

Symmetry, Pattern & Design in Motion

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Objective

The objective of this unit is to expose students to real life applications of Geometry focusing on symmetry and patterns. In order to achieve this objective, the class will study the downtown skyline of the City of Houston.

Several aspects of this unit will incorporate several standards recommended by the NCTM (National Council of Teachers of Mathematics). Several of the standards that will be incorporated in this unit are:

The vision of a reform curriculum is toward a balanced variety of rich problem situations that encourage students to make connections among the various mathematical topics and that reflect cultural diversity.

One aspect of this unit is to provide students the opportunity to utilize the world around them to make connections to Math. The downtown skyline of the City of Houston offers numerous opportunities to explore and discover mathematical concepts and procedures. One area of this unit entails a field trip to the downtown area. The field trip will provide students the opportunity to explore many of the shapes and patterns discussed in mathematical textbooks.

Shift in the vision of learning mathematics toward investigating, formulating, representing, reasoning and applying a variety of strategies to the solution of problems - then reflecting on these uses of mathematics - and away from being shown or told, memorizing and repeating.

It is the intention of this unit that students would be placed in situations to wonder “What If?” and then begin to explore and arrive at a conclusion. Traveling in the downtown area, exploring the Houston’s tunnel system and having the opportunity to redesign the City of Houston skyline will meet this standard.

Shift in the role of teacher toward “questioning and listening” as their classroom become stimulating intellectual learning communities and away from “telling” students what to do.

One aspect of this unit is intended to place the teacher in the position of facilitator. There is very little “direct teaching” associated with this unit. This is a purposely instructional technique in that students should be allowed to explore and discover as opposed to being shown or told. The facilitator primary task is to question the students, possibly to the extent of frustrating the student. Bear in mind that it is this author’s opinion that being frustrated is one form of thinking through a situation.

Being frustrated with a situation implies that the student is at least attempting to arrive at a conclusion. Listening to students and offering suggestion, assuring the student that they are on the right track is the primary responsibility of the facilitator.

Becoming confident in using mathematics to make sense of “real-life” situations.

Lastly, all the experiences of this unit will begin the process of becoming confident in using mathematics to make sense of real-life situations. By involving the students in the world they live in, by taking objects they view on a daily basis and making it real

Make the connection more beneficial.

Student Population

This student population is targeted for largely Hispanic, lower-social economic background. Part of the state mandated test for 8th grade students states “the student is expected to compare and contrast proportional and non-proportional relationships”. “The student identifies proportional relationships in problem situations and solve problems.” Both of these state-mandated objectives could be accomplished within this unit. It has been my experience that students are able to express themselves through their art. The Hispanic and African-American communities have many examples of patterns, symmetry, and geometric shapes. One element of this unit will provide students the opportunity to display their creative abilities. Writing is a key factor in developing certain skills, therefore students will write in journals a great deal throughout this unit. Students in the eight grades in the state of Texas are tested on their writing abilities, therefore this process will assist them in accomplishing this task

This unit is designed for a semester long, 85-minute block scheduled class. The unit is designed to encourage cooperative learning, and address individual learning styles .

Symmetry (defined)

Symmetry, what a beautiful word. In Math, the subject of symmetry provides the student with the opportunity to be creative and to discover the world of geometry, not through classroom lectures but through hands-on projects. For the purpose of this unit, Webster defines symmetry as: (1) balanced proportion; (2) the property of being symmetrical ; esp: correspondence in size, shape, and relative position of parts on opposite sides of a dividing line or median plane or about a center or axis; and (3) a rigid motion of a geometric figure that determines a one-to-one mapping onto itself.. Definitions (1) and (2) will be utilized throughout the course of the unit.

Symmetry is a very interesting topic to explore and discover. The topic of symmetry exist all around us: plants, clothes, drawings, etc., just to name a few. During the course of this unit students will identify and give examples of symmetry.:

Line Symmetry (defined)

A figure has line symmetry if it can be divided by a line into two parts, each of which is the mirror image of the other. Some examples of this are a picture of a butterfly, a tiger, or a leaf. Taking these pictures and drawing a line down the center of the picture would produce a line of symmetry. It is important to define two types of line symmetry (horizontal; vertical). One example of explaining a vertical symmetry is to show students a picture with the line drawn down the middle of the picture lengthwise (use words such as up and down to denote vertical). Horizontal should be noted that your line in the picture should be drawn from one side to another (use such words as left to right to denote horizontal).

Line Symmetry-Reflection (defined)

When a figure is reflected in a line, the image is congruent to the original figure (in other words, the figure is a mirror image of itself). A reflection line is perpendicular (exactly upright) to each segment that joins an original point to its image. The reflection line divides each of these segments into two equal halves. An example of reflection is looking at a clothing pattern of a vest. The pattern consists of three parts (vest front/left, vest front/right and vest back). All three parts sewn together create a vest. The vest back is an example of line symmetry (reflection) because it has one edge lying along the fold. Lastly, take a look at yourself in the mirror, describe what you see.

Rotational Symmetry (defined)

A figure has rotational symmetry if it coincides with itself after rotating 180 degrees or less, either clockwise or counterclockwise. Several mathematical publications state it's important that students are able to distinguish between what direction is clockwise and which is counterclockwise. One suggestion you can use to accomplish this is to have students look at a clock - see the direction the second hand is moving - now draw a picture of what they see. The second part of this assignment would be to draw the same picture but make the second hand appear to be going the opposite way of the first drawing. The final part of this assignment is to have students write a paper describing what they did - and without telling them, let them tell you in the paper which drawing denotes clockwise movement and which drawing denotes counterclockwise movement.

Lesson 1 - Day 1

PRE/POST QUESTIONNAIRE

1. Symmetry is defined as:
 - a. a line across the water
 - b. balanced proportion
 - c. the duplication of something
 - d. the world

2. Vertical line of symmetry is denoted by drawing a line:
 - a. around an object
 - b. outside an object
 - c. above an object
 - d. in the middle lengthwise (top to bottom)

3. Rotational symmetry is defined as:
 - a. something that is round
 - b. a figure that coincides with itself after rotating 180 degrees or less
 - c. something square
 - d. something that goes around itself.

4. Define clockwise.

5. Define counterclockwise.

6. Reflection is one type of transformation. Name two other types (give an example each).

7. Draw an example of something that is not symmetrical.

This pre-test questionnaire will be used to assess the students current knowledge of the topic. This will serve as an introduction into the world of symmetry, patterns and design. It is important to note that the facilitator is using such words as questionnaire versus test to avoid placing students in a stressful environment.

As stated before, the pre/post questionnaire serves as an introduction into symmetry. I strongly urge the facilitator to avoid using such terms as test, assessment, etc. This pre/post questionnaire will serve as the introduction, as well as the closure to this unit. Once we have completed the unit, it is my expectation that students will be able to answer the questions with ease and confidence.

After completion of the questionnaire, students will be assigned into groups of three to four students per group. The assignment will be to discuss their answers with one another and prepare a group response to each question. The facilitator will visit each group and sit in on the conversation. It is suggested that the facilitator pose questions to students that may assist them in arriving at a logical conclusion.

The group activity should be timed for approximately thirty minutes (maximum). It is suggested that additional time be granted if the facilitator feels that the groups are productive. After the time expired, each group should select a presenter(s) to address to the class their findings. Each group will place their answers on the board or overhead projector. After each group have been given their presentation the facilitator will lead the discussion of the result of the group activity.

The responsibility of the facilitator at this point is to bring the class opinion to a consensus. Now based on the answers, the class has working definitions to begin the task of understanding symmetry. The question the facilitator must answer is does the answers the groups arrived at denotes the topic discussed. If the facilitator feels these are workable definitions then the last phase of this lesson can be completed.

Lesson 1 - Day 2

So far the class has taken a pre/post test, discuss their answers in groups, arrive at a consensus as to a working definition of symmetry and other terms. Before closing out the class (Lesson 1 - Day 1) assign each group to bring an example of the topics discussed today. Be sure that the examples describe one of the terms discussed in class on day 1. (The students may bring anything they feel reflects the discussion (paintings, drawings, clothes, tablecloth, pictures, etc.)

Each student will be allowed 3-5 minutes to discuss their examples to the class. If at any time the facilitator feel the example does not actually meet the requirements of the assignment, then the responsibility of the facilitator is to ask the student a series of questions that will eventually have the student to conclude that his/her example did not meet the requirements. It's important that the student realize what the example actually represent. For example - a student may bring a flag that exhibit horizontal symmetry but because of the students' confusion of the terms horizontal/vertical symmetry, they believe it is the opposite of what it is. It is the facilitators' responsibility to be aware of the conversation going on in the classroom and stir that conversation in a manner that will eventually assist the student to arrive at a valid conclusion. It is this authors' opinion that through classroom discussion the student will arrive at the conclusion that the facilitator desire.

Closure (Lesson 1)

The purpose of this lesson is to assess the student's knowledge of symmetry and the terms we will be discussing throughout the course of this unit. This lesson is an introductory lesson that accomplishes many of the NCTM standards. As in the

introduction I stated that there will be very little “direct teaching” rather the pre/post questionnaire serves as an avenue for discussion. The cooperative grouping phase took the pre/post questionnaire to another level. The group discussion will give some students the opportunity to share knowledge that otherwise would remain between the student and the facilitator. The assignment of bringing in various examples of the terms really connect the concept to the real world.

Lastly, the facilitator should now discuss what the assignments of the last two days. The facilitator may share some examples of these terms (by displaying items he/she believes fits the definitions discussed). If there are still some confusion of some of these terms then it is the responsibility of the facilitator to make it clear. It is important that these terms are fully understood since each lesson will build upon one another.

Lesson 2 - Day 1

The class has arrived at a consensus on the terms used for the purpose of this unit. The facilitator will open today’s class by having the students write about their experiences in class for the past two class days.

The facilitator will discuss the field trip to the downtown area. The facilitator will advise the students that they will go on a search of the downtown area looking for geometric shapes, patterns and the forms of symmetry discussed the last few class period. Students will write in their journal about one building or structure they are aware of in the downtown area (note: I realize that many of the students in my classes may have never taken a trip to the downtown area. If that is the case, give the student the opportunity to write about any building/structure they are familiar with). Have the students to present to the class the results of their journal writing

Students will be placed in groups of ten students with two chaperones to each group. This will be a perfect opportunity to engage parents/relatives in school activities. Each group will have one person responsible for operating the digital camera assigned to each group. The assignment with the digital camera is to record any form of symmetry the group may encounter during the course of our field trip. This assignment is not restricted to the building structures - it could be any object the group believes demonstrate the topics we are discussing. The digital camera person will also take pictures of all the buildings discussed below.

FIELD TRIP QUESTIONNAIRE

1. Looking at the Pennzoil Building, what geometric shapes come to mind?
2. Looking at the Houston Public Library-Central branch, what geometric shapes come to mind?
3. Looking at the City Hall building - what geometric shape(s) come to mind?

4. Looking at the Nations Bank building, what geometric shape(s) come to mind?
5. Looking at the Texas Commerce Bank building, what geometric shape(s) comes to mind?
6. Looking at the George R. Brown Convention Center, identify as many geometric shapes that you are able to find and be specific as to their location.
7. Take a look at the Niels Esperson building and the El Paso Energy building. What do you think of these earlier structures versus more modern structures?
8. Take a look at the current construction of the new downtown sport stadium. Considering what you see now, what do you think the finished project will be? Identify as many patterns, symmetry or geometric forms as possible.
9. Take a look at the Hyatt Regency Hotel, focusing on the Spindletop Restaurant and Club. What form of symmetry do you feel this structure represent?
10. Pick any three (3) downtown structures and be prepared to discuss them during the next class period. During your discussion be prepared to talk about the structure, what type of geometric figure(s) does these structure(s) represent..

This field trip will start early in the morning and will conclude shortly after lunch. It's important that the facilitator have an opportunity to discuss with each the experiences they are having. Upon arriving back at the school, student are giving the next assignment - Write about their experiences today, (please indicate three forms of symmetry that they witness, what patterns and geometric shapes/forms did they encounter). Be prepared to discuss these in the class period. All digital camera managers must download their pictures into the computer under a file name that represent their group.

Take time to debrief with students - and bring closure to this portion of the assignment. Closure could consist of discussing the students experience while returning to the school. Discuss with students the purpose of this trip was to expose them to the real world of symmetry, patterns and design.

Lesson 2 - Day 2

Class will open with a discussion of the field trip. The facilitator will go around the room asking students several questions (really their opinion of what they experience and what connection did those experiences have with what we are studying in class). Students will then be able to present their papers concerning the symmetry they were able to discover.

Closure

The facilitator will discuss the overall purpose of this field trip - permit students to see symmetry, patterns and design in their everyday life. It is important that the students be able to express what they discovered versus the facilitator telling them what he/she expected. Actually the only results I expect from this assignment is for students to begin to think about Math and the connection to the real world.

Lesson 3 - Day 1

Bearing in mind that students have discussed various terms relating to symmetry, patterns and design, we are now ready to take this unit to the next level. This portion is a major project entitled "What If".

"What If"

The mayor of Houston is requesting that the students at John Marshall Middle School come up with proposals to revitalize the City of Houston skyline. The only stipulation the mayor is placing on these proposals is that students re-design the current skyline to reflect symmetry, unique patterns and designs.

OK class "what if" you could change the downtown area of Houston - specifically the building and structure you had the opportunity to visit on the field trip. Your assignment will be to take one of the downtown buildings and re-design it to reflect a certain type of symmetry. This assignment will be done in groups of fours. You will name your company, and begin the research to redesign the building. Bear in mind that the only stipulation is that the building should be unique and rich in symmetry, patterns and designs.

Each of Mr. Chizer's math students make up "The Marshall Planning Team". We are responsible for deciding what it is we want to do, draw up scale drawings along with cost estimates and be prepared to present our findings. Remember this is a group project - the grade that you receive will be a result of teamwork. **LET THE PLANNING BEGIN!!!!!!!!!!!!!!**

Note:

1. Teacher will assign students to groups randomly. One suggestion is to assign each student a number. Place all students numbers in a box and draw the number assigning them to groups - for example, all students are given a number, state group one - pull a number, group two - pull a number, until all numbers are pulled and all students are assigned to a group.
2. After assigning each student to a group, it is time to assign the students a building or structure. One way of assigning the buildings to students is

to give each building a number. Have someone in the group to pick a number out of a box . After all groups have picked a number then the facilitator will announce which buildings matches the number then the group picks. This will avoid students being able to select the more popular buildings, or those building they feel are too challenging.

3. Each group in each class will eventually have a building to re-design. All classes will be part of the Planning Team, with the facilitator acting as Planning Director (assuring that all tasks are completed in a timely manner).

“What If”

Congratulation Marshall Planning Team on your selection to re-design the City of Houston downtown skyline. You will have approximately six weeks to complete this project. Within these six weeks you will complete the following schedule:

- Week 1 - Preliminary Plan - submit a written proposal of what your group have decided to do. The only instructions at this point is to explain your intentions.
- Week 2 - Provide scale drawings of the current building and the groups proposed (re)design. This scale drawing should have the current dimensions of the building (you should be able to obtain this either via the public library, or contacting the building personnel personally.)
- Week 3 - Provide cost estimates of your proposed re-design. According to your scale drawing you are to compute the approximate cost of your re-design. Explain in these cost estimates how re-designing the building could save money or would you spend a great deal of money to accomplish your task. This task is very important and will require a great deal of time. I suggest that you begin by researching the cost of the building assigned to your group. One suggestion to obtaining this information is through the Public Library System or through contacting the building management. The information needed to perform this task is total cost of building and total square feet of building . If you are able to obtain this information (and I'm sure you will) then you may continue on by finding the cost per square foot. Finding out the price of the building and calculating the cost per square foot of the building will provide you with a starting point . The next step in this task is to see how the redesign your group have developed changes the overall structure of the building. Does the group redesign increases the measurements of the building? If so, do you think that the cost of

material would remain the same or increase? Please discuss this in your group and provide a half-page group response on Day 2 of class. The group will decide the cost estimates based upon the cost per square foot. GOOD LUCK.

- Week 4 - Consult with Planning Director on your progress. Advise Planning Director of any difficulty encountered. Please understand that you are two weeks away from completion.
- Week 5 - All preliminary plans, cost estimate should be completed. The group should be at the final stages of their proposal. The only requirement is that you be able to present your re-design proposal in a way that will convince the Mayor that your plan will greatly benefit the City of Houston (you are welcome to use the Power Point software on the computers utilizing the digital pictures we took). Please understand this is just a suggestion. Your group will eventually decide what method of presentation you will use.
- Week 6 - Presentation to the Mayor (Good Luck).
(Teacher Note: This may be a good opportunity to invite community leaders, city government personnel, etc., to review the student projects. This could possibly be in form of a town hall meeting where the students are able to present their proposals. I strongly suggest inviting your guest early in the project, therefore you will have ample amount of time to find alternate guest. Why not send the Mayor an invitation to review the students proposal. Another suggestion would be to invite the city council to join the Mayor to review the proposal). Students will be able to interact with various elements of the community they would otherwise never be involved with. Another possibility is to invite professors from the local university to review the proposal.

Note: This project encompasses many mathematical concepts (symmetry, proportions, ratio, estimations, etc.) The working in groups and sharing knowledge is another NCTM standard being utilized .

Closure: It is important to point out to students the many mathematical concepts they are using as they progress through this project. Closure will occur when students write individually in their journals the experiences they encountered preparing this project.

This is the final assignment of this unit. The purpose of this final review sheet is get feedback from the students .

FINAL REVIEW SHEET

1. What was the most important aspect of this project?
2. Describe your thoughts on the overall project? What suggestions do you have that may improve the project?
3. As a result of this project, do you feel that you have a better appreciation for the city skyline?
4. What math concepts did you discover and utilize during the course of this project?
5. What connection did you discover between the world we live in and Geometry?
6. Describe one career associated with the world of symmetry, patterns and design.
7. Describe your experience in constructing your scale model. Please indicate the mathematical concepts you learned or those mathematical concepts that were re-enforced as a result of this project?
8. Do you have any recommendations regarding this project?

FINAL NOTE TO STUDENTS

It has been my pleasure to be a part of this learning experience. I trust this project has provided you with a greater appreciation of this great city. More importantly, I trust you were able to discover the connection between Math and the world we live in. It was always my intentions to provide my students with the opportunity to explore and discover the relationship between Math and the world around us. To that extent I trust that you will continue to associate Math concepts and procedures with the world around you.

Finally, I trust you were able to identify career opportunities associated with this project.

FINAL THOUGHTS

“REAL-LIFE; REAL-WORLD APPLICATIONS” When I started to developing this unit it was my intention to provide “real-life; real-world applications” to my students. This unit begins as an opportunity to expose students to the world around them.

In preparing this unit, I recently read an article in the May issue of Teachers Magazine entitled “Design for Learning”. The gist of the article was that an architect named Steven Bingle want to “restore the traditional brick schoolhouse and connect students to the real world “(p.34). What attracted me to the article was Mr. Bingle’s statement “school today may be more flexible but the school still has a chain link fence around it. It’s still isolated from the community.” (p.34). This article really speaks to the intention of my unit - to take the students into the world we live in, to have them to discover the connections between life and Math. Every day, I am able to look out my window at John Marshall Middle School and see the skyline of the City of Houston . I would ask myself how can I use what I see to help my students to learn Math?

In Mr. Bingles article he states “What I keep hearing educators talk about is connections - about connecting learning to real-life experiences” (p. 35). I strongly agree with this statement. I feel that this unit could take place over the entire school year and when applicable this unit could be used to re-enforce certain math concepts. For example, when we are learning ratio/proportions the student will be able to place these concepts into the concrete form since they are actually seeing and using them in their projects. Mr. Bingles further states that in “trying to provide real-life connection that the schools we are building now.....creates an atmosphere just the opposite of that.” “They exclude the community. In most cases, the community can’t get in and students can’t get out “. (p.35). It’s important to me that the students be provided the opportunity to go beyond the textbook. I believe that many of my students may view the downtown area as a place that is not for them. Yes, they may go shopping and engage in other functions that the downtown area offers but many feel very isolated from the area itself. Not only that, the students probably never considered possible career opportunities associated with the area.

It is my intention to have students “discover” that Math is an important aspect of their lives. To associate Math concepts with the world around them. Not only Math but to see the world as a place of opportunities and to prepare themselves to take advantage of those opportunities.

In preparing this unit I felt that I wanted to provide my students with the skills necessary and useful in their educational experiences. To have students searching for data at their public library, interacting with people in the business community, utilizing modern technology (digital camera), cooperative learning prepares the students to enter the job market with skills needed to be successful.

It’s important that the students know how to gather data, how to plan and then execute their plan. This project goes beyond just Math, it encompasses preparing students to interact with people they probably would never encounter. It is my belief that educating

students has to go beyond the textbook. Educating students must become real. Again the question that many students ask “What does this have to do with me? “When am I going to use this stuff?” is answered not by the teacher (facilitator) but by the students themselves.

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