Brain-Based Learning and Handheld Computers

by

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Abstract

With the 1990s being deemed the "Decade of the Brain" by President George Bush, the decade saw an influx in the amount of research on the brain and on how we learn. Out of this research comes a new approach to learning that is finding its way into the educational world. Brain-based learning is an approach based on brain research that shows what is needed within a learning environment for the brain to be prepared for learning.

Within this same time period, the flood of technology in public education has come to a point that parents, educators, and communities are starting to ask "Where does it all fit in?" While technology continues to get smaller in size and larger in productivity a new wave of technology is making its way into the educational setting. Handheld computers are the next tool to influence education on a scale not yet seen.

When this new research on how the brain learns is applied with this new handheld technology, it creates an educational atmosphere that is prime for learning. It is an atmosphere that puts the learners at the center of the educational experience, and allows them to explore new knowledge like never before.
Technology is playing a greater role in our schools than ever before. A recent Department of Education report noted, "Support for the use of technology to promote fundamental school reform appears to be reaching a new high," (Jones et al. 1995). As technology is reaching a new high in public education, a new theory is also emerging on how the brain works and processes information. This new approach to teaching and learning based on brain research is called Brain-based learning (BBL). Jensen, a leading researcher and author on brain-based learning, states that new research shows "The brain is poorly designed for formal instruction. In fact, it is not at all designed for efficiency or order. Rather, it develops best through selection and survival" (Jensen, 2000, p. 3). These two new approaches to teaching and learning are creating a paradigm shift within the educational world. Not only are teachers trying to integrate more technology within the learning environment, they are also rethinking their whole approach to teaching and learning. The combination of technology and brain-based learning is a powerful tool when implemented properly within the educational setting.

Within the larger world of technology, the handheld computer is becoming more and more popular with schools and districts as a way to bring hands-on technology into the classroom and reduce the student to computer ratio. This new device has the power to combine the technological world with the brain-based learning approach to teaching and learning. "The more alternative methods are available to students, the more they will learn. And handheld computers promote this process. Since, all students in a class can have handhelds; they can use these tools for the kind of learning that works best for them" (techlearning.com, 2002). This paper will examine aligning technology with BBL and specifically look at the handheld
computer as a tool to help teachers implement not only technology into their classrooms, but also the brain-based learning approach.

Brain-Based Learning

Brain-based learning (BBL) is "learning with the brain in mind," (Jensen, 2000, p. 6). The brain is a complex organism made up of more that 100 billion cells. Jensen describes the brain as a jungle "active at times, quiet at others, but always teeming with life," (Jensen, 2000, p. 1). This new research on the brain has led to the development of new theories on how we learn new information, and how educators can create situations that allow for the brain to be 'ready' to receive information. This new breakthrough in brain research on how the brain learns is revolutionizing the educational world. "Regardless of what you might perceive as evidence to the contrary, keep in mind that your learners are capable beyond your wildest dreams." (Jensen, 2000, p. 12)

Within BBL there are five important concepts that need to be taken into consideration when designing a brain compatible learning environment. This is an environment that allows the brain to open up to receive new information. These five concepts are: Enriched environment, emotion, attention, meaning, and threat and stress, (AcheyCutts, 2002)

Enriched Environment

The old approach to an optimal learning environment "consists primarily of trying to maintain a relaxed, focused atmosphere that offers options for learning in individually satisfying ways." (SEDL, 2000, p. 3) This old model of students as empty vessels waiting to be filled with
knowledge is giving way to the new brain-based approach that students "continuously build understandings based on their prior experiences and new information." (SEDL, 2000, p. 3) There is much more that contributes to an optimum brain friendly environment than maintaining a relaxed focused atmosphere.

Although there are many factors that go into creating an enriched learning environment, most are easy to employ in any teaching or training situation. The first and most important is creating a positive facilitator-learner relationship, an environment characterized by trust, safety, and mutual respect. (Jensen, 2000, p. 55) A teacher or facilitator's primary responsibility is to provide a positive climate in which learning can take place.

The visual environment is another aspect of an enriched environment that brain research shows plays an important role on the brain's readiness to receive new information. Research has revealed that our eyes are capable of registering 36,000 visual messages per hour. (Jensen, 2000, p. 55) That amount of information alone makes our visual environment even more important than first thought. "Between 80 and 90 percent of all information that is absorbed by our brain is visual. In fact, the retina accounts for 40 percent of all nerve fibers connected to the brain." (Jensen, 2000, p. 55) As educators and facilitators, we need to create an optimal brain learning environment by attracting the brain with movement, contrast and color.

Research has also linked different colors to different feelings and different learning readiness. According to Jensen, the colors yellow, light orange, beige, or off-white seem to stimulate positive feelings the most in people. Jensen distinguishes Yellow and Orange as follows:
"Yellow is the first color a person distinguishes in the brain. Associated with stress, caution, and apprehension, yet it stimulates an overall sense of optimism, hope, and balance. Excellent for use in classrooms.

Orange has the characteristics halfway between red and yellow. It is one of the best colors for stimulating learning." (Jensen, 2000, p. 57)

This new belief in the power of color may show that educators and facilitators have underestimated the effect of color in the classroom. Colored paper and different colored chalk or white board markers may play a larger part in the understanding and retention of information than was first thought.

Educators have been discussing for years the effect lighting has on student and teacher performance, and brain research supports these earlier contentions. In a study conducted by Wayne London (1988) where he swapped the standard fluorescent lighting for Vitalite full-spectrum lighting in an elementary classroom, students missed 65 percent fewer days in the Vitalite full-spectrum classroom than students in a fluorescent lighted room. (Jensen 2000, p. 60) This is not the only finding in the use of fluorescent lighting in an educational setting.

"Fluorescent lights have a flickering quality and barely audible hum which can have a very powerful impact on our central nervous system. Apparently the brain reacts to this visual-auditory stimulus by raising the cortisol levels in the blood (indications of stress) and blinking excessively." (Jensen, 2000, p. 60) Although Vitalite full-spectrum lighting is more costly than fluorescent lights, we owe it to our learners to create an atmosphere that is best for their brain to receive and process information.
Emotion

The role of emotions in the classroom and in daily life is probably the most useful information researchers have that directly affects student performance and readiness to learn in the classroom. "Emotions drive attention, create meaning, and have their own memory pathways" (Jenson, 2000, p. 197). Emotions are not a separate entity as one thought, but are enmeshed in the complexity of brain function. "LeDoux argues that emotions or "arousal" is important in all mental functions and 'contributes significantly to attention, perception, memory, and problem solving'' (Jensen, 2000, p. 198). Without the brain being aroused through emotional responses the brain is not ready to pay attention in class, to memorize facts, or to solve problems. Too much arousal is not good for learning also, too much of a good thing can be harmful. When the brain is over aroused, people become tense, anxious, and unproductive. Finding this balance within the educational setting is what educators and facilitators need to aim for.

Educators and facilitators need to have a greater awareness of their learner's emotional state. Being able to deduce the emotional state of a learner will help educators and facilitators better prepare students for learning. "The emotional state of your learners is at least as important as the intellectual-cognitive content of your presentation. Never avoid emotions, deal with them gently and personally." (Jensen, 2000, p. 201) Emotion is one way the brain solidifies information, therefore educators and facilitators need to teach to the emotions of their learners. Asking questions like; "How did that make you feel?" or "What do you think that character was feeling?" are ways to help solidify the new information being learned. Educators and facilitators can also help prepare learners for learning by creating positive emotional routines within the
classroom. Jensen (2000, p. 204) gives three strategies to help foster positive emotional routines in the classroom:

- Establish new, positive, and production rituals such as arrival handshakes, music fanfare, positive greetings, hugs, high-fives, etc.
- Set a tone of teamwork with class rituals such as team names, cheers, gestures, games, and friendly competition.
- Encourage participation rituals such as a class applause when learners contribute or present; closing rituals with songs, affirmations, discussions, journal writing, cheers, self-assessment, gestures, etc.; and your own personal form of ritual to celebrate a learner's achievement such as a special student award, not of praise sent home, extra privileges, etc.

Attention

Being able to obtain and hold a student's attention in school today is a challenge. With television and technology creating instant access to information, how do teachers today create an environment that holds students' attention? The answer comes in the form of BBL. First we must understand what types of objects 'catch' the brain's attention. "Any stimuli introduced into our immediate environment, which is either new (novel) or of sufficiently strong emotional intensity (high contrast), will immediately gain our attention." (Jensen, 2000, p. 122) Next we need to understand the systematic process the brain goes through when new stimuli is introduced and recognized. Jensen (2000, p. 123) gives the following process.

1. Initial alarm or notice
2. Orientation of where the new information is
3. Identification of what the information is
4. A decision on what needs to happen next.

The answer to the fourth point in the process of "what needs to be done next" determines how long the attention on the object is held. Within the classroom, a teacher can use this information to help gain students' attention. By offering new information to students in a way that alarms or brings notice to them. Then by allowing the student to orientate where the information is coming
from. After that by allowing them time to identify the information and allowing them to decide what needs to happen with the information next, will help hold students' attention longer on a given topic or subject. For example, by starting a science lesson with an experiment and not explaining to the students what the experiment is about, this will capture and hold their attention. After the teacher has their attention, then an explanation for what the experiment was about would follow. By planning lessons in this way, teachers can create an atmosphere and a learning environment that readies the brain for new and novel information.

**Meaning**

After new information is presented to the learner, the brain needs time to create meaning out of the new information and find where it "fits" with information already known. "A principle to remember is that you can either have your learner's attention or they can be making meaning, but never both at the same time." (Jensen, 2000, p. 124) This is important to understand as a teacher. After new information is given, the brain needs "down-time" to sift through the information and make sense of it. This "down-time" can come in many different ways. It could be as easy as writing in a reflective journal, or talking about the new information in a small group discussion. Asking the question "what if" with a small group of learners will allow the brain to relate the new information to information it already understands, and then use the information in another context. This helps to solidify the information as it is compared and identified with information already learned.

There are many ways in which meaning connects within the brain, but emotional links are the most powerful within the brain. "Researchers have found critical links between emotions and the cognitive patterning needed for learning. Many have documented how emotions directly
influence learning." (Jensen, 2000, p. 283) There are many other ways that the brain links information within itself. The brain links information through creating context and patterns with information. The brain works more like a road map with connections leading and intersecting with other information. The brain must compare and connect the information already known to be able to apply meaning to the information. The brain also looks for patterns within new information. What patterns can be found within the new information that can relate it to information already know, is a question that teachers can ask learners to help create the patterns within the brain. Role-play and games can also enhance meaning-making. Role-play and games allow students to be active in their learning environment, to conceptualize the information on a higher level by acting out or becoming part of the information being learned. Role-play and games have long been used in education, and now have the support of brain-based research in that they play an important role within the educational setting. (Jensen, 2000)

*Threat and Stress*

Jensen explains that there are two types of stress. Positive stress which is good for the learning environment and distress which is negative in the learning environment. "The positive forms of stress occur when we feel moderately challenged and believe we can 'rise to the occasion.'" (Jensen, 2000, p. 229) Positive stress can occur under the following situations.

- The desire to solve a particular problem
- The ability to resolve the problem
- Some sense of control over circumstances
- Sufficient rest between challenges
- A perceived potential solution to the problem.

On the contrary, negative stress, or distress, "occurs when we feel threatened by some physical or emotional danger, intimidation, embarrassment, loss of prestige, fear of rejection or failure,
unrealistic time constraints, or a perceived lack of choice" (Jensen, 2000, p. 229). Negative stress can occur under the following situations:

- Learners are confronted with a problem they don't want to solve
- Learners do not perceive a solution to the problem
- Learners lack the resources to solve the problem
- Learners feel the risk levels involved are unacceptable
- Learners have little or no control over circumstances
- Learners experience repeated situations of intense prolonged stress

Both types of stress must be controlled within the learning environment. Educators and facilitators must try and create an environment where positive stress can flourish while negative stress is reduced to a minimal level.

Not every negative stress factor can be controlled within the learning environment. Many negative stress factors come from outside the learning environment, and learners bring these factors with them when they enter the learning environment.

If all you've ever known is poverty, for example, it's difficult to realize an alternative, a necessary step in the resolution process. Identifying the core stress; then creating an awareness of alternatives; and ultimately working towards a desirable change are the cornerstones of empowerment. (Jensen, 2000, p. 231)

Educators must find ways to reduce the negative stress within the learning environment. Incorporating such activities as stretching, relaxed breathing sessions, quiet walks, music, and art are ways to help reduce the negative stress within a learner. These activities give learners time to reflect and get in touch with their stress levels, allowing them time to manage their stress and prepare for learning.

Brain-based learning gives educators and facilitators the opportunity to create a learning environment that is 'brain ready' for learning. By incorporating color into an enriched
environment, and appealing to the emotional side of a learner this helps the learner to relax and opens the brain to the learning process. By giving the brain 'down time' to reflect and make meaning of the information just learned through reflection activities such as writing, drawing, role-playing and so on, allows the brain to create the pathways needed to store and connect the information learned with information already known. Lastly by creating an environment that fosters positive stress and helps reduce the negative stress and threat level within an environment and individual this will allow the learner to be at an optimal learning level.

Later we will look at these five factors of BBL and relate them to technology education, specifically the use of handheld computers. These five factors play an important role in the learning process, and if technology is going to be a part of the learning process, then there brain based factors of the learning environment must be applied towards the use of technology.

Handheld Computers

As handheld computers have made their way into classrooms, SRI International's Center for Technology in Learning, a nonprofit research group, completed one of the first studies of handhelds in classrooms in September 2002. The research surveyed more than 100 teachers who had been using handheld computers within the educational setting through the Palm's Educational Pioneers Program. Joyner (2003) reports the findings as follows:

- 93 percent of teachers believed the devices can have a positive impact on students' learning.
- 72 percent said handhelds were easier to integrate into classroom activities than desktop computers.
• 75 percent of teachers who let students take Palms home reported an increase in homework completion.

• 89 percent of teachers said handhelds are an effective instructional tool.

These results from the SRI International's Center for Technology show that educators feel that these handheld computers can be of beneficial use within the classroom. These new small devices might be the answer to the one-to-one computer problem that many schools have been searching for. With the price tag for handhelds being a fourth or half of a laptop, and their use in the classroom being numerous in nature, these small portable devices might replace the laptop before it even has the opportunity to change.

A Solution to the One-To-One Computing Problem

Many teachers will tell you that the perfect student to computer ratio would be one to one. At the same time, almost every school technology coordinator will tell you that this is impossible to accomplish given the price of computers.

"Due to lower costs, increased functionality, and the availability of new software designed specifically for education, K-12 schools are beginning to take a serious look at handheld computing for teaching and learning, administrative tasks, and communication and collaboration. In fact, the potential for using handhelds in education is almost limitless." (Byron & Bingham, 2002)

Handheld computers might be the answer for schools that are looking for increased student-computer ratios at a more economical cost. "Devices are relatively cheap, with popular models priced between $250 and $550, depending on their memory and screen capabilities." (Trotter, 2001) Handheld computers are increasing in functionality, not only will they perform the three basic functions of word processing, spreadsheets, and database, but they keep an address book, a calendar, can be used as a graphing calculator, and a thermometer. The high end handheld
computers can also take pictures, shoot movies, connect to the internet, send and receive e-mail, and send faxes. (Pownell & Bailey, 2000) The most useful feature that is included on all handheld computers is the use of wireless communication through an infrared port (IR). This port can be used to beam documents, programs and information to other handheld computers. All of the previously mentioned have a place in the classroom and in the learning environment.

Pownell and Bailey (2000) list four characteristics of handheld computers that set them apart from desktop computers. These are: portability, accessibility, mobility, and adaptability. A discussion of each follows:

*Portability* refers to the size of handheld computers. They are small enough to fit in a shirt pocket or a purse and can be taken anywhere with little limitation.

*Accessibility* refers to the ability to access information any time. Users are able to access information instantly any time they need it. No longer do they need to wait to find a computer at school or home to access the information required.

*Mobility* refers to the greater movement that handheld computers offer. Users are not tethered to one place or need cords to transfer and access information due to IR transmitting capabilities.

*Adaptability* refers to the ability of the user to change his or her behavior because of the technology. Handheld computers will change the way people access information. Handheld computers are not just an extension of the Internet and the user's desktop computer, but are an extension of people themselves.

These four characteristics, along with their economic cost, not only make handheld computers a solution to the one-to-one computing ratio, but allow educators a whole new way to integrate technology in the classroom.
**Handheld computers in the Classroom**

So how can these devices impact learning, and what can an educator do with them in the classroom?

Many high school students already own a graphing calculator that costs about the same amount as many of these handheld devices. So why provide a student a handheld computer? In addition to being a graphing calculator, a handheld computer can serve as a time-management tool, a graphic organizer, a word processor, a web browser, an e-mail device, and much more. (Byrom & Bingham, 2002)

Pownell and Bailey (2002) give six uses of handheld computers in the classroom setting. These are: Teaming and Collaborating, Communicating, Learning and Self-Improvement, Gathering and Analyzing, Reference Information, and Organizing and Planning. Each one will be discussed and a scenario will be given on how students might use their handheld computers in a school setting.

**Teaming and Collaborating**

Teaming and Collaborating refers to the use of handheld computers to communicate within a team setting, and collaborate and share information between team members. "Unique technical characteristics such as infrared beaming offer opportunities for real-time student collaboration." (Shields & Poftak, 2002) Students can make a plan for a project with due dates listed along with each team members responsibilities. The sharing of information becomes easy as team members beam information back and forth using the IR port on their palm.
Scenario for Teaming and Collaborating

Jessica and Mark are working on a project together. Their teacher has beamed them all of the necessary components that must be completed along with due dates and scoring rubrics. Jessica and Mark sit and talk about who is going to research and who is going to start an outline for their PowerPoint project.

The next day Jessica and Mark meet again and exchange information. Mark beams Jessica the research he found and she beams him an outline of their PowerPoint presentation. They then discuss and create a To Do List on their handheld computer of everything that needs to be completed by the time they meet tomorrow.

Communicating

Communicating is the exchange of information. Students can share important information with each other as well as their teachers. This can be done through e-mail, faxing, or beaming information from one handheld computer to another.

Scenario for Communicating

Sami was excited after leaving school today. They had just started a new unit on endangered animals in Africa and Sami was interested in learning more about them. She went home and logged onto the internet to start looking for more information on the endangered animals. Sami found an excellent web page with information about all the endangered animals of Africa and what people can do to help them. She decided she would share the information with her class, so Sami hot synced the web page to her handheld computer to take to school the next day.
The next day Sami beamed the information to her teacher's handheld computer and then beamed the information to her classmates. The students read the information and then the teacher held a discussion on the information they had just received.

*Learning and Self Improvement*

Learning and self improvement is what teaching is all about. Handheld computers allow students to access information any time anywhere, allowing the learning process to continue outside the walls of school.

*Scenario for Learning and Self Improvement*

Today in his fourth period class Geetak was introduced to an exchange student from Germany. He has always been interested in Germany and sees this as an opportunity to make friends with the new student as well as further his own knowledge of Germany. When Geetak went home, he logged onto the Internet and found a German to English and English to German dictionary that can be downloaded to his handheld computer. He downloaded the program and took it to school the next day. He shared the program with the new exchange student and they began to converse with one another.

*Gathering and Analyzing*

Gathering and Analyzing refers to the collecting and/or manipulating of information to answer questions or make decisions. Students can use form programs, databases, calculators and other software to gather and analyze data. All of these functions and others similar to them can be used on handheld computer.
Scenario for Gathering and Analyzing

Farheen is excited today. Her math class has been studying angles and geometric figures in class. Today her class is headed to a vacant lot where they had to gather information and then design a business and building to be built on the lot. When Farheen finally got to the site she began gathering information such as road names, length and width of the lot, and location from other businesses. As she starts to format a plan she jotted down notes and talks to other class members about what information they are gathering. When they return to the school, the teacher beamed the students pictures of the vacant lot so that they could view the lot as they worked. Farheen starts to analyze the data she had gathered and creates a plan for her business building.

Reference Information

Reference Information is a knowledge base that students can draw from. References for students can come in many different forms. They might have a list of math terms and definitions, or maybe research writing references for their high school classes. There are many ways in which schools can use handheld computers to make sure students have the information they need to be held accountable for their learning.

Scenario for Reference Information

It is the first day of school and Maria has just been given her handheld computer for the year. The teacher instructs the students on how to turn on their handheld computer and then webt through useful information for the students. First, Maria notices a document called "Students Rights and Responsibilities," the teacher explained that these were the expectations of the school and the rights that students have. Next the teacher instructs them to click on the school calendar icon. Here Maria saw a calendar of the school year complete with final exam
schedules and holiday breaks. She also notices the hours of operation for the school, and a schedule of all school sports events. The teacher instructs her to click on the "Writing Scoring Rubric". The teacher explained to her that this is the Six-Traits writing rubric that has been adopted by the school and will be used in all classes to grade written assignments. As Maria explored the rest of her handheld computer, she realized that all of this information was just a click away any time or any place she might need it.

Organizing and Planning

Organizing and Planning refers to managing time, keeping track of contacts, and targeting tasks to be done. All of these applications are standard with most handheld computer on the market today. These applications also allow students to set alarms and reminders for assignments or appointment they might have.

Scenario for Organizing and Planning

As Trevor sat at his desk, his handheld computer alarm went off telling him it was time to go to Mr. Bell's room where he worked one-on-one with the teacher to improve math problem solving skills. When he arrived at Mr. Bell's room, he beamed last night's assignment to Mr. Bell and Mr. Bell beamed him tonight's scavenger hunt for numbers. While he was working with Mr. Bell, his handheld computer alarm sounds again telling him it was time for him to take his medication. He walked to the office and took his medication from the nurse. She checked his handheld computer to see that the next alarm was scheduled correctly, and then he returned to class. At the end of the day as Trevor was packing to go home the alarm sounds once again, it was a reminder from his mother that he is going to his Grandma's house after school. Trevor finishes packing his backpack and headed to his Grandma's house.
All of the previously mentioned scenarios can be easily accomplished with handheld computers today. As the software for handheld computers increases, as well as their memory size increases, the way in which handheld computers can be used will change and enhance the lives of students even more. Pownell and Bailey's six uses of handheld computers is just a starting point of the influence handheld computers can have on education. They are good examples of the role handheld computers can play to promote learning in the classroom as well as outside the classroom.

Brain-Based Learning and Handhelds: Putting it Together

Both BBL and handheld computers have a place in the educational setting. When the theory of brain-based learning is combined with the usability of handheld computers in the classroom, it creates an atmosphere where learning becomes the center of the environment and the educator or facilitators has to do little but guide the learner down the path of discovery and knowledge. Let us revisit the BBL concepts mentioned previously: enriched environment, emotion, attention, meaning and threat and stress and apply these to the use of the handheld computer within the educational setting.

Enriched Environment

In a BBL enriched environment color and light effect the way in which the learner responds to the environment around them. Handheld computers offer both. Most handheld computers today come with colored screens that allow learners the opportunity to change color
of text and to view pictures and other color product in the palm of their hand. Handheld computers also come with a backlight setting that allows the user to adjust the light needed for optimal viewing of the screen. When learners are in control of the light setting, they can customize it to what is comfortable for them. In this way every learner has the light best needed for their brain.

*Emotion*

BBL states that emotions play an important role within the learning environment. Creating celebrations and rituals within the learning environment, engaging in reflective thinking and in dialogue from varying perspectives sparks emotion within the learner and opens their mind to learning opportunities.

Handheld computers can play a role in all of these. By creating appointments within the handheld's Date Book learners can celebrate memorable moments either within the classroom or within history. Rituals can be incorporated, such as how learners hot sync their data to the computer, or how the handhelds are distributed within the class. Reflective thinking opportunities can be given as students can quickly connect their handheld to a portable keyboard and reflect on the day's lesson. These reflections can then be easily shared with other learners or the teacher by beaming their reflection using the infrared port. These reflections can then be analyzed by other learners, giving other learners a varied perspective of that day's lesson. Or the teacher can read and respond to the reflection asking questions that lead to deeper understanding and reflection of the material.
Attention

According to BBL, creating appealing choices, making learning relevant, using novelty information and engaging the learner with emotion and varied learning experiences are ways to capture the learner's attention and retain it throughout a lesson.

With the mobility of handheld computers, learning can easily be taken outside of the classroom, making it effortless for students to turn simple lesson plans into real-world learning experiences. For example, a simple math lesson on comparing prices and products can become a real-world lesson where students are challenged to go to real stores within the community and compare prices and products. The information can be easily stored in the handheld computer and then shared in class the next day. An activity like this allows the learner to choose a product that is meaningful to them; the learning becomes relevant, as learners make the connection and apply their learning in a real world situation. This type of activity would be new and interesting to the learner therefore engaging the learner and creating an emotional response.

Meaning

In order for learners to create meaning, brain based research shows they must connect prior knowledge with new learning. Meaning is formed through emotions, acknowledging context and patterns, and role-play and games.

Because of the many programs that are available for the handheld computer, being able to connect prior knowledge with new learning becomes a simplified task. Using mind-mapping software, students can map out new learning and connect with prior knowledge. They can easily compare and contrast information, categorize information into themes or ideas, or create a Venn Diagram that shows the relationship between two or more topics or ideas. Students can also use
their handheld computers during role-play activities. Students can easily type up a script, beam it to other members of the group using the infrared port, and then act out the script with everyone reading from their handhelds. There are also many educational games that can be downloaded onto the handheld computers. For example, flash card games for math, world geography games for social studies, and translation games for foreign languages.

**Threat and Stress**

In any good learning environment, the negative stress level is reduced and the positive stress level is presented in a way that creates a safe atmosphere for risk taking. Such things as using wait time to encourage participation, demonstrate and clarify instructions, provide guidelines or rubrics for lessons, and allow time to 'destress' are all way to create a safe environment for learning.

By previewing the software and becoming comfortable with it before students use it, educators and facilitators can reduce student anxiety of using the technology. This also allows educators and facilitators time to coach, clarify, and provide hints that enable all students to be successful in using the handheld computers. Educators and facilitators can easily beam scoring rubrics or guidelines to students so that they have them in a safe place were they can be viewed whenever needed. Teachers can provide students with time to 'destress' by allowing them to explore and play with the functionality of the handheld computers. This time will allow students to relax and enjoy the handheld device and all it has to offer.
Conclusion

In conclusion, BBL offers educators, facilitators, and learners a better way to approach and acquire knowledge. BBL is creating a new pedagogy within the learning environment at the same time that handheld computers are redefining the use of technology within the educational setting. This new approach to teaching and learning along with the new tool of handheld computers is revolutionizing the educational process within the broader educational setting. Combining this pedagogy and this tool, gives educators and facilitators a new, fresh, research based approach to learning that has not been seen before. Not since the overhead projector and constructivism has a technology tool and a pedagogy had the power to change education like that of the handheld computer and brain-based learning.
References


