Stonehenge

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Topic: *Visualization in the Teaching and learning of mathematics.*

My personal beliefs as a mathematics educator are based on over thirty –four years of teaching. As part of my experiential base, I have attended many conferences, and explored numerous educational resources. Most current research indicates the process of educating students has evolved from past practices and will continue to mutate. These change factors force mathematics educators to modify and change their patterns of instruction in both content and delivery. Mathematical instructional content requires context, visualization, and relevancy in order to become part of the learner's knowledge base. This task becomes increasingly more complicated due to: the ever changing needs of society and technology, the different student learning styles, and the diversity of student back-grounds and culture. According to -EDTHOUGHTS What we know about Mathematics Teaching and Learning "Helping students make connections among related mathematics concepts across other disciplines (e.g., science and social studies) and related to everyday experiences" must become our focus if we are to succeed in educating the next generation of mathematicians and problem solvers.

Meaningful mathematical learning can be accomplished with tactile applications of mathematical concepts, , hence creating a visualization. The students need a connection between the theorem, its discovery, and past and current applications. Students need to realize and visualize the fact that most mathematics used today in textbooks and classroom environments, was actually solutions to application problems of the needs of man through out history. For years The National Council of Teachers Of Mathematics (NCTM) has focused on making mathematics more tactile and application based to allow students a means to connect mathematical concepts to their world. One of NCTM publications Connecting Mathematics stresses the use of physical modeling and current applications of mathematics in various industries and jobs. Dr. Spencer Kagan in his book Cooperative Learning also points out that students have three basic ways of sorting new data (learning) cognitively: by detail, relationships, and by categorization. Kagan further states "All three of these (learning) styles are valuable and students need to have cognitive flexibility enough to see the information in a variety of ways". Kagan is not alone in his beliefs, Jon Saphier and Robert Gower in The Skillful Teacher state "Skillful teachers are made not born". Jon & Robert reinforce Kagan's concept that different students respond to the learning environment based on their experiential back-grounds. These statements support modification of traditional lecture modality in educating our young.

Sonya Kunkel and Margaret MacDonald in the <u>The Path To Positive Classroom Management,</u> while discussing brain research, make a point of stressing the connections of "meaning and retention" and "making meaning using associations". They state " The brain sifts through all incoming sensory stimuli and selects those that are then most relevant or meaningful. If the information has no meaning to the students, they will not store the information." They also go on to state " One way to make information meaningful is to associate or compare the new concept with a known concept, to hook the unfamiliar with something familiar." The final link in this chain of modifications is alternative assessments as stressed by the NCTM new standards "…should promote valid inferences about mathematics learning". The end result is that professional educators of the next generation of mathematicians and citizens of our world have to realize that we no longer have a captive audience. Teachers have to compete for student interest in learning with an ever changing, highly defined, and marketed multi-media, multi-modal world. Through computer technology and other forms of media, our students are bombarded exponentially with increasing level of information. To win the students' focus, the definition of a successful educator must change. The educator who continually modifies his/ her classroom procedures and delivers to suit the ever changing raw material, the modern student, will lead the student to successful mathematical learning and recall for future use.

The fore mentioned concepts, coupled with my own experiences, led me to develop a modified learning environment focusing on the process of knowledge acquisition by the brain. This learning environment consists of developing techniques that elevate the learning of mathematics to higher levels of application based on historically connected events. These processes seemed logical to me since mathematics learned in context (who- when- where and why) based on research has a higher degree of student learning and retention success. Successful student has been and continues to be my major goal. I combined these concepts into learning modules. These modules were so successful in my classroom and my school, that I competed several times in the State of Connecticut's CELEBRATION OF EXCELLENCE PROGRAM. I have won the Celebration of Excellence award in Mathematics twice. The acceptance of my work and positive student results gave me a reason to continue developing these concepts into groups of modules or lessons. These groups of modules are now published in two books, <u>The Missing Link Between Pyhtogoras and King Tut</u> and <u>Circles Rolling Through Time.</u>

Both books connect the historical origins of mathematical concepts, to past and present applications. The books define man's need to solve problems he faced through out history, and how man found mathematical solutions for these problems of application. Based on the research of the previously stated educators and scientist, coupled with my own educational experiences, I have written two books that capitalize on the limitless curiosity that students have about the mystique surrounding the Pyramids and Stonehenge.

When students simulate an Egyptian surveying team, they not only use the Pythagorean Theorem, but also have the opportunity to see mathematics at work. Research does indicate that the more varied a lesson structure is, the more interesting the lesson becomes. Maintaining student interest in this MTV age is the problem. Countless stimulae compete for our student's attention. I have found that the following lesson set up for teaching and using the Pythagorean Theorem grabs and holds the students interest. Historical background and of this application is presented to the students to read prior to the lesson. So when the visualization demonstration occurs the students can make the connecting links between, history-applications and visualization of the concept. The origins of the Pythagorean Theorem can be traced back to the Babylonians about 5000 years ago. Archaeologist's have found clay Babylonian tablets near the Great Pyramid of Giza (Cheops or KUFU) in Egypt. These findings indicate detailed theories that the Babylonian mathematicians had contrived. The Egyptians the great builders of antiquity, were the first to apply the mathematics developed by the Babylonians. In Fact, " during the time of the ancient Egyptians the right triangle relationship was held in secret trust by their religious leaders. Each time a building was erected, these people, called 'rope stretchers' had to be employed to lay out the corners of the structure so as to form a right angle." (Lewis, 1964). A second more common application of these rope stretchers dates back to Mendez who unified the upper and lower Nile deltas. The Rope Stretchers {latter named the Royal Society of Rope Stretchers} were using the surveying technique of the 3-4-5 right triangle to define the borderline of adjacent farms in the Nile River basin. These first recorded land surveyors were called annually to measure the Nile River valley after the rich silt was deposited by the annual flooding. The Egyptians, faced with this unique problem, placed square pillars marking the farm's inland corner. At the top of these pillars the Egyptians placed a GOLD pin which acted as the key vertex for the 3-4-5 right triangle used by the land surveying team. During Napoleon's attack on Egypt, his soldiers stole the gold pins. They were replaced by metal pin soon after. This land surveying procedure was first documented in scenes from the 3000 years mural at Abd-el-Qurna. The method used by the Egyptian surveying team was simple, yet highly accurate in settling many property line issues. The surveying team had three members and they used only a rope. The rope, twelve cubits long (twelve times the distance from the bent elbow to the longest finger), was equally divided by twelve knots, each one cubit in length.

To create the right angle needed to define the corner of each farm, the surveying team used the same process each time. One member of the team would count out three knots, holding the third knot on the pin in the stone pillar. The second member of the team would then walk four knots toward the rising sun (the Nile river). The third member of the team would then connect the end of the five knot section with the end of the three segment. This process was repeated year after year –century after century until 1957 when the Hydro electric dam south of Giza plateau was built. The Nile no longer floods the basin below the dam. The accuracy of the ROYAL SOCIETY of ROPE STRETCHERS can be seen in the great Pyramid of Cheops with an error on the order of 0.1%

As can be seen, the roots of the Pythagorean Theorem pre-date Pythagoras by over a millennium and a half. Pythagoras, however is credited with the first demonstration of a formal proof and algebraic definition in 500 BC. The Greeks were so attracted to this theory that a group of scholars formed the secret Pythagorean Order. Here is a sample of one of my teaching modules or lessons.

Lesson Plan 6

THE EGYPTIAN SURVEYING TECHNIQUE

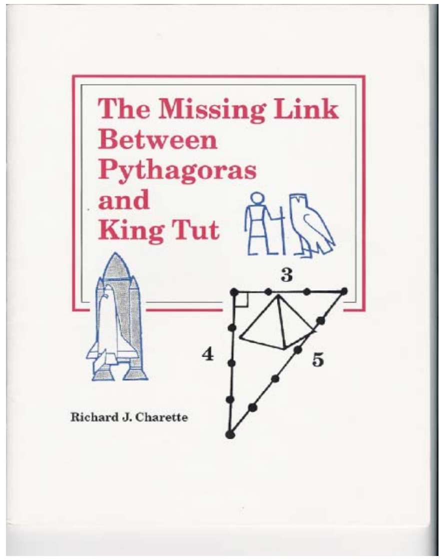
Objectives: To illustrate how people have used and continue to use linear measurement.
To simulate the right triangle measurement technique of the ancient Egyptians.

Materials: For each group of three students: Twelve-meter length of nylon rope 1/8 inch in diameter, meter stick, black electrical tape (optional); for each student: 12-foot length of string (also used for home-work assignment), colored marking pens, 2-foot length of string, ruler, copies of the Egyptian Measuring Rope*

Special Instructions: You will need a large open space.

Length of Time: One hour.

Procedure:
1. The teacher distributes copies of the Egyptian Measuring Rope and asks the students to read them.
2. The teacher tells the class that they are going to use the same technique. They are To mark the 12-meter rope at each meter to create a measuring rope. The rope is Laid on the floor, and a meter stick is used to mark off twelve one-meter increments. Each location is marked with a magic marker. Knots are tied at each location or black electrical tape is placed at each increment to simulate the tying of knots. (The tape is more visible from a distance.)
3. These students are selected to be the rope stretchers. They create a golden 3-4-5 right triangle in the following way:
    a. One person counts out three knots and holds the position of the third knot.
    b. A second member counts four more knots and holds that position.
    c. The third member of the team connects the end of the remaining five knot segment to the beginning.
    d. Members may have to change their positions until the angles of intersection are correct. The right triangle is formed only when the last member meets the first member.
4. Other groups of three students are rope stretchers until all have had a chance.
5. The students are each given a twelve-foot and two- foot length of string. They mark each of the strings into twelve equal spaces and practice the rope stretching technique.
6. The teacher leads the class in a discussion about the use of the right angle in today's society by asking questions like the following: {partial List}
    - Where have you seen the right angle in use?
    - How is it used in buildings?
    - Why do walls have to be 90^o to the base of a building? (Possible answers: strength, efficiency, style, tradition, best use of space).
    - How and why is the triangle used in supporting the superstructure of a building? (Answer: A triangle is the smallest strong geometric shape.) …



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