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Enhancing student learning styles through the use of technology

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Abstract

The multiple learning styles of students have in the last few years become a major topic of concern for all educators. Experience and time are valuable learning tools assisting teachers in developing an understanding of these learning styles. This review pursues the importance of considering student learning styles when incorporating technology within an existing curriculum. Research studies provide supporting evidence that a technology-rich environment promotes collaborative, project-based learning, which in tum has a positive effect on learning styles.

ENHANCING STUDENT LEARNING STYLES THROUGH THE USE OF TECHNOLOGY

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Abstract

The multiple learning styles of students have in the last few years become a major topic of concern for all educators. Experience and time are valuable learning tools assisting teachers in developing an understanding of these learning styles. This review pursues the importance of considering student learning styles when incorporating technology within an existing curriculum. Research studies provide supporting evidence that a technology-rich environment promotes collaborative, project-based learning, which in turn has a positive effect on learning styles.

Introduction

While learning styles have yet to be given a precise definition, they are best described as "the preferred manner in which an individual or group assimilates, organizes, and uses information to make sense of the world, including a classroom or job environment" (Anderson, 2001, para. 5). Learning styles research is based on studies about the psychological, social, and physiological dimensions of the educational process. Academic literature provides a range of models that assist educators in dealing with the interactions between teacher and learner. Anderson characterized learning styles by how we prefer to learn, specifically our preferences for:

- the type of information we receive (sensory vs. intuitive);
- how we perceive information (visual vs. verbal);
- how we organize information (actively vs. reflectively); and
- how we understand information (sequentially vs. globally).

He further believed there are many dimensions to these learning styles: (a) reflective vs. impulsive, (b) non-affective vs. affective, (c) elaborative vs. shallow (repetitive) processing, (d) scanning (visual) vs. focusing, (e) field-independent vs. field-sensitive, (f) analytical vs. relational, (g) independent vs. dependent, (h) participant vs. avoidant; and "students who are reflective, non-affective, elaborative-processing, scanning, field-independent, analytical learners are highly successful in both two-year and four-year colleges" (para. 9). These students are the ones who learn no matter what strategy the teacher chooses to use. Realistically however, all students should be able to reach their full potential, not just those who are primed for success. Educators must "accept the idea that there will be a lot of different styles used by students in their classroom and adapt

their curriculum and instruction methods to meet the needs of every student" (Guild & Garger, 1998, p. 20). This is perhaps the most important task confronting educators in the 21st century.

A team of 45 educators were involved in the study of defining the term "technology integration." This team was brought together through Iowa AEA 7/LEA initiative, called Ed Tech Connect. The finding of this group was the definition of technology integration: "the process of teaching technology and another curricular area simultaneously. In addition, it is the process of using technology to enhance teaching for learning" (AcheyCutts & Kuehl, 2000, para. 12). Educators who want to improve instruction to meet the needs of all students should consider the ways technology integration can enhance the learning styles of their students through meaningful technology integration.

Methodology

The information used in this review was gathered from three basic areas: Great River AEA 16 Media Center, Ebsco Online Professional Educational Data Bases, and the Internet. This author found that there is vast amount of material covering this topic. The material was chosen to provide a resource that will assist the beginning or veteran educator.

Analysis and Discussion

The formal study of learning styles began in the late 1960's and built on previous studies of cognitive style and psychological type. Understanding the human brain is the first step in setting up the curriculum for a class. The human brain functions as a whole, but it is actually divided into two hemispheres (the left and the right), which act, react,

think, process, and solve problems in very different ways (Frender, 1994). The following table provides a brief profile of the typical left and right side of the brain dominance characteristics (Fender, 1990, p. 36):

Left/Right Brain Dominance Characteristics

Left	**Right**
sequential	holistic
intellectual	intuitive
structure/planned	spontaneous
controls feelings	lets feelings go
analytical	creative/responsive
logical	more abstract
remembers names	remembers faces
rational	more likely to act on emotions
solves problems by breaking them apart	solves problems by looking at the whole
time-oriented	Spatially-oriented
auditory/visual learner	kinesthetic learner
prefers to write and talk	prefers to draw and handle objects
follows spoken directions	follows written or demonstrated directions
talks to think and learn	"pictures" things to think and learn
prefers T/F, multiple-choice and matching tests	prefers essay tests
takes few risks (with control)	takes more risks (less control)
looks for the differences	looks for similar qualities
controls right side of body	controls left side of body

thinks mathematically	musical abilities
thinks concretely	emotional
thinks of one thing at a time	thinks simultaneously

According to Frender (1990), each student will have modalities through which they learn. There are three basic modalities: visual, auditory, and kinesthetic. Students use at least three of the five senses in learning, storing, remembering, and recalling information. The way a student sees, touches, and hears the information will play important roles in the way they communicate and relate to others. Educators generally find communicating with students who share the same modality easier than with students who do not. Because people learn from and communicate best with someone who shares the dominant modality, teachers who know the characteristics of visual, auditory, and kinesthetic learning styles and can identify them in others are at a great advantage. The next table has a list of characteristics of the different learning modalities (Frender, 1990, p. 37):

Characteristics of Learning Styles

Visual	**Auditory**	**Kinesthetic**
mind sometimes strays during verbal activities	talks to self aloud	likes physical rewards
observes rather than talks or acts	enjoys talking	in motion most of the time
organized in approach to tasks	easily distracted	likes to touch people when talking to them
likes to read	has more difficulty with written directions	taps pencil or foot while studying
usually a good speller	likes to be read to	enjoys doing activities
memorizes by seeing graphics and pictures	memorizes by steps in a sequence	reading is not a priority
not too distractible	enjoys music	poor speller
finds verbal instructions	whispers to self while	likes to solve problems

difficult	reading	by physically working through them
has good handwriting	remembers names	will try new things
remembers faces	easily distracted by noises	outgoing by nature; expresses emotions through physical means
doodles	hums or sings	uses hands while talking
quiet by nature	outgoing by nature	dresses for comfort
meticulous, neat in appearance	enjoys listening activities	enjoys handling objects

To accommodate all students, a teacher needs to instruct the students in the classroom with a variety of approaches and activities. The following table has helpful suggestions for varying the presentations of lessons in the classroom to meet the needs of all students (Frender, 1990, p. 37):

Suggested Aids for Learning Modalities

Visual	**Auditory**	**Kinesthetic**
use guided imagery	use tapes	pace/walk as you study
form pictures in your mind	watch TV	physically "do it"
Take notes	Speak/listen to speakers	Breathe slowly
See parts of words	Make up rhymes/poems	Role play
Use "cue" words	Read aloud	Exercise
Use notebooks	Talk to yourself	Dance
Use color codes	Repeat things orally	Write
Use study cards	Use rhythmic sounds	Write on surfaces with finger
Use photographic pictures	Have discussions	Take notes
Watch TV	Listen carefully	Associate feelings with concept information
PowerPoint	Use oral directions	Write lists repeatedly
Watch movies	Sound out words	Stretch/move in chair
Use charts, graphs	Use theater	Watch lips move in front of mirror
Use maps	Say words in syllables	Use mnemonics
Demonstrate	Use mnemonics	
Draw/use drawings		
Use exhibits		

Watch lips move in front of mirror		
Use mnemonics		

Many of these suggestions not only focus on the learning styles of students but also offer ideas for enhancing learning through the use of technology.

In 1983 Howard Gardner, a developmental psychologist, authored a book called *Frames of Mind* which listed seven basic intelligences. He compared these intelligences to ones traditionally tested for a standard IQ test. This book was directed toward the psychology field and was embraced by educators. The seven intelligences identified by Gardner are:

- Linguistic intelligence
- Logical-mathematical intelligence
- Spatial intelligence
- Musical intelligence
- Bodily kinesthetic intelligence
- Interpersonal intelligence
- Intrapersonal intelligence (cited in Jasmine, 1996, p. 2)

Linguistic intelligence is also known as verbal intelligence. Students who possess linguistic intelligence more easily express themselves through words, both oral and written. Gardner (cited in Jasmine, 1996) described a student with linguistic intelligence as a person who has highly developed auditory skills and learns by listening. Those students enjoy reading, writing, and speaking. Examples of linguistic intelligence students are poets and students who enjoy crossword puzzles and Scrabble.

The logical-mathematical intelligence is associated with critical thinking and scientific abilities. Students who have this kind of intelligence love to be challenged with math problems, checkers, and chess. These students will be the ones who enjoy everything that is challenging with technology (Jasmine, 1996).

Spatial intelligence is associated with visual learning. These learners, according to Gardner (1993), think in pictures and learn with visual presentations such as videos, models, and demonstrations. Spatial learners enjoy activities such as drawing, painting, and reading maps and diagrams. They also enjoy mazes and jigsaw puzzles (cited in Jasmine, 1996).

Musical intelligence is possibly the least understood of all the intelligences. The students with musical intelligences are the ones who whistle, sing, or hum in school. These students also like to listen to music while doing homework. Jasmine (1996) suggested that educators most often see the musical intelligence learner as a disruptive distraction to the classroom because they like noise accompanying what others consider a quiet, study time. Characteristics of this intelligence include a love for music or playing an instrument and a sensitivity to sound. Some educators view students who listen to music when doing homework as a bad example because this suggests a lack of concentration on the learner's part. The students with this intelligence actually do their best under these conditions because that is how they concentrate.

Bodily-kinesthetic intelligence is described as students who enjoy physical activities. They excel in activities that require small and large muscle skills. Most often they are very successful in sports. They communicate information the best through demonstration and modeling. All learners experience bodily kinesthetic intelligence to a

certain degree. An example of this is when a person has not ridden a bike for several years, and how without thinking the ability just comes, and they are able to ride well (Jasmine, 1996).

Interpersonal intelligence is often linked to group activities. These students feel secure working with others. They learn the best while interacting and cooperating with others. These students often serve as mediators to solve disputes in a school setting. The disadvantage of having interpersonal intelligence is the ability to be easily manipulated (Jasmine, 1996).

Finally, Jasmine (1996) described intrapersonal intelligence as having an awareness of inner feeling. Students with intrapersonal intelligence understand three things: themselves, their abilities, and their options. Students who possess intrapersonal intelligence have great self-confidence and feel comfortable expressing themselves on controversial subjects. This student will enjoy working on their own projects by themselves. Intrapersonal intelligence is often associated with intuitive ability.

When trying to incorporate technology that enhances student learning, teachers need to consider the intelligences first, then match technologies that best support each intelligence rather than choosing the technology first and trying to make the technology fit the intelligences. McKenzie (2002) suggested the supporting technologies listed in the following table:

INTELLIGENCE	**TECHNOLOGIES**
Verbal/Linguistic	Textbook, pencil, worksheet, newspaper, magazine, word processing, electronic mail, desktop publishing, Web-based publishing, keyboard, speech recognition devices, text bridges

Mathematical/Logical	Lecture, Cuisenaire rods, unifix cubes, tangrams, measuring cups, measuring scales, ruler/yardstick, slide rule, graphing calculators, spreadsheet, search engine, directory, FTP clients, gophers, WebQuests, problem-solving tasks, programming languages
Visual/Spatial	Overhead projector, television, video, picture books, art supplies, chalkboard, dry erase board, slideshows, charting and graphing, monitor, digital camera/camcorder, scanner, graphics editor, HTML editor, digital animation/movies
Bodily/Kinesthetic	Construction tools, kitchen utensils, screw, lever, wheel and axle, inclined plane, pulley, wedge, physical education equipment, manipulative materials, mouse, joystick, simulations that require eye-hand coordination, assistive technologies
Musical/Rhythmical	Pattern blocks, puzzles, musical instruments, phonograph, headphones, tape player/recorder, digital sounds, online pattern games, multimedia presentations, speakers, CD-ROM disks, CD-ROM player
Intrapersonal	Journals, diaries, surveys, voting machines, learning centers, children's literature, class debate, real-time projects, online surveys, online forms, digital portfolios with self-assessments
Interpersonal	Class discussion, Post-it notes, greeting cards, laboratory, telephone, walkie-talkie, intercom, board games, costumes, collaborative projects, chat rooms, message boards, instant messenger

This list offers teachers suitable technologies to integrate while focusing on the intelligences and learning styles of their students.

In our society the verbal/linguistic and mathematical/logical intelligences are recognized and associated with IQ tests and Scholastic Aptitude Tests. If a student possesses two intelligences, they have a better chance of success in the traditional school setting. This does not, however, predict success in real life (Gardner, 1993, cited in Jasmine, 1996). To make the appropriate selection of technologies that enhance learning styles, teachers need to first look at the learners and consider if the material is new or a review of material that has been covered, what skills need mastered, and what the ability level is of the students. Next, teachers need to examine their learning objectives. Last of all, they need to think about student learning styles and what technologies best fit (McKenzie, 2002). When students are able to "work with many different materials and resources, including newer technologies such as computers and electronic networks, they are likely to learn more" (Saravia-Shore & Garcia cited in Cole, 1995, p. 69).

Cohen (2001) conducted a study to explore whether a technology-rich environment that promotes a constructivist approach to learning has a significant effect on the learning styles of freshmen high school students. Two high school freshmen classes were selected for this study. One school was located at the Academy for the Advancement of Science and Technology (AAST). Technology was strongly infused into every AAST class and teacher-directed lectures were kept to a minimum. The AAST is a school district that specializes in science and math and promotes instruction that is a team-oriented project-based approach to learning. AAST "is dedicated to educational reform and has developed an environment where students can explore, learn, and work together on projects they might encounter in the real world" (Cohen, 2001, para.5). The AAST academy is set up differently than the normal school setting. There are no desks

for students; instead there are workstations and informal worktables. Each classroom is setup with state of the art technology equipment.

The other school district included in the study conducted by Cohen (2001), Ridgewood, was a more traditional high school that did not infuse technology into any classrooms but was well known for its excellence in education. The classroom structure was very typical with rows of desks and lecturing being the primary instructional strategy. Technology within the classroom was minimal with only a few computers, if any, in the individual classrooms. Therefore, "when technology is used, the classes must move to a lab or media center where there are enough computers for all students" (Cohen, 2001, para. 10). Unlike the strictly monitored teaching approach and philosophy used by the AAST academy, this high school's methodology was based on each individual teacher's teaching style. Ridgewood also did not promote project-based learning.

Cohen (2001) listed three objectives of this study:

1. To determine if there was any significant effect on learning style when freshmen high school students were working in a technology-rich environment that promotes collaborative, project-based learning;
2. To compare two different types of learning environments on high students' learning styles; and
3. To determine the effect of specific variables in Dunn and Dunn's Learning Style Inventory (LSI) (Dunn, Dunn, & Price, 1989, cited in Cohen, 2001) on freshmen students after a year in two very different high schools. (Cohen, 2001, para. 2)

The following six variables were focused on as well: "motivation, persistence, responsibility, preference for working alone or with peers, parent motivation, and teacher motivation" (Cohen, 2001, para. 5).

The questionnaire results showed that both schools appeared to have a lot of the same concerns, frustrations, and insights regarding typical freshmen classes. Some of the similarities were that both groups of freshmen liked their schools, and for the most part, their teachers. The AAST students showed concerns about the long school days, how all projects were due on the same day, the challenge of working in groups, and the competitive environment that surrounded them. The other high school students' concerns were centered on daily schedule and interaction with certain teachers. The AAST students expressed that they found technology exciting, motivating, and relevant to their lives. They also commented on being able to see the connection between their education and their everyday life. The other high school students expressed disappointment with the limited use of technology in the classroom. These students felt that their education was relevant, but only when it pertained to going to college or pursuing a future career. The study indicated that the use of technology did have a positive effect on student attitudes toward learning.

The results of this study showed "a technology-rich environment that promotes collaborative, project-based learning can have an effect on leaning style" (Cohen, 2001, para. 1). The two schools used in this study were very different. The AAST students' learning styles showed significant change in four of the six variables while the other high school showed significant changes in only two of the variables. In this study the increase

in scores from the pre-test to post-test time suggested that the learning environment, which AAST promotes, contributed to student success.

Another study that supports the effects that technology has on learning styles is one that was done at North Carolina State University (NCSU) by Felder, Felder and Dietz (1998). This was a longitudinal study of engineering student performance and retention comparisons with traditionally taught students. As in the study comparing AAST with a traditional high school, two groups of students were again compared. One group, called the experimental group, took five chemical engineering courses taught by the same instructor in five consecutive semesters. The instruction for this group focused on using active and cooperative learning and a variety of techniques to address a wide range of learning styles. Instructors who used traditional methods of instruction taught the other group, the comparison group. The hypothesis of this study was that the experimental group would have a higher retention of material, more confidence, and positive attitudes toward the instruction.

During the first year of core classes, the difference between the two groups showed little variation in overall academic credentials. At the completion of the five courses, the experimental group was consistently better than the comparison group. The experimental group earned almost twice as many A's and less than half the percentages of D's and F's. The differences between the two groups at the end of the study were quite significant. They had noticeably different attitudes towards the education they had received. The experimental group gave a high rating to the quality of their course instruction, support from their peers, and the student friendliness of the academic environment. They also showed great interest in pursuing graduate study in chemical

engineering. The comparison group felt their achievements included being able to solve computer problems and being able to do work independently.

The NCSU study was intended "to demonstrate the positive effects of learning that might result from the repeated systematic use of well-established but non-traditional teaching methods" (Felder, Felder, & Dietz, 1998, para. 5). The researchers, however, also wanted educators to realize since no educational environment can be precisely simulated, "the same techniques used by a different instructor or by the same instructor with different students will inevitably produce different results" (para. 5), but "as they gain practice and learn more about the new methods, the skill levels of their students will continue to increase" (para. 6). According to D'Ambrosio, Johnson, & Hobbs (cited in Cole, 1995), "the use of technology throughout the grades helps to prepare students for increasingly sophisticated learning tasks" (p. 130).

Gardner (1993, cited in Jasmine, 1996) does not advocate "prepackaging" the multi-intelligence theory. Gardner feels that for students to be successful there has to be a combination between the teacher's personal instructional styles with the combination of the student multi intelligence profiles in the teacher's class. Gardner stated, "There are many questions that teachers need to ask themselves before modifying their lessons" (cited in Jasmine, 1996, p. 17). Asen (1992, cited in McKenzie, 2002) identified ten criteria to consider when integrating technology:

1. Students are involved in tasks that are broad in scope and challenging. Activities should span a range of experiences and be intellectually demanding.
2. Students rather than the teacher have control over the learning process. The teacher serves more as a guide and coach than as a supervisor or administrator.

3. Students work collaboratively and cooperatively. Learning tasks should not be completed in isolation.
4. Students practice and apply communication skills during learning. Learning tasks should promote discussion and interaction.
5. Students participate in varied learning tasks. This includes both variations in the format of the activities and in their objectives.
6. Students have opportunities to address learning tasks in different ways. In this way different approaches to a presented activity can be explored.
7. Students apply higher order thinking skills through problem-solving tasks. Activities do more than ask students to recall rote facts, terms, and definitions.
8. Students are encouraged to offer varied solutions to a given problem. Standard responses are not the only ones accepted; other answers can be acknowledged as acceptable.
9. Students are encouraged to contribute personal ideas and experiences to the learning task. There is validation of student input into the learning process.
10. Students are intrinsically motivated by the prescribed learning tasks. Accomplishing the task is rewarding on its own merits regardless of the technologies being used. (pp. 40-41)

These criteria are beneficial for teachers to consider when making decisions about incorporating technologies to enhance the learning styles of their students.

Conclusions & Recommendations

Teachers in today's educational setting have to adapt their curriculum so successful learning can be achieved. This change will need to include integrating

technology into the classroom to meet the various learning styles in his/her classroom. The beginning or experienced teacher will need to spend a great deal of time working with and designing lesson plans for these diverse learning styles. Research has shown that technology is a resource that will help educators reach those various learning styles in their classrooms. Technology needs to be implemented into the classroom with a very thorough thought process. Beginning teachers as well as those who have been in the field for years must be able to make lesson modifications. Many teachers are satisfied with letting textbook publishers and curriculum marketers piece together prepackaged instructional programs that are a combination of salesmanship, structure, and resources. Teachers must accept the responsibility of updating their curriculum to meet the changes of our society and mandated legislation.

Teachers should modify their existing lesson plans to maximize the accommodation of intelligences in their instruction. The groundwork of this is when teachers improve existing lessons in order to help all students in their classroom make the necessary connections to the lesson. Teachers need to keep in mind, while modifying their lesson plans, not to try to plug in all nine intelligences into one lesson. Gardner suggested that teachers try to integrate three to five intelligences into each lesson. The key to successful modification is that the students see the connection between the intelligences used in the lesson.

Gardner reflected on the importance of the lesson objectives being in place when designing a multi intelligence lesson. Teachers should look at the objectives to make sure they stay on task with the lesson. By concentrating on the objectives, plugging in the desired intelligences is much easier. Once the objectives and chosen intelligence

strategies are in place, the teacher can then decide what technologies to include with these new or modified lessons. Technology is an excellent tool when used to inspire students, but there are times when it cannot be used successfully with every lesson. Successful incorporation of technology takes time and practice to develop the understanding of effective use.

Being successful in the classroom is what every teacher wants. The only way to achieve this goal is to put in the time and effort to understand each student's individual style of learning. Developing units that focus on individual learning styles can benefit all students in the classroom. Through this development each student will have a better chance to achieve a successful learning experience.

Based on the literature reviewed, instructors who implement this instructional approach will see improvements in their students' success. This instructional strategy will need to be implemented gradually into the classroom using a step-by-step approach instead of overwhelming the students with it all at once. Students need to feel secure as they venture into this technology-rich environment. The results of planned integration will be a classroom that promotes collaborative, project-based learning, which has a positive effect on learning styles.

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