Addressing diverse learner preferences and intelligences with emerging technologies: Matching models to online opportunities

Ke Zhang

Curtis J. Bonk

Authors

Ke Zhang is an assistant professor in the Instructional Technology Program at Wayne State University. Previously, she was an assistant professor at Texas Tech University in 2003-2006. Correspondence regarding this article can be sent to: ke.zhang@wayne.edu

Curt Bonk is a professor of Instructional Systems Technology and adjunct in the School of Informatics at Indiana University. Curt is President of CourseShare and SurveyShare. He can be contacted by e-mail: cjbonk@indiana.edu

Abstract: This paper critically reviews various learning preferences and human intelligence theories and models with a particular focus on the implications for online learning. It highlights a few key models, Gardner's multiple intelligences, Fleming and Mills' VARK model, Honey and Mumford's Learning Styles, and Kolb's Experiential Learning Model, and attempts to link them to trends and opportunities in online learning with emerging technologies. By intersecting such models with online technologies, it offers instructors and instructional designers across educational sectors and situations new ways to think about addressing diverse learner needs, backgrounds, and expectations. Learning technologies are important for effective teaching, as are theories and models and theories of learning. We argue that more immense power can be derived from connections between the theories, models and learning technologies.

Résumé : Cet article passe en revue de manière critique les divers modèles et théories sur les préférences d'apprentissage et l'intelligence humaine, avec un accent particulier sur les implications qui en découlent pour l'apprentissage en ligne. L'article présente quelques-uns des principaux modèles (les intelligences multiples de Gardner, le modèle VAK de Fleming et Mills, les styles d'apprentissage de Honey et Mumford et le modèle d'apprentissage expérientiel de Kolb) et tente de les relier à des tendances et occasions d'apprentissage en ligne qui utilisent les nouvelles technologies. En croisant ces modèles avec les technologies Web, les instructeurs et concepteurs pédagogiques dans les secteurs de l'éducation ou en situation éducationnelle se voient offrir de nouvelles façons de tenir compte des divers besoins, horizons et attentes des apprenants. Les technologies d'apprentissage sont importantes pour un enseignement efficace, tout comme les théories et les modèles d'apprentissage. Nous sommes d'avis qu'en établissant des liens entre les théories, les modèles et les technologies d'apprentissage, il est possible d'obtenir un résultat plus puissant.

Introduction

Online learning is one among the extensive lineage of educational technologies and processes that has shifted where, when, and how learning occurs. As educational technologies continue to emerge and progress, the learning situations and problems as well as the resources to solve them can be customized for online learners. Online resources and technologies can support fascinating opportunities for interactive and collaborative learning among people who have never physically met. At the same time, they can sanction opportunities for knowledge sharing among learners and teachers in vastly different times zones (Papastergiou, 2006). What is perhaps most significant is that there is growing awareness of the importance of addressing individual learner needs and preferences in online learning spaces.

People differ along a wide continuum as to how they learn and how they prefer to learn. This continuum of differences is often referred to as learning styles or preferences (Pask, 1976; Riding, R., 1997; Riding & Cheema, 1991; Riding & Raynor S., 1998; Sadler-Smith, 1997), as well as cognitive styles, types of intelligences, and thinking approaches or styles (Jonassen & Grabowski, 1993, Sternberg & Zhang, 2001). While the names and terminology may vary, the key goal of education is to help all learners learn. The learning style and related literature highlights the needs for variety and diversity in instructional methods, reminding educators that there is no one single learning method that works for everyone. Thus, we use learning preferences in this paper as a general term to encompass the traditional learning styles literature, as well as that related to cognitive styles, multiple intelligence theories, brain-based learning, and other related models and perspectives, in an attempt to help build a broader understanding of how people differ in learning and more importantly, how to address these differences in teaching and learning designs and practices.

Despite the critical views on learning style research (e.g., Coffield, Moseley, Hall, & Ecclestone, 2004; Santo, 2006), these theories and models stimulate more thoughts and reflections upon how one might address diverse learners. As scholars pointed out (e.g., Knowles, 1984; Wedemeyer, 1981), choices and self-directed learning opportunities are more likely to result in learning-related success, especially with adult learners. Thus, by beginning to address learner preferences, one may be able to design more effective and engaging learning experiences.

Pros and Cons of Learning Preferences

The learning styles literature focuses on how people need or prefer to learn (Brophy, 1998; Riding & Cheema 1991). In a systemic review of learning styles and associated pedagogical applications, Coffield and his colleagues (Coffield et al., 2004) identified 71 different learning style theories. In the following, we briefly review some of the more influential learning preferences theories and models of the past few decades, with a particular emphasis on how they relate to online learning.

In general, learning styles refer to the pattern or tendency of an individual's learning

behaviours and attitudes. These styles influence how people learn and how they may be better taught. Effectively addressing styles of human learning can have enormous payoffs for an organization or institution that is expanding its education and training opportunities using emerging technologies. For instance, Judy Serwatka (2005) claims that the key ingredient in improving student retention and increasing motivation in online courses lies in addressing student learning styles. However, instructors and course designers will likely continue to encounter difficulty designing components of a course that will address all learning styles or preferences (Serwatka). Thus educators may benefit from finding and adopting free online resources, such as those in MERLOT (see http://www.merlot.org), which may engage multiple learning preferences. The increasingly available online resources, especially through Web 2.0 technologies (e.g., wikis, YouTube, etc.) certainly have great potential to help course designers and instructors to choose and integrate a wide variety of learning activities and materials to address various learner preferences.

In an attempt to document the relationship between online learning and learning styles, Santo (2006) finds that as a construct, the idea of learning styles is rather weak. Different instruments contain dissimilar factors making it difficult to know what to compare or address. And in some cases, a learning styles inventory or instrument is akin to a personality measure (Santo). Also, most of these learning styles instruments rely on learners self report, respondents may select answers that they think their instructor or those conducting the assessment want to see or that are deemed popular at the time (Santo). In addition, Santo also argues that there is a lack of research verifying any connection between the evaluation of learning styles and student success in an online course or learning experience. A fourth issue is that the more options offered by online learning experiences (e.g., synchronous learning combined with asynchronous), the more difficult it is to track or clarify any relationships that may exist. Yet another problem of most, if not all learning style schemes, is that while they may explain some aspects of human learning in one culture, they cannot be generalized across other cultures. The inability of most learning style instruments to address cultural differences in learning is perhaps its most serious flaw.

Despite the issues concerning learning styles literature, the awareness of learner differences may help instructors to better address the customization and personalization trends in online learning. The learning preference approach may also stimulate more active and more critical reflections on one's teaching or course design practices. In this paper, we review some of the most influential models that have significant implications for online teaching and learning. In our discussions in the later portions of the paper, learning preference(s), instead of learning style(s), will be used to hopefully convey a broader sense of learner differences concerning online instructions in particular.

Kolb's Experiential Learning Cycle

Kolb's experiential learning cycle theory is widely applied or adapted in teaching and training. According to Kolb (1984), effective learning involves a four-stage cycle, from (1) getting involved in concrete experiences (CE), to (2) reflective listening and observations

(RO), to (3) creating ideas with an abstract conceptualization (AC), and to (4) making decisions through active experimentations (AE). Kolb's experiential learning model not only specifies a four-stage learning cycle that applies to learning in general, but also identifies four learning styles or preferences that relate to individual learners. Two polar opposite dimensions exist, one on the vertical axis contrasting CE vs. AC (i.e., the perception continuum), and one on the horizontal wherein learners must choose between AE vs. RO tasks and activities (i.e., the processing continuum).

At the top of the perception continuum are those individuals with preferences toward concrete experiences who tend to learn by feelings. Such learners tend to learn best through immediate experiences which can be felt, heard, or seen. In contrast to the feeling preferences of concrete learners, those who are happiest with abstract conceptualization experiences (i.e., at the bottom of the perception continuum) are typically in a thinking mode when they learn. Abstract learners love to analyze, develop theories and ideas, and systematically plan things out. On the left side of the processing continuum are learners who tend to be in their element when reflectively observing and watching others. They feel at home when making careful observations and being exposed to different viewpoints or opinions. On the other end are learners who typically desire active experimentation and learning by doing. Such individuals love to have a chance to influence others, take risks, and simply like to get things done (Santo, 2006). For Kolb, no one type of processing or perception is preferred or deemed better. In addition, he asserts that one can enter the learning cycle at any of these four points.

Based on completion of a learning style inventory developed by Kolb (1976) which has questions related to each type of learning preference, the learner determines where she is on each of those two axes, horizontal and vertical. After determining one's position along the two dimensions, a line is drawn between the two points to determine which of four quadrants the learner tends to prefer: (1) accommodating, (2) diverging, (3) converging, or (4) assimilating. Kolb and his followers argue that these are the four key learning styles that need to be addressed in any type of learning situations. Accordingly, there are certain ways to address learners who exhibit each particular style of learning.

Table 1 summarizes some the key learner characteristics and preferred learning activities of each of the four styles of learning, together with some online learning technologies and activities. For example, accommodators prefer to learn through practical experiences (CE/AE) rather than logical analyses. Divergent learners focus on feeling, watching, and reflection (CE/RO), and often view things from different or multiple perspectives. Assimilating learners learn from watching and thinking (AC/RO) and prefer reading, lecturing, and logical analyses. A converging style is indicative of people who learn from doing and thinking (AC/AE). Convergent learners also enjoy experimenting with new ideas and solving practical problems.

Table 1. *Linking Kolb's learning style theory (Smith, 2001) to emerging technologies*

Learning Style	Preferred learning activities / stages	Highlighted learner characteristics	Examples preferred learning activities	Online learning technologies and activities
Accommodating	Active experimentation & concrete experience	Risk taking; Attracted to new challenges & experiences; Carry out plans; Good in roles requiring action & initiative; Prefer to work in teams to complete tasks; Motivated by questions like: "what would happen if I did this?"	Doing, hands on activities; Working on complex issues or problems; Working with others; Implementing ideas; Intuitive activities preferred over logical ones	• Action research • Case simulations or real case analysis • Content review games • Cross-course creativity &/or productivity projects • Dynamic, authentic data analysis • Learner podcasts • Mock trial • Online problem solving, project-based, & problem-based learning • Online role play • Posting group work in discussion forums • Practicum • Scenario-based & case learning • Video-scenario learning • Web-based survey research • Wiki projects
Diverging	Concrete experience & reflective observation	People-oriented More emotional & imaginative Strong in the arts Broad cultural interests Sensitive to feelings Incorporate different perspectives	Imaginative activities Idea generation, brainstorming Cultural influences Social interactions Prefer to work in groups Prefer personalized feedback Discovery of the "why"	• Analysis & reflections upon archived or live expert talks/presentations • Anchored instruction with online videos • Collaborative blogs • Creating or contributing too online e-books & wikibooks • Critical peer review (critical friends) • Digital storytelling.

Table 1 (cont'd). Linking Kolb's learning style theory (Smith, 2001) to emerging technologies

Learning Style	Preferred learning activities / stages	Highlighted learner characteristics	Examples preferred learning activities	Online learning technologies and activities
				• Exploring online museums & historical places • Individual or team reflective writings • Lurking, observing, & summarizing online discussions • Make model responses/projects/answers available; • Online brainstorming & synchronous chatting. • Online collaborative writing • Online storytelling & digital poetry projects • Online resource libraries • Self-check reflections • Social networking linkages • Special interest groups • Reuse of expert chat sessions • Role play, mock trials, debates, and reflections upon these activities afterwards • Virtual worlds such as Second Life • Web-based videoconferencing
Converging	Abstract conceptualization & active experimentation	Prefer dealing with objects rather than people Prefer decisions related to real-world problem solving Less concerned with interpersonal aspects of	Practical application of ideas /theories/ models Experimentation Technical tasks & activities Discovery of the "how"	• Broadcast major learning events • Charts & graphing tools • Dynamic database-related learning • Guided readings

Table 1 (cont'd). Linking Kolb's learning style theory (Smith, 2001) to emerging technologies

Learning Style	Preferred learning activities / stages	Highlighted learner characteristics	Examples preferred learning activities	Online learning technologies and activities
		problems Experiment with new ideas Focused relatively narrowly on certain interests Less emotional	Simulate & work with practical applications	• Mashups of Google maps • Mathematical or scientific visualization tools. • Media-rich online cases • Online quizzes & self checking. • Position & reaction papers. • Simulations & gaming • Using & creating learner-generated advanced organizers: models, flowcharts, diagrams, systems, & illustrations • Web-based survey reports • Whiteboard demonstrations
Assimilating	Abstract conceptualization & reflective observation	Like to find the "right" answer instead of random exploration Understand & organize a wide range of information Motivated by questions like: "what is there to know?"	Theoretical models Reflective observations Abstract concepts Inductive reasoning & logic activities Expert advice situations Prefer readings, lectures, exploring analytical models	• Blogging • Creating wiki projects • E-portfolio • Flash animations of complex concepts • Field/lab observations • On-demand & work-flow learning • Online experiments & hypothesis testing • Online guest experts & tutors. • Online science labs & simulations • Online timeline, flowcharting, & concept mapping tools • Online tutoring/mentoring • Online video anchors

Honey and Mumford's Learning Styles

Based on a simplified version of Kolb's (1984) learning cycle, Honey and Mumford (1986, 1992) defined the following four learning styles: (1) activist, (2) reflector, (3) theorist, and (4) pragmatist. As illustrated in Table 2, these learning styles are each related to a particular stage of Kolb's learning cycle. For example, activists are similar to accommodators, reflectors share characteristics akin to divergers, theorists and assimilators are much alike, and pragmatists have many of the characteristics of convergers.

Table 2. Linking Honey and Mumford's (1986, 1992) learning styles to emerging technologies

Stage in Kolb's learning cycle / *Honey and Mumford's Learning style*	Learner characteristics	Recommended learning activities	Online learning technologies and activities
Stage 1: Experiencing (CE) / *Activist*	Excited about new ideas Enjoy doing Throw themselves into a task Seek challenges & immediate experiences Open-minded Like working with people	New experiences and problems Team tasks	• Action research • Client consulting & experiential learning • Content review games • Creating wiki projects • Digital story telling • Interactive, collaborative creative writing or projects • Jigsaw activities • Learner podcast events or shows Mock trial or case simulations • Online cases & scenario activities • Online design comparisons & activities • Project & problem-based learning • Role plays • Text messaging • Video scenario learning • Virtual labs • Virtual practicum • Web-based survey research • Webquests
Stage 2: Reflecting (RO) / *Reflector*	Reflect with various perspectives Like to collect data & analyze Enjoy observing & listening	Observation Data gathering Review & analysis	• Analyzing archived debates & real cases • Animations • Blogs • Critical feedback • Debates • Illustrations • Online role play reflection

Table 2 (cont'd). Linking Honey and Mumford's (1986, 1992) learning styles to emerging technologies

Stage in Kolb's learning cycle / *Honey and Mumford's Learning style*	Learner characteristics	Recommended learning activities	Online learning technologies and activities
			• Online videos & lectures • Podcasts • Reflection or position papers • Self-check reflections • Social networking linkages Small group case analysis or creation • Team reflective writing tasks • Webinars
Stage 3: Conceptualizing (AC) / *Theorist*	Analytical, think things through See wider picture Less emotional	Complex tasks Activities wherein one must make sense or organize disparate facts or form theories based on evidence	• Advanced organizers: models, concept maps, flowcharts, diagrams, illustrations • Animations & simulations • Concept mapping • E-books • Expert commentaries • lab demonstrations • Mashups, Google maps • Models & frameworks • Scientific visualization tools • Second Life demonstrations • Streamed videos • Timelining data & events • Whiteboard demonstration • Wiki projects
Stage 4: Experimenting (AE) / *Pragmatist*	Practical Down-to-earth Enjoy problem solving & decision making	Hands-on experiences Practical applications of knowledge & skills On the job & on demand learning	• Analyzing archived debates or real cases • Digital storytelling • Authentic data analysis & reports • Client consulting & experiential learning

Table 2 (cont'd). Linking Honey and Mumford's (1986, 1992) learning styles to emerging technologies

Stage in Kolb's learning cycle / *Honey and Mumford's Learning style*	Learner characteristics	Recommended learning activities	Online learning technologies and activities
	Bored with long discussions	Provide activities wherein they can try things out	• Course project galleries • Cross-course content discussions, critiques, analysis & evaluations • Cross-course product development & creativity • Debate • Expert presentations & commentaries • FAQs • Gaming • Learner-generated learning materials & resources • Learner-generated reports & podcasts • Learner-generated wiki projects • Mock trials • Online panels • Product evaluations. • Problem solving • Role plays • Real time case studies, analysis • Simulated cases • Simulations

Honey and Mumford admit that the similarities are greater than the differences in this model since the four stages of their learning cycle had their roots in the Kolb model. In both cases, it is important to combine opportunities for gaining experience, reflecting on that experience, coming to new insights or conceptualizations, and then taking action or experimenting with such new theories, ideas, or approaches. Hence, activities that can engage all four styles can be important for effective instruction. Given that approaches to learning vary across the population, involving multiple instructional methods, models, and strategies in online courses will perhaps help in creating more appealing learning experiences that address the ways in which different people learn.

4MAT

In extending Kolb's (1984) experiential learning approach, Bernice McCarthy (1987) developed the 4MAT system, which also addresses four types of learners, (1) innovative, (2) analytic, (3) common sense, and (4) dynamic. According to McCarthy, innovative learners are primarily interested in personal meanings, whereas analytic learners tend to focus on acquiring facts to understand concepts and processes. Innovative learners, therefore, try to connect their learning situations to their daily lives. Instructional approaches that might be effective in this regard include cooperative learning, brainstorming, and content integration activities. Such innovative learners deeply appreciate personal reasons and connections within their learning environments. Analytic learners, on the other hand, might prefer lectures, independent research projects, opportunities to analyze real-world data, and listening to expert viewpoints and advice.

Innovative and analytic learners are not the only two choices, however. In contrast to these two approaches, are common sense and dynamic types of learners. McCarthy notes that common sense learners want to know how things work, while the fourth type of learner in her model—dynamic learners—are primarily interested in self-directed discovery. Instructional methods of choice for common sense learners include the use of

manipulatives and other hands-on tasks as well as kinesthetic experiences. As the name of this type of learning implies, common sense learners tend to succeed when practical learning activities are used. For dynamic learners, popular instructional methods might include independent study or self-selected experiences, games and simulations, as well as interactive role-playing and debates.

Even though learners have their preferences, McCarthy contends that true learning strengths are evident in a learner who can move from one mode of learning to another depending on the requirements of the particular problem or learning situation. Thus, the curriculum should be designed in ways that allow learners to shine as well as encourage them to stretch to new learning heights. In effect, learners should learn within their comfort zones as well as in places beyond or at the edges of their learning envelopes. As a tool for both classroom management and organizational change, the 4MAT system attempts to shed light on learning at the individual, group, and organizational levels. It is useful for explaining and demonstrating the diversity of learning approaches.

VARK

Another widely influential model is VARK (also known as VAK or VACT) which was designed by Fleming and Mills (1992a, 1992b). Similar to the three learning style models already reviewed, the VARK model identifies four types of learners and learning preferences (Fleming, n.d.): (1) Visual; (2) Auditory; (3) Reading/writing; and (4) Kinesthetic, tactile, or exploratory. As official website of the VARK (Fleming, n.d.) points out, while many people have a dominant or preferred learning style, some have a mixed and evenly balanced blend of two or more of these styles.

The VARK system not only provides a way to identify learning preferences but also clearly demonstrates the needs and advantages of multimedia applications in education to address these varying styles. From the VARK perspective, visual learners prefer diagrams, flowcharts, and graphics; however, instructional technologies such as videos, films, or PowerPoint presentations are noticeably absent from their descriptions. Fleming (n.d.) argues that some of these media actually use a strong auditory component, instead of visual, and many computer-based learning programs only appeal to the R (read/write) preference with heavy text-based information. Some media do not use the diagrams, charts, and symbolisms that visual learners prefer; and videos and photographs showing real situations actually address kinesthetic learners, not the visual ones. Also, television often appeals to all preferences. Of course, the medium itself does not guarantee the quality of learning materials delivered through it, and, thus, one may claim that not all videos appeal to those with a strong visual preference. However, we would argue that perhaps videos, films, PowerPoint and the like would appeal to either one or multiple modalities or preferences of learning, depending on the design of the materials and activities.

In contrast to visual learners, auditory learners naturally prefer hearing directions, lectures, or verbal information, while learners who prefer reading and writing learn best

from text passages, words, and written explanations. Finally, tactile or kinesthetic learners excel when connecting their learning to reality through hands-on examples, role-play, debates, practice exercises, and simulations. While a learner may have a preference to learn by processing text, hearing information, visually perceiving the content, or actively engaging in or doing a particular task, as indicated, many people are multi-modal and have more than one learning preference.

Gardner's Multiple Intelligences

Unlike traditional learning style theories, Howard Gardner (1983, 1993) proposes that people differ in terms of their intellectual compositions. According to Gardner (1983, 1999), intelligence is a set of talents, skills, or potentials for finding solutions. He contends that people have varying amounts of different intelligences (Smith, 2002). Gardner further argues that multiple intelligences may be cultivated, strengthened, or otherwise weakened. Gardner (1993, 1999) identifies the following three categories of intelligence: (a) thought, which includes verbal/linguistic, logical/mathematical, naturalist, and existential forms of intelligence; (b) sensate, including visual/spatial, body/kinesthetic, and auditory/musical forms; and (c) communicational intelligences, such as interpersonal and intrapersonal.

While nine different types of intelligences are listed in Table 3, he originally was known for seven intelligences, with the naturalist and existential forms being added later. Despite the clamour over his nine forms of intelligences, Gardner argues that there may be even more categories or types of human intelligences. Table 3 attempts to link the nine intelligences detailed here to technological processes and activities that one might attempt to conduct online. This list makes it clear that educators have enormous online resources for addressing many forms of human intelligence. Learners can collect original data online, analyze and visually represent such data, reflect on the findings, and then electronically share their findings and final products with peers and experts for their honest appraisals and feedback. While the technologies for verbal/linguistic as well as logical/mathematical intelligences are perhaps widely known, there are now a host of tools to address intrapersonal and musical intelligences. even bodily/kinesthetic, naturalist, and existential intelligences, online.

Though often contested theoretically by academic psychology, multiple intelligence theory is well accepted by both the educational community as well as the general public (Smith, 2002). In fact, it is widely applied in education, as instructors have adapted instruction to address varying individual learner's needs and preferences with a range of learning materials and activities. Of course, as Table 3 reveals, increasingly available computer and Internet technologies further extend the power and possibilities of addressing learning preferences and stimulating multiple intelligences in online learning.

Table 3. Linking Gardner's Multiple Intelligences to Emerging Learning Technologies

Intelligence (Smith, 2002)	Brief definition	Characteristic skills	Examples of preferred online learning activities (Lamb, 2004, 2006)	Examples of emerging learning technologies
1. Verbal-linguistic	Well-developed verbal skills & sensitivity to sounds, meanings & rhythms of words	Listening, speaking, writing, teaching; Understanding the order & meaning of words; Humour; Memory & recall; Explaining, convincing others of a course of action	• Voice annotations, podcasting • E-mail, electronic libraries, word processing • Audio recordings, chats, discussion forums, debates • Online dictionaries, encyclopaedias, online puzzles & word games, & online reference materials & resources • PDF files • Story creation tools, tools for sharing writing & poetry	• Audio cases • Audio chats • Audio dramas • Blog • Digital storytelling • Discovery reading • E-books & wiki projects • FAQ & course announcements • Google Documents & Spreadsheets • Guided reading • MP3 files for documents & books • Online dictionaries • Podcasts • Style guides • Text messaging course notes & content • Thesauruses • Voice e-mail • Voice discussion board • VoIP • Web tours & Safaris • Wikis: Wikipedia, Wikictionary, Wikinews, Wikibooks, Wikiquote, Wikiversity, Wikicommons
2. Mathematical - logical	Ability to think conceptually & abstractly, & capacity to discern logical or numerical patterns	Problem solving Experiments Inductive & deductive reasoning Abstract pattern recognition Discerning relationships &	• Scientific probes • Graphing aids • Online data collections & surveys • Video demos & animations of experiments • Critical thinking program • Math skill tutorials	• Advanced organizers • Charts & graphics • Concept mapping • Flash movie • Online calculation tools & utilities • Online spreadsheets • Streamed video • Super summaries

Table 3 (cont'd). Linking Gardner's Multiple Intelligences to Emerging Learning Technologies

Intelligence (Smith, 2002)	Brief definition	Characteristic skills	Examples of preferred online learning activities (Lamb, 2004, 2006)	Examples of emerging learning technologies
		connections Logical thinking, scientific reasoning	• Problem solving exercises	• The Global Grocery List Project: http://www.landmark-project.com/ggl/ • The Globe Program: http://www.globe.gov/globe_flash.html • Theory building & model testing • Web quest portal: http://webquest.org/ • Online scavenger hunt: http://www.spa3.k12.sc.us/Scavenger.html • Vodcasts • YouTube videos
3. Musical	Ability to produce & appreciate rhythm, pitch, & timber	Singing, playing instruments Composing music Sensitivity to sounds Recognizing, creating, or reproducing music	• Sound & music files & clips • Music composition software • Interactive books & resources with audio & musical components • Audio annotations • Digital singing • Online musical instruments & acoustics	• E-books • E-portfolio • Media rich learning materials • Music podcast directory: http://www.podcastingnews.com/forum/link_19.htm • MySpace • Online live / archived performance • Online portal exploration • Online resource libraries • Podcast • Podcast or stream live learning events • Second Life • Wikibooks • YouTube

Table 3 (cont'd). Linking Gardner's Multiple Intelligences to Emerging Learning Technologies

Intelligence (Smith, 2002)	Brief definition	Characteristic skills	Examples of preferred online learning activities (Lamb, 2004, 2006)	Examples of emerging learning technologies
4. Visual -spatial	Capacity to think in images & pictures, to visualize accurately & abstractly	Puzzle building, painting, constructing Fixing, designing objects Active imagination, graphic representations, forming mental images Recognizing relationships of objects in space	• Timeline, concept mapping, & other map making tools • Oral history projects • Board games • Digital cameras • Online clip art • Electronic chess • PowerPoint presentation • Digital artwork, charts & graphs • Spatial problem solving games	• 3D tools • Drawing tools • IHMC concept mapping tool: http://cmap.ihmc.us/ • Interactive news & news documentaries • Photo albums • Second Life • Timeline tools • Video conferencing • Virtual archaeology • Virtual field trips • Virtual tours • Visual Understanding Environment (VUE): http://vue.tccs.tufts.edu/ • YouTube, TeacherTube, CNN News & Video, BCC News & Videos, CurrentTV, SplashCast
5. Bodily-kinesthetic	Ability to control one's body movements & to handle objects skilfully	Dancing Sports Hands-on experiments Acting Awareness through body, mind & body connections	• Online role plays, skits, & demos • Online scientific probes & microscopes • Online surgery demos • Handheld activities, motion-simulation games, hand-eye coordination games • Haptic tools • Virtual reality systems	• Creative productions • Flash animations • Interactive visual with online chats: http://www.learningbydoing.net/ • MedCases CME Portal: http://www.medcases.com/Physician/cme_portal.asp • Mock trial • Online case scenarios • Online simulations & labs • SimTeacher: http://www.simteacher.com/ • Simulated or real cases • Video productions

Table 3 (cont'd). Linking Gardner's Multiple Intelligences to Emerging Learning Technologies

Intelligence (Smith, 2002)	Brief definition	Characteristic skills	Examples of preferred online learning activities (Lamb, 2004, 2006)	Examples of emerging learning technologies
				• Virtual field trips • Virtual Jerusalem tour: http://www.md.huji.ac.il/vjt/ • Virtual practicum • Virtual tour of Antarctica: http://astro.uchicago.edu/cara/vtour • Virtual tour of the sun: http://www.michielb.nl/sun/
6. Interpersonal	Capacity to detect & respond appropri-ately to the moods, motivations & desires of others	Seeing issues or situations from other perspectives Empathy Effective with verbal & nonverbal communication Working cooperatively Counselling Creating synergy	• Collaborative activities, online group presentations • Peer tutoring • Online coaching & mentoring • Group editing • Brainstorm-ing • Online phone calls	• Blogs • Bulletin boards • Chat • Email • Online cafe • Peer critical friends • Second Life • sixDegrees: http://www.sixdegrees.org • Social networking software: MySpace, LinkedIn, Facebook, • Synchronous communications • VoIP • word processing
7. Intrapersonal	Capacity to be self-aware & in tune with inner feelings, values, beliefs, & thinking processes	Recognize one's strengths & weaknesses Reflective, aware of inner feelings Metacognition Mindfulness Higher-order thinking & reasoning	• Reflective writing tasks • Self-paced online research & activities, multimedia • E-portfolios • Personal or anonymous brainstorming • Review & self-check	• Blogging & online journaling & diaries • Critical analysis • Lurker, browser, observer or summarizer of online discussions • Online role play reflections • Peer critical friends • Reflective activities

Table 3 (cont'd). Linking Gardner's Multiple Intelligences to Emerging Learning Technologies

Intelligence (Smith, 2002)	Brief definition	Characteristic skills	Examples of preferred online learning activities (Lamb, 2004, 2006)	Examples of emerging learning technologies
			questions • Career counselling & personal advisement tools	• Second Life • Self-check reflection activities • Word processing
8. Naturalist	Ability to recognize & categorize plants, animals & other objects in nature	Recognize one's connection to nature Apply science theory to life	• Online microscopes & probes • PowerPoint presentations • Earth science programs	• Adventure blogs • Classification tools • Image files • Nature sound files • Online databases • Online journals • YouTube or CNN videos on the environment • Videoconference • Virtual field trips
9. Existential	Sensitivity & capacity to tackle deep questions about human existence, such as the meaning of life, why do we die, & how did we get here	Reflective & deep thinking Design abstract theories	• Websites with tests & assessments related to personal philosophies • Big picture tools such as concept mapping	• Adventure blogs • Blogging • E-books on philosophy, religion, the environment, life, etc. • E-mail • Expert chats • Reflective portfolios • Reflective YouTube & other shared online videos. • Super summaries • Theory & model review, building, analysis, & testing • Wiki projects

Implications for Online Learning

One of the principal challenges facing online education today is the need to stimulate and sustain learner motivation and retention (Bonk & Dennen, 2003). To address this challenge, effective online environments can be designed for diverse learners with different learning preferences, expectations, experiences, cultural backgrounds, and generational lifestyles. However, it is easier said than done. Just attempting to grasp the sheer number of learning style schemes and approaches is a daunting task. Implementation of one or more of them in an educationally beneficial way can be even thornier. Perhaps the key is to be aware that different learners learn differently.

When web-based learning started to explode in the late 1990s, researchers (e.g., Bonk & Dennen, 1999; Oliver, Omari, & Herrington, 1998) repeatedly argued that popular courseware or course management systems (CMS) were not sufficiently sophisticated for engaging and motivating high quality learning. Such tools not only lacked pedagogical sophistication, the designers of such systems did not appear to be making attempts to address these pedagogical deficiencies (Bonk & Zhang, 2006; 2008). As a result, there are now many calls for pedagogical improvements to learning management systems and other online tools and resources (Bonk & Zhang). However, the expectations for change remain modest at best. In part, such low perceptions were the result of shovel-ware in online courses (Rosenberg, 2001) found in both higher education and business settings. Such online course deficiencies would have permeated K-12 education as well, but, at that time, online learning was not quite as pervasive there.

Despite the negative views and the limited research and development related to effective pedagogical tools from learning management systems (LMS) and course management systems (CMS) vendors, the next generations of LMS and CMS will likely offer more

participatory learning outlets and opportunities to personalize and individualize learning. Already participatory technologies, including podcasts, wikis, blogs, and social networking software, all offer ways to align learning situations with learner preferences and informal learning experiences. Those involved in online education during the coming decade should witness an explosion of such opportunities. As that explosion occurs, educators should be mindful of existing linkages between learning styles, preferences, and approaches, and online learning technologies such as those documented in this paper.

All types of learning situations and events have their respective benefits and opportunities. The options available in online environments can make the learning formats more explicit. Some recent research indicates that we are in the midst of a dramatic shift to more active learning, problem solving, authentic learning, and virtual teaming or collaborative learning in online environments in both higher education and corporate training settings (Bonk, Kim, & Zeng, 2006). Such research indicates that online courses are moving away from their text-centered and lecture-based past while increasingly incorporating hands-on activities (Kim, Bonk, & Zeng, 2005) and some visual and reflective ones as well. While our own research has revealed that hands-on learning is currently deemed the least addressed learning style in online courses across a variety of settings, there seems some hope that it will be increasingly used in the next couple of years (Bonk et al.). Of course, more complex and realistic simulations, scenarios, and interactive news stories are already signalling part of this trend.

As learner differences have been discussed for millennia, what is perhaps unique about the early years of this century is that there are powerful ways to do just that. For instruction of any kind to be successful and have lasting impact, not just temporarily be deemed satisfactory, it must be responsive to learner developmental, linguistic, cultural, and socioeconomic needs as well their learning styles, preferences, or favoured approaches to learning (Wedemeyer, 1981).

As illustrated in this paper, the time is ripe for addressing learning preferences and interests through online tools and activities. Clearly, the various learning styles, learning preferences, and human intelligence theories and models can be linked to emerging and useful technologies for online instruction. With the ample technologies presently available, each instructor or instructional designer will have their own, unique ways of implementing some of the emerging technologies to address particular learner needs and differences apparent in their classrooms or training situations. To help in such efforts, the authors have attempted to offer a few brief examples for this to occur with the hope that it can perhaps open a door to the enormous opportunities for better serving the diverse online learners in the future.

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