How Shapes Have Shaped Our Lives

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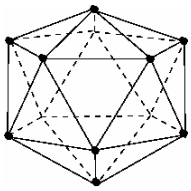


I remember when my 75-year-old mother first saw the new 3-D calendar that I had purchased for my classroom. She was delighted when the dimensions jumped out at her. She saw them immediately, while I still have to hold the page up to my nose to start with every time. Her pleasure increased with each picture of the month as she discovered the wonderful secrets hidden in the artwork. That kind of awe and excitement is what I want my students to feel as they discover the world around them and their part in it.

In my first year of teaching, I had the honor of having a wonderful artist in one of my classes. Actually, I had quite a few artists, but this one stood out. He could copy anything, and it would look just like the original right down to the smallest detail. So one day I asked him, "How do you do that? Copy so perfectly?" He said, "I look at the thing." I told him I understood that you had to look at "the thing," but that still didn't tell me the secret of being able to copy so beautifully. Patiently, he looked me right in the eyes and told me carefully and slowly what he had already said except this time he ended with, "I *really* look at the thing."

I believe that right then and there he influenced my way of teaching. If I wanted my students to really understand something – to see the whole picture and its details – I would have to provide them with a lot of "things" to look at. So now I had two objectives. I wanted my students to experience the joys of discovery in the same delighted manner as my mother as well as being completely involved and focused in any given learning experience. I believe that too much teaching focuses on the giving of information to children rather than allowing them to discover concepts and laws on their own.

Ms. Frizzle from the Magic School Bus series was my role model. She always created a situation where students could discover the answers to their questions. Unfortunately, I don't have a magic school bus, so I started bringing the real world into the classroom. Over the years, I have carried tons of "stuff" to class, carefully setting the scene for discovery to happen. So when I saw "Geometry in the World Around Us" as one of the seminars offered by HTI, I thought to myself, "This is perfect for me, and my students will love it."

While attending grad school, I worked for a remodeling company. The painter in charge explained to me that most of the work was not in painting but in preparation for painting. I think that a lesson in class is only as good as the preparation (not to imply that an occasional "teaching moment" should be passed up by any means). Yet I quickly learned that many of my at-risk students were hesitant to delve into their studies. They were not used to working on projects or in groups. They had not had many opportunities to do hands-on activities. Even the use of scissors, paper, and glue was a challenge for many of my seventh graders, but as the year progressed, they became more confident and efficient.

"Geometry in the World Around Us" sounded like it offered a stimulating new way to help my students appreciate the wonders that are everywhere. Oh, and did I mention that I teach English? I probably forgot to say that I have never had a geometry course in my life; this year I will be 59. Our professor made sure that every workshop allowed each teacher/student to have real hands-on experiences. He also brought a wonderful array of models to inspire us. It became immediately clear that however geometry was going to fit into my English curriculum, it would be hands-on and fun!

Of course, one cannot simply start painting a room. One must first take things off the walls, tape the woodwork, cover things up, and generally spend some time preparing the surface to be painted. Similarly, the first thing I had to do was identify exactly what I wanted my students to learn. Only then could I determine how to set the scene. Having emigrated to the U.S. from Germany in 1956, I know the importance of being able to speak the language. Students can't discuss geometry until they acquire the geometric lingo. So that is the first objective – vocabulary acquisition. Needless to say, this will be an ongoing process.

The second objective is to allow students to create art and build models of a geometric nature. I believe these activities will be especially helpful to students when they are confronted with geometry on standardized tests; also, they will serve to increase students' awareness of the geometry all around them. Once students are comfortable with the vocabulary and knowledgeable about shapes in general, the third objective moves students into discovering and creating patterns, analyzing symmetries, and marveling at the ingeniousness of tilings and tessellations.

It is no secret in the educational community that a sort of gap forms in the fourth grade (Hirsch 10). At that point, students have to tackle books with fewer pictures in order to decode meaning, and vocabulary plays a major role. Instead of learning to read, they must now read to learn. If a child can only understand a percentage of the words due to a vocabulary deficiency, then that child will have difficulty determining meaning.

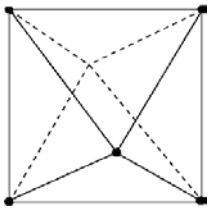
Research has also shown that this chasm continues to widen, as shown by the rapid deceleration of scores on word meaning beginning in grade four and continuing through grade seven. During follow-up studies, this decelerative pattern continued through high

school (Chall and Jacobs 15). Many of my at-risk students have a very limited vocabulary, most of which registers on the informal level of language. There is no doubt in my mind that this interferes with their ability to develop critical thinking skills. I believe that increasing a student's vocabulary increases their knowledge base, develops verbal and written communication skills, and ultimately leads to higher-level critical thinking skills.

The language of geometry lends itself well to word analysis due to the combinations of many Greek and Latin roots and prefixes. Let's just think about all the different polygons (literally, "many angles." For example, take the prefix "hexa." Once a student knows that the prefix hexa in hexagon is a Greek prefix that means six, he or she has a much better chance of understanding what a hexapod is in biology, a hexachord in music, and a hexameter or hexastich in poetry.

Students might get a clearer picture of a **tri**angle if they can associate it with the little tricycle they rode as a child or if they see a surveyor's equipment on the side of the road, mounted on a tripod. On a more somber note, a student may know someone who became a **quad**riplegic, losing control over all four extremities after a terrible accident. Most students in middle school know that the part of the government that has to do with the armed forces resides in a space called the Pentagon, but do they recognize the five-footed pentameter of a poem? As you can well imagine, by the time students have worked their way through **heptagon, octagon, nonagon, decagon**, and **dodecagon**, as well as the many other geometry-related words, they will have probably accrued a decade's worth of vocabulary.

At the beginning of this proposed unit, which I have entitled "How Shapes Have Shaped Our Lives," students will be asked to keep a "Book of Records." Eventually, they will create a border for the cover page using their knowledge of patterns. The book will be made up of 15 pages of lined paper, five pages of graph paper, and five pages of typing paper. Students will record their vocabulary words along with illustrations, creating several pages of a "pictionary" in their book of records. This collection of words will grow as students move through the unit.



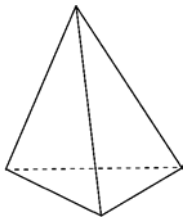
It has been my experience that, when teaching at-risk students, it is best to begin with the simple and then steadily move toward the complex. So the first few assignments will deal with simple shapes. In order to begin setting the scene, students might be asked to choose their favorite simple shape. They will then write limericks about their chosen shape on a piece of construction paper cut, of course, in the appropriate shape. These will be displayed, hopefully creating a bright visual stimulus. Here's a silly example.

SQUARE LACKS HAIR
There once was a shape named Square
who didn't have much body hair.
The triangle said,
Look at me instead –
I've got hair that stands in the air!

There is a cartoon on television that kids really like called SpongeBob Squarepants. Maybe the artists in your class would like to create a cartoon strip using this character.

Now, I happen to like triangles, so I might choose that as my favorite shape. I also happen to know a German song about a hat that has three corners. Just in case you want to use it, here it is:

Mein Hut der hat drei Ecken
Drei Ecken hat mein hut
Und hat er nicht drei Ecken
Dann war er nicht mein Hut.



My hat it has three corners
Three corners has my hat.
And if it didn't have three corners
Then it wouldn't be my hat.

The hand signs are as follows: when you say *mein* or my, point to your chest. When you say *Hut* or hat, point to your head. When you say *drei* or three, hold up three fingers, and when you say *Ecken* or corners, use the outline of your forearm, elbow, and upper arm to make a triangle. When you're at the word *nicht* or didn't, shake your head no. I find that middle school children like hearing foreign languages spoken aloud.

If this verse/song isn't your cup of tea, there is a wonderful story in the oral tradition called "Lazy Peter and His Three-Cornered Hat," which focuses on the negative consequences of being greedy. In our seventh-grade literature book (*Language and Literature* 843), Ricardo Alegria retells the classic story. Perhaps you can make a three-cornered hat; then, you can manipulate it as you go through the story.

When I first began to think about this unit, I was reading a book by Keith Critchlow entitled *Islamic Pattern: An Analytical and Cosmological Approach*. In the introduction, I came across a statement that made me stop and wonder. (Remember, I've never had a geometry course.) This is what it said: "From the basic circle and the hexagonal arrangement of a group of tangential circles of the same radius surrounding it emerge the three primary shapes: the triangle, the hexagon and the square" (7). Before turning another page, I wanted to see how that worked. Since I teach English, I do not have a classroom set of protractors or compasses. So, I had to find something to replace those tools.

My answer was "bottle cap" geometry. I have saved hundreds of bottle caps over time, so I have plenty for each student. First, I just moved the caps around, figuring out different possible arrangements. Then, I used a bottle cap to draw circles on paper. On one paper I simply made rows of circles, and I put a dot in the center of each circle. On another paper I arranged the circles in hexagonal arrangements according to the instructions in the above paragraph. Not only did I put a dot inside each circle, but I also placed a dot on the outside arc of the circle to create the same radius. I made two separate nets because I wanted to see if it made a difference in the types of shapes I would find. Students might raise this question, too.

As I began to connect dots, shapes began to materialize. It seemed to me that the principal polygon established by the relationship between centers and points of contact was the triangle. For me, the fun came in the discovery of the various shapes that I could form. I felt certain that the students would be amazed, too. Triangles developed into parallelograms, and hexagons became six-pointed stars. I got out map colors, highlighters, and markers, and before long, I had two examples of colorful, interesting geometric art. After my experiment, I went back to the book, and what I had discovered on my own, took me all the way to page 33 (from page 7).

Before moving on, you might take some time to review the following terms/concepts: radius, diameter, circumference, and pi. Seventh-grade students should understand these words, but many are still not sure how to calculate the circumference of a circle. As I questioned some of my students, I found that they don't really understand the relationship between the radius, diameter, and circumference. I also discovered that many of my students have trouble multiplying numbers with decimals. I thought, "But remember, English teacher, there is a math teacher on board, and you are not responsible for teaching all aspects of geometry."

Summer school was in session as I was writing this paper, so I had the opportunity to work through some issues with the students. Here's an example of what I was seeing. A student measures the diameter of a soda can and finds it to be 2.5 inches. Then, the student multiplies (2.5*3.14). But instead of coming up with 7.85 inches, the student places the decimal point incorrectly and comes up with 78.5 inches. When a student does not catch the mistake, it let's me know that there's a real lack of understanding of geometric relationships on the part of the students.

I decided to suggest to them to approximate by just multiplying 2 and 3, forgetting for the moment the .5 and .14. The answer, then, is simply 6. This let them know that their precise answers couldn't possibly be 78.5 inches. Rather, the answer would be close to six. After that, we measured all kinds of round objects, such as lids, cans, balls, etc.

I began to think of the circle as an almost magical entity, so I decided to spend a little time working with it. The circle is an important symbol in American Indian cultures. There are stories about the circle of life; the dream catcher is another example. I also

found a Carl Sandburg poem that I really liked. If you decide to use this poem, I suggest that you take a long stick and your class outside. (The stick is not for disciplinary purposes.) You can either read the poem or tell the story in your own words while drawing the circles in the dirt.

The story goes like this – first a white man drew a small circle in the sand and told the red man, "This is what the Indian knows." Then he drew a larger circle around the smaller circle and said, "This is what the white man knows." So the Indian took the stick and drew an enormous circle around both circles and said, "This is where the white man and the red man know nothing" (Sandburg 11).

This poem can lead to a serious whole class discussion. What is the real meaning of the story? Who is the wiser man? Who does know all the things that are in the large space encompassing both circles? What is the symbolic meaning of a circle? For a writing assignment, students could retell the story in their own words and analyze the meaning of the poem.

I was reading an abstract by Slavik Jablan entitled "Symmetry and Ornament," in which he had this to say about the circle: "Due to the maximal visual and constructional simplicity and maximal symmetry, a circle represents the primary geometric shape – geometric archetype" (1). He goes on to say ornamental art, the oldest aspect of geometric cognition, dates back to the Paleolithic and Neolithic (1). You might ask your students what could have influenced cave people in the year 25,000 BC to carve an ornamental circle on a piece of bone. What in nature might they have been copying? Were they thinking of the circle as a symbol? What message did they want to convey? Give students a few minutes to discuss these important questions in small groups.

When I asked myself these questions, I first thought of the full moon. But as I read on, the circle with its completeness and perfection, became instead the symbol of the sun and has remained that throughout history (Jablan 3). I can't help but envision a drawing done by a six-year-old of a house, a fence, green grass, a red flower, blue sky, and of course, that bright yellow round sun with several radiating lines, making the picture complete. On a deeper level, "the circle is not only the perfect expression of justice—equality in all directions in a finite domain—but also the most beautiful 'parent' of all the polygons" (Critchlow 9).

Then I remembered that children like to draw spirals. I recall that I liked to draw snails with spirally houses on their backs. For a bit of fun and an optical illusion, the spiral is one of the oldest dynamic visual symbols. "Fraser's Spiral is perhaps the most enduring of all printed optical illusions" (Cassidy 89). Even after a person realizes that it's not a spiral but concentric circles, the brain wants to continue to deny it. Middle school students like to make spinners, and many use the spiral as a means of decorating their spinners.

For more fun with spirals, use the Moire Spinner (Cassidy 84). One of my favorite books is Cassidy's *Klutz Explorabook: A Kids Science Museum in a Book*. This book has a Moire spinner on the cover right above a picture of Albert Einstein. Unfortunately, mine has succumbed to wear and tear, so the plastic overlay is somewhere never to be found again. But these spinners can be made quite simply. If you don't have access to this Klutz book, just find a copy of a Moire spinner and reproduce it several times over. Once you have a good copy, run a transparency through. Now, you have the spinners on paper and on a transparency. Cut out all the spinners. Use a transparency spinner to overlay a paper spinner. If they are mounted on cardboard or Styrofoam with a small pin, students can spin them easily.

Be sure to ask students to predict what will happen prior to assembling their spinner. Will it make a difference if you spin it clockwise or counterclockwise? A homework assignment might be to write down the reactions from family or friends when they show off their Moire spinner.

Having used a bit of magic, mysticism, and illusion, to hook the students, it's time to get their feet back on the ground. A good weekend homework assignment might be to have students find examples of simple shapes in their neighborhood and at home, record them on a chart in their book of records by drawing the shape, naming it, and describing the object found. Hopefully some students will record traffic signs.

Traffic signs convey information through their shapes, colors, messages, and placement. Did you know, for example, that the octagon is used exclusively for stop signs? Students can log on to <http://members.aol.com/rcmoeur/sgnshape.html> to find this information. In small groups they can analyze the shapes and discuss such issues as: Are some shapes more readily seen than others? Which shape gives us life-saving instruction? How does color influence the message on the shape? Are messages influenced by shape? Students might develop more questions on their own. These traffic signs may help students begin to see that shapes do shape our lives.

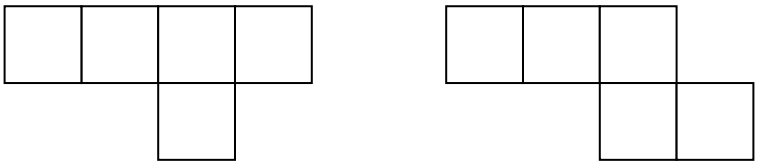
As students look, record, and research, they will quickly recognize that most shapes are not flat, but three-dimensional. Looking at the façade of a building, one might see a square, but looking into that glass of diet Pepsi, one finds a much more interesting, sparkling cube. Soon, students will begin to recognize that geometry is all around us – in nature and in our own construction of our physical world, whether it is a structure we work or live in or a bridge we cross simply to get to the other side.

By now, students will be ready to make three-dimensional models of these marvelous shapes they have been discovering. After having reviewed the seventh grade TAKS math test from the year 2003, I believe that hands-on geometry will be extremely valuable. For example, there are problems where students have to be able to look at a flat net and determine a dimensional shape. As children build models using nets, they will begin to see the relationship between a flat net and a 3-D model.

What could I use in my English class now? Digging around in my garage, I found just what I needed – 30-year-old, large, wooden building blocks. (When I brought them to class, students immediately tried to outdo one another by building the tallest structure. They quickly discovered that the foundation is very important.) Using square building blocks, students can easily draw a net for pentomino open boxes and cubes.

Students might feel more comfortable in making pentomino open boxes as their first venture into making models. They can use these boxes to store small items at home. There is also a very clever children's book out entitled *The Big Box* by Toni Morrison, which is a story about children who are compulsive and act out in school. The grown-ups say, "You just can't handle your freedom" (10). So off they go to live in a box. Many students can probably relate to the story, and lively discussion should follow. For homework, students could write and illustrate a mini-book report in order to practice their character analysis and summarization skills. But enough English—back to our geometric adventure.

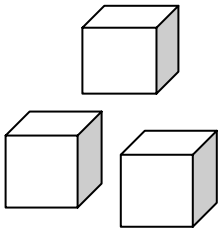
A pentomino net is five squares joined together, with whole sides touching. (Don't forget the mini-vocabulary lesson on the prefix *penta* or *pent*, meaning five.) Initially, the teacher should draw a pentomino net on the board and ask students to copy the net into their book of records in the graph paper section. In my class, students will use the wooden blocks to create a larger net on colorful poster paper. The teacher could also provide square patterns, or students could make a square pattern with paper, pencil, and a ruler. The blocks just make it faster and easier, and students like using them. Below are two samples of pentomino nets:



There are twelve different pentominoes. After students have made their initial box using the net from the board, have them work in groups to discover the other nets that will also make pentomino boxes (Stienecker, *Three-Dimensional Shapes* 6- 7). There might be a friendly competition between groups to see which group can find the other 11 nets. Before leaving "pento" behind, you might want to step into a short discussion on iambic pentameter in verse.

Now, that students have built pentomino boxes, they will certainly be ready to make cubes. I suggest you don't give them a net for the cube, but ask them to create their own. They should be able to discern that in order to form a cube, a pentomino box needs a lid, a sixth square, or another face. Is there more than one net that will work to form a cube? Students can experiment using different nets to see what works and what doesn't. Some

students will spend more time decorating one cube, while others will want to make several using a variety of nets. It's good to have lots of cubes for stacking.



Ask students to leave at least one of their cubes open for now, and read any version of the myth, "Pandora's Box." If you have access to a Texas state-adopted literature book for eighth grade, there's a retold version on page 908 (Untermeyer). After some discussion, have students write behaviors that they might like to eliminate or diminish in themselves on small strips of paper. One of mine might be "procrastination." Then, have students place the strips into their cubed boxes. Perhaps you could have a box-sealing ceremony and solemnly acknowledge the symbolism of sealing up these negative behaviors. These cubes can still be used; it's just that they will have a small rattle.

Once each student in each group of four has made at least one cube, the group can play the "four-cube stacks puzzle." Instructions are quite simple. Ask students to see how many different ways the four cubes can be stacked. They can be stacked one cube high, two, three or four cubes high. Have students draw each cube stack in their book of records, in the graph paper section. As students change the arrangements of the cubes, ask them to also count and record the number of faces, edges, and vertices.

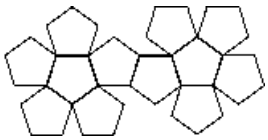
After a hundred cubes or so have been made, students can begin to work on geometry problems. Looking at standardized tests, one can find a number of problems dealing with stacked cubes. Children are expected to look at flat nets, for example, and determine which stacked-cube picture represents that net. On the first day, the teacher might stack the cubes following a sample problem. As students enter the class, they are asked to solve the problem that has been set up on the table. They are to draw a net showing the front, sides, and top of the cube arrangement. This can be a quick warm-up activity. (I have a table in the center of my room, so students can walk around it.)

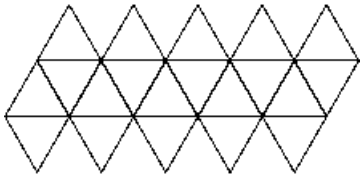
Once students are in their groups, give each group at least 15-20 cubes. Ask students to arrange these cubes and then draw nets that represent the top, sides, and front views. Middle school students like to decorate their folders and notebooks. They will enjoy decorating their cubes. Some will surely decorate their cubes like dice. If they start rollin' the dice, you might work in a probability problem. So, what else can you do with a cube?

Discover magazine features a puzzle page of mind puzzles called "The Boggler." The October 2002 issue fits right into our cubing project by taking the cube to the fourth dimension. This might prove a wonderful extension lesson for your G/T students (Kim 82). You can also turn your students on to the possibility of becoming computer animators. In the April 2004 *Discover*, there's an article entitled "Paint the Light Fantastic" that explains that "[c]omputer modeling begins with two primary elements: the geometric shape of an object and the way light bounces off it" (Johnson 24). The article discusses the making of *Shrek* and *Shrek 2*. Students should be able to relate because most of them are familiar with these movies.

It's fun making 3-D shapes, but it's also important to draw them. On their graph paper, students should draw a cube, a rectangular prism, and a square-based pyramid. You can find an array of patterns in books and on the Internet. Soon students will be gluing different shapes together. For example, two square-based pyramids will become an octahedron when the bases are pasted together. Some students will glue pyramids on their cubes. Other students will waste no time in finding nets on the Internet, copying them and enlarging them, and making such interesting shapes as dodecahedrons. Don't forget to have those regular vocabulary lessons—do-deca-hedrons (two-ten-faces). Looking at the root words, one can see that a dodecahedron has 12 faces.

The net on the left will create a wonderful dodecahedron, and if you count the faces, you realize that the net on the right is the net for an icosahedron (20 faces). Nets can be separated if students want to make larger models. Two of my students immediately constructed a more complex, stellated dodecahedron that was much admired by everyone, including the principal. The math teacher in my cluster was amazed at what the students built in English class. After a model is built, a students can write a "how to" composition for homework.





This might be a good time to ask students to research regular solids, sometimes referred to as Platonic solids. Plato and other Greeks thought that these solids had magical powers. Just for your information, the ancient Greeks thought that the tetrahedron was connected with fire, the hexahedron was connected to earth, the octahedron was connected to air, the dodecahedron was symbolic of the universe, and the icosahedron was connected to water (Stienecker, *Three-Dimensional* 18-19). You can find more in-depth information about these issues on the Internet.

As students are researching and discovering this information, they need to record their findings in their book of records. Along with the names of the five regular solids,

students should draw and label these solids. Each student also needs to know how many faces each regular solid has and what regular polygon is used to make each solid.

I find that middle school children enjoy puzzles. Our school library had several simple books with numerous activities, including making geometric puzzles to "dazzle their friends." David L. Stienecker has a series called Discovering Shapes that is really kid-friendly. Marshall Cavendish Corporation has also published a series of books, and one of them is called *Let's Investigate Shapes* (Smoothey). This book shows a variety of tangrams to be made. If the time is near any holiday, students can make a holiday tangram. Then they can write a short story to accompany their tangram.

A fun way to display the smaller geometric models students create is to use them as decorations on a "geometree." In the past I have created a three-dimensional "poetree." This tree climbed from the floor with branches spreading across the ceiling. For each season we changed the color of the leaves, and the poetry written on them. The students really enjoyed this on-going project. A "geometree" could be created in the same way, but every once in a while my oak tree will drop a really large branch. I've used dead branches to create trees in the classroom before. A Christmas tree stand is ideal for standing up large, dead, branches, which can easily be transformed into a geometree.

When working on larger models, it is suggested that students work in pairs. Perhaps an auditory learner can team up with a kinesthetic learner. Visual and kinesthetic learners will be in geometry heaven. One of the benefits of having large, 3-D models is that students can hold them and rotate them to really see the various shapes and patters that are displayed depending on the point of view.

By the way, English teachers, when you run into trouble, go and ask your art teacher for assistance. Here are some helpful tips I received: silver duct tape works really well when taping the inside of the net; putting tabs on some of the pieces of the net helps to put the model together neatly; and colorful electrical tape can be used on the outside of the model, as it helps to strengthen the model, cover up small gaps, and outline the individual shapes, making them even more visible.

After students have had a chance to admire and manipulate each model, the models can be hung from the ceiling for display. Middle school teachers already know not to hang them too low or else they might get batted around a lot. Most schools also have display windows, and these models make beautiful, colorful exhibits. They can be labeled with each name being broken down such as icosa (20) hedron (faces). Students' self-esteem will definitely be raised; they will feel proud of what they have created with their own two hands.

In exploring the world of shapes, patterns, tilings and tessellations, you may want to start with showing the students one or two examples that clearly reveal shapes and patterns that can be found in nature. For example, pictures or collections of butterflies

and moths should help students identify patterns. The May 2002 *National Geographic* magazine has a beautiful centerfold of a butterfly along with several other incredible photographs. Every time I go to the seashore, I collect seashells. The lovely spiral shape can also be seen in Georgia O'Keeffe's paintings, *Pink Shell with Seaweed* (*Bertrand*) and *White Shell with Red* (*White Shell with Red*). Students might be encouraged to find these on the Internet or in art books. I found these years ago in a calendar featuring O'Keefe's work.

The June 2004 edition of *Discover* magazine has an interesting article by Keith Devlin entitled "Cracking the DaVinci Code," which deals with the golden ratio, represented by 1.618 (an irrational number), and Fibonacci numbers (1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144 . . .). The article has some lovely, delicate illustrations of an apple core, a pinecone, and a nautilus. The apple exhibits five pips, a pinecone often has five clockwise spirals and eight counter-clockwise spirals; and eight divided by five equals the golden mean, of course. Students can discover the golden mean through a variety of measurement exercises.

If sunflowers are in season, you may want to bring some to class. Students will find that the seeds are arranged in two spirals, one running clockwise and the other counterclockwise. One spiral has 34 seeds, and the other spiral has 21 seeds. Both are Fibonacci numbers (Devlin 67). Divide 34 by 21, and what do you get? I think you've got it.

Once students have the idea that there are many interesting shapes and patterns in nature, you may want to take them on a campus "walk-about." I suggest that students pair up for this activity; one can carry the clipboard with pencil and paper, and the other can carry a paper bag. Some examples can be brought back to the classroom, such as leaves, wildflowers or weeds, prickly balls from gumball trees, and pinecones. Other examples may have to be sketched on paper such as the outgrowth of branches on a bush or tree or flowers that are part of the school's landscaping and shouldn't be picked.

Of course, if they happen to find a honeycomb or a wasp nest, they should report that finding to you before trying to pull it down to bring to class. Instead, you may use this fun activity in class. You will need a honeycomb net clearly showing the repetition of hexagons. Then, make a transparency of that net. When you lay the transparency over the paper net and move it about, the honeycomb becomes dimensional.

When students return to class with their treasures, they should begin recording their findings in their book of records. This can be done with sketches and sentences describing the patterns found. I like to supply students with magnifying glasses, which help them to see smaller details they might otherwise pass over, making their descriptive sentences more meaningful and accurate.

For homework students might be required to find more examples of patterns. They could take photographs and later paste them in their book of records along with descriptive sentences if they didn't want to sketch. There are many patterns found in wallpaper, in cloth or carpets, shawls, tablecloths, towels, beaded jewelry, and let's not forget the popular checkerboard. Encourage students to find patterns that might represent a part of their culture and heritage and set aside a day for show-and-tell.

I have a number of books about Native Americans that show a variety of patterns decorating pottery, cloth, and other artifacts. As students research and find patterns, ask them if they can identify the design that is repeated. Students should record their findings in the book of records, giving information and copying patterns. The patterns should also be labeled to identify the culture.

By now, students are ready to create some patterns of their own. A simple way to get them started is by using stencils. I have some stencils, but I think students would feel a greater sense of pride if they designed their own. Maybe something they've seen or collected on their "walk-about" will inspire them, such as a particular leaf or flower. Remind students that eventually they will need to develop a pattern for the cover of their book of records. Patterns use repetition to create a pleasing effect, but patterns and repetition are also found in words.

During time devoted specifically to teaching English/reading you may want to review the three sound devices used in poetry: repetition, rhythm, and rhyme. Repetition refers to the repeating of a sound, as in alliteration and assonance. Also repeated are words, phrases or lines. If the repetition is at the end of the word it creates rhyme, and rhythm is a pattern of stressed and unstressed syllables. One of my favorite poems in the seventh grade literature book we use is "Casey at the Bat" by Ernest Lawrence Thayer. I've used lines 29-32 from that poem to illustrate these literary devices.

> And now the leather-covered sphere came hurtling through the air,
> And Casey stood a-watching it in haughty grandeur there.
> Close by the sturdy batsman the ball unheeded sped;
> "That ain't my style," said Casey. "Strike one," the umpire said.

I chose these lines as an example because that *spheroid* brings us full-circle back to geometry. I have attached a relevant lesson plan at the end of this narrative.

The wonderful thing about these geometry activities in a language arts class is that students can convert their talking about the activity into writing about it. Students can also express any difficulty they might have understanding concepts in their book of records. These anxieties and problems can be passed on to the math teacher. English teachers and math teachers should communicate more often to insure that more effective learning occurs across the curriculum.

An online article entitled *Critical Issue: Providing Hands-On, Minds-On, and Authentic Learning Experiences in Mathematics* indicates that learning "does not mean simply receiving and remembering a transmitted message; instead, educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding" (Cook). The article states that experimenting first-hand with physical objects in the environment will then help students understand abstract mathematical concepts.

Once students have recognized and worked with patterns in nature, their awareness of geometric designs will hopefully be heightened. Perhaps at this point they will notice that the five oak leaves growing around a slender twig create a five-pointed star when laid flat. This reminds me of a poem that used to be in a literature textbook a few years ago entitled, "Reply to the Question: 'How Can You Become a Poet?'" It begins like this:

> take the leaf of a tree
> trace its exact shape
> the outside edges
> and inner lines
> memorize the way it is fastened to the twig
> (and how the twig arches from the branch) . . . (Merriam)

Do students now wonder if the number of flower petals around its precious center reflect a number in the Fibonacci sequence? Can they identify the spirals of a sunflower center? Are they aware of the pattern found on a pinecone? Have any of the students talked about patios at home where bricks or tiles are laid out in a specific pattern – or how about that tile floor in the bathroom? Or maybe just that brick wall they pass every day on the way to school? Heightened awareness – that is an objective that I didn't spell out, but I certainly hope it happens.

It might be fun to stop and have students create a tiling pattern from a single, simple shape such as the block letters T, S, or C. The letters must all be the same size and must fit together just right. Therefore, students should use graph paper to make the tiling pattern. The idea is to cover an entire surface without overlapping or leaving gaps (Stienecker 18-19). Students often learn about tilings and tessellations in art class. Many students are already familiar with the tessellations created by the famous Dutch artist, M. C. Escher, but first, I want to go where Escher went when he became frustrated with his own efforts at tessellating—Islamic art:

> Islam contains the means to enable man to see the forms of nature once again as the *vestilgii Dei* [. . .] The doctrine of Unity which is central to the Islamic revelation combined with the nomadic spirituality which Islam made its own brought into being an aniconic art wherein the spiritual world was reflected in the

> sensible world not through various iconic forms but through geometry and rhythm. (Critchlow 6)

Since the terrorist acts on September 11, 2001, most of my students have heard very little that is good about people practicing Islam. I remember that students wrote extensively about their feelings and fears in the days following the tragedies. Students shared their thoughts by reading them out loud. There was an Islamic student in one of my classes, and his words have stayed with me. At the end of his essay, he reminded students that he and his family were not bad people, and he hoped that no one at school would hate him. Now, of course, we have a war to contend with, along with all the negative propaganda that goes along with it. Is it any wonder that many students feel prejudice against the people of Islam?

By studying Islamic art, students will hopefully gain a new perspective on the Muslim people. Very few Islamic people participate in radical acts. Most of them are like us – they want peace and a safe world in which to live and raise children. When I want pictures that depict a culture, I often go to my collection of *National Geographic* magazines. But many examples of Islamic art can be found in books and on the Internet.

Students can increase their visual literacy by studying pictures, paying particular attention to clothing, carpets, pottery, and architecture. All of these will reflect many wonderful patterns, tilings, and tessellations as well as reveal much about the people of a given culture. As an English teacher you might want to work together with the social studies teacher. Through research, students should begin to identify the symbolic meanings of Islamic art. Once students appreciate the complexity of Islamic art and gain some understanding of its spirituality, I believe they will begin to perceive the Islamic people in a different light.

Meanwhile, in class, students will continue to work on their vocabulary words. They will need to gain some understanding of the four basic symmetries: translation, reflection, glide reflection, and rotation.

Rotation means to turn an object around its center; two reflections always give you a rotation. To translate simply means to move an object without rotating or reflecting it. When you reflect an object you create a mirror image, and a glide reflection is a combination of reflection and translation (Thibault). There are many sites on the Internet that do a great job of explaining these symmetries. Many hands-on activities give students opportunities to create tilings and tessellations without having to have special software.

Oriental carpets from different parts of the world like India, Turkey, or Iran "encourage symmetry analysis by examining these objects to identify areas of pattern that exhibit expected repetitions, and areas that vary from that expectation" (Thibault 1). The four basic symmetries will be reflected in these carpets. I enjoyed The North Carolina

Teachers' Network; they had good information, good lesson plans, and fun things for the kids.

Speaking of carpets, I'd like to take a moment to relate a Persian folktale that I read years ago. I'm not sure how well I remember it, but that's the great thing about folktales: you can change them. Anyway, it went something like this:

> A grandmother was sitting at the table drinking coffee and talking to her grown grandson. He was an author, but writing books did not impress the grandmother. She insisted that everyone needed to be able to make something with his hands. If you couldn't make something with your hands, well then, you really couldn't do anything worthwhile.
>
> In order to prove her point, the grandmother related this tale that happened long ago in Persia, presently Iran. A young prince was ready to marry, so he sent his servants out into the land to find the fairest maidens and bring them back to the court. When they were assembled, the king and the prince regarded each maiden very carefully. Finally after having spoken briefly to all of them, the king asked the prince to choose one for his bride. The prince knew right away which young lady struck a chord in his heart, so he quickly walked his father over to her. But when the young lady found out that she was to marry the prince, she had a question of her own.
>
> "What can you do?" she asked the prince. The king and prince were quite taken aback by this question. She thought surely the prince must have something specific that he was good at. When she found out that he couldn't do much of anything, she refused to marry him until he had learned some trade. So the prince, who was really in love with her, agreed to learn the art of carpet weaving. It turned out that the prince was quite good as he had a keen eye for color. Soon he was making lovely carpets.
>
> One day, as the prince was riding through a nearby village, robbers ambushed him and took him away to their robbers den. The prince sensed that his life was in danger, so he told the robbers that he had a real talent for carpet weaving, and that if they took one of his carpets to the castle, the queen would pay dearly to own it. At least 1,000 rials. (I'm not sure about the money.☺) The robbers thought that that was a grand idea, and quickly set the prince up with all the necessary materials. Soon, the prince had woven a lovely carpet. Two robbers, who had good manners, were selected to go to the castle.
>
> When the queen, who had been grieving for her kidnapped husband, saw the carpet, she immediately recognized her husband's handy work. Upon close and careful inspection, the Queen began to see that there was a cleverly disguised message woven into the carpet. The message revealed a place – a place no doubt

where he was being held captive. Immediately the queen paid off the robbers and released them. Then she called on her most trusted guards, and instructed them as to the location of the robbers den.

Well, the prince was rescued, the robbers den was destroyed and the robbers were taken off to serve many years in a terrible prison in the desert. The queen was ecstatic to have her dear husband back, and he was ever so grateful to his smart wife for having insisted that he learn such a valuable trade. It had, in fact, saved his life.

"So now do you understand why it's important to be able to make something with your hands?" asked the grandmother when she had finished her Persian tale. Her grandson offered to buy a birdhouse kit and build her a birdhouse. But the grandmother was quite put out at his lack of understanding the message. He tried to explain that writing a book was something he did with his hands, but she said it wasn't the same. His cup was empty, and it was time for him to move on, but he thanked his grandmother for sharing such an entertaining story.

The End.

At this time I need to interject some information. I was cleaning up my garage to get ready to bring home my "classroom stuff" after summer school was over (as teachers you can probably relate), and lo and behold I found a copy of a short story entitled, "The Shepherd's Daughter" written by William Saroyan. I had used the story back in 1983 when I was teaching high school from a textbook entitled *Arrangement in Literature*. I decided to leave my version of the story in this paper, but I needed to set the record straight.

Once students have had a chance to research and explore Islamic art, they will probably enjoy studying M. C. Escher. Escher was inspired by the Moors of Alhambra, Spain. From 1926 to 1936, Escher attempted to perfect a rhythmic theme on a plane surface, but he wasn't successful. Then, in 1936, he and his wife returned to Alhambra and made lots of copies of the Moorish tessellations (Ernst 35). He studied them carefully.

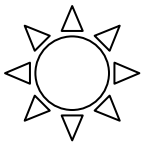
He read books and tried to understand mathematical treatises, but he couldn't understand them. He really had no mathematical background. At best he could study the illustrations. But through his perseverance, he himself became a master of tilings and tessellations. Unlike Islamic art, though, Escher did use representations of animals, insects, and humans. Maybe the art teacher will work with you to make sure the students have a chance to experiment.

Research papers are in order. Students can research the man or his art, or both. Visual aids are a must. Escher's work can be somewhat categorized into polyhedra,

infinity, knots, perspective, mirrors, and impossible architecture (*Trends in Escher*). That certainly gives students a wealth of possibilities from which to choose. Some students may be interested in creating Moebius Strip art. The *Magic Mirror of M. C. Escher* by Bruno Ernst is recommended for any classroom. It will give students much food for thought and much to look at as well. Hopefully students will see the connection between much of Escher's art and the Islamic art previously studied.

Even having experimented just a bit in class, I have already seen that including geometry in a language arts study is a lot of fun and creates real excitement. Have you ever hung a mobile over a baby's crib? Well, hanging geometric models from the classroom ceiling has a very similar effect. The children really enjoy them, and since I keep a ladder in the room, I allow them to climb up now and then to have a good, close look. Strict ladder etiquette is enforced, of course, and horseplay is not acceptable. But being on a ladder really gives students a different perspective—it sort of adds another dimension to the class.

At first I thought I was going to put together a unit, something that could be taught in a very specific time period. I realize now that geometry can become an integral part of language arts throughout the year. This workshop has opened up another window of opportunity for me as a teacher. It has heightened my awareness of geometry in the world around me. I have become extremely aware of how shapes have shaped our lives. Nature surrounds us with her perfect geometry, and we try to reproduce that perfection in our own physical world. We find peace in symmetry; the beauty of geometry creates harmony, and it gives us pleasure. I plan on incorporating geometry into my teaching as often as possible.



LESSON PLANS

Lesson One: *Casey at the Bat* by Ernest Lawrence Thayer

I used this during summer school, but I'm sure that any spring day, when baseball is in the air, will also do just fine. I made up a handout and folded it like a program. On the cover I had a circle that looked like a baseball. On the inside I had the five vocabulary words on one side with room for a definition, and five questions on the other side. On the back cover, I simply had lines, and students were asked to write a summary. Students earned two tickets when they turned in their completed "program." They could use them to buy a cup of root beer and a bag of peanuts. (For props I wore a baseball cap and brought a plastic bat and ball.)

Objectives
Students will review sound devices, rhythm, rhyme and repetition.
Students will recognize the use of exaggeration – hyperbole.
Students will identify and measure circumference, diameter, and radius.
Students will answer questions and summarize the story.

Materials
A "program" handout for each student created by the teacher
Two tickets per student
Rulers and pencils
Root beer and peanuts
Cups and bags

Activity
Review sound devices. Preview hyperbole. Most students understand the prefix "hyper."
Teacher presents a dramatic reading of the poem.
Students discuss Casey's character in small groups.
Is he a team player? Is he arrogant? Did he lose the game?
Students complete their "program."
Everybody drinks and eats.

Homework
Student may either write a sports article for the Chronicle, or write a screenplay for the six o'clock news.

Assessment
The summary will have to be graded by the teacher.
Students can earn a daily grade for the rest of the "program."
Students will present their "news item." You may want to use a rubric.

On the previous day we worked on measuring circumference. I brought a variety of balls to class. Each group had to measure and record their findings for three balls in order to help students understand the relationship between diameter, circumference and pi (approximately 3.14). I also brought an orange for each student. They had to measure around the orange with a string, convert that to inches with a ruler, and divide by 3.14. Then we cut the orange in two and measured the diameter with the ruler to help them see the relationship.

Lesson Two: Snowflakes

This is a great lesson for the month of February because the story, "The Woman in the Snow," as retold by Patricia McKissack in our eighth grade literature book, is an urban legend that is written around the Montgomery, Alabama, bus boycott event. (Maybe you

can coordinate with the history teacher since this is the month we celebrate black history.)

The day before reading the legend aloud to your students, the scene needs to be set. I like to read "Winter Poem" by Nikki Giovanni (*Language of Literature* 387). On page 387 of the book used for seventh-grade literature in Texas, there are also six beautiful photomicrographs (light + small + to write/scratch/draw) of snowflakes. For more beautiful examples, just visit the Internet and type "fractal snow flakes" into a search engine. Also, <www.a-i-studio.com/snowflake/> offers a small freeware utility for creating fractal snowflakes. The February issue of *Discover* magazine has a wonderful article by Amato entitled "The Secret Life of Snow," which is accompanied by lovely photos.

After much visual stimulation, it's time to cut out lots and lots of snowflakes to be hung everywhere in the room; in the windows, on the walls, and from the ceiling, to give the appearance of a snowy day. I even ask the students to leave all the little clippings of paper on the floor. By the end of the day, we had a lot. Kids picked them up and threw them; they slid through them. They treated the paper clippings like snow. (When the principal came to visit, she was told right away that we would clean up, and we did.)

Objectives

First day: Students will read Giovanni's "Winter Poem" and identify personification.
Students will cut out snowflakes and write a snowflake poem.
Second day: Teacher reads "The Woman in the Snow" an urban legend.
Students will separate fact from fiction; what is legend what is real.
Students will gain a greater understanding of the genre, urban legends.

Materials

Lots of white paper
Scissors
String
Seventh and eighth grade literature books
Different-sized plastic lids or paper plates (You may want students to measure and figure out the circumference as a review.)

Activity 1

Draw a circle on a piece of white paper.
Fold the circle in half. Fold it again and perhaps once more.
Cut designs along the edges of the folded circle. Unfold and hang.

Instead of a circle, make a square. Encourage students to try different shapes and different number of folds to see the effect on the pattern.
Each student should cut out at least three snowflakes.

Assessment
Students will read their poems out loud and display their snowflakes.

Activity 2
Using a T-bar, students should identify parts of the story that were historically correct on one side, and on the other side they should identify scenes which were strictly fictitious.

Homework
Ask students to interview friends or family members to see what kind of legends they know. Some students might want to write their own stories based on an event they read about or saw on the news on TV. Have them write down and illustrate the story.

Assessment
Students will relate their stories to the class, which will be graded by the students using a rubric made up by the class and the teacher.

Lesson 3: Ojo de Dios

This lesson works out well for the end of the school year when all the books have been collected, and you still have a few days of school left. I like to celebrate Hispanic heritage not just on the fifth of May, but during the whole month. By now students are used to multicultural activities, and they understand legends and symbolism.

There are several versions of the legend that accompanies Ojo de Dios, or Eye of the Gods. But most will agree it began with the Huichol Indians of Mexico. When a child was born, the father would weave an Ojo de Dios in the center of two sticks. Each year of a child's life up to age five was celebrated by adding rings of yarn. (The cross symbolizes earth, wind, fire and water.) Some legends include a prayer arrow, which is put through the center to channel the prayers.

Another legend goes back to the Aztec tribes. This story tells about a princess who was born blind. The gods promise to give her sight if someone can duplicate what god's eye looks like. No one could do so. Then one day the sun's rays were reflected in a tear shed by the princess. The mother, who saw this, immediately reproduced the pattern in beautifully colored yarns. As soon as she was finished, the girl regained her sight.

The Ojo de Dios is also used by many South American Indians as protection against evil.

Objectives
Students will review what makes a legend a legend.
Students will research the legend to know the symbolism of the sticks.
Students will review 90-degree angles and symmetry.
Students will make at least two God's Eyes – one to keep and one to give away.

Materials
Popsicle sticks
Glue (I use the hot glue gun)
Different colors of yarn

Activities
Glue two crossed sticks together at the center. If you use the hot glue, the yarn will stay secure as well. Begin weaving the yarn around the sticks. For really detailed instruction, go to <http://www.caron-net.com/kidfiles/kidsapr.html>.

Assessment
Did you have fun? Did you make at least two Eyes of God?

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