconnect with the two strengths mentioned above to provide a much broader, highly interrelated learning experience.

Then, as it is also chaotic in nature (not ordered), it is possible to reshape knowledge in a multitude of ways to accommodate all individual cognitive schemas and so, encourage wider learner engagement in a given learning activity. What should now be apparent is that an open systems model has been applied to the design structure. There are levels within levels, all interconnected through a network of relationships. Yet the structure is flexible enough to accommodate linear, hierarchical or even heterarchical sequences as well as multi-dimensional continua at all system levels. Thus, the contextual permutations are endless, each providing an opportunity to teach new aspects of an infinite array of knowledge.

Final Thoughts

It is not difficult to be absorbed by the wealth of technical 'treats' technology has to offer and as a result, assume the learning process is somehow supported by the chosen technology. In turn, such an assumption may lead to a failure to prioritise how technology should be applied within the context of education. Compounding these problems further, is the lack of emphasis placed on determining how people learn with computers and with each other. For learning to be successful, it is important that online designers construct an adaptive learning environment, which provides the flexibility needed to support the individual needs of students. To achieve this type of learning requires an environment where a detailed understanding of the teaching and learning process rests not just on the quality of the curriculum materials, but also on strategies designed to encourage learners to think independently of the teacher. Students can also be prompted to learn how to understand their own cognitive processes and optimise the rate at which they are best able to learn through social interaction. Examples of how the explicit teaching of thinking skills and social skills benefit learning can be found in many computer-based teaching environments and the research literature that describes such activities. Then there is the issue of whether the use of technology actually supports independent learning that is also the subject of much debate. What is known however, is that an individual who is aware of their own thinking processes is experiencing metacognition as characterised by an ability to analyse and define the problem at hand; reflect upon what is required to derive a solution to the problem; devise a plan to deal with the problem; and regularly monitor their own progress.

The relevance and importance of using computers to develop thinking skills in students are two-fold. Firstly, a more creative learning environment can be established where the lecturer adopts the role as a facilitator of information and knowledge construction. Secondly, students are provided an opportunity to attain self-sufficiency and mastery over their own learning and thinking processes and thereby develop the skills considered essential for success in an information age. In order to impart such skills, schools and especially lecturers must acknowledge the need to examine the relationship that exists between data, information and knowledge, how meaning is derived, the role of context in determining meaning, and most importantly, to understand how best to facilitate the intricate process of generating new knowledge. To neglect, or even remain unwilling to accommodate such insights may well result in serious disadvantages for students preparing to graduate in a future that for the most part, will be driven by technological innovation. The current capabilities of digital technologies for retrieving, producing, storing and disseminating data and information, are a given. The digital capabilities in the future are such that the effects on the way content is organised, manipulated, and displayed onscreen will be profound.

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