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Résumé de l'article

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Aligning the Quantum Perspective of Learning to Instructional Design: Exploring the Seven Definitive Questions



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Abstract

This paper builds upon a foundational paper (under review) which explores the rudiments of the quantum perspective of learning. The quantum perspective of learning uses the principles of exchange theory or borrowed theory from the field of quantum holism pioneered by quantum physicist David Bohm (1971, 1973) to understand learning in a new way. Bohm proposes that everything exists as wholes, rather than as parts, and that everything is connected. Similarly, the quantum perspective of learning proposes that individuals learn in holistic ways as they interact with temporal and in infinitely extending virtual worlds. Further, according to the quantum perspective of learning, learners have infinite potential. In this paper, the quantum perspective of learning is examined utilizing a combination of Schunk's (1991) and Ertmer and Newby's (1993) definitive questions for aligning learning theory with instructional design. These seven definitive questions focus on how learning happens, influential factors in learning, the role of memory, transfer of knowledge, modalities of learning that can best explain the quantum perspective of learning, applicable assumptions, and a discussion of how instruction can be organized to optimize learning. Examples of strategies that facilitate the quantum perspective of learning are provided.

Keywords: Learning; the quantum perspective of learning; quantum state; quantum leap; quantum dimension; quantum memory channels; memory, instructional design; photovoice; artistic pedagogical technologies

Introduction

Learning theorists not only refute and negate one other, they also "tend to narrowly define knowledge and learning" (Yang, 2004). While constructivism (Vygotsky, 1978) and most recently connectivism (Siemens, 2004) have emerged and been embraced by educators and academics, these theories still stand in isolation, finding little common ground with each other.

If it is accepted that there are multiple ways of knowing (Netzer & Mangano Rowe, 2010) then it follows that there are multiple ways of learning. If there are multiple ways of learning then multiple ways of explaining how individuals learn must be requisite. Considering how consilience has integrated knowledge across disciplines (Morris, Urbanski, & Fuller, 2005), it is posited that the creation of a learning theory or perspective that has the potential to integrate theories of learning is long overdue. Further, this integration would bridge theory and practice (Netzer & Mangano Rowe, 2010).

The purpose of this paper is to apply selected principles of quantum mechanics, in particular quantum holism (Bohm, 1971, 1973), to learning theory in order to explore the creation of a new integrated learning perspective called the quantum perspective of learning. A full description of aspects of the quantum perspective of learning has been presented in a series of papers currently under review. This paper further examines the quantum perspective of learning by posing Schunk's (1991) and Ertmer and Newby's (1993) seven definitive questions for aligning learning theory with instructional design.

To provide background for the examination of Schunk's (1991) and Ertmer and Newby's (1993) questions, properties of the quantum perspective of learning are briefly described. Each of the seven questions is examined in relation to the quantum perspective of learning. Examples of teaching strategies that facilitate the quantum perspective of learning are provided. Implications for e-learning are presented.

Properties of the Quantum Perspective of Learning in Brief

The quantum perspective of learning is predicated on the work of David Bohm (1971, 1973) related to quantum holism. Human beings share connections with themselves, other individuals, the environment, and the universe (Hare, 2006). Quantum holism suggests that this interconnectedness extends infinitely in all things, in all places, and at all times.

This interconnectedness is exemplified in a posture of holism. In short, everything is connected, entangled, and in constant communication from the tiniest of structures (neutrons and quarks) to the largest of structures (planets, universe-multiverse) (Aczel, 2001). Connection, entanglement, and constant communication configure the basis of the quantum perspective of learning.

Connection can be thought of as an expansive multidimensional fabric which exists through time and space to which all things belong or are a part of. In this quantum fabric there is no independent existence. Rather, all existence is interdependent and entangled. Entanglement is indicative of each aspect touching or bordering all others. Further, constant communication suggests that on some level each particle (large or small) can communicate with all others.

These constructs form the basics of the quantum perspective of learning. Schunk's (1971) and Ertmer and Newby's (1993) seven definitive questions assist in clarifying the properties of the quantum perspective of learning. Each question is explored in detail.

Exploring the Seven Definitive Questions

Question 1 - How Does Learning Occur?

While Siemens (2006) suggests that learning consists of making connections between nodes within a larger network, the quantum perspective of learning proposes instead that learning is the process of discovering connections which already exist ubiquitously. While individuals each have a learning network of connections that they are aware of, the network that forms the total learning milieu extends from structures smaller than the sub-atomistic to the vast expanses of the universe. These structures can be represented through four realms of learning: quantasic, atomistic, temporalistic, and universalistic.

The quantasic realm of learning consists of the spaces that represent the purest and most primary forms of intelligence or learning. An example of this is quarks, which are considered to be the most fundamental unit of the universe upon which all else is built or predicated (Olive, 1981). The atomistic realm reflects the sub-atomistic domain of the electron or neutron. This refers to learning which can be explained through neurobiology, where there is constant communication and learning within an expansive neural network (Shahaf & Marom, 2001).The temporalistic realm pertains to learning and knowledge that are found temporally or in our existence as human beings in our everyday lives. The temporalistic realm includes learning that arises through and within technology. The universalistic realm of learning is found within spaces which exist outside the boundaries of our earth and extend into the cosmos. The universalistic realm is further explained by the laws of classical quantum mechanics (Raković, 2007).

It is proposed that these four realms of learning are all connected, continually communicate, and are entangled with each other. Further, through these connections, communication, and entanglements, learning exists in a posture of holism as part of an implicate order where all is connected rather than existing solely in discrete or distinct parts of an explicate order (Bohm, 1971). For the purposes of this paper, learning is primarily discussed within the temporalistic realm.

While in a holistic sense learning is always occurring within, between, and throughout all

realms of learning, human learning is experienced when a connection is discovered. Consider a hologram of infinite dots and connections. The dots represent all knowledge and the lines, connections, or vehicles that connect all knowledge. In essence the dots are already connected and learning provides the vehicle to discover and provide answers as to how, why, when, where, and what connections exist.

For example, consider learning related to causes of illness. At one time illness was believed to be caused by the presence of evil spirits. Through advances in science, the discovery of a link or connection between bacteria and illness paved the way for other discoveries that, for the most part, have vastly improved the health of the human race. While this connection between bacteria and illness always existed, learning (framed as discovery) had to occur for the relationship to be identified and understood. In this way, learning, or the discovery of single or multiple sets of connections, can be considered an ongoing process which continues throughout human mortality.

Question 2 - Which Factors Influence Learning?

Learning is filtered or influenced by various planes or dimensions that humans encounter in their everyday lives. Naming these planes or dimensions has been expanding since the early seventeenth century when behaviouralism was first identified by Locke (Davis, Edmunds, & Kelly-Bateman, 2010). Cognitivist theory proposes that learning only occurs on a single intellectual plane (Piaget, 1960, 1981), while social constructivism suggests that learning is influenced by social, historical, and cultural factors (Vygotsky, 1978). Connectivism goes further and recognizes that learning is influenced by multiple dimensions including technology (Siemens, 2004). Connectivism represents the first learning theory that recognizes the presence of a multitude of dimensions.

The quantum perspective of learning takes the concept of multiple dimensions one step further and suggests that there are innumerable dimensions that exist that influence learning. The dimensions include those that can be named at this time and those that remain unnamed or are yet to be discovered. In the quantum perspective of learning, dimensions that have been named include technology, culture, sociality, behaviour, cognitions, spirituality, corporeality, and the intersecting vision of teacher and learner. There are more dimensions that influence learning yet to be discovered. It is posited that even time and space in terms of Einstein's theory of relativity exist as dimensions which influence learning, although we do not at this time fully understand how. The multiple dimensions in the quantum perspective of learning are referred to as quantum dimensions.

Question 3 - What Is the Role of Memory?

Memories are first encountered as infants and normally develop exponentially as individuals reach and continue through adulthood (Conway & Pleydell-Pearce, 2000). Memory in children is entwined within several worlds: "imaginary worlds formed through various media," "an ongoing social world," and a "wider experienced world" (Dyson, 1988, p. 355). Dyson goes further to explain that

> ...tensions [exist] between these worlds [and] that the . . . developmental challenge is to not simply create a unified, 'disembedded' world but to differentiate and coordinate these multiple worlds" which exist within the various dimensions of time and space. (p. 355)

With the development of technology these findings could be applied to adult learning within a millennial world where humans increasingly experience virtuality within a "technosocial" reality (Fuchs, 2010, p. 788). Further to this, the role of memory in learning can be viewed as an active process of coordinating temporal, social, and virtual worlds and unfolding the resultant reality that ensues.

Three more principles guide the understanding of memory in the quantum perspective of learning context. First, memory in the quantum perspective of learning is posited to be highly connected through the passage of time and space where it becomes identified and mediated by the past, present, and future. Second, memory can be either conscious or unconscious. Finally, memory is felt to be formed through decoding and encoding within a continuous cycle of inputs and outputs.

Question 4 - How Does Transfer of Knowledge Occur?

The quantum perspective of learning occurs in a quantum state. A quantum state is abstracted as a state of readiness to learn and can also be expressed as a way of being-in-the-world (Heidegger, 1962). All knowledge, by virtue of being connected, in constant communication, and entangled, exists in quantum states. In the temporal realm of learning, or in our everyday world of human learning, these quantum states can be either conscious or unconscious.

While input can be understood as stimuli, the quantum perspective of learning suggests that stimuli are expressed chiefly as input. This input is carried across an intricate pathway of neural nets. The neural nets are all connected by virtue of constant communication and interference patterns which arise through this communication (Walonick, 1993). Learning is composed of infinitely occurring streams of input and output (Kretschmann & Werner, 2005). In a larger sense, teaching reflects all input while learning represents all output. Learning can be conceptualized in terms of either unconscious storage or immediate utilization of input. Teaching and learning can ultimately be expressed cyclically. This is the quantum perspective of learning cycle. The starting point and ending point of the quantum perspective of learning cycle is input. Input culminates as learning or output, which is then in essence "recycled" as the learning is again reflected as input to self or others.

All learning can be conceptualized in this cycle, where there is continuous input and output of information. It is suggested that all input passes through dimensional filters (i.e., technology, corporeality, culture, sociality, etc.) before transmission or transfer. This filtering can alter what is inputted. The dimensional filters are viewed as lenses through which individuals interpret input much as they do while wearing glasses. Subsequently these lenses/dimensions reflect or refract input in unique ways.

The transfer of learning occurs primarily through quantum channels (Cirac, Zoller, Kimble, & Mabuchi, 1997). These quantum channels are conduits through which memory-based and memoryless-based (Kretschmann & Werner, 2005) inputs pass and are decoded. Decoded memory subsequently becomes encoded and stored. The storage and encoding of the input manifests itself as internalized learning. As internalized learning is needed, concatenated memory channels (Kretschman & Werner, 2005) act to put memory back into a recognizable form where memory is once more decoded and becomes output. The outputs are exhibited as externalized learning which is reflected in changes or expansions in some capacity in one or all quantum dimensions that influence learning.

Question 5 - What Types of Learning Are Best Explained?

The quantum perspective of learning suggests that all learning is holistic in nature. Learning holistically, therefore, necessitates that quantum dimensions and quantum states exist ubiquitously. Ubiquitous properties of the quantum perspective of learning have ties to holistic learning in education.

Holistic learning, in an educative sense, refers to the "education of the whole person" (Hare, 2006, p. 301) rather than focusing on a single dimension. Holistic learning focuses on several areas of personal growth within an individual, which include "interpersonal awareness, self-awareness, disciplinary and interdisciplinary knowledge and understanding, and cultural and intercultural awareness" (p. 315). The quantum perspective of learning, as it recognizes all facets or dimensions in which humans learn, may be considered as a bridging perspective between all contemporary learning theories. While there may be no perfect type of learning that addresses all quantum dimensions simultaneously, there are several types of learning that may best typify the quantum perspective of learning. Examples include science-based learning, creative learning, emotional intelligence, and arts-based learning. These types of learning are explored further.

Science-based learning.

Science-based learning is traditionally expressed in terms of the acquisition of knowledge of scientific properties and equations (Bohm, 1971). An example of science-based learning is classical quantum mechanics. In classical quantum mechanics, rules prevail, represent constants, and explain scientific phenomena such as relativity. Science-based learning, which has long been understood as chiefly cognitive (Klahr & Nigam, 2004), can also be explained through the quantum perspective of learning and the principle of holism.

Science-based learning can be explained in terms of holism as "direct instruction" and is associated with "diffuse authentic reasoning and modelling" (Klahr & Nigam, 2004, p. 661). Through the inclusion of other modes of learning, "explicit [or cognitive] knowledge [does not exist independently as] meaningless facts and figures or bytes of information [but rather is supported by the] other facets [or dimensions that exist holistically]" (Yang, 2004, p. 243). In science, learning occurs "through time and space" and within a dynamic interplay of "relationships and artefacts" (Bleakley, 2006, p. 150). Science learning is felt to be "co-produced, context bound," socially constructed within a "reciprocity of perspectives," and

largely framed within outcomes of making or creating meaning (Sarangi & Candlin, 2001, p. xiii). Thus science learning is thought to be consistently transformative, highly innovative, and creative in nature (Kress, Charalampos, Jewitt, & Ogborn, 2001).

Creative learning.

Groves (2009) suggests that as a human race we are leaving the information age and entering the creative age. No longer will technology and current modes of teaching and learning be solely adequate for the millennial learner as "the age of logical, computer-like abilities [gives way to an age and] society based on invention, conceptualization, creativity and design" (p. 5). Creative learning, as a holistic endeavour, is purported to "bridge theory and practice" (Netzer & Mangano Rowe, 2010, p. 125). Creative learning is defined as learning that embraces "both rational and intuitive epistemologies" (p. 141), which are expressed though a "dance between inspiration and reason, logic and symbolic expression, [and] expansive and structured ways of knowing" (p. 123). Creative learning espouses the principles of the quantum perspective of learning especially through its emphasis on kinaesthetic intelligence (Simons & Hicks, 2006).

Netzer and Mangano Rowe (2010) propose that creative learning "opens learners to multiple ways of knowing [by] developing [learners] experientially [and thus] increasing the capacity for reflective awareness of self in relationships to a larger scope of being in the world" (p. 125). These relationships include, and recognize, the interconnectedness of self, others, and the environment (Hare, 2006). Creative learning encourages holistic growth in a multitude of dimensions. These include emotional, cultural, physical, aesthetic, moral (Hare, 2006), social (Yang, 2004), and spiritual dimensions (Netzer & Mangano Rowe, 2010).

Creative learning addresses possibility and potentiality (Simons & Hicks, 2006). Simons and Hicks cite several benefits of using the creative arts such as music, dance, movement, and drama to facilitate learning. For example, music helps to "connect and reconnect feelings with emotions, reconnect with memories [hence] deepening relationships and offering opportunities for personal experience" (p. 83). Drama encourages the occupation of differing roles, which increases students' abilities to enlarge their perceptions of the world and others in the world. Further, movement and dance appeal to kinaesthetic intelligence with outcomes such as (a) "freeing expression and developing creativity, and integrating emotion and intellect" (p. 84); (b) "building trust, gaining confidence and valuing differences" (p. 85); (c) acting as an adjunctive "assessment skill" where "knowing becomes indisputable" (p. 85); and (d) developing "communication skills, questioning skills, team skills, problem-solving skills, lateral thinking, flexibility and adaptability" (p. 87).

Emotional intelligence.

As whole beings, humans have many dimensions, which include not only intellect but also emotions. Emotional intelligence (EI) refers to "the ability to monitor one's own and other's feelings and emotions, to discriminate among them and to use this information to guide one's own thinking and actions" (Salovey & Mayer, 1990, p. 189). Intellectual learning alone

does not prepare students for the realities of the workplace in today's globalized world (Graham, 2009). Graham notes that today's world of "web-based communication illuminates the connectedness and interdependence" of individuals (p. 773), making adequate levels of EI even more important.

In view of this, the development of EI is necessary, if not imperative, in integrating both "technical [skills and the more] qualitative skills" of social competence and empathy (Morris et al., 2005, p. 892; Sherlock, 2002). In this integration ideas and emotion meet (Sherlock, 2002). The result is the creation of virtual-techno-social environments wherein individuals are self-aware, possess self-understanding, demonstrate self-regulation and therefore exhibit the "social competencies of teamwork, communication and conflict resolution" (p. 139). Morris et al. (2005) identify the use of the visual arts and poetry as particularly effective in operationalizing EI.

> The visual arts and poetry can be thought of as the competency of using words and images charged with their utmost meaning. It is within these meanings that powerful and significant evocations of emotion and feeling can be found. Because poetry and the fine arts have the power to shape minds and give meaning to what is seen and heard, they provide a rich contextual background for developing components of EI. (p. 893)

Arts-based learning.

Dewey (1934) was one of the first theorists to suggest that a link existed between the arts and learning that was larger than either. This connection is part of an unidentified whole (Dewey, 1934) which can now be understood in Bohm's (1973) notion of an implicate order where everything is connected. The arts could be understood as a linking mechanism in which intellect, emotion, and "embodied transformation" (p. 141) entangle on multiple levels such as "intuition, imagination and contemplation" (Netzer & Mangano Rowe, 2010, p. 125). In doing so, arts act as a conduit to exploring and linking emotional and real-world issues (Biley & Campney-Smith, 2003).

Arts-based learning uses various art forms as learning modalities. These include poetry, painting, sculpture, guided imagery, journaling, music, dance, and drama (Lane, 2005). Lane reports that using the arts in education has physical benefits as well as cognitive and social benefits. Physical benefits are a result of stimulation of the parasympathetic nervous system, which decreases heart rate, blood pressure, and respirations and results in a shift to "deep relaxation" as endorphins and neurotransmitters are released into the body (p. 123). Additional outcomes of utilizing the arts have been identified. These include amplified energy, compassion, enriched understanding of self (Lane, 2005), increased self-awareness, increased reflexivity (Freshwater & Stickly, 2004), increased ability to communicate experiential knowing (Yorks, 2001), refinement of writing abilities and accuracy (Biley & Campney-Smith, 2003), promotion of meaningful engagement, and facilitation of "shared

understandings of concrete lived experience" (Biley & Galvin, 2007, p. 800).

Staricoff's (2004) review of the medical literature frames additional benefits of utilizing the arts in education such as increasing the ability to think multidimensionally, stress and anxiety reduction, enhanced cognitive task execution, decreased aggression, improved communication, empathy, and heightened understanding of the needs of others. Learners who have engaged in arts-based learning also "respond in a more humane and thoughtful manner to ethical and social needs," resulting in a "powerful way of expressing self and understanding the world" (p. 10). Further, arts-based learning is felt to "re-humanize" the world through "meaningful engagement" with various art forms (Biley & Galvin, 2007, p. 800).

Question 6 - What is the Relevance to Instructional Design?

The quantum perspective of learning is predicated upon five assumptions:

1. Learning is multidimensional;
2. Learning occurs in various planes simultaneously;
3. Learning consists of potentialities which exist infinitely;
4. Learning is holistic/holographic and is patterned within holographic realities;
5. Learning environments are living systems.

The assumptions of the quantum perspective of learning are relevant to instructional design. Designing instruction necessitates that, first, a determination of the properties of that instruction be explicit. This can be understood in terms of five key aspects: what, who, why, where, and when. The "what" of instruction represents course materials that are tailored to fit online curricula and extend to the learners' need for knowledge. The "who" is the online learner. It is of note that defining the characteristics of that learner is a process that is continually evolving. The "why" has ties to both learning outcomes in the various disciplines and to student motivation. The "when" of learning in online instruction has been largely shaped by online and/or mobile technology, which allows almost unlimited access to course materials and interaction forums. It is the "how" aspect with which the quantum perspective of learning is primarily concerned.

The quantum perspective of learning principles apply to instructional design.

1. Online learning needs to be multidimensionally constructed. If it is accepted that humans are holistic beings, then learning must be able to reach the learners' multiple dimensions.
2. Online learning must occur in various planes/dimensions in order to access holistic development. Reaching the learner simply in one quantum dimension (i.e., cognitive or social) is not sufficient to promote learning that extends beyond the confines of the online classroom. Learning that reaches multiple dimensions becomes learning that is

accessed for life.

3. Humans have infinite potential to learn and develop in all dimensions.

4. Human potential for learning is ubiquitous. Geographic separation and asynchronous learning are not limitations in online learning.

5. Online instructional design should encourage learners to reach beyond temporality and virtuality into holographic realities. Holographic realities (which encourage interaction with and between learners, instructors, the learning environment, and technology) become the essence of holistic online education.

6. Online learning environments are living systems which grow, evolve, and develop through the passage of time and space. Online learning environments are dynamic spaces which support the needs of learners, instructors, and educational institutions.

7. Online learning can result in transformation for teachers, learners, and the educational environment. Ultimately through this transformation, technology is potentially both directly and indirectly transformed.

Question 7 - How Should Instruction Be Structured to Facilitate Learning?

Online instruction can be structured to facilitate learning through linking technology to learning strategies that exemplify holism. In doing so, the quantum perspective of learning environments are created. These quantum perspective of learning environments reach students holistically. This holism is created as educators reach toward providing innovative and creative strategies for teaching and learning.

As Yang (2004) stated, "most of the existing adult learning theories tend to narrowly define [what constitutes] knowledge and learning" (p. 260). The quantum perspective of learning environments provide a balance of challenge and skill (Groves, 2009), creativity and interaction, and become an expression of multi-modal strategies for reaching and developing students holistically (Kress et al., 2001). For education to be truly holistic, students must have opportunities to participate, conceptualize, contextualize, systematize (logic and reason), validate, legitimize, transform, interpret, and materialize (action) (Yang, 2004). Ultimately, it is through teaching and learning strategies that the quantum perspective of learning environments are created to provide a path to holistic learning.

Online teaching and learning strategies.

Teaching and learning strategies that facilitate the quantum perspective of learning environments can be found within contemporary educative literature. These include strategies that have been investigated in both traditional and online learning milieus. This section of the paper describes online strategies or strategies that can easily be adapted to the online

environment that facilitates the quantum perspective of learning. Strategies are categorized as they relate to creative learning, EI, science-based learning, and arts-based learning. These strategies are felt to be particularly effective as they model the principles of the quantum perspective of learning and promote the development of the quantum perspective of learning environments.

Creative learning strategies.

Barrett (2006) provides several strategies for enhancing creativity through collaboration. These include encouraging goal setting (both in the short and long term), self-analysis through writing/sharing, providing possibilities to extend thinking through the use of well-placed questions, the provision of multiple alternatives, joint problem finding and problem solving, offering social and emotional support, encouraging risk-taking, assisting students to find their own voices, and finally, modelling "ways of being" (p. 210). In addition, encouraging students to "take control over their own work. . . takes advantage of [and promotes] 'serendipitous' discoveries as they [arise]" (p. 209). Music, dance, and movement have also been found to be powerful tools to stimulate creativity in that they provide conduits for connecting feelings, emotions, and memories through activities aimed at "personal expression" and "engaging with multiple senses" (Simons & Hicks, 2006, p. 83).

EI strategies.

Armstrong (1994a, 1994b, 2009) identifies a multiplicity of instructional strategies that can be adapted for online use to enhance EI. These include the use of metaphors, visualization, analogies, music or environmental sounds, colour, art, and visual organizers in course work (Armstrong, 1994a). Further, Armstrong (1994b) suggests peer sharing activities, cooperative groups, games, one-minute reflection periods, connecting the course materials to the student's own life through reflective writings, giving students choices around lesson content and strategies, providing opportunities to share feelings, and having students adopt one another's perspective for a period of time.

Morris et al. (2005) lend support in emphasizing the use of visual arts such as paintings, photography, and poetry to develop EI. Photographs or paintings can be used to teach students to identify non-verbal signals, while instructor-or student-generated poems or song lyrics which "have identifiable emotional content and imagery" can be used to assist students in recognizing thoughts and feelings (p. 896). Reflective journals that help students to relate subject matter to their experiences, as well as the use of case analyses, composing "gratitude letters," and requiring students to engage in service work in their communities, have been found to help students develop EI (p. 898). Further, Graham (2009) claims that the use of email, blogs, and text messaging "increase opportunities to use EI" (p. 779).

Science-based strategies.

Science can be explored from various perspectives, including aesthetics, history, philosophy, bibliography, economics (van Rooyen & de Beer, 1994), and ethics (Hartsell, 2006).

Online group work and discussion forums are teaching strategies that can help students work through ethical dilemmas. Hartsell notes that online forums are particularly effective "for the purpose of analyzing and describing solutions to difficult problems" (p. 270). Art such as paintings, poetry, and photography can be used by students, instructors, or both (van Rooyen & de Beer, 1994) to supplement discussion forums and/or course materials. Instructors may need to instigate the use of these augmenting strategies. Klahr and Nigam (2004) emphasize the role of modelling from instructors as pivotal in promoting "diffusion and authentic reasoning" in students (p. 661).

Arts-based learning strategies.

Many of the preceding strategies have ties to arts-based strategies. In addition to those already presented, artistic pedagogical technologies (APTs) (Perry & Edwards, 2010) are arts-based teaching strategies utilized in online postsecondary learning environments. APTs encompass a variety of teaching strategies that use drama, literature, music, film, and photography to promote interaction, enhance community, and encourage participants to become "real" to one another in online courses (Perry & Edwards, 2010; Janzen, Perry & Edwards, 2011). The uses and benefits of these online strategies have been explored in several studies (Perry, 2006; Perry, Dalton & Edwards, 2008; Perry & Edwards, 2010; Janzen et al., 2011; Perry, Menzies, Janzen & Edwards, 2011; Perry, Edwards, Menzies, & Janzen, in press).

Photovoice (PV) is an example of an APT that facilitates holistic learning. PV as a teaching strategy consists of a photograph and reflective question posted to an online discussion forum on a weekly basis during a course. Each photo and question dyad is relevant to a specific course topic. PV activities are optional and non-graded. Students are invited to respond to the image and question. An example of a PV activity from a course on organizational change includes an image of a tree in autumn (see Figure 1). The accompanying reflective question is, "How has change impacted your workplace?" Students use the metaphor of the autumn tree to describe and discuss aspects of transition and change in their professional lives.

In the online milieu PV has been found to assist students to move beyond the dimensions of technology and virtuality and become "real" to one another as they interact in these spaces (Janzen et al., 2011). Students share their thoughts and feelings as multidimensional persons as they move through PV activities in successive course units. Students often describe "aha" moments when learning in these spaces is wrapped not only within the cognitive and social, but in other dimensions as well. PV in this way encourages holism and holistic development. PV encapsulates three types of learning: holism-based learning, creative learning, and learning that is arts-based. The effectiveness of this teaching strategy may be explained using the quantum perspective of learning.

Figure 1. Photovoice image (Image Otto F. Mahler, 2010, used with permission).

Implications

There are several implications which arise from a discussion of the quantum perspective of learning. As the world continues to shrink geographically through the expansion and discovery of technological connections, creation of knowledge and learning is likely to accelerate. Those learners who were previously not able to be reached through time or space limitations can be party to increasing opportunities to connect with other learners and educational institutions in new ways. The quantum perspective of learning in essence is about helping learners to discover the connections that will ultimately enrich their lives as learners and as human beings in a wide array of dimensions such as culture, corporeality, and sociality.

Online learners have instant access to vast amounts of information in real-time as they are learning. The Web becomes an integral part of this learning. Online learners, through searching ideas, terms, topics, and keywords, have the capacity for a breadth and depth of knowledge that in times past was only reserved for a select few who had access geographically to educational institutions. With this instant access, a holistic view of topics may be more achievable. In this way learning can become infused with infinite possibility.

Courses can be designed that encourage the discovery of the multiple connections that already exist. In terms of learning design, courses can be developed that have less prescription in terms of "assigned" readings. Instead learners can be provided with topics and themes and encouraged to seek out information sources and resources to inform themselves. In this way, courses reflect benchmarks while providing student engagement, and perhaps increased immersion, in specific connections that are important for the individual student. Preparing learners to know how to select credible online resources remains a precursor.

Students, being multidimensional, learn using different learning styles. Some learn by listening and some by doing, while others are visual learners. The quantum perspective of learning involves encouraging learners to select resources that meet their learning style preferences. Examples include podcasts for auditory learners and online videos or e-books for visual learners. Learning designers need to lead the way in providing learning opportunities so that learners discover their meaningful connections through their preferred way of learning. In this way educational institutions and instructors create partnerships with students that co-create accountability, creativity, and discovery.

The quantum perspective of learning environments often consist of virtual classrooms that can be designed to accommodate the quantum learner. The virtual classroom has the potential to merge virtuality and temporality with several advantages. Online learners have private space and time for thinking and learning. In some ways the relative "isolation" of their learning environments is an advantage with respect to undistracted thinking and reflection. Learners have the silence needed to dwell and reflect. Further, online learners have the freedom to learn at a time and place that is right for them. That is, they have more control over their learning environments. Learning can be engaged in comfortable, personally motivating spaces and places that become their individualized classroom.

In the quantum perspective of learning, learning is influenced by a myriad of factors including culture, sociality, behaviour, cognition, spirituality, and others. In some ways it may be an advantage for online learners to learn in their own spaces as these spaces are rich in cultural and spiritual cues important to their learning and understanding. In other words, taking students from their home environments and placing them in an alien environment (a traditional university classroom) may inhibit learning as the cultural and spiritual foundation of their being is not present. Learning at home in comfortable, familiar surroundings may, from the quantum perspective of learning, be an advantage as the student is in context.

Conclusion

The quantum perspective of learning was examined utilizing a combination of Schunk's (1991) and Ertmer and Newby's (1993) definitive questions for aligning learning theory with instructional design. Four types of learning, which may be best explained by the quantum perspective of learning, were delineated. Strategies that can enhance and create the quantum perspective of learning environments were provided. Implications were discussed.

The quantum perspective of learning provides an opportunity to view learning, learners, and learning environments in a new way. If all exists in holographic realities and all is connected, it may become even more important that learning environments which espouse the tenets of the quantum perspective of learning be created. These environments are dynamic and continue to evolve over time in keeping with the plethora of connections that are discovered every day. The quantum perspective of learning may provide a bridge to understanding more fully how we learn.

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