How can we use brain-based research teaching methods and strategies to enhance student learning in math?

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> Today, education is poised to move beyond tradition for tradition's sake. Although we certainly have not uncovered all there is to know about the brain and learning, the medical field has given us some concrete, physiological data to consider when developing and implementing teaching strategies. Educators working in brain-compatible environments can develop an unprecedented professional competence that will enable students to reap the rewards of powerful, successful learning. (Erlauer, 2003, pg. 1-2)

Biographies

Tina VanKuren currently teaches the Primary Assessment Class at J.L. Mitchener in Cayuga, Ontario. She is in her third year as a Special Education Teacher at the elementary level. Her previous careers have ranged from retail management, recreation, social services, brain injury rehabilitation to health care. Her educational background consists of a Bachelor of Recreation and Leisure services, Bachelor of Arts in Psychology, Master of Education, Multidiscipline Rehabilitation Certificate, and Bachelor of Education. Many of her professional roles have involved working with persons of different ages with a variety of special needs. Tina=s current assignment is working as a primary teacher (ages five to seven) with a small class of children who have special learning needs due to speech, language, and attentional difficulties. This is Tina=s second action research project.

Dave Love currently teaches Grade 5 at J.L. Mitchener in Cayuga, Ontario. Previously, he has taught Grades 2, 5 and 6. With 11 years post secondary education, he has always been interested in learning. Dave attended the University of Windsor for his B.A. in English and History and his B. Ed. He has a Masters degree in Theology from the University of Toronto. Dave believes asking questions is a great way to learn. Combining reflection and asking questions provides for meaningful application of current learning. After completing a year long action research project in 2001, dealing with improving student learning by integrating subjects, he became hooked on professional development involving action research. The implications of knowing that integrating classroom experiences helps improve student learning, changed his planning and approach to teaching. This year=s research considering the application of brain-based learning with mathematics brings the same excitement and the added joy of working as part of a group.

Krista Thompson currently teaches the Developmentally Delayed class at J.L. Mitchener in Cayuga, Ontario. She is in her second year as a Special Education Teacher at the elementary level. Krista's educational background consists of a Bachelor of Arts in Psychology from the University of Windsor, where she also attended Teacher's College. Her current assignment is working with a small group of children (ages 7 to 13) who have special needs, both physically and academically.

This is her first time participating in action research.

Elizabeth Greasley currently teaches at J.L. Mitchener in Cayuga, Ontario as the Learning Resource teacher. This is her second year as a Special Education teacher. Previously, Elizabeth worked for the Rainbow District School Board teaching various computer programs to Adult learners. Elizabeth has a Bachelor of Arts degree in Geography from Laurentian University in Sudbury and she attended Teacher=s College at Lakehead University in Thunder Bay. In her current assignment she is working with struggling students ages seven to thirteen. This is her first time participating in an action research project.

Abstract

As the quote above states, teacher knowledge of brain-based learning will improve teaching practice. This paper describes the efforts of 4 teachers working with students of various ages and abilities. The focus is on the utilization of brain-based teaching to assist with the acquisition of skills in the subject of math. The goal was to test the effectiveness and universality of implementing brain-based instructional techniques across all divisions, including special education, which would provide the opportunity to compare results with different student populations.

Background and Rationale

Brain-compatible instructional strategies work because they are based on research, match common sense, and involve teaching the way students learn (Erlauer, 2003). There are four general principles of brain-compatible learning: active meaningful learning, stimulation and varied input, accurate feedback and a safe, non-threatening environment (Jennings and Caulfield, 1997).

Active meaningful learning provides students with opportunities for project-based learning and teamwork, gives students responsibilities, has students create displays, products and services, and attends to student learning styles and intelligences. While involved in physical activities, the brain is highly engaged in cognitive functions. Learners use their brains, for counting, figuring, planning and problem solving. According to Jensen (2004), there are many reasons to engage learners physically. It strengthens more neurons than sedentary experiences. It provides the teacher and learners a lot of feedback on what they know and do not know. Physical movement is usually motivating and rewarding. Kinesthetic involvement encompasses emotions, develops problem-solving skills and assists with learning by including data in the brain so it can be recalled easily at a later time. Physical movement involving lesson content enhances brain function and learning. Physical exercise triggers the release of brain chemicals that enhances communication between the parts of the brain, elevates mood and assists in long-term memory formation (Jensen, 1998, pg. 59).

Young children learn subtraction faster and retain it longer when it is presented in a variety of forms, including physical activity such as moving classmates as numbers in an equation or calculating comparable distances or times for outdoor runs (Bucko, 1997). The purpose of instruction in mathematics is to allow students to develop the skills they will need to solve real-life problems involving numbers. However, too often, the problems presented in typical textbooks are abstract and

meaningless. When students can write their own word problems for classmates to solve, the problems then have more true meaning and can be a lot of fun. For example, one student wrote the following problem: "AI started out with 37 ants. I put 15 in my sister's bed and 16 in my mother's cookie dough. How many ants did I have left?" (Wolfe, 2001). In terms of meaningful learning, if the brain cannot find a link to information presented it will probably not be stored in long-term memory. Unfortunately, this situation is usually common in many classrooms because teachers require students to memorize a great amount of material that has little or no inherent meaning (Wolfe, 2001).

To begin a unit on fractions with elementary students, they can do such things as peel and section an orange, count the sections, and discuss the parts (fractions) of the whole orange. This is meaningful and often there is a built-in inherent motivation because they are familiar with this fruit and can then enjoy eating the orange at the end of the lesson. Students who are in the middle school grades thoroughly enjoy activities that engage them in physical activity such as described in the example below. In a unit on measurement, students will be intrigued to discover that they are all almost a certain height as they use their own feet as a non-standard unit of measure. The students could support this information by marking their head heights on paper taped to the wall and then actually measuring their height by using a tracing of their feet. Then the students can construct graphs and determine averages as part of the lesson (Wolfe, 2001).

In order for accurate timely, helpful feedback for students, the teacher needs to provide explicit criteria for assessment and use real audiences to judge performance on products and services. Feedback should recognize many types of achievement. In a classroom, feedback could be an oral compliment, a facial expression, a written comment, or a full discussion. Maximizing learner feedback reduces uncertainty, increases coping abilities while lowering the pituitary-adrenal stress responses (Jensen, 1998). The brain itself is exquisitely designed to operate on feedback, both internal and external (Jensen, 1998, pg. 33). Our whole brain is self-referencing. When prompt feedback is received, the learner can either make a quick correction and move on or proceed with the confidence that he or she is on the right path. One of the most difficult things for a brain to do is to unlearn deeply embedded knowledge or skills. This leads to a situation when simply giving up becomes the easiest option for a student (Erlauer, 2003, pg. 123, 126).

The classroom must provide a rich, stimulating environment that uses posters, ads, photos, provides many field trips, encourages students to pay attention to their surroundings and arranges for Asparks@. It used to be that we thought that the brain was hard wired and that it didn=t change...(but)positive environments can produce physical changes in the developing brain (Jensen, 1998, pg. 29). One of the critical ingredients in creating this environment is to challenge the student with new information and/or new experiences (Jensen, 1998). Enriched classrooms are not just those with multi-sensory stimuli but foster genuine enrichment such as novelty, challenge, and feedback (Jensen, 1998). Mental challenge can come with learning new material, adding a degree of difficulty, and varying time, expectations and the degree of support. Change instructional strategies such as using computer, field trips, guest speakers, pairings and student teaching. The classroom environment filled with maps, pictures and graphic organizers will be taken in on some level by most students as they become increasingly aware of the world around them. It has been found that the brain changes physiologically as a result of experience. The environment in which a brain operates determines to a large degree the functioning ability of that brain. Therefore, the brain that eventually takes shape is the result of

interaction between the individual=s genetic inheritance and everything he or she experiences (Wolfe and Brandt, 1998).

It is important that the learning environment be free from embarrassment, humiliation, sarcasm or student bullying as can be clearly seen by the latest brain research on the necessity of creating a non-threatening environment. A safe, non-threatening environment which builds trust and portrays to all students a sense that the teacher cares deeply for them is essential. When we feel stressed, our adrenal glands release a peptide called cortisol. Chronically high cortisol levels lead to the death of brain cells in the hippocampus, which is critical to explicit memory formation. Chronic stress also impairs a student's ability to sort out what's important and what's not. The brain's short-term memory and ability to form long-term memories are inhibited (Jensen, 1998, pg. 53). School stress also diminishes serotonin levels, the number one chemical for modulating our emotions and behaviours. This has been linked to increased violent and aggressive behaviours (Jensen, 1998). For math, high stress levels over time have very detrimental effects on students= learning.

Survival always overrides pattern-detection and complex problem solving. Students are less able to understand connections or detect larger levels of organization (Jensen, 1998, pg. 57). Since we know that the brain is a complex, dynamic system that has an innate ability to search for meaning and that meaning occurs through Apatterning (Pool, 1997, pg. 88), it is easy to see how stress would negatively affect not just the conceptualization of math concepts, but learning across all disciplines. This non-threatening environment is brought about by providing an atmosphere of courtesy and by holding regular conferences with each student. The more we feel valued and cared for the more our brain releases the neuro-transmitters of pleasure. We enjoy our work more.

Tina's Reflective Narrative

Generally speaking, I make a conscious attempt to ensure the environment of my classroom is non-threatening and enriched for all lessons in each area of the curriculum on a daily basis. Prior to doing my research in brain-based teaching and learning I have always believed that in order for children to learn best they need to feel safe and comfortable in the classroom. I use a variety of visual aids posted around the classroom and within specific lessons to help assist with understanding. In addition, I try to incorporate an adequate level of challenge in my lessons to encourage risk-taking and to avoid the problem of having students become bored with the tasks because the expectations are not difficult enough.

My major math focus for the purposes of data collection during this action research project was in the Grade 1 Geometry and Spatial Sense strand of the curriculum. I was utilizing different lessons to help the students learn and become familiar with the positional language used when describing and demonstrating the relationship of oneself and objects in the environment (e.g. in, on, beside, right, left, over, under, etc.). For gathering data, I used anecdotal observations, audiotapes, videotapes, verbal feedback from students, and student work samples. I purposely included both pen and pencil types of lessons intermittently along with many active tasks using different manipulatives to allow me to compare the effectiveness of brain-based teaching with traditional instructional methods.

My initial lesson for this unit involved an Easter egg hunt within the classroom just prior to that

special holiday weekend. Ironically, I did this same lesson last year and I did not realize that it would be considered brain-based at that time but it definitely was active and meaningful with immediate feedback. The students were given the opportunity to individually take turns following specific directions which I read aloud to the class and each student had several eggs to locate throughout the duration of the lesson. Some examples of instructions/clues that I offered verbally included the following: look on the windowsill behind the curtain; look on the toy shelf beside the water table; look on the shelf under the stereo; look on the top of the bookshelf between the books; and, look in the doll crib on the fridge. When we were finished finding the plastic eggs containing edible items, they were divided equally and the treats were placed in small ziplock bags for the students to eat when they returned to school after the Easter weekend. Two of my lessons for this math unit encompassed pen and pencil tasks with very little active meaningful learning. On one day, I used a colourful big book illustrating a dinosaur placed in different positions related to a ball while I asked the students to describe what they saw in the picture. Following this they completed a worksheet in two small groups with assistance to print the appropriate positional word chosen from a word bank in the proper place to describe where a person or object was located in the picture on the page. Another lesson involved me reading aloud two small books which used the words “on” and “under” to the whole class with them doing shared reading after they realized the repeated pattern of the word in the books. Then we completed an activity sheet in two small groups with assistance choosing the correct word to print in the space given to describe the position of objects in a picture. We concluded that lesson by having the students in the same two small groups take turns reading aloud each page of a similar small book which contained pictures and a short sentence using either the word “on” or “under”. The students then had time to colour these books and take them home for reading practice. Both of these lessons were enjoyed somewhat by the students but they had a considerable amount of difficulty paying attention and completing the tasks which were time-consuming, required printing and sedentary seatwork.

Other active lessons I incorporated into this unit included the following: (1) doing the action songs Hokey Pokey and Simon Says using positional directions; (2) partners choosing two cards from a pile which contained position words and then each having a turn demonstrating those two words together for the class; (3) using pattern shape blocks to place these objects in certain positions in relation to each other following verbal directions; and, (4) using a student’s special stuffed animal having individual students place the animal in specific positions (e.g. under the table, beside John,

above my head, behind Susan) as verbally described by myself.

There were some additional aspects of my research which were not related to the unit on Spatial Awareness. These elements involved having our board Primary Numeracy/Literacy Consultant, Anita Ricker, provide some interesting hands-on addition and other math lessons using different manipulatives. I utilized a gumball candy machine for periodic use one-to-one at the end of random days for the students to practice coin identification. Also, I established a "Math Buddies" program with our school Learning Resource Teacher to bring some Grade 7 students to our class two days each cycle at the end of the day to play math games with my students so both groups reinforced some basic math skills and enjoyed the benefits of the inherent social nature of the human brain. Overall, the feedback from the students was very positive in terms of all lessons and activities. Verbal responses indicated that the favourite activities in the Spatial Awareness Unit involved movement such as the Easter egg hunt, the Spatial Awareness Simon Says, using the stuffed animal and having the students demonstrate with partners how to represent certain positional terms. When making observations and obtaining oral comments about the other components of brain-based math teaching strategies which I implemented this year, my students enjoyed all of those listed above but they were always very excited and enthusiastic about AMath Buddies.@ Finally, my students thoroughly enjoyed and obviously benefited from this approach to learning math skills and I discovered some new strategies to improve my ability to provide a brain-compatible classroom environment.

Dave's Reflective Narrative

It seems amazing that so much of what happens in my classroom exemplifies a natural awareness of brain-based learning. In order to create a rich, stimulating environment for students they have been encouraged all year to identify new or different elements or patterns within the classroom. The first person to say what they noticed could choose something from a "drawer" in my desk. The drawer has a variety of stickers, candies, fancy erasers and pencils. It took a few weeks for them to begin noticing changes but it is now an exciting part of the day with more and more students participating.

The idea of noticing changes and patterns is often part of my introductory lessons with Math. To introduce lessons about division, I clapped multiplication questions. The first set of claps represented the multiplicand and ended with a hand motion to indicate that number was finished, and I said,

"multiplicand". The next set followed the same procedure and represented the multiplier so I said, "multiplier". A student was asked to clap the product. When they were correct, the student clapped their own question and selected another student to clap the answer. This continued for four or five questions. At this point I clapped sets to represent the dividend, divisor and quotient but did not name the parts. I challenged them to identify what operation was being clapped. After two unsuccessful attempts I gave them the clue, "dividend" after I clapped it. There was some confusion with the clapping because they were not used to three sections being clapped by one person. My next clue was saying, "quotient", before I clapped the answer. Hands flew up as they understood what was happening. One of the usual spontaneous students called out "division". Five students then proceeded to clap and say dividend and divisor, seeking others to respond by clapping the quotient. Other lessons began with a variety of clapping procedures, some stood to clap or respond at their desk or move to various places around the room, while others shut their eyes to start.

Students then had a timed sixty-question division activity in which they did the best they could while I wrote the time on the blackboard in intervals of 30 seconds. They understood that the timing was only for their benefit, to compare this first try with the same timed test at the end of working through this unit. They had something ready to do if they finished before others. Everyone stopped at eleven minutes and recorded that time if they had not finished by then. Student responses were exchanged and marked as answers were provided by a 'Round the World' activity.

The next step was to introduce the concept and drill portions of the lesson. The rap song, "Divide and Conquer", caught their attention. I gave copies of the words to them and we sang it again. I repeated this song for a number of lessons and the chorus became very popular and sometimes sung quite loudly. I wanted to know that they knew a particular division aspect of the song so I challenged them to complete the lines following a verse which ended with: "dividing by zero always is zero and dividing by one always is that same number". A majority

of the class sang it out the first time. I was reassured.

Concept songs focused upon understanding division as dividing a set into smaller groups, noting patterns in multiplication facts and what happened to them in division, being certain to set all digits in the "best" place, e.g., when dividing, that the numbers in the quotient are placed directly above the number being divided in the dividend, and correct usage of the terms to describe division.

The drill songs reviewed all facts from dividing by two to ten. I always gave the students the words for each song along with questions that were lacking quotients so that they could sing and compute at the same time. I encouraged them to clap the rhythm or tap their feet and sing along, as long as that movement did not get louder than the singing.

I repeated the concept and drill songs at least once after they were introduced and more often as students asked for their favourites. Sections of the class were given the opportunity to dance with the songs while others sang along with the tape. A group of students added their own sounds in places where the original music held a long note or was quiet. For three songs where the rhythm was difficult they heard their error after anticipating the beat and stopped those who sang too soon. They had the idea of challenging groups to see who could do it totally correct. A reward from the "drawer" was expected.

This approach for student learning about division concepts and facts provided for:

a) active meaningful learning as they enjoyed the music, applying previous learned patterns, and having fun as they "drilled" division facts. The learning became meaningful to the students when they saw the improvement that occurred from the first test to the second. Three students out of 28 scored perfect on the first test and fifteen scored perfect the second time. The two lowest scores improved to passing scores from three and five out of 28.

b) stimulating and varied opportunities of input were provided by music, movement, and multi-sensory perception. The students created their own responses to the input as well as adding their own stimulating challenges for others.

c) accurate timely feedback occurred in that they were constantly involved with concepts and division facts in various ways experiencing immediate correct answers. Both of the tests provided immediate feedback by the exchange for marking, answering by 'Around the World' and students getting their tests returned to them within a few minutes.

d) actualization of the need for students to have a safe, non-threatening environment. I have attempted to create this from their first day in my class. Student response with personal suggestions indicates how comfortable they were with risking ideas that could have been rejected by other students or myself.

Music can be a powerful approach for integrating various curricular areas. The patterns and symbols in music are underlying concepts that help to make math more understandable (Wolfe, 2001, pg. 164).

Krista's Reflective Narrative

My students have a variety of ages, abilities and interests. To complicate matters, half of my class use wheelchairs for mobility and have limited verbal and motor skills. I am continually searching for multi-modal activities that my students can enjoy on many levels.

When I began this project I did not really know what brain-based learning was. As I started reading more and more, I realized how much I already use in the context of my class.

An example of a way I used brain-based teaching methods prior to this project occurs during our morning circle time. Each day, we count the number of days that are in the month. As we count, I touch the days on the calendar while the entire class says the numbers. At the same time they are saying the numbers, they are supposed to touch a part of their body with both hands for each number said, for example the first ten numbers are counted on their knees, the second ten on their heads. This is brain-based in that it integrates the senses because they are seeing the numbers, hearing the numbers, and feeling the touch. As well, they are counting a finite set that is meaningful, and they have a sense of safety in that the whole class is involved simultaneously.

The problems I found were that the students were not looking consistently at the numbers, and they were touching body parts more than once for multi-syllable numbers such as, seven. Since I was not aware of brain-based research I did not know which parts of my lesson were effective. Once I learned that lessons should be multi-modal, and that kinesthetic movement was a key to association, I was able to change my practice to be more effective.

First, I taught the skill of touching for each number. I showed them how each square on the calendar is a number, and explained that they were to touch their knees each time I touched a square on the calendar. This helped to reinforce the number words. Next I had a student touch the calendar squares. The rest of the students watched more carefully knowing that they would be expected to perform this task sometimes. By watching the calendar more carefully, the students had more experience associating the numbers with their corresponding words. The student who touches the calendar squares gains extra experience, as they are actually touching the numbers.

Quickly following these small changes in the lesson, I noticed a change in one to one correspondence while counting. Students made fewer mistakes in counting the number of objects in a set. One student, who previously could identify numbers consistently to 5, could now recognize 6,7,8,9 and 10, although 6's and 9's are still often reversed in his writing. By using what I had learned from brain-based research, I was able to determine why the lessons I had were effective. Games work because they are fun, which produces a strong emotional link to the material, which helps with memory. Choral reading of numbers works because it is multi-modal. Kinesthetic activities, when the skills are taught, help reinforce patterns. Knowing the basics, I tried a few more brain-based lessons.

Songs are interactive and fun. To teach the spelling of the word "two", I used a song from the Frog Street Press I had learned from another teacher. When I later showed a page of number words, one of my students pointed at the word two and sang the words to the song, "t-w-o, that spells two". It

remains the only number word he can recognize or spell. My students were having difficulty learning the patterns in counting. They didn't understand that they had to keep repeating the word "thirty" when counting the thirties. On a whim, I started doing hip shakes while we counted to help demonstrate the pattern, and then my students decided to join in. We would push our hips to the right for twenty and to the left for one, to the right for twenty and the left for two. They kept counting, and one student made it to eighty-five before he stopped to go out for recess. Later he asked when we could "shake our butts again".

A few of my students were having trouble counting backwards. I wanted to give them a safe activity with lots of clues, that would be kinesthetic to help them with the pattern and make it multi-modal to help with memory. I had them sit in a circle, and then they chose the numbers

One to six from a bag. They placed the numbers in front of them, so that everyone in the circle could see them. I asked the students to throw the ball to the number that came after theirs, and when they caught the ball, they were to say only their number, and then throw to the next person. Then I asked them to do it backwards. I gave them a lot of assistance at first, but because they weren't switching numbers they learned when it was their turn. When we did switch numbers, I didn't have to give much assistance because they had been hearing the counting backwards all along, and most could remember the numbers, not just the person, that came next.

This action research project allowed me to change my practice to more effectively help my students. The more I learn about brain-based learning, the more I feel I am better equipped to teach my students to learn many skills.

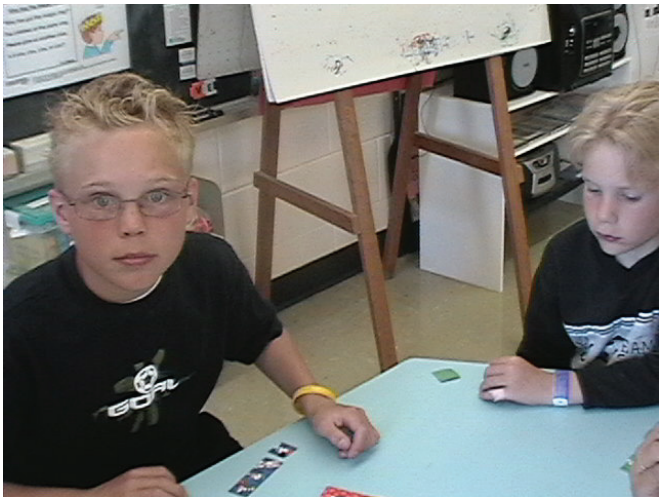
Elizabeth's Reflective Narrative

When I heard about the action research project on brain-based research, I knew I had to be involved. I have always been fascinated about how the brain learns and wondered how could this be applied to teaching. Math has always been a difficult subject for me to teach and I have been looking for ways to improve my methods. As the Learning Resource Teacher, I did not have a classroom of children in which to try out these brain-based teaching techniques. Through our group research, talks and also the meeting we had with Karin Mertins, it became clear that organizing a Math Buddies group was the way to go.

Two days per cycle, I took a small group of Grade 7 students to the Primary Assessment Class (PAC) to play games. I took only volunteers and in the beginning there were few. My only instructions to the grade 7 class were that we would be playing games with the PAC students and that they would have to teach them how to play and help them out. Not wanting to influence what occurred, I did not give them any further guidance.

Information was gathered through observation and a questionnaire that was completed by the Grade 7 students. Questions on the questionnaire were:

1. Did you enjoy participating in Math Buddies? Why or why not?
2. In what ways do you think Math Buddies helped the PAC students?
3. In what ways has Math Buddies benefited you?
4. Any other comments?



There were several games that we played with groups of four; two PAC students and two buddies. The games were: Battleship, Yahtzee Junior, Clue Junior, Snakes and Ladders, Octopus Dominoes, Xs and Os, and various dice games from the Boxcars and One Eyed Jacks kit.

It was surprising and amazing to watch what occurred with the math buddies. The buddies were enthusiastic, patient and quite naturally fit into the role of teacher. Encouraging comments were plentiful as were high fives. I frequently overheard the buddies saying things like Good job!, Excellent roll! and Way to go! Buddies helped the PAC students with strategies, counting, number recognition, and one to one correspondence. They made helpful suggestions and used guiding questions such as: If this is 6, then this is ____? —— Right, Count up from here., or Where is the 10? It was not long before I had students stopping me in the hall to see if it was “Math Buddies” day and ask if they could come. The PAC students were equally excited and never noticed that they were missing their activity time on those days and had a shorter afternoon snack. “Math Buddies” had created a safe, non-threatening environment for the students to learn some math skills, and the activities were so much fun that they did not notice that they were learning. The experience was novel and interactive and provided prompt feedback for the PAC students. This translated into a

noticeable difference accumulated over time in the confidence and ability of the PAC students and in their belief in themselves. The feedback from the Grade 7 students was very illuminating for me and insightful on their part. Without any guidance from me or explanation as to what the purpose of the activity was, they knew.

In answer to the question In what ways do you think Math Buddies helped the PAC students?, the following were some of the answers:

....teaching them to count better, how to estimate and a bit of probability.
They learn new stuff like math terms.
It helps them tell time and count higher
...the games get them to learn about math and language.
..helped their counting skills and visual and hearing skills.

...made them less afraid of older kids...
...it encouraged them to do better.
...learn in a fun way.

Clearly the Grade 7 students knew what the PAC students needed and were able and quite happy to help them. The Grade 7 students reported that they benefited from the experience by learning patience and all of them said that they really enjoyed helping and teaching the little children. One special education Grade 7 student said I like to teach kids about how I learn differently, so I try to help them so they don't make mistakes. Even the Grade 7 teacher began to see the benefits for her students when they told her they could see how important using math manipulatives was.

It is interesting to note that the Grade 7 boys were much better at encouraging and teaching the PAC students than the girls were.

The "Math Buddies" was such a phenomenal success that we plan to continue with it in the following school years with this same group of students when they are in Grade 8 and to begin with another new group of students in Grade 7.

Conclusion

Today, the evidence is overwhelming that enriched environments do grow a better brain (Jensen, 1998). Brain-based learning may be the most important influence on the way we teach since the first school was founded. Knowledge of brain-based learning will be essential to educators of the future because good teaching requires an understanding of how the brain receives, processes, and produces

information. Brain-based learning can be the foundation of pragmatic future education reform based on clear evidence of how children learn (Bucko, 1997).

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