Connecting Learning Styles and Multiple Intelligences Theories Through Learning Strategies: An Online Tutorial for Library Instruction

May Ying Chau

Associate Professor/Agricultural Sciences Reference Librarian

The Valley Library, Oregon State University

Corvallis, Oregon USA

Abstract

Although the Dunns' learning styles and Gardner's multiple intelligences theories are two distinct areas of research, they do not oppose each other and can be used together to improve learning. The design of this tutorial is an attempt to integrate students' learning styles and their unique blend of intelligences in the library research process. The goal is to encourage higher-order thinking so that learners can make meaningful associations among information acquired during research. The means used to integrate these two theories is sequenced learning strategies. This tool-kit provides a favorable environment so that participants can learn the styles in which they learn best and intuitively apply their own blend of intelligences.

Keywords: *Library instruction, online tutorial, critical thinking skills, information management, concept mapping, mental imagery, storytelling, information literacy, learning strategies, higher-order thinking, multiple intelligences, learning styles.*

Fallows, Rainie, and Mudd (2004) reported that 84% of online users use search engines (approximately 107 million people); and, according to the report of the Pew Internet and American Life Project, 87% of this population claimed that the engines are able to fulfill their information needs. Since supply and demand are directly connected, it is not uncommon for searchers to locate quality information on the Web. Indeed, many information providers choose to disseminate information by means of the Internet (e.g., non-restricted government information, statistical data from professional societies, university theses/dissertations, and many other research materials). In addition, there are subject specific research databases that provide specialized information.

The dilemma is that, even with quality information, it can be difficult for searchers to effectively solve research problems. In other words, what methods or techniques can help searchers associate information with research goals? Finally, does the association method vary with different kinds of learners? If so, how can each learner effectively apply information to solve problems and analyze results?

These questions need to be addressed in library instruction programs in order to prepare students to become information literate. To address these questions, instructors need to understand that everyone learns and thinks differently. The ability to make meaningful associations between information and research topics is an ongoing learning process, varying from person to person and requiring higher-order thinking skills. Unerbakke, Bor, and Peterson (1993) confirm that "it is crucial for students to engage in higher-order thinking in the library research process in order to interrelate and rearrange information for problem solving, argument analysis, issue negotiation, and prediction making." Often, higher-order thinking skills need to be developed through effective teaching methods. Whittington, Lopez, Schley, and Fisher (2000) state that teaching at different cognitive levels is important to develop students' higher thinking skills.

The teaching method directed towards reaching students' different cognitive levels discussed in this paper is a sequence of learning strategies. These strategies are used as experimental tools to help students apply, analyze, synthesize, and evaluate information. Since no single strategy fits all types of learners, a combination of strategies may better accommodate different kinds of learners.

In order to match learning strategies to suitable learners, it is important to understand how people learn. Therefore, it is important to examine various learning theories. The learning theories discussed in this paper are the Dunns' learning styles (Carbo, Dunn R., & Dunn K., 1986) and Gardner's multiple intelligences (Gardner, 1983, 1993). They are different but not opposing theories that can be used simultaneously if connections are made between them.

This paper discusses the potential of applying a specific sequence of learning strategies in the online tutorial "Computerized Information in Agriculture" to target learners with various perceptual strengths (visual, auditory, kinesthetic, and tactile) as delineated in Dunn & Dunn's model and special forms of intelligences (linguistic, visual-spatial, and bodily kinesthetic) as described in Gardner's theory. Based on assumptions interpreted from the literature (Rochford, 2003; Hough & Donlan, 1994; Denig, 2004; Gardner, 1999; Grow, 1999; and Noble, 2004), the author argues that the sequenced learning strategies used in this tutorial connect the two theories. The goal is to help learners develop higher-order thinking skills. In turn, these thinking skills will help learners extrapolate meanings from information, ask crucial questions, and determine what information is needed to further the research.

APPLICATIONS OF THE LEARNING STRATEGIES

The Learning Strategies and the Research Cycle

This tutorial has three components that mimic the research cycle in order to help learners develop higher-order thinking. The research cycle is a series of ongoing cyclic activities involving repetitive planning, searching, and evaluating/learning. It is crucial to realize that research itself is an ongoing learning process and that each different study will take its own course. Consequently, the starting point(s) of research cycles will also vary from time to time as well as from learner to learner due to different styles and forms of intelligences. For one research cycle, the starting point will be planning, while another time, it will be searching or evaluating. Each time a new research interest is initiated, the research cycle will need to be repeated since a new learning process will begin again.

Relationships Among Components in the Research Cycle

Relationships among components in the research cycle are very complicated. For example, one needs searching skills to retrieve information and, subsequently, to perform thorough research; for if any crucial data is missing, the ability to evaluate information will be impaired. It is, however, counter-productive if the only goal of research is to accumulate information. Planning is needed to direct the path of the research and manage the data retrieved. Planning and searching alone, however, will not be sufficient to perform efficient research. It is extremely important to extrapolate meanings from bits and pieces of data so that they are applicable to the current research. Effective research requires the researcher to exercise all three components in the research cycle.

The most logical place to incorporate the sequenced learning strategies designed for this tutorial is in the evaluating/learning component. The two other components, planning and searching, provide basic knowledge to help learners retrieve and organize information effectively. When such effectiveness has been acquired, it becomes an asset, enabling learners to evaluate information more holistically. Hopefully, learners will learn to look at each piece of data in a more critical manner.

*Description of each component (planning, searching, and evaluating/learning) of this tutorial appears in the appendix of this article.

Learning Strategies Employed in This Tutorial

The learning strategies selected for this tutorial are based on the premise that processing information visually and aurally are integral parts of modern-day life. Modern people are accustomed to having information presented to them in such visual and auditory formats as daily news presentations on television, giant billboard advertisements, and radio broadcasting, etc. Information can also be presented in multimedia format, narrating stories told through simulation of events such as the Discovery television channel's *Walking with Dinosaurs* series.

The sequenced combination of strategies in this tutorial (concept mapping, mental imagery, and talking aloud) is designed to help learners process information in three different ways, i.e., telling the stories that emerge from the information at least three times. First, all information from various sources is processed though graphical means (visual, externalization). Then the graphically processed information will be re-processed through abstract thinking in the mind's eye (imagery, internalization). Finally, the information will be processed a third time verbally (speech, externalization).

Each time the learners tell the story, they will need to use different perceptual strengths and move back and forth between the planes of internalization and externalization. Hopefully, such alternation of perceptual focus will stimulate and enable learners to search for the deeper meaning of the information.

THE ANTICIPATED LEARNING PROCESS OFFERED BY EACH STRATEGY

As indicated below, the evaluation and learning component in this tutorial employs three strategies. They are arranged in a specific sequence to stimulate thinking at different cognitive levels. The purpose is to encourage learners to weave in and out of the planes of externalization and internalization.

Concept Mapping (Externalization)

Concept mapping can be used to develop structural knowledge (Jonassen, as cited in Dabbagh, 2001), derived from the interdependence of declarative (knowing why) and procedural (knowing how) knowledge so that facts, concepts, processes, procedures, and principles can be transcribed to knowledge (Clark & Chopeta, 2004, as cited in Clark, 2004). Activities during concept mapping help learners visually summarize and interpret bits and pieces of information and apply them to different aspects of their research (application). Learners can connect or compare concepts to discover their relationships to each other and then describe or label what the relationships are (analysis). After relationships are established among concepts, they can be organized into a structural framework. Related concepts or keywords can be drawn in hierarchical order, either convergently or divergently. They can also be drawn to represent a holistic picture that includes many facets of the research, for example, why an event takes place or how to make an event happen (synthesis). Finally, learners can compare or rank information presented in the diagram to determine what information is most relevant to their research and what they can discard, or learners can determine what questions or problems need to be solved and what information will be most pertinent for such research (evaluation). See Fig.1

Mental Imagery (Internalization)

Throughout history, mental imagery has accounted for many scientific discoveries. Einstein was "known for using 'thought experiments' to work out problems in a uniquely nonverbal manner. Perhaps his most famous thought experiment was imagining what it would be like to ride on a beam of light. This allowed him to make the conceptual leap of 'seeing' light as though it were in static form. This helped him to resolve the paradoxes underlying what was to become his special theory of relativity" (Rieber, 1994).

Concept mapping can be used to explore various aspects of a research interest, to convert bits and pieces of information into meaningful knowledge, and to better define a research problem or direction. A well-defined problem or more concrete knowledge may potentially increase one's chances of

deriving a solution during the mental imagery process. Because of these benefits, mental imagery is used following concept mapping. Rieber (1994) pointed out that "visualization, like perception, is not like a camera objectively capturing images on film. Interpretation and understanding are continually filtered through one's entire knowledge, values, and beliefs. People often see and imagine what they want to see and imagine. Visualization, like any cognitive process, is greatly influenced by prior knowledge."

Antonietti (1999) finds that imagery is most useful when dealing with concrete situations and that "the spatial character of visual images makes them directly accessible to intuitive abilities." He cites the work of Helstrup and Anderson (1996) and Roskos-Ewoldsen, Intons-Peterson, and Anderson (1993), concluding, "transformation and synthesis of mental images can lead to the discovery of emerging meanings that induce insightful ideas to help create new products."

When mental imagery follows concept mapping, prior knowledge can be translated into mental pictures and/or language-like thoughts (application). Using prior knowledge and/or inferences produced during the concept mapping process and translated to the mind's eye, a learner's insights or intuition may be further developed. Sometimes this reanalysis process may enable learners to ask questions that otherwise would be ignored (analysis). This mental exercise may also result in further reconstruction of inferences or resimulation of events (synthesis). After this stage, learners should search for more information to confirm whether the insights, assumptions, or meanings derived from the mental imagery process are valid (evaluation). See Fig.1

Talking Aloud/Narrative/Storytelling (Externalization)

In this tutorial, the terms talking aloud, narrative, or storytelling are used interchangeably to elicit a single effect, which is learning by telling. Telling can be merely conveying what is learned, explaining how problems are solved, what information is doubtful, or how interesting ideas are developed. Craig, Hull, Haggert, and Crowder (2001) applied storytelling in the linguistically diverse classroom. Craig and his colleagues identified the benefits of storytelling as a tool to develop literary themes, identify author/audience relationship, and tap into prior knowledge. Campbell L., Campbell B., and Dickinson (2004) stated that "expressing ideas verbally is an important meta-cognitive exercise, for it is often in hearing ourselves speak or reading what we have written that we gain insights into what we really think and know." Papadimitriou (2003) applied storytelling in his computer science and math classes. He used three principles in his classes; they are "providing historical/biographical context to a subject, illustrating a concept by a story, and embedding educational material into a story."

In this tutorial, talking aloud makes up the last of the sequence of the combined learning strategies. Learners explain verbally what has been learned during the concept mapping and the mental imagery processes. Talking aloud is a means of verbally communicating knowledge gained and inferences deduced in a way that others can understand (application and synthesis). This process provides opportunities, either with oneself or with others, to debate further whether an inference deduced from the information processed is accurate. It also provides opportunities to explore whether the alternatives derived from the two previous learning strategies (concept mapping and mental imagery) and used to solve different problems are indeed valid (analysis).

During the talking aloud segment, prior knowledge may be tapped and new meanings may be discovered. As many people like to talk about what they do and what they learn, the process is very engaging. During such engagement and socialization, understanding of knowledge gained may be deepened and the research perimeters may be extended. It may also help one decide what information is needed in order to further the research, thus enhancing the evaluative process (evaluation). See Fig.1

The selection of strategies for this tutorial has been determined by the perceptual elements (visual and auditory, kinesthetic and tactile) in Dunn and Dunn's model of learning styles and the spatial and linguistic intelligences in Howard Gardner's multiple intelligences theories.

THEORIES THAT SHAPED THE DESIGN OF THIS TUTORIAL

The Dunns' Learning Styles (LS) and Gardner's Multiple Intelligences (MI) are different but not opposing theories. Reflections of the similarities and differences of these two theories were found in the research literature (Dunn, Denig, & Lovelace, 2001; Denig, 2004). Both theories are student centered and advocate for changing traditional teaching methods in the classroom to accommodate various types of learners (Denig, 2004). Others have integrated these two theories into the design of their curriculum activities (such as Harvey's Intelligence-Learning Style Menus to enhance learning in the classroom (Silver, Strong, & Perini, 1997)

These two theories differ, however, in the question of how people learn. Learning styles research found that not all students learn intuitively and that many need structure and supervision, while multiple intelligences theory suggests that students learn intuitively (Dunn et. al., 2001).

The Dunns' Theory and the Element That Influenced This Tutorial

The Dunns' learning styles model includes twenty-one elements, which can be categorized under five stimuli. "Although no one is influenced by all 21 elements, most students are affected by 6 to 14" (Denig, 2004). Learning style is defined as "the way in which each person begins to concentrate, process, internalize, and remember new and difficult academic content" (Denig). In other words, it is the way people prefer to learn and process information.

The 21 elements and their matching stimuli are

1. Environmental: sound, light, temperature, and design.

2. Emotional: motivation, persistence, responsibility, and structure.

3. Sociological: self, pair, peers, team, adult, and varied.

4. Physiological: perceptual, intake, time, and mobility.

5. Psychological: global, analytic, hemispheric, and impulsive-reflective.

This tutorial focuses on the perceptual strengths (auditory, visual, tactile, and kinesthetic) of learners, but that does not mean other elements are not simultaneously engaged, e.g., eating, walking around, and discussion with peers, etc.

Gardner's Multiple Intelligences Theory

Howard Gardner (1983, 1993) declares that humans have different forms of intelligences or intellectual strengths and that each one of these strengths has its own developmental path. He describes intelligences as

> a bio-psychological potential of our species to process certain kinds of information in certain kinds of ways. As such, it clearly involves processes that are carried out by dedicated neural networks. No doubt, each of the intelligences has its characteristic neural processes, with most of them similar across human beings. Some of the processes might prove to be more customized to an individual. (Gardner, 1999)

He originally proposed seven forms of intelligences. They are (1) linguistic, (2) musical, (3) logical-mathematical, (4) visual-spatial, (5) bodily-kinesthetic, (6) interpersonal, and (7) intrapersonal. He emphasized that specific intelligences do not exclude other intelligences but operate in conjunction with others.

Certain intelligences, such as linguistic, visual-spatial, and bodily-kinesthetic, share similar characteristics with various perceptual strengths (visual, auditory, kinesthetic, and tactile) and should be addressed together with the corresponding perceptual strengths rather than separately. Based on

this idea, concept mapping and mental imagery are used to target visual learners and those who possess spatial intelligences. Talking aloud is used to address auditory learners and those who possess linguistic intelligence. In addition, the application of concept mapping may relate well to tactile learners, while gestures and movements during talking aloud may relate well to kinesthetic learners.

Similar Characteristics of Perceptual Strengths and Spatial, Linguistic, and Bodily Intelligences

The Visual-spatial Learning Style and Spatial Intelligence

Visual-spatial learners. Linda Silverman describes a visual-spatial learner as one

who learns holistically rather than in a step-by-step fashion. Visual imagery plays an important role in the student's learning process. Because the individual is processing primarily in pictures rather than words, ideas are interconnected (imagine a web). Linear sequential thinking—the norm in American education—is particularly difficult for this person and requires a translation of his or her usual thought processes, which often takes more time. Some visual-spatial learners are excellent at auditory sequential processing as well. (Silverman & Freed, 1996)

In order for this type of learner to learn best, well-matched instructional strategies must be employed, such as graphical tools (concept mapping, charts etc.).

Spatial intelligence. Spatial intelligence is described as “the ability to ’think in pictures,’ to perceive the visual world accurately, and recreate (or alter) it in the mind or on paper. Spatial intelligence is highly developed in artists, architects, designers and sculptors” (Guignon, 1998). Grow (1999) relates spatial intelligence to writing as the ability to see the abstract relationship between concepts and ideas.

* Similarities interpreted: both are visually oriented and can see information in the mind’s eye and are capable of abstract thinking.

The Auditory Learning Style and Linguistic Intelligence

Auditory learning style. Auditory learners are defined as those who can recall “at least 75 percent of what is discussed or heard in a normal 40-45 minute period” (Carbo et al., 1986).

Auditory learners learn best by hearing; they understand and retain information well when it is communicated orally. They have strong language skills and are able to articulate ideas clearly.

In addition, this kind of learner needs to listen and likes to talk to himself/herself or others. They understand better if concepts are explained in their own words. More details can be found from these websites: http://www.yk.psu.edu/learncenter/acskills/auditory.html and http://gladstone.uoregon.edu/~cwong/auditory_learners.htm

This kind of learner will benefit from instructional strategies that involve language (e.g., storytelling, self-talk, rhymes, etc.).

Linguistic intelligence. This type of intelligence

involves sensitivity to spoken and written language, the ability to learn languages, and the capacity to use language to accomplish certain goals. This intelligence includes the ability to use language effectively in rhetorical or poetical expression and language as a means of remembering information. Writers, poets, lawyers and public speakers are among those that Howard Gardner sees as having high linguistic intelligence. (Smith, 2002)

*Similarity interpreted: both prefer to use language (either spoken or written) in learning and remember well what they hear.

Tactual and Kinesthetic Learning Styles and Bodily Intelligence

Tactual and kinesthetic learning styles. Note: The Dunns' learning styles theory differentiates tactual and kinesthetic learners while Gardner does not.

Tactual learners are those who "use their fingers and hands while concentrating" and who "remember more easily when they write, doodle, draw or move their fingers" (Carbo et al., 1986).

Kinesthetic learners are those who learn best with a "combination of tactual and kinesthetic experiences—a great deal of experiencing, doing and involvement" (Carbo et al., 1986).

Bodily-kinesthetic intelligence. This kind of intelligence "entails the potential of using one's whole body or parts of the body to solve problems. It is the ability to use mental abilities to coordinate bodily movements. Howard Gardner sees mental and physical activity as related" (Smith, 2002).

*Similarity interpreted: both relate body movement to learning, either using part or the whole body.

Note: There are different reports on the assessment of perceptual strength. Learning style research shows that 40% of the population are visual learners and 20-30% are auditory learners. Many remember basic facts through writing or manipulative use of fingers; some need to experience real-life activities in order to internalize the information (Carbo et al., 1986). Other reports state that 65% are visual, 30% are auditory, and only 5% are kinesthetic (Mindtool, as cited in Brown, 1998).

Integration of These Two Theories Into the Tutorial

The goal of integrating the Dunns' and Gardner's theories in this tutorial is to enhance learning. In this tutorial, sequenced learning strategies (concept mapping, mental imagery, and talking aloud) are used as a tool-kit to integrate these two theories so that limitations can be minimized and strengths enhanced (Silver et al., 1997). Based on the assumptions interpreted from the literature (Rochford, 2003; Hough & Donlan, 1994; Denig, 2004; Gardner, 1999; Grow, 1999; and Noble, 2004), one can argue that the sequenced learning strategies can be used as tools to connect these two theories. The assumptions follow.

Assumption 1: Suitable learning strategies enable individuals to manage and process information best suited to their own learning styles.

This assumption is interpreted from Rochford's study, which shows that when students are prepared with learning-style responsive materials, they score higher on the ACT test. This success requires that materials be taught to students in meaningful and motivating ways. Students need to participate "in activities that foster autonomy and control over learning situations" and be "instructed in individually effective methods for learning" (Rochford, 2003).

This tutorial suggests using concept mapping and mental imagery as learning strategies to provide favorable situations for visual learners and using talking aloud as a strategy for auditory learners to manage and process information.

Assumption 2: Using a combination of learning strategies is more likely to include learners' secondary learning styles.

This assumption is interpreted from Hough and Donlan's studies (1994). A combination of teaching and learning styles is more effective than a single approach (Hough & Donlan). Research also has shown that many people possess secondary learning styles that can reinforce initial learning (Denig, 2004).

In this tutorial, a combination of concept mapping, mental imagery, and talking aloud are used to accommodate learners with various perceptual strengths.

Assumption 3: Using sequenced learning strategies will be an effective tool for those who need structured learning as well as those who learn intuitively and will offer both a more favorable learning environment.

The Dunns' (2001) research shows that not all students learn intuitively and that many need structure and supervision. This finding is different from that of the multiple intelligences' theory, which maintains that people learn intuitively. This theory states that each individual is equipped with a unique blend of intellectual strengths and that each of the multiple intelligences can be nurtured and developed (Gardner, 1999).

In this tutorial, the sequenced learning strategies are used as tools to accommodate these differences. The rationale is that sequenced learning strategies provide a structured process, which in turn nurtures a favorable learning environment. When learners are provided with favorable learning environments, they may intuitively engage their own blend of intelligences during the learning process.

Assumption 4: Learning strategies used in this tutorial provide a favorable learning environment for visual and auditory learners and thus enhance the possibility for these types of learners to engage higher order thinking in the research process.

This assumption is based on the implications that "students generally may engage higher order thinking and problem solving in an area of intellectual strength and only lower order thinking in an area of relative weakness" (Noble, 2004).

EXPECTED OUTCOME

If the above assumptions are true, the combined learning strategies used in this tutorial are enablers. They enable learners to learn with their preferred learning styles and intuitively apply their own blend of intelligences. In this case, the core function of learning strategies is to create positive learning environments that allow learning in the way learners learn best. If learners learn with their own strengths, they are more likely to engage in higher order thinking and be able to acquire a certain degree of competency in crucial library research skills.

These research skills are

(1) The skill to extrapolate meaning from various sources by applying, analyzing and synthesizing the information.

(2) The skill to ask crucial questions so that various research aspects or viewpoints can be explored by analyzing and evaluating the meaning extrapolated.

(3) The skill to determine what information is needed in order to refine the research by further analyzing and evaluating the whole research direction and/or the process.

In summation, each learning strategy employed in this tutorial serves to nurture or develop learners' higher-order thinking skills. Eventually, they will be able to apply, analyze, synthesize, and evaluate information acquired and associate that information to their research goals.

ASSESSMENT

The author asked two questions in the introductory paragraph in this paper: (1) what methods or techniques can be used to associate information with the intended research goals? and (2) does the method of association vary with different kinds of learners?

The author's answer to the first question is to apply sequenced learning strategies as one of the methods to associate information with research goals. Many methods, however, have been developed over the years, and very often, learners may instinctively use methods that are most suitable for them. It will be interesting, therefore, to find out what other methods are being used in the future.

Presently, the author is collecting data to pursue the second question within the context of the learning strategies included in the tutorial. Due to this restriction, the goal of the research will be focused on the tendency to use concept mapping, mental imagery, and talking aloud (as methods of associating), which vary with different perceptual strengths (visual, auditory, kinesthetic). In addition, research will try to determine if the tendency to apply specific methods (concept mapping, etc.) is connected to certain characteristics listed in the learning style assessment form.

The author has obtained permission from the Institutional Review Board (IRB) to perform this assessment. The method is to distribute a questionnaire and a learning style assessment form to determine if common characteristics exist when certain learning strategies are favored.

Although this assessment is already in place, more participation is needed. Among those who have participated, many returned the learning style assessment form without the questionnaire. It is important for future participants to complete both forms in order to provide meaningful data for the research. Although the participants will be asked for contact information, their anonymity will be protected.

If readers are interested in participating in this research, please go to the tutorial and follow these steps:

1. Complete the tutorial
2. Read the informed consent letter
3. Complete the questionnaire
4. Complete the Learning Styles (VAK) assessment form
5. Submit 3 & 4 online or
6. E-mail 3 and 4 to learningstyles@oregonstate.edu

Your participation is much appreciated.

CONCLUSION

Many believe that the Dunns' learning styles and Gardner's multiple intelligences theories can be combined to improve learning in the classroom, for they are not opposing ideas (e.g., Guild, 1997; Dunn et al., 2001; Denig, 2004).

In this tutorial, these two theories are connected by means of learning strategies. These strategies serve as enablers that help learners learn with perceptual strengths. At the same time, they provide a favorable environment that allows learners to engage intuitively their unique blend of multiple intelligences. When concept mapping and mental imagery are used as learning strategies to accommodate visual and auditory learners, spatial and linguistic intelligences can be expected to be involved due to the common characteristics these forms of intelligences share with visual and auditory learning styles.

Isolating different intelligences into categories may be helpful for studies with narrow scopes, but in reality, intelligences are used together all the time. For example, a person who walks and sees details along a path is combining kinesthetic and visual abilities at the same time. It is likely, therefore, that learners will engage a few intelligences simultaneously when applying the learning strategies used in this tutorial to manage and process information.

The sequence of learning strategies presented in this tutorial is only one combination of tools used to manage and process information. It is important to select learning strategies that can match individual needs. Dunn et al. (2001) have asserted, "different students need to use different instructional resources in a different sequence in accord with how each learns best." In addition, "no single measurement of style ensures that a learner's need will be met. It is perhaps more important to build an adaptable learning environment that presents the material in a variety of methods than try to determine each learner's personal style" (Clark, 2000). The author is also aware that the learning styles and multiple intelligences theories are not the only effective approaches to deal with the complex nature of human learning; there are other theories that are just as crucial.

In conclusion, this tutorial is an experiment that explores alternative ways to design a library instruction course that can promote information literacy through the engagement of higher-order thinking skills. The goal is to help learners develop basic research skills that will allow them to learn throughout their lives.

DISCUSSION

The explosion of information in this electronic age has become a major concern in higher education. As a result, libraries and higher education organizations promote information literacy as a means to maintain intellectual integrity. In 2000, the Association of College and Research Libraries (ACRL) approved the Information Literacy Competency Standards for Higher Education. The American Association for Higher Education and the Council of Independent Colleges also endorse these standards. (http://www.ala.org/ala/acrl/acrlstandards/informationliteracycompetency.htm#ildef)

These standards define information literate persons as those who know the extent of information needed. They are competent searchers and are able to evaluate information and its sources critically. They can also selectively incorporate information into their own knowledge base to accomplish a specific purpose. The standards also address the responsibility of understanding the legal, economic, and social issues in the application of information and the ethics and legality of information acquisition.

These standards mirror different cognitive levels in Bloom's taxonomy of thinking. These levels are knowledge, comprehension, application, analysis, synthesis, and evaluation. The first two levels, knowledge and comprehension, are termed as lower order thinking. The higher-order begins with application and ends with evaluation.

At the levels of knowledge and comprehension, learners can remember and understand acquired information. This understanding will be deepened as the cognitive levels ascend, and each level serves as a step to reach the next level. As the understanding progresses, the individuals will be able to apply the learned information to specific needs. They are capable of identifying embedded meanings, can distinguish fallacy from facts, and determine whether the information is reliable and or relevant. Increasingly, the learners will be able to reorganize the information and formulate new meanings to address their research purposes. Finally, the learners will be able to express their creativity through their unique treatment of assimilated information and become independent thinkers who are capable of thinking for themselves.

The ability to apply higher order thinking skills is urgently needed in this electronic age due to the easy access of information, for no information is better than being misinformed. If learners assimilate information in their research in a non-discriminatory manner, it will affect their judgments, and they may end up with inadequate or detrimental decisions. It is important, therefore, for library instruction to include teaching/learning tools to reach learners' different cognitive levels and prepare them to become information literate individuals.

Acknowledgements:

Thank you to Dr. Dwaine Plaza for his assistance in designing the questionnaire, Jeanne Davidson for editing the questionnaire, Don Clark for his generosity in permitting the author to distribute the VAK

survey he developed, and Ron Stewart and the other colleagues in the author's departments for all the input they provided.

Appendix:

SCOPE OF THE LEARNING STRATEGIES IN THE COMPONENTS IN THE TUTORIAL

There are three components in the online tutorial. They are:

The Planning Component

The planning component has five modules and each has a specific function. The Assessment module requires learners to assess their own mindsets and available resources, intended audience, research objectives, and timeline. The Organization module familiarizes learners with the organization of information. The Identifying module helps identify possible information providers and distribution methods in research areas. The Referencing module introduces learners to various existing citation styles and makes clear the ways to incorporate legitimately the work of others in their own research. The Managing module links learners to existing information-managing software online.

The main objective of the Planning component is to help plan and build a knowledge base so that searchers can keep track of research development and avoid unnecessary time and effort. Learners should, however, be aware that planning can be an on-going process and should be revisited whenever needed (e.g., change of research focus or new information that needs attention, etc.).

The Searching Component

Information is necessary to evaluate information; for if any crucial data is missing, the ability to evaluate information will be impaired. The searching component has four modules that introduce learners to various search tools. It includes databases distributed by major information vendors (FirstSearch, SilverPlatter, ISI, and EBSCOHost). It also features free online sources (e.g., Agricola from USDA) and Research on the Web specifically for agriculture-related information. OSU students, staff, or faculty are able to link to the databases and practice searching in the respective modules.

The objective of this component is to help learners effectively use research tools. Again, information retrieval is a cumulative process and should be returned to whenever needed.

The Learning and Evaluation Component

Bits and pieces of information are not knowledge unless they become meaningful to the researchers. This component presents a combination of three learning strategies used to tie together data into meaningful information that accumulates knowledge during the course of research. These strategies are concept mapping, mental imagery,and talking aloud (narrative). Collectively, they serve three functions: (1) to extrapolate meaning from information gathered from various sources, (2) to ask crucial questions, and (3) to determine what information is needed to further the research.

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