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**Class and Grade Taught: 8th Grade Math**

**Lesson Date: March 26, 2013**

**Lesson Logistics and Setting**

**Unit Topic:**Pythagorean Theorem

* **Previous Lesson Topic:**Developing Pythagorean Theorem and Finding Missing Lengths
* **Current Lesson Topic:**Proof of Pythagorean Theorem
* **Next Lesson Topic:**Converse of Pythagorean Theorem

**Lesson Objectives:**

**I CAN… prove the Pythagorean Theorem through the knowledge of area of multiple squares and triangles.**

**GOAL: The use of manipulatives will give students a visualization of the proof of the Pythagorean Theorem.**

* **Standards Addressed:**

**8.G.6 – Explain a proof of the Pythagorean Theorem and its converse.**

* **How will I know students have met the objectives?**
  + **The students can construct the puzzle boards with the triangles and squares.**
  + **The students will use their knowledge of area of triangles and squares to compare areas in each puzzle boards.**
  + **After comparing the two puzzle boards, students can recognize the difference between the boards and use that to prove the Pythagorean Theorem.**
  + **Students can use the Pythagorean Theorem to prove a triangle Is a right triangle from this experience.**

**Materials Needed:**

* Laminated cut outs of right triangles and squares
* Puzzle boards to construct triangles and squares upon
* Exploratory worksheet focused on constructing puzzle pieces.

**Introductory Routines**(announcements, homework review, etc.)

Journal (8 min)

* When bell rings, start timer for four minutes. Students should have already picked up a Journal sheet since it is the start of the week. During this time, I will take attendance and monitor student work. As students work individually, they may talk at a level of 0-1 with their table partner.
* After four minutes, I will bring the class together and go over the journal with the use of student volunteers. I will call on students who have hand raised and waiting quietly.

Announcements

* Any necessary announcements to make this would be the time.

Journal:

Find the missing length of a triangle with the following lengths: a = 5, b = 12, c = ???

**Lesson Activities**

**(Attach any handouts you will use)**

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| **Lesson** | **Students are working …**  *(details about how students are configured, what work they are doing and how they are recording their work)* | **Anticipated Student Thinking/Questions** | **Teacher Moves** |
| **Launch (12 min)**   1. Review what Pythagorean’s Theorem is used for. Review the formula and provide connections to what they are working with. (2 min) 2. Define a proof and theorem. Hold discussion on why proofs are needed in mathematics. Connect to how/why Pythagorean’s Theorem is proved. (8 min) 3. Explain the type of task students will be working on at their seats. While explaining, materials are being passed out by student volunteer. (2 min) | 1. Students will be discussing the Pythagorean’s Theorem in two ways. What is the formula? What is it used for? 2. The students have partner conversations at first about why proofs are necessary. After, ideas are collected into a whole class discussion.Have students discuss when they need to prove in their lives. Connect this to their discussion on proofs in math. 3. Students are listening to task at hand. They will wait to use the materials until all instructions have been given. | 1. Students will be reflecting on Pythagorean Theorem. Students should remember what a right triangle looks like and how Pythagorean Theorem was constructed. Students may wonder why this is exactly the case. 2. Students provide reasoning for why proofs are necessary. Students may be wondering what makes something a proof and wonder if they have already proved 3. As teacher is explaining, students listen intently to how the task will be completed. Students may start to wonder how to work on the task. | 1. If not done already, I walk mark attendance. I will hold a quick discussion on the formula for Pythagorean’s Theorem. 2. As the students finish their work, I will introduce Pythagoras and how this theorem came about. The worksheet will have this material for students as I read aloud. 3. After completed with the story, I will have a few volunteers pass out the materials to work on during the explore task. While this is being done, I will explain the activity aloud to the whole class. |
| **Explore – Description of Task(s) (22 min)**   1. Students start activity. First, students must look at the lengths of the right triangles and make comparisons to the side lengths of the squares. (4 min) 2. Once students have established a connection, students can place the puzzle pieces on the board. Students will continue to explore until they can get all pieces to be on the board with no overlaps. (10 min) 3. Students are given an opportunity to compare what they have gathered with another group. Students will work in a bigger group to solve this situation. (3 min) 4. Once students finish, they will reflect on their constructions and how that relates to the areas of the squares. (5 min) | 1. Students will work with their table partner on determining how the sides of a triangle compare to the sides of the squares. 2. Students move to the puzzle frames and try to place the pieces in exactly two puzzle frames. Students will use four triangles in each frame and must decide what to do with the three squares. 3. After about 5 minutes, students will be given 2-4 minutes to work with another group to work on the problem and discuss what they discovered. 4. Students complete reflection in the form of a worksheet. This should mostly be done quietly as they had a chance to talk in a small group. | 1. Students may not be sure what they are looking for when discussing side length. They may not exactly understand what sides have to do with anything in this task. Students should notice that each side of the triangle is the length of all three squares. 2. As students are putting the pieces together, I sense many students will get frustrated. Students may look to have their partner do the work. Students may also forget that all pieces must stay on the frame. Students should be able to construct, but may struggle to find the connection to side lengths to help them out. 3. Students work in groups and may wonder why they need to meet in more groups. Students should show their work with the other group and explain their thinking for those that are still confused. 4. Students will start to wonder why doing this activity was relevant. Students will wonder what they learned. Students will develop an understanding of Pythagorean Theorem through the discussion and can find the values of the triangles in their puzzle frames. | *Exact question that you will pose to students to begin the exploration.*   1. First, I want students to investigate the relationship of the side lengths and the squares. What exactly are the students working with? What relationships can be made with any of the puzzle pieces? I need to hold a conversation about the relationship of the squares and triangles and label the sides (a, b, c) to assist in finding areas of each square. 2. I want to notice if students are using any strategies to solve this problem. As students begin to work, I will explicitly state there is a difference between the medium and large squares. I will compare these on the doc cam. What makes solving this problem easier? What strategies are students using to solve? 3. The point of having other groups working together is to acknowledge how different approaches may still lead to the same answer. What did your group do differently? Did you still arrive at the same answer? 4. What do you know about each of the frames? What is the same in each frame? What is different? What is left if the triangles are removed from each? These questions all point to arriving at the realization that only the squares are different between frames. When comparing the two frames the Pythagorean Theorem can be developed. |
| **Summarize/Share and Discuss (14 min)**   1. Discussion over the findings of the exploration. First, students will explain the relation between the side lengths of the triangles and squares. This is followed by a discussion of the areas of the pieces versus the board it is placed on. (8 min) 2. Through discussion, the Pythagorean Theorem will be developed using squares. This connection will then lead to a discussion where side lengths become involved to eventually lead to the Theorem. (6 min) 3. An exit slip follows to assess understanding of proofs and the use of manipulatives. | *Presentation mode – Sharing solutions, teacher-led discussion, student led discussion, etc.*   1. I will introduce the whole class discussion to go over the Explore. Multiple student examples will be presented on the Doc Cam. I will ask for student response to why they took a certain strategy. Other students will be listening quietly. 2. I will establish a connection to Pythagorean Theorem. Students will be called on for volunteers so students should either be listening quietly or actively volunteering to provide assistance in reaching the Pythagorean Theorem. 3. Students complete exit slip before leaving classroom. | 1. Students will notice that the triangle sides match the sides on one of the squares. Students may not have picked up on all of these unfortunately. Students should have been able to produce the puzzle frames with the pieces. 2. Students may need refreshers on the area formulas. If students did not remember the area formula for triangles, this could lead to an incorrect assumption on the answer. The students will approach Pythagorean’s Theorem of a2 + b2 = c2 from looking at the squares as the only difference in two puzzle frames, 3. Students use what they learned in class to answer exit slip questions before leaving class. | *What will you say or do to set up the discussion of the big math ideas?*   1. To start out the discussion, I will ask students to notice a connection between the sides of the triangle and the squares. After, I will ask how students built their puzzles. I will look for a key connection between side lengths to ignite reasoning for constructing the puzzle. I will stand back for most of the discussion to allow students to lead this discussion. I will provide points when necessary. 2. I will then guide the discussion towards area. What do students notice that are the same in each puzzle board? What’s different? The goal is to guide students to notice the difference in two squares vs. one. I will ask what this means? My questioning will lead students to the Pythagorean Theorem. 3. Have students pick up exit slip when finished with worksheet in class. |
| **Summary Statement (2 min):**  *(May change based on what actually happens in class)*  The Pythagorean Theorem resembles the sum of two smaller squares equally the area of a larger square. These squares each have a side length of a right triangle will match this as each side is resembled in the equation of areas.  KID FRIENDLY: You learned how to prove Pythagorean’s Theorem from constructing a puzzle board with squares and triangles. When comparing the two puzzle frames, you notice the difference in the equal frames is the size of squares on each frame. This proves the formula that the length of each side length squared of a leg equals the hypotenuse (side length of biggest square) squared. | | | |

**Homework:**

None (but there will be an exit slip at the end of class)