Stephen R Quinton

Centre for Technology Enhanced Cognition

ctec.think@gamil.com

Book chapter published in:

User Interface Design for Virtual Environments: Challenges and Advances
Badrul H. Khan (Ed.), McWeadon Education

Title:

Redefining the Role and Purpose of Learning

Redefining the Role and Purpose of Learning

Abstract

In an era marked by rapid change and increasing reliance on digital technologies, there is much evidence to suggest that the learning preferences and goals of today's students have become distinctly different to those of the past. Taken as a whole, it is conceivable that education as we have known it over the past two hundred years is poised on the verge of entering into a new realm of possibilities that will revolutionise accepted views on the role and purpose of learning. If such claims are correct, a highly adaptive, systemic theory of learning may assist to explain the complexities and implications of the present (emergent) and future (unknown) challenges facing educationalists and learners in the coming decade.

This chapter presents a philosophical treatise on how I envision the design of electronic learning environments in the future. The uniqueness of the theory of learning foundation to emerge from this exploration lies in its capacity to dynamically adapt and evolve in response to the changing expectations of the teacher and the changing learning needs of the student. It promotes the concept of a continuum of possibilities and opens the way to move beyond the application of a static approach to learning design that is limited in its capacity to satisfy the needs of all, to the adoption of a dynamic, highly adaptable approach that begins to address the specific learning goals of every individual. Thus, educationalists are encouraged to explore what might be possible and not be constrained by current assumptions on contemporary electronic learning environment design.

Background – the Current State of Play

As a general précis, the higher education system has been very successful in transferring skills and competencies for gaining formal qualifications, yet has failed to encourage the higher order analysis, problem solving, and metacognitive thinking skills required to exercise competence in creative and innovation knowledge construction in the twenty-first century. As currently practised, education in general not only has a tendency (often inadvertent) to stifle creativity and innovation, it is also inherently counterproductive to creative thinking.

Unmotivated teachers, irrelevant curriculum, substandard learning environments and uncomfortable conditions all contribute to unsatisfactory learning outcomes. Despite such limitations, many readers would recall that special teacher who was able to connect with our individual learning needs and motivations in a way that was inexplicable yet perceptively transformed the learning experience from a tedious, unrewarding chore to something that was intrinsically fulfilling and life changing. Thus it can be acknowledged that with the 'right' teacher, in the 'right' learning environment, using the 'right' resources, individual learners can be encouraged, motivated, and inspired to be highly creative and innovative.

It is the 'right' combination of components that this chapter will attempt to identify and explore as a theoretical basis for constructing dynamically interactive 'intelligent' electronic learning environments that respond to students' learning needs as and when required. Only then (I believe) will it be possible to inculcate the complex cognitive analysis strategies that enable learners to apply a creative mindset to solving the problems of tomorrow. Whilst it may be countered that creativity can never be taught, at the very least 'creative thinkers' can be better equipped with the cognitive tools required to derive elegant solutions to complex problems.

A more inclusive approach to articulating what 'learning' means is crucial to ensuring successful participation in a world that focuses more and more on the creative production of knowledge. Today's young people exercise their imaginations in ways 'undreamt' of a few years ago. They want (and demand) continuous education and ready access to 'always-on' knowledge. Only sophisticated design models that guide the development of innovative educational delivery practices to provide individualised learning experiences can meet these expectations.

The task of bridging the transition from 'traditional' learning practices to individualised human or electronically facilitated learning is fraught with difficulties as success in meeting learners' needs in a rapidly changing future requires radically different teaching methods, design approaches, and cognition skills. Any attempt to accommodate the skills and preferences of the current generation computer 'literate' student for example, must inevitably compel educational designers to think entirely 'outside the box' and consider real time interaction strategies that are in line with students' expectations and demands.

Such strategies include the provision of 'intelligent' cognition support tools capable of meaningfully interpreting natural language input; the dynamic assembly of customised content to deliver interactive assessment and constructive feedback tailored to students' immediate learning needs; and the capacity for learners to annotate and record ideas that generate user defined (manual) and automatic (dynamic) alternate information and teaching content relative to the current context. In effect, the nature of the learning environment must undergo a dramatic transformation, in particular with regard to the application of distributed information and communications systems, the cultivation of sophisticated metacognitive thinking strategies, and the efficient provision of universal access to high quality learning resources irrespective of device, location and time. In essence, I simply argue there is a need to articulate a new perspective on education as a means of exploring and identifying new strategies for constructing knowledge and solving problems.

Introduction - Challenges and Opportunities

A major challenge facing educationalists today is to devise advanced learning design methodologies that employ emerging technologies to support the refinement of the essential knowledge creation skills of analysis, problem-solving and metacognition (that encompasses the capacity to apply tacit, experiential knowledge). Proficiency in the application of higher order cognitive competencies to the creative construction of knowledge extends well beyond the transmission of prescribed knowledge and facilitating practice in problem-solving activities.

The task of addressing higher-order learning skills not only extends to the many latent and complex tasks of determining how to model and structure knowledge, but also to identify the relationships that connect defined knowledge structures to selected teaching content while retaining contextual relevance and innate meaning. Resolving the inherent complexities of such obscure abstractions requires an unreserved commitment to: identifying the key properties and relationships that structure knowledge and thereby provide direction on constructing tailored learning strategies and navigational pathways; devising 'intelligent' design approaches to managing and transferring knowledge construction skills; and, enabling the efficient exploitation of digitised teaching resources using dynamic selection and contextualisation strategies.

Given the tenor of the preceding claims, learning solutions in the immediate future should strive to demonstrate a clear pedagogical and technological capacity to interweave all known aspects of the learning process within a highly adaptive (flexible) environment where the focus is on facilitating the needs and preferences of all individuals. In addition to improving learning quality and effectiveness, all learning environments regardless of the applied delivery mode, should support the divergent needs of current and past generations, from pre-school through to senior citizens. Equally critical, is research to determine the needs, preferences and propensities of disaffected ethnic groups, disabled people, and the mature aged.

The needs requiring most attention apply to the distinctive attributes of technology use and related skills; personal influences and aspirations; values, perceptions and attitudes; and, current and future concerns. Moreover, emphasis must be directed toward identifying and allowing for variations in learner behaviours, inter-personal communication aptitudes, preferred learning strategies, and intelligence types relative to all generations, interests, and modes of learning. In essence, the individualisation of learning requires an evolving programme of design, experimentation, and development augmented by qualitatively and quantitatively distinctive modes of interactive learning resources and just-in-time support.

Ultimately, such learning solutions should facilitate the personal development of all individuals through the provision of dynamically managed and/or self-directed environments that are characterised by flexible, ubiquitous, and individually adaptable delivery modes accessible at any time and from any place. By adding a systemic approach to designing a flexible, individual learning solution, the focus of research is redirected towards the creation of new approaches to delivering learning while recognising the emergent need for learners to develop advanced knowledge construction skills that demand entirely new perspectives on the role and purpose of learning.

Instead of requiring learners to follow the same course en masse in the same manner, today's technologies have the capacity to facilitate just-in-time collaboration whilst permitting the pursuit of their own individual approaches to learning. Technology can also assist lecturers to collaborate to develop and share resources and teaching strategies; and instead of competing for student numbers, technology can permit institutions to cooperate (internally and externally) to better serve the needs of students. Rather than separate the values and goals of education from the learning aspirations of the individual, the opportunity now exists to hand control back to learners so that they are empowered to learn, understand, and grow in response to their unique preferences, interests, and circumstances.

The problem however, is that in general the present education system is designed for the transmission of prescribed content, thereby making it difficult for many schools and universities to tailor learner-centred approaches such as individualised learning, small group learning, problem-based learning, or many other non-traditional pedagogical approaches. At a time when process skills are increasingly favoured over factual knowledge, skills involving teamwork, problem solving, evaluation, interpretation, application, and interaction have become more difficult to cultivate (Liber, 2004, p 135). Aside from the issue of learning process skills versus factual knowledge, there is also the perennial issue of personal experience versus conceptual understanding as observed as far back as Schopenhauer's time (Magee, 1997, p 6):

> The chief drawback of formal education is that it reverses the proper order of experiences and concepts. Concepts have content and significance in so far as they derive from experience and can be cashed back into it. And the trouble with formal education is that it pre-empts experience in this regard by giving us our first knowledge of many of the most important aspects of life not through experience, from which we then abstract and generalise, but through concepts based on other people's abstractions and generalisations to which nothing in our own experience corresponds or can be opposed. So for all of us, reality is bound to be to some extent impeded by the observations and perceptions and of others; and so, therefore, is truly original thinking and insight.

People of all ages now prefer to define their own learning agendas and engage more actively in the learning process. No longer should governments, politicians, and institutions set the agenda: individuals and groups want some say in what and how they learn. The current change in expectations is challenging not just particular beliefs, but also entire belief systems (Mendizza, 2004, p 3). In essence, greater flexibility in accessing learning solutions and how well such solutions meet their needs has become important factors in the minds of learners. A more significant issue is the need for cultural change in the delivery of teaching and learning. The use of digital technologies to support the learning process has the potential to radically change learning solution design through the introduction of highly interactive, intelligent models of learning.

This chapter does not aim to construct a new theory of learning for the twenty-first century. A task of that magnitude extends well beyond the bounds of a single chapter. Instead, it is argued that the key to achieving real change is to rethink the relationship between learning and information, and once defined, establish the groundwork for advancing such a theory by arguing the need to reconceptualise the design strategies that must be applied to the organisation of instructional information and teaching content. This approach will assist to enhance the learning process and promote the creative construction of knowledge. Alongside this approach there is the potential for the foundation of a new theory of learning to emerge as new insights are identified and explored. The question for now is "what is the role of information in facilitating the learning process?"

Relationships Define Meaning, Understanding and Knowledge

Providing access to information without the benefit of equipping students with the cognitive skills to convert information into knowledge will prove detrimental to their future learning abilities. Today's learners require skills to reflect on new materials, discuss their tentative understandings with others, actively search for additional information in ways that further illuminate or strengthen their understanding and ultimately assist to build conceptual connections to their existing knowledge framework (Brown & Thompson, 1997, p 75). There are other, equally important issues to consider. If graduates are to be proficient in creating new knowledge, then a clear understanding of the relationship between data, information and knowledge is critical. The importance of such understanding is made clear by Megarry (1989, p 50):

> 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.

An examination of how these relationships are derived reveals a useful framework for describing the process of converting data into information and then information into knowledge (or knowledge construction). This framework is comprised of three distinct stages of a knowledge construction continuum:

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

At the level of what we perceive to be reality, data is the given – derived primarily through sensory input. A unit of data represents a fact or statement of an event that is without relationship to other things. It is symbolic as in for example, the statement "it is raining". Information relates to a description, definition, or perspective on data (through recognising / identifying patterns and meanings) that in some way has been cognitively processed to be useful. It provides answers to the 'what', 'who', 'when', and 'where' questions and embodies an understanding of relationship such as cause and effect. Building on the previous example, we can say "the temperature dropped fifteen degrees and then it started raining". At the next level of "making sense" of data (or interpretation), information becomes the equivalent of data, but nevertheless is relative to knowledge, which in turn results only from 'higher levels' of conscious adaptation.

Knowledge requires the application of strategy, experience, and method to discern the pattern of relationships that connect information. To derive knowledge requires the application of data and information to determine the answers to the 'how' questions. Once discerned, the cognitive patterns provide a high level of predictability in relation to what has been described and what will happen next. Consider for example the statement "if the humidity is very high and the temperature drops substantially, then the atmosphere is unable to hold the moisture, thus resulting in rain". From this statement we can see that understanding is a cognitive and analytical process through which previously held knowledge is integrated with new information and then synthesised into new knowledge. In other words, it provides an appreciation of the 'why' factor as derived from the available data, information, knowledge, or prior understandings.

Given there are important distinctions to be made between the concepts of data, information and knowledge, the next step is to determine how to manage information (information literacy), and most critically, how information literacy skills can be applied to the conversion of information into knowledge. However, competence in information literacy does not necessarily lead to the ability to understand what information is and how to apply that understanding in productive and creative ways. If for example, we equip people with the skills to discriminate quality information from inaccurate information, then it is clear that a deeper understanding of information types and their distinctive characteristics is essential. We must also accept that a knowledge-based economy will prescribe an information competency at many levels of abstraction and complexity.

As will become clearer, technology has created a level of complexity that extends well beyond the explanatory scope of the reductionist approach to deriving knowledge. In order to understand, interpret, synthesise, and derive new knowledge, a holistic, systems approach to learning design is required to manage the vast quantities of information that will be generated over the next decade. This added complication poses a dilemma in that it compels us to acknowledge one crucial question: how can we even begin to manage such complexity without losing the capacity to construct new knowledge?

The Interconnectedness of Data and Information

Whenever unfamiliar data is encountered, we attempt to attribute meaning in some way by mentally forming associations with other data or information. Take the number '5' for instance. We immediately associate it with other cardinal numbers and determine its relationship is greater than '4' and less than the number '6'. Alternatively, we could consider the word 'time'. Again, the tendency will be to form associations with previously known contexts wherein the word 'time' was found to be meaningful. This act of association might take the form of 'a period of time', 'the time of year', 'take time to smell the roses', or 'we tried several times'. What is implied here is that without context, little or no meaning exists. To compensate for the absence of context, we associate the word or object with a known context, which may or may not be valid. The point is that once data is given relationship, meaning is attributed and therefore, becomes information.

An explanation of the distinction between data and information in relation to learning and understanding is offered by Capra (1996, p 265). Whenever a fact is regularly encountered in a comparable context, we abstract that fact from the original context and in the process associate the derived meaning with the author's intended meaning. We are so conditioned to this process that the original meaning is somehow assumed to be encapsulated in the fact itself, whilst neglecting to note that the original meaning is embedded in the context from which the information was originally extracted. The mistake often made is to refer to the derived meaning as information, when by definition a fact (the intended meaning) has become data (the replaced meaning). Thus, there are occasions where our attempts to create context amounts to little more than conjecture.

The extent to which a collection of data can be defined as information is dependent on the associations that can be discerned within the given set (Bellinger, 1997, p 2). This assertion implies that a collection of data for which there is no apparent relationship across the various elements of data is not information. That is to say, information is an understanding of the relationships between data elements, or between elements of 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, we can state that information is in fact data that has been given meaning by way of recognised relational connections. In other words, information is context dependent. However, we must bear in mind that not all relationships assist to construct useful meaning. The 'meaning' may be of some use, but at the same time is dependent on the individual's prior knowledge.

Whereas information requires an understanding of the relationships that connect data, it generally does not provide a foundation for understanding why the data is what it is, nor an indication as to how that data may change over time. Although information may be relatively static over time, the data it draws meaning from is constantly being refined and updated. Thus, because information is dependent on the relationships between data and requires context to give it meaning, information generally holds little implication for the future. Even though as noted, information represents an abstraction of ideas, information itself does not create ideas. Ideas are integrating patterns that are derived through experience, not from information. This is because the human mind operates with ideas or concepts. Information is derived through ideas, not vice versa (Capra, 1996, p 70).

When considered in isolation, concepts can be perceived as conceptual nodes in an interconnected (networked) system of information and media. Representing knowledge as an integrated network of concepts and ideas as opposed to a linear, structured sequence of data and information permits students to discover previously unknown relationships and work through the connections in their own way. Students are enabled to reconstruct the network (or part of it) so that it more closely aligns with their prior cognitive experiences. Although on occasion there may be a need to impose a sequential or hierarchical structure to comply with predefined teaching objectives, some allowance can be given to providing flexibility in terms of individual learning strategies. Moreover, a networked structure of concepts permits students to conduct critical interrogations in order to form new conceptual understandings as prerequisite concepts are mastered. It is possible for example, to provide a networked structure of information in which sections within a document are connected and also interconnected across many separate documents that prompt students to conceptualise and formulate non-linear or multidimensional explorations of the presented teaching content (Harris, 2000, pp 36 - 7).

The implications of the preceding design approach extend well beyond requiring students to proceed through a body of information by observing prescribed pathways in a linear, regulated pace (the once-heralded attributes of computer-aided instruction). Instead, learners focus their investigations on questions informed by their own unique interests and experiences. They are able to proceed through and organise materials so that it makes personal sense, thereby enabling opportunities to test and comprehend their own heuristics. As new understandings emerge, they can discuss their findings with their tutor and their fellow peers. This flexible 'connectivist' approach to discourse and inquiry has many advantages, not the least of which is the capacity to accommodate diverse personal or cultural learning styles. However, in order to manage this level of autonomy and faculty, learners must be experienced in the explicit use of tutorials, guides, indexes, and reading materials that are designed to provide both a basic grasp of what the textual source contains along with the models or heuristics that can be learned and adapted whilst being actively encouraged to develop as independent thinkers.

Beyond conceptual relationships there are patterns, where pattern is more than just a relation of relationships (Bateson, 1988, pp 9 - 11 and p 29). Pattern embodies a consistency and completeness of relations, which to an extent creates its own unique context. When patterned relationships are discerned amidst a collection of data and information, the potential for deriving meaning is increased. New knowledge is constructed when recognised meanings are cognitively analysed (processed) to interpret the implications inherent within each perceived connection (Bellinger, 1997, p 2). Therefore, the act of deriving meaning 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 (communication) skills to identify and restructure patterns of relationships. 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 simplistic terms that results in learning.

The relationship between understanding and knowledge can be compared to the difference between ‘learning’ and ‘memorising’. The learning that assists in the creation of knowledge involves several important processes (Rucker, 1988, p 26). The first applies to the input of information through each of our senses, which 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. By sending and receiving information, as well as actively processing previously unknown information to construct and store new knowledge, learning is transferred from one individual to another (or to a group of individuals). Complete understanding encompasses the need to comprehend varied perspectives coupled with an ability to explain and a capacity to reason using one’s individual knowledge construct. Thus, understanding involves a transformation of meaning based upon associations with personal experience and prior knowledge. It is at this point that the influences of technology on information organisation and knowledge construction require further exploration.

The Inherent Intelligence of Information Networks

The design of most electronic information management and learning delivery systems is motivated by the perceived need to organise information and media in order to facilitate efficient access to learning materials. Their underlying instruction sets and protocols tend to impose explicit organisation on information using preconfigured criteria (although some solutions now permit the capacity to specify alternate organisations). Many electronic learning systems permit explicit (hyper) links to resources predetermined according to external judgements of relevance or importance, effectively pre-structuring and connecting the teaching resources prior to delivery (Rieh, 2002).

In theory, such delivery systems support learning either by overtly directing or cueing users to the next segment of information or to related information. While this method is useful for certain applications, it can also generate confusion and give rise to uninformative results. This is because learning resources designed for one purpose that are (inappropriately) applied to other purposes may contradict or be inconsistent with their original intent and hence, unsuited to learners’ needs (Hammer, 2000; Leacock & Nesbit, 2007). Therefore as emphasised earlier, it is important to be aware that application and meaning varies according to context and hence produces variant learning outcomes. Such design may be relevant for example, in instances where the learner is encouraged to apply preferred learning strategies and so construct their own knowledge based on individual goals and interests (Hannafin, 1997, pp 255 - 8).

The benefit of associating apparently incongruous ideas or facts is in learning to discern the connections that support meaningful and useful interpretations, which in turn give rise to novel and insightful understandings. Thus, hyperlinked information and media afford opportunities to exercise effective learning strategies as it assists to highlight ideas and possibilities visually in ways that are not inherent in reading and reflection on print-based materials. Hyperlinks designed with a degree of built-in structure may serve as effective bridges or scaffolds to bring learners to a point where they can create more personal and distinctive organisations of the available materials. Alternatively, hyperlinked learning materials that facilitate varying degrees of unstructured and idiosyncratic exploration provide an indispensable learning strategy for students who are comfortable with independent learning activities. There are however, hidden problems to contend with.

In constantly dealing with large, uncoordinated compilations of electronic information and media, we are habituated over time to believe our knowledge systems are valid (Green, 2005). Consequently, the need to think more critically is ignored. For example, whenever we encounter a familiar sight such as another individual, we often perceive them as male or female without considering other possibilities. Alternatively, when confronted with the unexpected or anomalous such an earthquake, we make judgements or deliberate on what has occurred. In both instances, varying degrees of meaning are added and therefore each encounter leads to new information, albeit in different levels of detail. Regardless of how often or how well information is obtained and subsequently manipulated, at best it is an abstracted representation of ideas. To enable analysis and interpretation, the information presented requires prior knowledge, yet at the same time, presents a useful building block for constructing new knowledge (emergence). By itself, information does not transform into knowledge, but alters the individual's existing knowledge, thereby extending the potential for deriving new knowledge (Stenmark, 2002).

In determining a suitable design model for the delivery of educationally effective information and media, a productive start is to propose that the goal of learning is to assist students to develop 'holistic understanding' through active participation in learning environments modelled on networked systems of learning systems' (Campos, 2004). For such systems to support the cultivation of enhanced learning outcomes, the preferred model for learning design should be composed of multidimensional, multi-levelled, interconnected, and interrelated webs of data, information (including media) and knowledge. Thus, principles of networked ecological systems, self-organisation, and properties of emergence are introduced as integral components of learning environment design (Brown, 2002). In this refined systems model, information and media are not presented in a prescribed format, but instead are structured, destructured, restructured, interwoven and interrelated to form highly complex (self-organised) configurations wherein all entities influence each other and the value of any is dependent on the purpose and context to which it is applied. As a result, meaning, understanding, and knowledge do not emerge as unidirectional, sequentially derived outcomes.

If the goal of scholarship and education is to provide accurate insights into reality, then students must be taught to understand that all knowledge believed to be 'real' should not be assumed to be factual and therefore, must be challenged through continual questioning and examination. However, the established strategy for explaining unknown phenomenon is to seek out further information. The problem is that instead of finding that the accumulation of information leads to a more predictable world, many of our assumptions are cast aside as we discover our beliefs are not as immutable as first believed (Dickau, 1999, pp 1 - 2).

As emphasised several times, the most productive learning occurs when new material is readily connected with what are often complex, a priori, multiple links of association. The capacity to act intentionally and purposefully on an accumulated understanding of previously derived personal knowledge guides 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, identifying new connections, or articulating new ideas and perspectives. As Tan and Biswas (2007) attest, 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 key factors to note at this stage are that learners naturally construct knowledge as they process information resources, pursue their personal learning goals, construct working hypotheses, and create solutions to the problems at hand.

In attempting to articulate and subsequently derive a personal understanding of new ideas and concepts, learners must actively engage in the process of knowledge construction. One noteworthy, longstanding 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 an object or concept it becomes possible to perceive this same structure as an integral part of a greater whole that possesses meaningful connections to other areas of knowledge.

For learners to understand the educational purpose of the content presented requires the lecturer and students to reach consensus on the distinctions to be made between data, information, and knowledge. In so doing, they are equipped to identify the relationships that lead to the discernment of meaning. Without meaning, data does not equate to information, which in turn is not the same as knowledge. The implications raised in this statement are crucial to understanding how context may influence the creation of new knowledge. To derive complete understanding and knowledge from a given body of information requires a holistic, (systems) approach to learning where deriving insights into contextual relationships are essential for constructing 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 systems perspective on learning design begins to take shape.

The construction of new knowledge is not simply the result of the individual's capacity to act intentionally and purposefully on their accumulated experience and understanding. In order to be actively creative and innovative, learners require ardent encouragement to use their imaginations. To this end, educators must allow students to express their innate thoughts and ideas, and not intentionally or unintentionally stifle such expressions before their imaginations are afforded the right conditions and opportunities to inspire a substantive idea. Whilst it is acknowledged that not every kind of imagining is creative or productive, healthy, or even meaningful, nevertheless every attempt at exploring new relationships and meanings brings the individual one step closer to understanding something of the complexity that is the world around us. As will emerge in the pages to follow, the true test of a mature imagination is found in the capacity to follow unrestrained imaginings and then return to the starting point without losing sight of the original learning goal. Once returned, the learner is able to approach the problem under analysis from an entirely new and different perspective. Even young children experience uncontrolled flights of imagination and their play inspires rapid growth in thinking capacity, which the best attempts at training and conditioning can never match. The ability to direct this activity so that they return from flights of imagination to the point of departure with an expanded vision, is something we seldom teach, but is nevertheless the most useful skill we can learn (Dickau, 1999, p 1)

In a free-form learning environment, the role of the teacher is to create the conditions in which the student is encouraged to discern the underlying structure of a given subject. Once such conditions are established, Bruner insisted that 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 compared with existing cognitive structures. In this way, new meaning is given to existing patterns of organisation and experience which assists the individual to think beyond the information given (Bruner & Anglin, 1973, p 397). As noted earlier, 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.

Where this chapter is concerned, the question to be resolved is how to underpin the knowledge construction process with the theoretical principles required to devise a design approach for structuring data and information that affords the effective conversion of information into knowledge and in so doing, enhance/reflect/mirror the way the human mind naturally functions (Quinton, 2006). A potentially useful hypothesis is to propose that the goal of learning is to assist students 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 through higher order thinking, it is argued that such a model should be composed of multidimensional, multi-levelled, interconnected and interrelated networks of data, information and knowledge.

Structuring Electronic Information for Learning

A well-practiced method for creating artificial associations within electronic text is to organise it into linked nodes that may be as small as a word or a character, or as large as a book or collections of manuscripts. Pre-coded links or hyperlinks allow direct access to alternate information sources regardless of location and format that have the effect of forming subsystems or collections of information. This non-linear form of organising text (and media) transforms the sequential constraints of printed material into a 'meta-structure' enhanced with interconnections and cross-references that provide access to multiple entry points and permit the flexibility to navigate in a manner determined entirely by the reader's interests, curiosity, and experiences (Burbules & Callister, 1996, p 3).

Non-sequentially linked data and information afford an educationally viable option for learning design as it reinforces the skills inherent in the processes of reading and thinking. Learners can construct a unique, personally meaningful, useful interpretation of the displayed learning materials and increase the opportunity to identify new associations from amongst the given data and information. The benefit of learning environments that allow a degree of unstructured and idiosyncratic exploration is in learning to discern the associations that assist to support meaningful and useful interpretations. One design solution is to employ hyperlinked content to prompt learners to apply multiple strategies to enhance their problem solving and information retrieval skills, noting as always that in all complex learning tasks, teacher guidance and modelling exercise a crucial role. Students follow teacher directed pathways through the electronic text, observing and learning how someone with experience searches, collects, and connects information to derive meaning.

Alternatively, hyperlinked pathways could assist teachers and students to focus more on the important learning processes of interpreting and organising information, and less on the acquisition of facts. Either way, students are exposed to a wider range of learning 'possibilities'. A third approach involves the use of 'scaffolding' concepts where the teacher engages learners at an early stage with explicit explanation and guidance, then leads them through a succession of electronic links. The supports are gradually removed as learners gain greater confidence and become more autonomous in their explorations (Burbules & Callister, 1996, p 16). The more links that are established amongst the given body of material, the greater the exposure to additional relational concepts.

A more radical approach to organising information and media is to consider the possibility that all nodes of information are equal and treated as though there is no hierarchical structure. Hence, no node is considered central or more important than other nodes. From this perspective, learners may form new and previously unimagined associations (links) opening the potential for creativity and innovation in ways that are not possible using print-based materials. The key is to determine the conditions under which it is appropriate to free up and decontextualise each node and thus provide an effective means of identifying useful and novel 'lateral' connections. The optimal representation of knowledge is achieved when one segment of information is connected with as many related concepts as possible. This approach expands the opportunity to derive a comprehensive understanding of a given concept and its related concepts (Korytkowski & Sikora, 2007, p 713).

Whereas the traditional 'linear' mode of connecting ideas or facts is limited to 'manageable' subsets, the notion of levelling out and equalising all nodes along a continuum of non-hierarchical concepts effectively allows for the number of nodes to be boundless. This is because virtually anything is assumed to be relevant, interesting or important. By drawing on a broader range of sources, the number of potentially useful connective data points is increased considerably, in turn diversifying the range of exposure to include otherwise unknown associations.

The notion of all elements being equal provides a basis for designing learning systems that have the capacity to impose many patterns of organisation on existing information (regardless of how it was originally organised – or unorganised) and thus facilitate the learner's capacity to imagine and create new patterns of relationships. In essence, this design model represents a move away from the relatively inflexible, pragmatic, instructivist approach to learning, towards a broader, more open and interpretive exploration of the latent possibilities held within all structured and unstructured information and media. This line of thought will be continued later as a 'continuum of equal possibilities'.

Notwithstanding the potential advantages of unbounded, free form associations, the concern is that unstructured information can lead to undesirable learning experiences. There is the need to recognise the risks in designing electronic learning solutions that provide either too much information with an unbounded structure, or confine learners to a prescribed, inflexible structure that may contain inaccuracies due to the unintended (or even intended) introduction of implicit judgments. Thus, not just any association will serve the learning process. All the while, educators must remain mindful of the fact that there are certain accepted and well-proven conventions and heuristics (Burbules and Callister, 1996, p 5) that promote meaningful and useful interpretations. Ultimately, in order to develop deep understanding, learners sometimes need to make personal choices and at other times, there is a need to impose restrictions.

Care must also be given to avoiding chaos, arbitrariness, as well as the counterproductive and time-consuming exposure to permutations and juxtapositions that are without purpose or application. The meaning of data and information varies from individual to individual due to the innate influences of divergent backgrounds and perspectives that are further complicated by the unique intentions of every learner. The key to successful learning design is to determine when it is appropriate to free up and decontextualise each node of information and so provide an effective means of deriving useful and novel 'lateral' connections. It is only then that the juxtaposition and contradiction of concepts and ideas afford the conditions required to construct knowledge. The question is how to design such solutions whilst ensuring the risks are reduced to a minimum.

Hypertext configured systems have the capacity to impose patterns of organisation on existing information and to facilitate the user's ability to imagine and create new patterns of organisation. In essence, hypertext represents a move away from a relatively inflexible, pragmatic, scientific approach to deriving knowledge towards broader, more open and interpretive explorations that have the potential to produce refined or even new knowledge structures. It is through the cognitive processes of understanding and interpretation rather than the information or knowledge provided that ultimately assists in the learning process. That is, the object of learning is not at all the object per se; it is the process of learning. The symbols we use to interpret reality (words, numbers, and maps) are not the object or event they represent.

As (Ingraham, 2000, p 1) explains, the intellectual challenge is to explore the "limits of interpretation within the potentially infinite play of signification". As will be clarified in the following section, this somewhat lateral perspective clearly moves the process of deriving knowledge beyond the constructivist approach and begins to align with the notion of a continuum of possibilities. Imagine for a moment, a learning environment in which the technology itself assists students to extend their thinking processes to connect with and explore the 'reality of reality' and thus expose the ingrained illusions that have moulded a surrogate reality formed over time in the minds of learners.

A Continuum of Equal Possibilities

There exists an assumption that digitised information needs to be organised and classified (Peterson, 2006, p 4). In the digital world, there is no requirement for a categorisation or organisational system, which if applied, inherently imposes artificial constraints on how electronic data and information are organised. The application of categorisation strategies to electronic text and media is incongruous to human thinking as it does not permit sufficient departure from traditional habits of mind and practices to the full extent that is afforded by digital technologies (Shirky, 2006, p1).

What is emerging are ways of organising information that are more organic than current categorisation schemes allow. Two factors make this possible. One as outlined earlier, is the hyperlink, which can point to anything; the other is the tag, which can be used to label anything. The essential strategy is free-form tagging, which is removed from all known categorical constraints. Instead, what is possible in the electronic world are links that act as symbolic connections, aliases, or shortcuts. Taken to its ultimate outcome, if enough links are established, the need for a hierarchical file classification system no longer exists – the links alone are all that is required (Shirky, 2006, p 10). Already the web is demonstrating how significant value can be extracted from complex, disorganised information sets.

The Web is a world where it is possible to allocate a unique identifier to everything. The universal resource locator (URL) provides globally unique identifiers for everything that is directly or indirectly released to the Web. Whenever a URL points to the contents of a webpage, the pointer is direct. If a webpage displays a link to a resource located elsewhere on the Web, the pointer is indirect. For something that does not have a specific location and requires multiple layers of indirection, a uniform resource identifier (URI) is used. Once pointers exist for all elements of a given collection of information, anyone can label each pointer and tag URLs so that they are more useful to their needs without conforming to a top-down organisation scheme (Shirky, 2006, p 16).

In addition to links, the presence of unique labels (tags) allocated to each and every resource regardless of its location (physical or virtual) reinforces the notion that a categorisation/classification strategy is not a requirement. Applied at a global level, the notion of a continuum of possibilities becomes slightly easier to grasp. Not only can resources be uniquely labelled, so too can the links that connect them regardless of whether the configuration is one to one or one to many. The ability to free-form label links combined with the potential for deriving meaning without restriction in the number of interpretations introduces the possibility of generating novel ideas and concepts each time an inquiry is made or unfamiliar information is encountered.

Once such an arrangement is established, then each resource along with all their links can be statically or dynamically metatagged using any strategy deemed appropriate – taxonomy, folksonomy, ontology, or concept mapping analysis. In this way, no file system, predefined categories, and hierarchical structuring need to coexist alongside the link structure. If deemed essential, the unique identifiers in combination with the metatag information permit such organisation. By foregoing formal classification, learners can apply words, numbers, acronyms, concepts – whatever makes sense to them personally, without restriction or regard for any other preference or method. Thus, an enormous amount of user-generated organisational arrangement is made possible. By allowing learners to tag information and then to collaboratively aggregate the tags, more refined, alternate organisational systems emerge that have the effect of assisting individuals to recognise they are providing value to each other, often times without even realising it (Shirky, 2006, p 23). The use of metatags (whether manually or dynamically constructed) as described here allows information, ideas, facts and concepts to be viewed as components of a complex 'neuronal' net, any part of which can trigger any other part.

The foregoing paves the way to considering Pearce's (1974, p 194) description of Piaget's highest form of operational thinking: "the ability to hypothetically consider any state along a continuum of possibilities as potentially equal to any other state, and return to the same state from which the operation began". If an inquiry to discover something unknown is conducted along the lines of what Piaget proposed (and expounded on by Pearce with his notion of 'reversibility thinking'), then unrealised opportunities for breaking through accepted cognitive boundaries become evident. By conceding that such a seemingly impossible notion may be feasible, new pathways could be opened to empower learners to redefine normalised views of reality and consider new ways of thinking that give rise to unimagined strategies for analysing information and building knowledge. The potential is for the minds of learners to be exposed to new understandings and ideas, new ways of defining what it means to learn, what needs to be learned, and most important, how to learn (Dickau, 1999, p1).

There are no fixed rules, only goals and the possibilities that can be imagined in order to achieve those goals. By possibilities, I refer to a continuum of equal possibilities in which all data, information, and knowledge interrelate and interact without structure or favour, and with only one purpose – to facilitate learning in a way that best accommodates learners' individual preferences, values, and needs. While the concept of a continuum of equal possibilities may at first seem antithetical to accepted thinking strategies, consider that even partial acquiescence presents new opportunities to reflect on alternate views and to explore options that in many instances would be dismissed as impractical. Such a model of learning inverts the traditional linear teacher-to-student transmissionist approach, as does it also for the rhetoric of most curriculum frameworks. By encouraging students to process information independently, to identify and derive meaningful relationships, to recognise patterns of principles and properties, to generate new knowledge, then eventually, they will devise proto-theories or hypotheses that enable them to explain why the newly derived connections are valid.

A theory of learning that faithfully supports such an approach might also allow for an open systems model for identifying relationships among networked repositories of unorganised information. In this model, there are levels within levels, all interconnected through a complex network of relationships that unite every identifiable element and can be adapted and readapted to form linear, hierarchical and even heterarchical (where connections can be established from many different points to any other position within the overall structure) pathways throughout all system levels.

In a complex system, we know that the solution is out there somewhere; it exists in the informal networks and communications of trust and interdependency that are the day-to-day reality of any large organisation or group. By increasing the number of connections, the greater the likelihood a new idea, concept, or understanding will emerge. Once emergence has occurred, a new pattern of understanding is established and is self-evident, albeit only in retrospect (Snowden, 2000, p 20).

Then, because most information repositories are inherently chaotic (witness the results of an Internet search) in that they are mostly independent of context, it is technically feasible to reshape the information (and therefore) the knowledge they contain into a multitude of knowledge structures to accommodate individual cognitive schemas and so encourage wider engagement in a given learning activity. Such structures guide the construction of pathways that learners observe as they strive to comprehend and master an understanding of the core concepts embedded within the displayed information and media. The strategy of turning links on or off (link-hiding) permits the establishment and adaptation to individual pathways. Add to these properties the capacity to automatically organise content in response to user input that prompts learners to recognise emergent properties (through pattern recognition) within complex information systems, then we begin to understand how learners can be exposed to deeper, more comprehensive learning experiences.

If we accept the world is made up of an infinite number of systems in which there are unlimited possibilities, how then it is possible to construct useful knowledge without consuming inordinate amounts of time and eventually risk overwhelming the learner? Out of practical necessity, any attempt to identify valid connections must be finite in number, whereas in theory all possibilities along a continuum of infinite possibilities are there to be explored. Given such unmanageable potential, we should not assume that valid (useful) connections will always be made nor overlook the fact that there may be zero probability of a valid connection. Another, more productive way to deal with the complex task of managing infinite possibilities is to look to the manner in which the human brain functions.

A useful comparison with the learning design model unfolding above can be found in the work of one of the forefathers of hypertext Vannevar Bush (1945, pp 101 - 108). He held the view that 'the structure of hypertext environments parallels and can facilitate the ways in which we learn: non-sequentially, dynamically, and interactively, through associations and by exploration'. Thus, the structure and the function of the brain can be favourably compared to the underlying concepts and principles that explain systems, subsystems, and networks. The view of human thinking that mimics the key properties of networked systems is further strengthened by Bush's argument for applying artificial hyperlinks to electronic text (Bush, 1945, pp 101 - 108):

> The human mind...operates by association. Man [sic] cannot hope to fully duplicate this mental process artificially, but he certainly ought to be able to learn from it. One cannot hope to equal the speed and flexibility with which the mind follows an associative trail, but it should be possible to beat the mind decisively in regard to the permanence and clarity of the items resurrected from storage.

From the perspective of constructing an efficient information search and retrieval mechanism, complete connectivity among all system components is the perfect arrangement. It is not feasible of course to interconnect all information, but as a metaphor, the notion that everything is connected is a useful strategy for inspiring new ideas. Assuming all components within a system are fully interlinked, the task of establishing meaningful relationships or locating useful information is unwieldy to manage and impossible to process, particularly where the goal is to innovate. This is where ‘intelligent networks’ and globally unique identifiers (URLs) which can be used to point directly, indirectly, or even randomly to indeterminate resources play a crucial role.

Intelligent Networks of Learning Objects

Earlier, hypertext technology was raised as an example of a familiar tool for users of the Internet. A less familiar technology is learning objects – essentially segments of self-contained teaching content that can be interlinked to form a myriad of interrelationships at multiple levels extending from a single character to complete literary works. Content management systems can search, retrieve, and assemble this independent content for any purpose, in any order, recontextualise it, and present it at any level of complexity the learner can manage. Thus, the application of a continuum of equal possibilities to exploring the contextual relationships among electronic content becomes technically feasible, opening up unimagined opportunities for learners to look outside the prevailing disciplinary and cultural dimensions to examining the reality that lies within and beyond.

The notion of a fully equalised field of information opens the way for exploring alternate views and to consider new design options. To this end, I refer to the key principles of a systems-based learning model. By discarding the tendency to apply a linear or a hierarchical structure, it is feasible to design a networked system of learning objects comprised of concept descriptions, supporting (instructional) information, and 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 expose the learner to richer, more productive learning experiences than are attainable using known 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 multiple nested systems made up of learning objects housed within other learning object systems, yet at every level, all 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. 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 can be applied include a capacity to:

- alert the student to the need for revision and present appropriate alternate material
- require the student to repeat a certain activity using alternate material
- dynamically generate customised quizzes, assignments, or activities that correspond to each student’s specific needs and competence levels.

The most optimal design is to create objects that have a high degree of interrelatedness and context independence that are combined with support tools and strategies 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 are 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 (therefore 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 depth and degree 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 thereby the difficulty that will be experienced by the learner. A large concentration of facts for example, may provide little learning value if the amount of meaningful information provided is inadequate. Conversely, 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 data and information, and the opportunities required to derive the knowledge that is essential to achieving the expected learning outcomes. The interconnectedness of the various components is such that they should form a highly interrelated set of data, information, and knowledge that is not only tailored to student’s specific needs in direct accordance with the intended learning outcomes, but also increases the opportunity to generate new ideas through exposure to a continuum of equal possibilities.

If the preceding example is extended to include a learning object made up of smaller (sub) objects, then the above configuration still applies. However, what is now 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 achievement of 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 complex and dynamically adaptable learning experiences.

To illustrate the preceding points further, it is useful to view the act of creativity or knowledge construction as a cognitive activity in which the abstract compilation of previously unrelated mental structures or ideas results in the formation of an emergent whole. Anyone who has experienced that moment where a new idea arises without apparent prior connection would agree that the resultant outcome is often much more than the mere sum of a collection of disconnected thoughts. However, it is not just the sum of the parts that is important, but of comparable significance is the notion of the creative process as an expression of the relationships between the various abstract components. The formation of each new synthesis leads to the emergence of new patterns of relationships with each more complex than the previous, each extending to higher and higher cognitive levels of a mental hierarchy. Koestler's (1978, pp 131 - 33) view is that contrary to popular beliefs, scientific discoveries do not occur by producing something out of nothing. Instead, scientists combine, relate, and integrate known, but previously separate ideas, facts, and associative contexts. The scientist aims to synthesise prior knowledge in a way that adds new levels of understanding to the existing knowledge hierarchy. For some, the synthesis of previously unrelated knowledge may result in what is commonly referred to as the 'aha' effect where apparently disparate bits of information suddenly click into place. At this point new knowledge is realised, and in the process we strive toward higher levels of cognitive understanding.

A Warning – The Potential for Disaster

Piaget's highest form of operational thinking is grounded in a substantially developed imaginative capacity. The essential indicator of a well-formed and rational imaginative structure is its capacity for driving creative thought and ideas. To develop this higher order skill, imaginative nurturing throughout the developmental learning process is essential. Without it, the deeper layers or realms of truly significant insight are not reachable.

Electronically associated information offers great potential for extending the learner's mind beyond their current context to consider previously unknown relationships at the click of a mouse button. The problem with such connections is that the same author that prepared the main text also predefines the associations and therefore decides what relationships are embedded before the learner commences reading. The predetermined relationships may or may not be meaningful to the learner, thus elevating the risk of retarding the learning experience rather than enhancing it.

Whenever the learning process involves exploration and discovery, the ambiguity of learning, not teaching gives rise to the potential for chaos. There is no prior experience, expertise or belief system to draw on, and thus the limits to deriving comprehension and understanding are boundless. Such systems are turbulent, they operate under conditions of extreme uncertainty, and so at best learners operate on the edge of chaos, at worst they are paralysed by the chaotic situation (Snowden, 2000, p 3).

In effect, interrelated material offers students with less developed cognitive structures the equivalent of 'calculator-enabled' short cuts for attaining perception and precision even though they do not have the capacity to fully comprehend how the result was achieved or possess the ability to determine the implications hidden within what appears to be a correct solution (Peterson, 2006, p 4). Despite the author's intent, readers of texts on the Internet become individual interpreters. Without deeper levels of understanding and experience, the learner believes that what has been achieved or imagined is true insight. From a learning perspective, such adverse consequences are a disaster and may prove detrimental to the learner's capacity for effective analytic ability for life. This outcome raises two potential dilemmas. On the one hand, if considering the author's intent, personal interpretations and judgments introduce the likelihood that the learner's judgement is incorrect. On the other hand, when multiple interpretations abound and all are afforded equal significance, then at some point the entire system of possibilities will become unusable as it will not be feasible to distinguish accurate meanings.

Technology is providing greater capacity to generate and store large quantities of information. As the power of technology increases, so too does the quantity of information, which leads directly to an increasing obligation to manage and preserve the human ability for coherent thought. The computer and the information it processes can create a reality that is easily accepted as an independent reality. If this reality is not based on fact, it is clearly inaccurate. Even with this acknowledgement, we must also recognise that the human thought process readily constructs another version of reality where no distinction is made between that part of reality created by thought and the part that is independent of thought, or even those parts which are a mixture of both (Bohm, 1995, p4). Therefore, there is a real need to understand how the human mind affects reality, how technology influences thought, and conversely, how technology can empower thought for the better.

If the starting premise is aligned more with the view that absolute truth is not found in ideas and theories, but through imagination and adaptation, then new opportunities for explorations and discovering new ideas can arise in unexpected and exciting ways. The key to success is to ensure the learner remains cognizant of the hidden dangers at all times. Thus, while the potential for disaster must be diligently observed, Mendizza (2004, p 5) provides encouragement to continue pursuit of the goal of unlimited thinking by speculating that "the next frontier in education is moving us away from "content" to a rediscovery of the natural unconditioned state of the mind and its limitless capacity to learn."

Conclusions

The liberating power of the new information and communications technologies extends from their capacity to redefine the learning environment in a way that allows individual potential to be truly maximised (Gipson, 1996, p 19). However, technology alone cannot do this. Unless technology is intentionally coupled with reformed educational practice that acknowledges the primacy of the learner rather than the centrality of the lecturer, then its use is limited. Such a shift in thinking permits the teacher to become a facilitator of the student's learning as opposed to being the sole repository and provider of knowledge.

Unrestricted access to information and related technologies provides an opportunity for teachers to develop and devise learning experiences that are tuned to individual needs. More significantly, it affords learners the opportunity to experience both independent and group learning. Thus, the power of technology lies in its capacity to enable individualised learning whilst encouraging participation in co-operative learning environments, a community of learners where learning is the focussed intention, not the incidental outcome.

In the years ahead, greater numbers of users and learners will access material on the web and therefore, more and more information will accumulate around that material. For the most part, this organic, probabilistic approach to deriving meaning from existing information will be about the active use of information that is generated and refined real time as a product of online activities. Such individual sense-making will not involve information from a standard ontology that has been previously produced by an unknown third party that may (intentionally or unintentionally) impose alternate organisational systems. The accumulation and reinterpretation of information coupled with a focus on end use are two key aspects of an ecological approach to building a world of knowledge where hierarchical or any other organisational structures do not need to coexist with the innate relationships, meanings, and possibilities – there is no one correct way to organise data and information, and hence the boundaries to imagination are completely removed as are the influences imposed by artificial (human imposed) structures.

Given the increasing complexity of information and knowledge and the potential for technology to generate total interconnectedness, greater opportunity arises to explore interdisciplinary cross-fertilisation, where even apparently unrelated findings can lead to unexpected ideas. In this example of technological influence on context and relationships, learning is ultimately induced through the cognitive processes of understanding and interpretation. The next frontier in education has little to do with information and a great deal to do with the state of mind that is required to efficiently process information (Mendizza, 2004, p 7).

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 identify and define conceptual relationships, which in turn has the effect of fostering deeper insights into the information presented to the learner. This is where novel solutions to practical problems are often found when least expected (McCalla, 2004, pp 4 - 5).

Systems principles represent a plausible theoretical foundation upon which a new, technologically driven model of learning can be established. Each principle holds the key to devising a range of strategies for recontextualising learning material (configured as learning objects) that 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 disciplines to reveal relationships learners may otherwise not have considered. The benefit of course, is to provide the student increased exposure to new opportunities to construct knowledge 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.

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. In essence, the educational implications for applying Korytkowski and Sikora's notion of interrelated learning objects using a more holistic, systems design approach are profound.

For now, the challenge is to design and deliver learning solutions aimed at not just representing knowledge and facilitating navigation through structured or unstructured information and media using complex learning pathways, but also to develop advanced design methodologies that employ emerging technologies to support the refinement of the higher order cognitive skills of analysis, problem-solving, conceptual thinking, and metacognition. Notwithstanding the potential 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.

In practice, the issues and strategies for designing educationally effective electronic learning environments are highly complex and diverse. Without a thorough examination of the relationships between technology, communication, information, media, human/computer interaction and cognitive development, the full power of ICT as an aid to learning will not be realised. To this end, a core focus of all ICT related educational research should aim to identify and explore the benefits of applying advanced learning strategies, design methodologies and pedagogical innovations to the complex task of delivering learning environments that augment learners' information and media literacy skills and address the goals of all individuals.

As indicated at the outset, this chapter presented a personal vision for the design of electronic learning environments in the future. The design approach proposed during this exploration of technological capacity to empower the learning process lies in the potential to apply the concept of a continuum of possibilities to inform the construction of learning environments that dynamically adapt and evolve in response to the changing expectations of the teacher and the individual learning needs of the student. After reading this chapter, it is my hope that educationalists will be inspired to exercise their imaginations and reflect on what is possible and so extend the boundaries of accepted thinking on the design of electronic learning environments. To encourage and inspire further thinking, the words of Manzini and Cau (1989, p 17) encapsulate the essence of what the preceding synopsis alludes to in relation to fulfilling the potential of human thought and creativity:

> Every object made by man is the embodiment of what is at once unthinkable and possible... This interaction, which we refer to as design, is neither simple nor straightforward. There is no broad, free-ranging Thinkable that has only to squeeze into the boundaries of the Possible because the very awareness of those boundaries is a basic element in what can be thought of. On the other hand, thought is not merely the acceptance of known limits. The activities of creation and invention are expressed in the ability to relocate the bounds imposed in other systems of reference, thus creating the new, that which until now has not been thought of and indeed unthinkable. The model one creates of the possible thus becomes a constituent part of creativity.

References

Bateson, Gregory. (1988). Mind and Nature: A Necessary Unity. New York, USA: Bantam Books. pp 9 - 11 and 29.

Bellinger, Gene. (1997). Knowledge Management - Emerging Perspectives. Retrieved on 15th September, 2008. WWW Ref. http://www.systems-thinking.org/kmgmt/kmgmt.htm

Bellinger, Gene. Castro, Durval and Mills, Anthony. (1997). Data, Information, Knowledge, and Wisdom. Retrieved on 15th September 2008. WWW Ref. http://www.systems-thinking.org/dikw/dikw.htm

Bohm, David. (1995). The Limitations of Thought. Retrieved on 15th August, 2008. WWW Ref. http://ttfuture.org/services/visionaries/Dbohm/BohmLT.pdf

Bohm, David. (1981). Knowledge & Insight. Retrieved on 15th August, 2008. WWW Ref. http://ttfuture.org/services/visionaries/Dbohm/BohmIK.PDF

Brown, J. S. (2002). Growing Up Digital: How the Web Changes Work, Education, and the Ways People Learn. United States Distance Learning Association. Retrieved 20th September, 2008. WWW Ref. http://www.usdla.org/html/journal/FEB02_Issue/article01.html

Brown, Allison and Thompson, Herb. (1997). Course Design for the WWW - Keeping Online Students Onside. In 14th Annual Conference Proceedings of the ASCILITE. Academic Computing Services, Curtin University of Technology, Perth, Western Australia. pp. 74 - 81.

Bruner, Jerome and Anglin, Jeremy M. (1973). Beyond the Information Given - Studies in the Psychology of Knowing. Toronto, Canada: George J. McLeod Limited. p. 397.

Burbules, Nicholas C. and Callister, Thomas A. (1996). Knowledge at the Crossroads: Some Alternative Futures of Hypertext Learning Environments. Educational Theory, Winter. p. 3.

Bush, V. (1945). As We May Think. Atlantic Monthly, Vol. 176, No. 1. July. pp. 101-108.

Campos, Milton. (2004). A Constructivist Method for the Analysis of Networked Cognitive Communication and the Assessment of Collaborative Learning and Knowledge-Building. JALN. Vol. 8, No. 2. April.

Capra, Fritjof. (1996). The Web of Life. London, UK: Harper Collins. p. 70.

Daniel, J. S. (1996). Mega-universities and Knowledge Media: Technology Strategies for Higher Education. London, UK: Kogan Page. p. 2.

Dickau, Jonathon J. (1999). The Known, the Unknown, and the Unknowable: Are the Boundaries of Consciousness a Fractal? Retrieved on 30th July, 2008. WWW Ref. http://jond4u.jonathandickau.com/known.htm

Gipson, Simon. (1996). Feral, Facsimile of Facilitated? Technology Serving Teaching and Learning. Tridos School Village, Chiang Mai, Thailand: Learning and Teaching: Implications for Gifted and Talented Students.

Green, Mitchell S. (2005). You perceive with your mind: Knowledge and perception. In Hip Hop and Philosophy, D. Darby and T. Shelby (Eds.). Open Court. pp. 6 - 8.

Hammer, D. (2000). Student resources for learning introductory physics. American Journal of Physics, Physics Education Research Supplement, Vol. 68, No. 1. pp. 52 - 59.

Hannafin, Michael J. (1997). Resource-Based Learning Environments: Methods and Models. In 14th Annual Conference Proceedings of the ASCILITE. Academic Computing Services, Curtin University of Technology, Perth, Western Australia. pp. 255 – 62.

Harris, David. (2000). Knowledge and Networks. In Terry Evans and Daryl Nation (Eds.), Changing University Teaching: Reflections on Creating Educational Technologie. London, UK: Kogan Page. pp. 36 - 7.

Ingraham, Bruce Douglas. (2000). Scholarly Rhetoric in Digital Media: Post-modernism. Journal of Interactive Media in Education (JIME). Retrieved on 30th July, 2008. WWW Ref. http://jime.open.ac.uk/00/ingraham/ingraham.pdf

Koestler, Arthur. (1978). Janus – A Summing Up, Tiptree, Essex, UK: The Anchor Press Ltd., pp 131 – 33.

Korytkowski, P. and Sikora, K. (2007). Creating Learning Objects and Learning Sequence on the Basis of Semantic Networks. Book Chapter in Lecture Notes in Computer Science Database and Expert Systems Applications. R. Wagner, N. Revell, and G. Pernul (Eds). Volume 4653/2007. Springer: Berlin / Heidelberg. p. 713.

Laurillard, D. (1993). Rethinking University Teaching: A Framework for the Effective Use of Educational Technology. London, UK: Routledge. p. 268.

Leacock, T. L., & Nesbit, J. C. (2007). A Framework for Evaluating the Quality of Multimedia Learning Resources. Educational Technology & Society, Vol. 10, No. 2, pp. 44 - 59.

Liber, Oleg. (2004). Cybernetics. e-Learning and the Educations System. International Journal of Learning Technology, Vol. 1, No. 1. p. 135.

McCalla, G. (2004). The Ecological App roach to the Design of E-Learning Environments: Purpose-based Capture and Use of Information About Learners. Journal of Interactive Media in Education, Vol. 7. Special Issue on the Educational Semantic Web. Retrieved 15th November, 2007. WWW Ref. http://www-jime.open.ac.uk/ 2004/ 7

Magee, Bryan. (1997). The Philosophy of Schopenhauer. Schopenhauer 1788-1860 (On the Fourfold Root of the Principle of Sufficient Reason, 1814 -15). Clarendon Press: Oxford, UK. p. 6.

Manzini, E., & Cau, P. (1989). The Material of Invention. Cambridge, Mass: MIT Press. p 17.

Megarry, J. (1989). Hypertext and Compact Discs: the Challenge of Multimedia Learning. In C. Bell, J. Davies and R. Winders, (Eds.) Promoting Learning: Aspects of Educational and Training Technology XXII. London, UK: Kogan Page. p. 50.

Mendizza, Michael. (2004). Love of the Game Applying what athletes call the Zone to parenting and education. p. 5. Retrieved 20th February 2008. WWW Ref. http://www.rethinkingeducation.com/Mendizza.pdf

Mendizza, M. (2006). The Next Frontier in Education. Retrieved 20th July, 2008. WWW Ref. http://www.dawntalk.com/NewFiles/Article-Mendizza.html

Pearce, J. (1974). Exploring the Crack in the Cosmic Egg: Split Minds and Meta-Realities. Washington Square Press: New York. p. 194.

Peterson, Elaine. (2006). Beneath the Metadata: Some Philosophical Problems with Folksonomy. D-Lib Magazine, Vol. 12, No. 11. November. Retrieved 15th August, 2008. WWW Ref. http://www.dlib.org/dlib/november06/peterson/11peterson.html

Quinton, S. (2006). Contextualisation of Learning Objects to Derive Meaning. Chapter in Koohang, A. & Harman, K. (Eds.), Learning Objects: Theory, Praxis, Issues, and Trends. Santa Rosa, California: Informing Science Press. pp 113–80.

Rieh, Soo Young. (2002). Judgment of information quality and cognitive authority in the web. Journal of the American Society for Information Science and Technology. Vol. 53, No. 2. pp. 145 - 161.

Rucker, Rudy. (1988). Mind Tools: The Mathematics of Information. London, UK: Penguin Books.
p. 26.

Shank, Roger. (1996). Information is Surprises. New York, NY: Touchstone. Ch 9. p. 173.

Shirky, C. (2006). Ontology is Overrated: Categories, Links, and Tags. Economics and Culture, Media and Community. Retrieved 30th September, 2008. WWW Ref. http://shirky.com/writings/ontology_overrated.html.

Snowden, David J. (2000). Strategies for Common Sense-Making in Innovation Enabling Emergence at the Edge of Chaos Part III, Journal of Scenario and Strategy Planning, Vol.2, Issue 3, October/ November.

Sprinthall, Richard C. and Sprinthall, Norman A. (1981). Educational Psychology A Developmental Approach. Reading, Massachusetts, USA: Addison-Wesley Publishing Company. p. 281.

Stenmark, D. (2002). Information vs. Knowledge: The Role of Intranets in Knowledge Management. In Proceedings of HICSS-35, IEEE Press, Hawaii, January. pp. 7 - 10.

Tan, Jason & Biswas, Gautam. (2007). Simulation-Based Game Learning Environments: Building and Sustaining a Fish Tank. The First IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning, 2007 (DIGITEL). March. pp. 73 – 80.