Annie Carpenter
MSM 540B
Lesson Plan
July 25, 2012

**Enclosures:**
Lesson Plan
TEAM Sheet (Student Activity Sheet)
Review and Suggestions by Callie Kronlage
Statement of changes made or suggestions exempted

**Carpenter Geometry – (9-12) – (Midsegment Theorem)**
**Note: Please attach any handouts that would be given to students and/or make it clear what problem(s) students will be working**

| | |
|---|---|
| **Objective(s):** | Prove and apply the Midsegment Theorem on the coordinate plane. |
| **Grade Level OR Course Name** | Geometry (9-12 grades but mainly 9 and 10) |
| **Est. Time** | 2 days |
| **Pre-requisite Knowledge:** | Distance Formula, Midpoint Formula, slopes of parallel lines, Segment Addition Postulate, and graphing on the coordinate plane |
| **Vocabulary:** | Midsegment, Midsegment Theorem, and Coordinate Proof |
| **Materials Needed:** | Graph paper, Geogebra or GSP, TEAM hand out |
| ***Iowa Common Core Content Standards*** | **Prove Geometric Theorems:** 10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; **the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length**; the medians of a triangle meet at a point. (**G-CO.10**) |
| ***Iowa Standards for Mathematical Practices*** | 1. Make sense of problems and persevere in solving them.<br>2. Reason abstractly and quantitatively.<br>3. Construct viable arguments and critique the reasoning of others.<br>5. Use appropriate tools strategically.<br>(Hopefully) 6. Attend to precision. |

**Launch (How will you engage students in the content for the day?)**

Pose the question:

On graph paper or using geometry software, draw several different types of triangles. Pick two of the sides of each triangle and connect their midpoints. What conclusions can you make?

Students will work individually on this part for 5 minutes and then work with their assigned TEAM members to compare and make additional conclusion

**Explore (How will students explore the content for the day?)**

Students will use graph paper and or geometry software to look at several different types of triangles and one of the midsegments of each.

Students will then get in their TEAMs and compare their conclusions and verify them with geometry software.

Students will complete Part 2 in their TEAMs. When they are done, each TEAM will share out their definition and theorem. We will come to a consensus as a class.

The definition for a **midsegment** is a segment that connects the midpoints of two sides of a triangle.

The **Midsegment Theorem** is the segment connecting two sides of a triangle is parallel to the third side and half as long as that side.

After verifying, students will make a plan for a coordinate proof using a specific triangle. As a class, the TEAMs will compare their plans and help critique them. This will be a time to ask questions to make sure students understand that they will need to use the midpoint formula, distance formula (or at least understand how to find the distance between two points on a coordinate graph), and how to find slopes of parallel lines. Once we have discussed these as a class, students will then prove this for a specific triangle that has been given to them. This proof is part 3 number 1 on the TEAM sheet.

They will be asked to compare their proof with another TEAM.

As a whole class we will do part 3 number 2 together. First we will discuss how the problem is different from number 1 in part 3. Prompting questions will be:

What is the least number of variables we need to set up this problem?

How do we construct a triangle? (Connect two point together.)

Is there a friendly point on the graph that we could pick to be our first point? (The origin.)

What would be a good second choice? (On an axis.)

This will conclude day 1. For the closing activity, the students will answer the following statement on their exit card and hand it in before they leave.

Please summarize the midsegment definition and Midsegment Theorem so that someone who was gone today could look at your card and understand what they missed. What value do you see that this definition and theorem provide to mathematics?

They will then be asked to consider how we could finish the Proof for the Midsegment Theorem we started. For homework, they need to plan the rest of the proof. What are the key steps we still need to take?

**Day 2**:

Students will be asked to share their thoughts on completing the proof of the Midsegment Theorem at the beginning of class. We will then finish the proof together as a class.

Students will stay in their TEAMs but will be instructed to first try each problem of part 4 numbers 1-3 by themselves and then compare with each other. When they are done, they will signal me for a check. I will check their work and ask different members questions to make sure they are all understanding.

Students will then work on number 4 in the same fashion and then number 5.

Please see the TEAM worksheet for more specific instructions to students.

**<u>Summary/Close of the lesson (How will you close your lesson and bring student understanding to a close for the day?)</u>**

The different TEAMs will summarize what they have learned and then the reporter will share out this brief summary from each TEAM.

I will then ask students questions so we can summarize how we create a Coordinate Proof.

**Where are we going from here?** Students will then be asked to reflect individually on the following questions on a piece of paper to be turned in at the end of class on day 2.

1. What is the significance of the midsegment being parallel to the corresponding base?
2. What knowledge do we gain from knowing this?
3. Why do you think this is significant?

For their homework I will ask them to find another polygon with a similar property and be prepared to share this idea with the rest of the class tomorrow.

When we explore similarity, I will recall this information we gather from the list of questions on **Where are we going from here? numbers 1-3**.

**<u>Extension(s)</u>**

Can we prove this without using a coordinate proof? If so, how? If not, what additional information would we need? (We will not have covered similar triangles yet. My intention here is that students will see that we can prove both parts of the theorem if we could show that they triangles were related. Or, if we were given that the midsegments are parallel, we could prove that the midsegment is half of the base it is parallel to.

If we have triangle $\Delta ABC$ with midsegments *D, E,* and *F* respectively, how is the midsegment of $\Delta DEF$ related to the corresponding base of $\Delta ABC$ ?

**<u>Check for Understanding (How will you assess students throughout and at the end of the lesson?)</u>**

During class I will be checking in with all the TEAMs to see what questions they have and how they are coming. I will use questioning for individuals, TEAMs, and the class as a whole. Students will indicate understanding by self-assessing with a thumbs up side down when prompted. On part 4 of the TEAM worksheet, I will check each section for the group before they move on to the next item. The TEAM sheets will be collected and assessed for understanding.

**<u>Strategies to support English learners:</u>**

The TEAM activity sheet as well as a definition list with translations will be given to the ELL instructor before the lesson. They will go over the two items with the ELL learner in advance. All notes made prior to the activity will be used by the student during the class period and on homework. Visuals will be used whenever possible and words will be written as well as stated to aid students.

**Key Ideas**

| Key ideas/important points | Teacher strategies/actions |
|---|---|
| Midsegment and Midsegment Theorem | Facilitate TEAM activity to develop both the definition and the theorem. Guide students through questions when the need arises. |
| Coordinate Proof | Guide students by asking appropriate questions within the process of the coordinate proof. Give hints on how to choose the point locations so they are generic. |
| Applying Midsegment Theorem | Monitor students as they work on part 4 of the TEAM activity. |

**Guiding Questions (focus on the mathematics and using open-ended questioning)**

| Good questions to ask | Possible student responses or actions | Possible teacher responses |
|---|---|---|
| Does the location of the triangle matter on the coordinate plane for this proof? | Yes, we have to know where to put the points so we can connect them.<br><br>No we can put it anywhere. | Are we working with one specific triangle? Or are we trying to show that this is true for all triangles? How does that answer affect location?<br><br>If we can put it anywhere, what would be a nice "starting" point? |
| In order not to have any fractions in our equations, how could we choose our variables? | I have no idea…<br><br>As even numbers.<br><br>Numbers that a divisible by 2. | How do we make sure a variable is even?<br>How could we represent our variables so that they take on even values? |
| How many unknowns do we have in the proof? | 6 because we have 3 different points each with an x and a y value. | If we give one of the points a specific location, can I create any triangle from that point? How could we choose our points so that we have the fewest number of variables as possible? |
| How is the coordinate proof we did for the Midsegment Theorem similar to the proof on part 4 number 5? | Both are triangles, both use distance, and both have several unknowns. Only the Theorem uses the slope. | Even though this is not using the midsegment of the triangle, is there a connection you can make for the midpoint of a hypotenuse of a right triangle, the midsegment, and the vertices? |

**Misconceptions, Errors, Trouble Spots (Minimum 3 – focus on the mathematics)**

| Possible errors or trouble spots | Teacher questions/actions to resolve them |
|---|---|
| **Students will have a difficult time with picking the three points for the coordinate proof.** | **See questions in table above. I may let them make their case with a more specific example and then help them adapt it to all cases.** |
| **Students will make the proof for a specific set of points that they create.** | **I will help them see how to apply this to all triangles.** |
| **Students may have a difficult time with the fact that there will be 3 variables in their proof.** | **I would encourage them to use actual values first to see how it all fits together and then ask them to use the same process but use variables instead.** |
| **Students may confuse the midpoint and midsegment ideas.** | **I will ask questions that point out the differences in the two terms depending on which problem we are on.** |
| **Students may forget that we do not have to use the actual distance formula when the two points are on the same horizontal or vertical line.** | **Let them use the distance formula and then ask what is the same for both these points? (They are on the same line horizontal line.) Is there a relationship that is true about distance when points lie on the same horizontal? Is this also true when they lie on the same vertical?** |
| **Students may not know how to start the proof for part 3 number 1.** | **When we are given coordinates, what is something we can do with them to help us visualize the probem? Now that we have the three points graphed, how can we find where to plot D and E?** |

Name ____________________________
Date _________________ Period ____

Geometry Midsegment Theorem

TEAM member names:

1)__________________________ 2)__________________________ 3)_____________________________

**Part 1:** Making a conjecture
On graph paper or using geometry software, draw several different types of triangles. Pick two of the sides of each triangle and connect their midpoints.

1. What conclusions can you make?

2. Share with your TEAM members the conclusions you found. Make a list of what you had in common and what you learned from your TEAM members that was new.

3. TEAM member 1 please go to the board and list what you have for number 2. TEAM member 2 and 3 be ready to defend your conclusions.

4. List anything new that your classmates have listed on the board below.

**Part 2:** Creating a plan to show our conclusion is true.
1. Based on the information above, please work with your TEAM to create a definition for midsegment.

**Midsegment:**

2. Based on the information above, please state your conjecture about midsegments as a theorem.

**Midsegment Theorem:**

3. Verify the Midsegment Theorem with GSP or Geogebra. Do you believe this is true for all triangles? If yes, why? If not, find a counter example for it. List your big ideas below.

4. Discuss with your TEAM how you could use a coordinate grid to help prove the statement in number 2. List your ideas below.

**Part 3:** Proving our conjecture.

1. Using the vertices $A(0,0)$, $B(2,8)$, and $C(6,2)$ construct triangle ABC on graph paper. Find the midpoints of $AB$ and $BC$ called points $D$ and $E$ respectively. Prove that line $DE$ is parallel to line $AC$ and that line $DE$ is half of line $AC$.

2. We will be proving this theorem as a whole class. You should remain in your TEAMs for support.

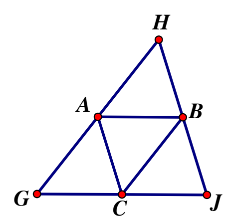
   Given: $\overline{DE}$ is a midsegment of $\Delta OBC$

   Prove: $\overline{DE} \parallel \overline{OC}$ and $DE = ½\ OC$.

   (Hint: We want this to be a generic proof for all triangles. Because we are placing this on a coordinate grid, we can assign one value for one point but the other two points need to represent all values. If we can assign a location to one of the points, what would be a good point to use?)

**Part 4: Check for understanding.** Use $\Delta GHJ$ where *A, B,* and *C* are the midpoints of the segments.

1. If $AB = 3x + 8$ and $GJ = 2x + 24$, what is $AB$?




2. If $AC = 3y - 5$ and $HJ = 4y + 2$, what is $HB$?

3. If $GH = 7z - 1$ and $BC = 4z - 3$, what is $GH$?

4. **Planning a proof:** Please explain how you would go about proving the following statement.

   Given: $\overline{ST}$, $\overline{TU}$, and $\overline{SU}$ are midsegments of $\Delta PQR$.
   Prove: $\Delta PST \cong \Delta SQU$.

   You do not need to do this as an actual proof. Think about the big ideas you would use and how you would use them to prove this.

5. **Coordinate proof:** Given $\Delta ABD$ is a right triangle with right angle at $\angle A$. Point $C$ is the midpoint of the hypotenuse $\overline{BD}$.
   Prove: Point $C$ is the same distance from each vertex of $\Delta ABD$.

Callie Kronlage Review

Review of Annie Carpenter's Lesson Plan:
Annie-

This lesson seems like a really great way to get students involved in learning. I think just letting them make their own triangles is a great way to start instead of keeping them limited to isosceles triangles. Most students will probably end up making fairly basic and easy to work with triangles anyways but there will be some students who are able to make some more interesting triangles and get their groups to think about different types of triangles. Here are some things that I noticed that you may want to think about and/or update:

Part 1 question 1 will be students individually working on the launch and THEN move to their groups or will they be in their groups but working alone?
Does each group get assigned a specific triangle to work with?

Part 2 question 1 has a typo at the end. I'm not sure what you were trying to say at the end of the question or if there was supposed to be more that got cut off.
Is a ticket out the door similar to an exit card? The students answer a question and turn it in at the last few minutes of class.

The questions you have prepared for the students seem very reasonable and like good questions to help them work through their proofs.

Is a coordinate proof something that your students have done before or will you be going through this together as a class? Because just telling them they need a coordinate proof may get some blank stares from students if they haven't done one before.

What will you be doing with the other half of the half class period?

I think for the ELL students it will be important for them to work in their groups with their peers so they can all discuss it in their own words at their understanding level, before getting together with the class as a whole and using more formal language. Overall I would like to see a little more details as to want the students will be working with in the coordinate proof.

Annie Carpenter
July 25, 2012
Lesson Plan for MSM 540B
Midsegment of a triangle and Midsegment Theorem
Changes made based on Callie's Review

Upon reviewing what Callie had suggested, I made a few changes to the lesson plan. Concerned that students would see the coordinate proof better for an isosceles triangle, I originally opened with the statement, "On graph paper or using geometry software, draw several different types of isosceles triangles. Pick two of the sides of each triangle and connect their midpoints. What conclusions can you make?" Deciding that this was too specific, "isosceles" was removed form the statement to allow students more exploration. Asking Callie what she thought of the two options, she agreed that it should be less specific confirming the decision to leave it out.

Taking the advice to clarify the students' role with the opening statement, I added that students will work on this problem individually for 5 minutes before they move into TEAMs and share their findings.

The two biggest changes I made after Callie looked over the lesson and gave suggestions was to extend the lesson into 2 days instead of 1.5 and add two more proofs that tie into the overall theme. These proofs extend into the next topic causing the extra time to be used in a manner that does not take away time from other necessary curriculum. Callie expressed concerns about students being ready to do a coordinate proof on their own. I agreed with her on this. One of the two proofs that I added to the check for understanding section is a coordinate proof allowing students to explore one on their own. This will be done after we, as a class, construct the coordinate proof for the Midsement Theorem and students in their TEAMs construct one for a specific triangle.