

# Symmetry in Culture

*Charles Sauter*

## Introduction

What do Arabian rugs, Islamic architecture, and native American blankets have in common? Symmetry. The phenomenon of symmetry spans the cultures of the world, the phenomenon of symmetry reaches across time, and, now, with the help of this unit, the phenomenon of symmetry will enter the minds of your students.

## Why Symmetry?

Why study symmetry? What makes symmetry special? To begin with, it is a matter of scientific proof that the study of symmetry leads directly to an increase in standardized test scores...um, well, okay, it hasn't been proven...yet. Nonetheless, many standardized test objectives, both Math and Reading, do relate to finding patterns. Furthermore, it is true that minds taught to look for patterns and to look for symmetry will be increasingly able to identify patterns and symmetry. Practice in this area will certainly assist students in dealing with relationship questions on standardized test. In addition, students, and teachers of all disciplines, will find this unit highly stimulating and fun.

The following Sixth Grade Social Studies unit challenges students to look for patterns in a multitude of places. While my goals in producing this unit revolve around the need to find additional means of expanding student concepts of the world, many other goals can be achieved. Important by-products include increased attention to patterns and greater spatial intuition.

In this unit, students will first learn basic concepts of symmetry, and then they will apply this knowledge in making connections with cultures from around the world. Symmetry truly does play a role in our daily lives, and it can be applied to many different disciplines and subjects. I implore you to read on and gain insight into an aspect of intellectual thought which remains unappreciated, if not ignored, by the pundits of the education industry.

## What Is Symmetry?

Symmetry is everywhere present. Therefore, ask not what symmetry is, young grasshopper, rather ask what it is not. I challenge you not to locate symmetry, but, rather, to locate its absence. Where you find it's absence, there you will find strangeness, uncertainty, and even unpleasantness. Do you believe me? Briefly exercise your imagination. The human form exhibits symmetry. We have two opposing arms, roughly equal sized feet, the same number of fingers on both hands, etc. Now picture a person with three unequally spaced arms on one side of their body, another person with one very large foot and one very small foot, and so on. How would these changes effect

movement and balance? How would their efficiency be effected? And for heaven's sake, where would they buy clothes? We humans, and all creatures for that matter, function better physically as a result of symmetry.

Therefore, symmetry means balance. Balance not only, however, on the physical plane, but also in the intellectual realm. The philosophers of both ancient Greece and the Far East have long preached a balance between mind and body, between self and selflessness, between dark and light, etc. It is no mistake that the Confucian symbol of Yin and Yang exhibits symmetry. Wherever a holistic symmetry exists within one's approach to life, there you will find a healthy and happy individual.

Aside from serving mere functionality, however, symmetry assays a higher, and highly intangible, purpose. In short, symmetry fulfills intellectual needs. Which ones, you ask? Well, the intellectual needs which the study of symmetry fulfills are as varied as your student population is diverse. Producing a list of these needs may actually limit the effectiveness of this unit. Furthermore, I am not here to provide you with all the answers, even if I knew them, just as you are not, as teachers, present to provide your students with answers. Instead, it is our duty to provoke students with stimulating questions, and then we are to stand back, intervening only to offer guidance. The purpose of this unit is to stimulate students into perceiving the presence of symmetry in their daily lives, to theorize as to its uses, and to use symmetry as a looking glass into cultures of the world. Recognition of symmetry as a world wide cultural phenomenon will enable students to better understand their own culture (yes, I know I sound like a History major now, but bear with me). Furthermore, students will arrive at a more complete intuitive comprehension of cultures around the world through the study of how those cultures use symmetry. The common thread of symmetry unites cultures of the world. As students come to identify symmetry and its uses, a high level of empathy, unachievable to many students, even those caught up in worlds of trouble, can be attained.

All right, that's enough of waxing eloquently. Let us now get down to the hard facts. Now let us deal with the nuts and bolts, and now for the moment you have all been waiting for...the definition. No discussion of a concept is complete without the entrance of the ubiquitous definition. I'm afraid a simple dictionary definition will not assist some people, but I include it anyway. Under symmetry the Oxford American Dictionary says, "1. being symmetrical." Wow. Lots of help there. But wait, there is also, "2. pleasing proportion between parts of a whole." Okay, I can begin to get a better grasp of what symmetry is all about with the assistance of the phrase, "pleasing proportions."

Looking further, under symmetrical now, one also finds, "able to be divided into parts that are the same in size and shape and similar in position on either side of a dividing line or around a center." Aha. For our purposes, this is a nice definition. As we shall see later, there are four basic ways a shape exhibits the type of symmetry with which we will be dealing. In this unit only bounded planar figures(i.e.: simple two dimensional shapes) will be examined, and this definition gets at the heart of the matter. Students will be expected first to look for those dividing lines. This objective is a fairly

simple one and should not present a problem. The next objective students will need to master will be to begin to learn these four most basic symmetrical occurrences.

### **Where Does One Find Symmetry?**

There is really no end to the search for symmetry. It exists not only in art and design, but it also exerts its strong presence in mathematics, in the physical world of science, in history, and even in story plots and character development. As a Social Studies teacher, I shied immediately and vigorously away from most of the Mathematical aspects of symmetry studies. Yes, indeed, you may rest assured, my fellow Humanities students, this unit does NOT contain challenging algebraic equations, mystical calculus derivations, nor complicated geometric proofs. It has been designed for Sixth graders at an 'inner-city' school enrolled in what is now called 'World Cultures Studies.' My students are from predominately lower socio-economic households and have no prior experience working with symmetry. However, they exhibit interest in and skill with designs, patterns, and, well, to be blunt, graffiti(tagging). Generally speaking, cooperation and interest in class activities is directly proportional to the amount of manipulatives or drawing involved.

### **When and How Will This Curriculum Help**

Since the World Culture Studies curriculum is designed to progressively cover each of the continents, I will be utilizing this unit early in the year. This way we will be able to review the concepts of the unit many times throughout the course of the year. At each continent we visit, the students will be asked to find examples of symmetry.

As previously mentioned, very little math is used in this unit, however, some basic definitions are required for discussion and identification of types of basic symmetry. The first lessons will address the basic concepts of symmetry. After these lessons are completed, we shall look at different examples of symmetry in cultural items from different parts of the world.

This unit has been set up to work with a block schedule consisting of eighty-five minute classes, meeting every other day. I believe this unit has the flexibility to work under a different time schedule. If your schedule differs from the one herein, then some rearranging will have to be done to the lesson plans, of course. However, that will not present a major challenge since I usually try to create two smaller lessons within one of my block periods. Therefore, in most cases simply splitting one lesson plan in half should do the trick. This unit is certainly not a work of artistic genius which suffers not to be altered. Feel free to chop, hew, or rework this curriculum to suit your needs.

Finally, I have one last note to pass along before getting into the curriculum itself. There is one aspect of this subject which I was unable to find the time to exploit. I hope you already know of that to which I'm referring, because implementing this aspect of the curriculum would truly lift it onto a higher plane. What I'm talking about is welding this

unit into a cross-curriculum exercise with the Mathematics teacher in your grade level. This unit is a shoe-in for a collaborative effort with your Math department. The extra reinforcement provided by another teacher in a different environment could spell all the difference between success and failure in this unit. One difficulty might be in the positioning of the unit in the course of the year. The Math curriculum might not call for a discussion of symmetry until well after the time I plan to present this unit in my class. I could do two things. First, I could present this material as planned and simply rest easy in the knowledge that, in previewing a topic she will have to teach, I have made my colleague's job easier. Alternately, I could hold off with a discussion of symmetry until later in the year. This second option may indeed have some merit, for, in holding off until a later date, I could use that time to prepare my students for the eventual implementation of this unit. We could discuss aspects of culture which would come to bear in this unit. The students could become acquainted with artifacts (rugs, pottery, jewelry, etc) of different cultures. Teaching them to squeeze information from these artifacts would help pave the way for the students to perceive the role symmetry plays in these self-same artifacts.

In any case, the benefits of cross curriculum cooperation far outweigh the drawbacks. I highly recommend discussing the possibility of collaboration with your Math colleagues before implementing this unit. At the very least, you should inquire to what extent, if any, your students will come into contact with symmetry during the course of the year, and use this information to further the efficiency of this unit.

## **THE UNIT**

### **Week One**

The goals for this week will be to introduce the students to the basic concepts of planar symmetry. While symmetry may at times become a complicated issue, the work these students will do must be kept painfully straightforward and uncomplicated. The attention span of Sixth graders is not exceedingly great. Therefore only bounded planar figures will be discussed, which, in fact, suits the subject matter just fine. Most of the cultural artifacts(i.e.: vases, rugs, wall decorations, clothes) the students will study exhibit only such symmetry anyway.

In order to teach these basic concepts, though, one must first study them oneself. An excellent resource for doing so it at

[www.ucs.mun.ca/~mathed/Geometry/Transformations/Transformations.html](http://www.ucs.mun.ca/~mathed/Geometry/Transformations/Transformations.html)

This website offers excellent examples of translations, rotations, reflections, and glide reflections. Until you study these four concepts the remainder of this unit will be a mystery to you. I highly suggest that you at least get a glimpse at this site before you read further, especially since the technique used at that site, the one also recommended by Professor Field, is the same one that I will use in the first lesson plan; namely, the use of

letters as objects of symmetry.

**Note :** It is *very important* for the success of this unit that abundant *examples of symmetrical designs* be readily accessible for student observation. I suggest as many examples as possible be posted about the room. Pictures, wall hangings, and other objects must be available for the students to gain inspiration. Wall paper samples are another excellent source, one that students may have at home.

### *Lesson One (Week One)*

Warm Up (the immediate activity upon entering class, 10 min.) - Ask the students to answer these questions: “What do you know about symmetry? What does it mean to you?” If you feel more comfortable with substituting “pattern” for “symmetry,” do so.

Focus - It is important that one have an object exhibiting symmetry for this, such as a piece of wallpaper or a hubcap: hold up the object and initiate discussion as to what is special or unique about it. Answer : shows a pattern.

Lesson - Lead a discussion about “patterns.” Get your class to develop a definition for pattern/symmetry. This probably will not be easy. It would be useful to have an example of a simple pattern on hand, maybe a piece of wallpaper, that you would feel comfortable discussing. You might make the students copy the definition down, and you should have your own definition in mind beforehand (if you’re still not comfortable after having studied the aforementioned website, then I suggest using a dictionary).

Now instruct the students to make a list of items around the room or in the school that have patterns. Share answers and use this opportunity to introduce the unit and it’s objectives. Next turn on the overhead and say, “Now we will look at examples of symmetry in places where maybe it was not designed to be: letters. Let’s look at the letter A. We’ll divide it horizontally and vertically, which of these, class, is symmetrical? Why?” (see diagram below, figure 1). Stress that this is called Reflection Symmetry. This is where you will begin to teach types of symmetry. Model the next couple of letters using the same process and categorizing the letters as either horizontally, vertically, both or not symmetrical. Let the students practice on their own with the remainder of the alphabet. This exercise will start the students on the road to greater consciousness of symmetry. Collect the papers and check for mastery. If the students are not ‘getting it’ at this point then reteaching will be in order.

Homework - Students should be asked to bring an object from home that exhibits this type of symmetry (ie., reflection). As stated before, wallpaper usually contains a pattern. Some other potential items might include: table cloths, blankets, paintings, clothes, even photographs of tiling or wallpaper is an acceptable product. The point of this exercise is not to make them dig something out of the attic, rather the purpose here is to start them thinking about just how much symmetry surrounds them. Hopefully they will begin the process of noticing symmetry.

## *Lesson Two (Week One)*

Warm Up - Which letters show Reflection? List as many as you can remember from the previous lesson. (Answer : A,B,C,D,E,H,I,K,M,O,T,U,V,W,X, and Y.)

Focus - Write 'Z' on board. Ask in what way it shows symmetry. Probably no one will know. It does not show reflection symmetry. Explain that other types of symmetry exist and we will be learning about them today. (Answer : Rotation.)

Lesson - "We will now learn other types of symmetry." Students must simply take notes on the four types of symmetry. The good news is these concepts translate readily into drawings.

Rotation :

Center of Rotation

Reflection :

Line of Symmetry

Translation :

Glide Reflection :

This situation begs for the use of an overhead projector. When the students copy this information down, make sure that they do so with a great degree of care. Make them use rulers. Also they should again create definitions, using their own words, of course, for each of the above transformations (types of symmetry).

At this point a little practice is required. A worksheet is in order for students to practice identifying these variations. I've included examples of worksheets below, however you can easily do better. You will need more than just two sheets anyway, I imagine. Simply draw shapes going through one, or more, of the symmetrical transformations above, and then leave space for one, or more, of the four answers above. An additional option, and a very good one, is to dictate that students should have to come up with examples of their own (answers included).

Homework - More practice. Make them reinforce what they've learned in class. Either another worksheet, or perhaps the students could draw one example from two of the different types using items at home for inspiration. They could also write a description of those designs.

### *Lesson Three (Week One)*

Warm Up - “Which type of symmetry do you think occurs most often and why?” If your students are like mine they will not have done any homework, and the majority will have forgotten all information from last class. So prompting may be necessary in the form of hints, etc.

Focus - Again, an object is necessary. In this case, you need a hubcap. Yes, a hubcap! Well, if this is too hard to find, then get a picture of one, or at least get one of your creative students to make you one beforehand. Hold your hubcap up and ask again if the students can figure out the symmetry in the figure. Please make sure that the hubcap in fact possesses Rotational symmetry before you begin.

Lesson - Begin with a discussion of hubcaps and wheel spokes. See if any students are aware of the importance of spokes in the design of wheel strength. (Example: Olympic cyclists rely on specially designed wheels to aid in minimizing wind resistance. The fewer the spokes the better, however strength can not be sacrificed, meaning that wheel design relies on the study of symmetry to provide a Gold medal winning innovation). Also discuss translations and where they may be found in daily life. The activity for this lesson should be for the students to create their own rotational or translation design.

Homework - Find an example of Glide Reflection outside of school. Write a description of it and where it was found. Again, as the perceptive Prof. Field reminded me during the seminar wherein I developed this unit, examples can be found in such everyday items as wallpaper, furniture, clothes, rugs, etc. Show the students an example, like the one below, to remind them of Glide Reflection.

### *Lesson Four (Week Two)*

Warm Up - “Where have we found most examples of symmetry? What purposes does symmetry seem to serve?” Lead a discussion. The purpose here is to remind students of the topic at hand. The discussion does not have to be in depth or for any length of time. It should lead directly, hopefully seamlessly, into the Focus.

Focus - Hold up checkerboard, ask “What purpose does this serve? The symmetry on it?” Answer: the symmetry enables the game to be played, the game allows us to sharpen intellectual skills. Overall, symmetry allows progress by creating predictability and laws.

Lesson - Lead a discussion of symmetry’s purpose. Point out the clock on the wall. Ask if its symmetrical. Do we count time symmetrically? Is the school schedule symmetrical? How does this serve us? Does symmetry allow us to do things we otherwise would not be able to do? The activity for this lesson is for the students write about one symmetrical aspect of life and what life would be like without the symmetry.

It will probably be necessary for you to make a list of the aspects of life that contain symmetry. Time, calendars, physical attributes, etc.

### *Lesson Five (Week Two)*

Focus - Do songs have symmetry? Play the song 'John Barleycorn.' Discuss the story. The purpose of it was to teach people how to make beer. John Barleycorn was not a person, 'he' is the personification of barley. The things that occur to 'him' constitute the steps that used to be used in the process of making beer. The song has a recurring pattern. A series of events occur to this imaginary person, John Barleycorn. Do you think that the symmetry of the song helped people remember the song and the information in the story. Do other stories have symmetry?

Lesson - The point of this lesson is to make a connection between our culture, and the uses of symmetry in our culture, and other cultures from around the world and their uses of symmetry. As an activity the students should read a fairy tale, a folk story, a poem, etc., from another culture. Discuss its value to that culture. What does it teach? Warning: not all stories/poems have a lot of value, so you need to make sure your choice will be a good one before getting into a classroom situation. Make sure your version of Hansel und Gretel is the one where the evil children get eaten by the witch, not the one where their wealthy stepfather hires a lawyer to get them out of trouble. One good example of symmetry in language arts can be found in Whitaker (Whitaker, inside cover).

“Then weave for us a garment of brightness;  
May the warp be the white lights of morning,  
May the weft be the red light of evening,  
May the fringe be the falling rain,  
May the border be the standing rainbow.

*—excerpted from a Tewa Song”*

This poem is full of symmetry. Try to have a Navajo blanket on hand to use in conjunction with the poem. Students should make multiple connections between the blanket and the poem. The poem uses an analogy, which is a symmetrical construction of concepts. Symmetry in poetry is found not only in the rhyme and meter of a poem, but also in analogies, metaphors, and similes. In the above poem, the author compares the blanket to the world. The creation of the blanket should be approached, according to the author, with as much care and intensity as they imagine the world had been created. This reveals some values held by the Indians. They put great value into both their rugs and the world around them, otherwise they would not have created, and then kept alive, a poem about them. Also they see a redemptive value in the process of creating rugs. This is evidenced by the peaceful and healing imagery used to describe the process.

After discussing the poem, students should be shown examples of Navajo rugs. They should be asked to discuss exactly what the poem means, in a literal sense, not figuratively. Then, and this is the fun part, they will draw their own rug on construction



paper, and, of course, they will write a short poem, similar to the one above, which reflects the Navajo values toward their rugs and towards nature. They should be prepared to explain how their poem relates with their rug.

Furthermore, as another activity the students could choose an artifact (or a picture of one) from another culture. They should reason as to the purpose it may have served to those who designed it.

### *Lesson Six (Week Three)*

Lesson - Students have the enviable task now of assimilating all the things they've learned and generating a final product. At the teacher's discretion, the students could use all four types of symmetry, and the ideas concerning the functions of symmetry, to create an artifact or many artifacts from an imaginary culture. Those teachers with truly adventurous tendencies might like to open this unit up to include other disciplines. Students could be asked to use Fine Art time, whether it be Art, Band, Choir, Drama, etc., to create something using 'cultural' symmetry. The students would not only be required to use symmetrical designs, but they would be asked to create designs which would be used for a purpose by their imaginary cultures. An elaboration in the form of a written component would be required from the students.

### *Lessons Seven and Eight (Week Three)*

Lesson - Simply continue the Project from Lesson Six. The entire week will be spent pursuing this goal, as it is the summation of the entire unit. The students should have a basic outline completed by the end of the Lesson Six. Lesson Seven should focus on the design of the artifact, and finally, Lesson Eight should wrap up the design early and complete the written component. Students should be allowed to work on this for homework if possible, although other activities could probably also be assigned.

## **Conclusion**

At the end of this unit, students will have the ability to gain additional insight into different cultures through a deepened appreciation of the uses of symmetry and design. Furthermore, familiarity with symmetry translates quite smoothly into other disciplines. This unit can easily be integrated into a multi-subject unit. Math and science teachers can be brought into the picture to enhance the complexity of design and to increase the availability of subject matter, respectively.

## Diagrams

Figure 1. Reflection Symmetry (see Lesson One)

Reflection symmetry - "A reflection flips all the points in the plane over a line, which is called the mirror." Vertical examples using 'A' and 'H,' horizontal using 'I' and 'K.'

Figure 2. Rotation Symmetry (see Lesson Two)

Rotation Symmetry - "a rotation turns all the points in the plane around one point, which is called the center of rotation."

### Symmetry Identification Worksheet

Directions: Identify the following patterns. You may find that some patterns have more than one type of symmetry.

A - Reflection   B - Rotation   C - Translation   D - Glide Reflection

Example :

1.

Answer : C - translation

2.

Answer : \_\_\_\_\_

3.

Answer : \_\_\_\_\_

4.

Answer : \_\_\_\_\_

5.

Answer : \_\_\_\_\_

6.

Answer : \_\_\_\_\_



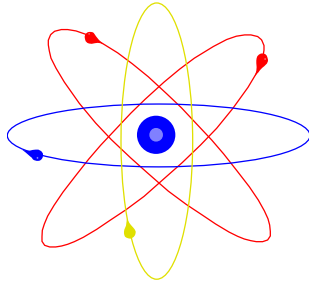
7.

Answer : \_\_\_\_\_



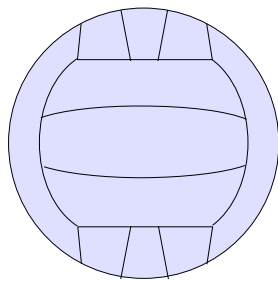
8.

Answer : \_\_\_\_\_



9.

Answer : \_\_\_\_\_



10.

Answer : \_\_\_\_\_

### Bibliography

Field, Michael. "Lectures on Symmetry, Patterns, and Designs".

Reid, David, "Transformations," <http://www.ucsf.edu/~mathed/Geometry/Transformations/Transformations.html>, (25 May, 1999)

Washburn, Dorothy K., and Donald W. Crowe. Symmetries of Culture : Theory and Practice of Plane Pattern Analysis. Seattle : University of Washington Press, 1988.

Whitaker, Kathleen. Common Threads : Pueblo and Navajo Textiles in the Southwest Museum. Los Angeles : Southwest Museum, 1998.