

**“Polyhedra, Learning by Building”  
Elementary Level with Simon Morgan**

**Submitted by Carolyn L. White  
Teacher, William B. Travis Elementary Grade 5 GT<sup>1</sup>**

**At the fall 2000 RUSMP Conference, I viewed the interest level that adults had developed in the large triangular pieces the Simon Morgan was utilizing. I wanted to know how the experience of discovery he was implementing could be offered to my fifth grade students. I obtained Simon’s email address to find out his availability.**

**After several e-mail’s, we chose November 10 to be a planning session. We discussed prerequisites to the lesson and charts that students should have on paper.**

**Prerequisites were:**

- **View web site:**  
<http://www.math.umn.edu/%7Emorgan/Triangles.html>
- **Define polyhedra**
- **Students make models of polyhedra with rectangular, square and triangular faces.**
- **Students develop an understanding of the terms: faces vertices and edges**
- **Students prepare a chart that show the number of faces, edges, and vertices they find in the polyhedra models**
- **Eulers Formula: Faces-Vertices-2=Edges be discovered by the students from the data gathered on the number of faces vertices and edges in the polyhedra models that were made**

---

<sup>1</sup> Carolyn L. White 2000

- **Students prepare a chart that will be ready for the discovery lesson utilizing only triangular faces. The chart would include:**

<b>Number of Triangles</b>	<b>Can you make a polyhedra?</b>	<b>How many shapes can you make?</b>	<b>Draw each shape</b>
<b>4</b>			
<b>5</b>			
<b>6</b>			
<b>7</b>			
<b>8</b>			
<b>9</b>			
<b>10</b>			
<b>11</b>			
<b>12</b>			

2

The lesson began on November 17 as planned in the outdoor classroom. We allowed two hours to implement the lesson with a thirty minute break for 12 students to go work with the garden teacher and the top twelve students work with Simon on discovering an equation for calculating the number of edges and rods utilized in polyhedra with a given number of faces.

Simon started with a definition of polyhedra. The students had models of the polyhedra and Hannah announced that she discovered Euler's Formula first.

Simon announced that triangles would be utilized to make polyhedra. The students new that the fewest number of triangles that could be utilized to make a polyhedra from their models was four. Simon utilized this knowledge to begin exploring and complete the chart that was made utilizing different number of triangles from 4 to however many we would have time or supply would allow.

The class was divided into teams of four. Students explored the number of faces needed to make polyhedra, the number of edges, and how many different shapes that could be made with a given number of faces.

---

<sup>2</sup> Carolyn L. White 2000

At this point, it was time for the students to be broken into two groups. The twelve that were left with Simon were guided by Simon to utilize the data to come up with an equation similar to Euler's formula to use with triangular faced polyhedra.

Travis discovered the formula first. He figured out that:  
if you multiply  $\frac{3}{2}$  by the number of faces = number of edges from utilizing the data gathered from the polyhedra made by the class.

Simon then wrote:  $F \times \frac{3}{2} = E$  All students agreed. Simon then challenged them to find the number of rods. The students found the number of rods in the shapes made then found a pattern. The pattern: Rods = 2 x edges or 3 x faces. Simon guided the students to seeing where the  $\frac{3}{2}$  came from in the equation to find the number of edges.

The students were allowed to make the largest polyhedra. The class was divided into two larger groups for this project. Students new that if a side was to be added from a given shape you needed two additional pieces to make a new one.

Kindergarten students were in the garden and they thought the fifth graders were building something for them to play inside of.

Simon wanted to invite them over to see a four-sided polyhedron. He explored faces, and sides with them. He took off one side of a tetrahedron and placed it over their head for them to see inside. Wow were they excited!!!

When the time was up for making the largest polyhedra, the group with the largest polyhedra had utilized 46 triangles Simon guided them into utilizing the newly found equation to find the number of rods, and edges.

What a wonderful day to discover concepts in mathematics. The students were excited and still ask about Simon. I did observe the under achievers participate with excitement and display a knowledge base I did not know they had. They were please to have Simon because they new he did not know about past failure or did not set expectations. One girl underachiever took the large chart tablet and completed that chart Rods, faces and edges to include polyhedra up to 39 faces. Students fearful of the word math were not afraid to take a risk on exploring because they new they were not graded.

Pictures were taken from beginning to the end of the lesson, including the kindergarten experience. If I had known the success rate would have been this great, I would have had this experience video taped. However, the great feeling of success that the student received from this experience will be greatly shared with others.