**Lesson Plan for Surface Area of a Sphere (Orange You Glad...?)**

By: James Schaffer and Kassie Smith

Class: Math II

Class Size: 31 students

Topics:

* Surface Area of a Sphere

Objectives:

* EQ: How do you find the surface area of a sphere?

Standards:

* MM2G4. Students will find and compare the measures of spheres.
	+ a. Use and apply surface area and volume of a sphere

Instructional Tools/ Resources:

* Projector, Interwrite, Mobi
* handout for students
* oranges, paper towels, ruler, paper, cleaner

Initial Classroom Setup:

* groups of 4

Main Ideas/ Definitions:

* Surface area
* great circle – largest circle from any sphere. Intersection of plane and sphere through the center
* area and circumference formulas
* formula for surface area

Connections to Previous Day:

* Students will have to recall the formulas for area and circumference of a circle

Time Schedule:

* (15 minutes) Warm up and answering any questions from homework at the beginning of class.
* (40 minutes) Orange you glad..? task and discussion
* (5 minutes) Let's Practice problems – applying the formula
* We will then begin with the volume activity.

Questions:

* Why is each half of the orange a great circle? Could we have cut it another way and still have gotten a great circle?
* Can you explain to me how you got your formula for surface area? What were you thinking about?
* What part of the orange represents the surface area?

How to Monitor:

* Because the students will not know how many great circles the peel of the orange should fill up, we expect that there might be some differences in what the groups come up with. We will be walking around, visiting, and talking to each group as they are working on it. So, we will have to remind them to make sure that the entire circles are covered but that the peel is not overlapping. They might need to flatten the peel to make it more accurate.
* We will have monitoring sheets to record any success or troubles. We will focus primarily on whether the groups are getting 4 circles of the peel and whether they are able to generate a correct formula based off their orange representation.

Anticipated Student Responses (including representations, questions, and misconceptions):

* We expect that there will be some resistance with completing this task and discovering and compiling the material along the way. We hope that the context of using the orange will be fun enough to motivate them to continue.
* We also expect that there will be some variation in the number of circles that the peel takes up. We hope to be able to monitor this and ensure that it fills up whole circles.

How to Select and Sequence Student Solutions:

* This will depend on the solutions we observe. We hope that all groups get 4 circles. In this case it will not matter who we choose to talk first. Regardless of whether they get 4 in the beginning or not, we hope to be able to get the groups to that point by the time we talk as a class.
* There is some risk here that they might get 3 or 4.5 or something like that. If this does occur, we might get the groups to get up and walk around to look at the other groups' representations and compare those to their own. This may inspire them to make some changes.
* From there, there are not too many different ways to solve this task. So we should be able to call on any group.

Transitions:

* After we finish surface area, we will have finished one of the two measures of a sphere. We will ask students what the other measure is and if they know how to find it. We might even bring in a context to think of in regards to the surface area and volume of a sphere. For example, we could use the Earth. The surface area is all the land and ocean area combined. But what makes up the inside of the earth? Core, mantle, etc.

Formative Assessment:

* Formative assessment will occur as we are walking around the classroom, observing their work. It will also occur as the groups begin to discuss their formulas in the whole class discussion.

Tasks:

* warm-up : area of shaded region



* (Surface area of a sphere.pdf) task : Orange you glad....? Adapted from <http://www.mathsolutions.com/documents/9780941355810_L2.pdf>

Accommodations for students with disabilities

* For ELL's, I would be sure to have more pictures of spheres on the presentation. I would also utilize technology more to explain what a great circle is. I think it would help all students, not just ELL's.
* I do not think that I would have to make any modifications for students with sight issues for this lesson. Most everything is happening right at their desk or within their group. I could make the font bigger on the handout for them.

Plans to Extend/ Scaffold:

* We are aware that our three lessons might be the students' first time working with a task and really working in a group like we are expecting. Therefore, we expect some resistance along the way. We are optimistic that they will appreciate the change and work hard. Nonetheless, we will be walking around, monitoring their progress, and keeping them moving. We will be around to answer any questions along the way or to provide a little guidance when they reach a standstill.
* We will be going into volume of a sphere after they complete the orange activity and the practice problems.
* However, if we also finish the volume then we will go into examining the effect on the surface area when you double the radius? Triple the radius? Generalize.

Alternative Plans:

* This will be the first half of a day. So, we will not run out of time necessarily. However, I might have to hurry things up to get to the volume activity. Students might be trying to fill the great circles up too perfectly with the peel which might take to long. So I would just have to encourage them to fill them up and to get on with the rest of the handout (the actual mathematics part of it). If we finish earlier than anticipated, we will go ahead with the practice problems and then the volume activity. We have some extra planned (effect of changing the radius) in case that happens. We are not really depending on technology for this part of the lesson so if it is not working it is not a big deal. We can draw a warm up problem, review homework, and post findings on the whiteboard instead.

Closing: Let's practice problems

Homework: The homework will be whatever we do not finish in class. We have practice problems prepared to work through but we think we have a pretty ambitious schedule. So we will leave the students to complete whatever we do not complete in class.

Summative Assessment: end of unit assessment

**Monitoring Chart**

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| --- | --- | --- | --- |
| Group Members  | Correct # of circles | Correct Formula based on their # of circles | Notes  |
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Analysis of cognitive demand of each task (warm up, other problems done in class, main task)

1. Warm up (simple area of shaded regions problem similar to one on their homework)
	1. I think this was likely a procedures without connections task. The pathway to completion was evident from our instruction. The students did much better on this problem than they did on problem from the previous day.
2. Orange you Glad...?
	1. The surface area task was a procedures with connections task. In this case, I am considering the tracing of the great circles, the peeling, and the filling of the traced circles with peel as the procedures. The connection was the act of deducing the formula for surface area of a sphere from their representations. It was a neat activity that led them to constructing the formula rather than us just giving it away to them. It was not incredibly difficult because the steps were so clearly laid out for them in the handout. Now I think that the formula makes sense to them and is not just the compilation of numbers and letters. Instead, it is four times the area of a great circle. Moreover, I think that the students understand what it works for spheres of all sizes.
3. Let's Practice

These practice problems were there just to make sure that they could correctly use the formula they found. They were procedures without connection problems. Again, we ran into the problem of the students having a difficult time with the algebra, so I think it was appropriate to give them the opportunity to practice.