YDI Lesson Study/Research Lesson

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| We want students to be able to Persevere while inventively solving problems During this lesson, we want students to... * have the opportunity to be challenged in a situation that is unfamiliar
* inventively solve problems finding their own approach, using their own unique toolbox of understanding including (a) concepts and strategies built in math class, and (b) real world knowledge/math from everyday life (not just money)
* feel (a) capable of bravery, (b) comfortable and committed to trying and making mistakes and (c) assertive towards their own sense-making
* be eager to challenge themselves, both with the given work and seeking further problems and challenges. When they get the answer, they will not just say what's next and want to go on to the next thing - they will say, "What else can I learn from this?"

We decided to target our research lesson on…Proportional Reasoning & Relationships, with a focus on students recognizing when something is a proportional relationship |

**Materials**

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| For Warmup | Handout with 2 opportunities  |
| For Step 4 | Pre-made Model Newsprint for students to copy |
| ForStep 5 | Handout with Opportunity for students to complete and then work on:*A survey of a previous class showed that they had \_\_\_ Left-thumbed people and \_\_\_ Right-thumbed people. Is our class more or less “Left-thumbed” than the previous class? Give evidence for your answer.* |
| Handout with Pre-Made/Back-up Opportunity:*In classroom A, there are 9 left-thumbed students and 5 right-thumbed students.* *In classroom B, there are 20 left-thumbed students and 15 right-thumbed students.**Which classroom is more “Left-thumbed”?* |
| Enough Markers for student group work (at least two different markers per group) |
| Chart paper/Newsprint for student responses  |
| For Step 8 | Sheet of Reflection Questions |
| \*Note\* | If board space is an issue, teacher will need newsprint for visuals produced during Warmup, Step 1 and Step 3 to remain up during the lesson |

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| **Steps of Lesson:** **Learning Activities/Key Questions- Minute by Minute**  | **What are students doing? /Expected Responses/ Reactions**  | **Teachers response to student reactions/ Things to remember** | **Goals/Methods of Evaluation/****assessment** |
| Warm Up. (Optional)Give out handout that reads “Create a chart, graph, or draw a picture to illustrate the following:1. 56 ÷ 4 =
2. Two common multiples of 9 and 12”

Have a few students demonstrate their answers/methods on board/newsprint. | Drawing, making charts, or graphsAsking what a “multiple” isSome students may find the answer to #1 first and then create a picture to match itSharing their responses | Many teachers give warmups as part of their regular class routine to give students a chance to settle in. This particular warmup helps focus students in and primes them for what is coming, without directly referring to it. It gets students thinking of drawing, charts and of common multiples. This creates an opportunity to draw out student knowledge that may be built upon Student work/methods should go on board/newsprint and remain visible for the duration of the activityLook for at least one student who lists the multiples of 9 and 12 and circles (or connects in any way) the common multiples. Once identified, teacher should ask student to present their work.The first three common multiples of 9 and 12 are 36, 72 and 108.Using this warmup also allows for latecomers to be included in Step 1 of the lesson.  | Student pictures and charts |
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| Step 1.Teacher should clasp their hands and ask students to do the same. Take a tally (draw out tick marks and not digits) of the class. Record the total right thumbed and left thumbed students on the board. | Clasping their hands and taking note of which thumb is on topWondering what clasping hands is about Wondering if they are similar or different from the rest of the class Voting | Assure the correct clasping method was used and then ask who was R-thumbed and who was L-thumbed.Write two columns on board, “Left-Thumbed” and “Right Thumbed”, recording the tick marks for each student vote in appropriate column. The tally should remain up for the entire lesson (on board, or on newsprint if board space is limited)Do not record total (until Step 2)If there are an odd number of students in the class, include yourself in the tally and record a tick mark in the appropriate column. Note: Regardless of your actual “thumbedness”, use the tally mark representing you to break any ties, and to make sure the total is an even number. | To record the number of right-thumbed and left-thumbed studentsLooking around/asking around to see what other students are doing  |
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| Step 2.Teacher asks, “Has everyone voted? Can we prove it? How do you know?” | Counting the number of people in the class and counting the number of tallies on the board Explaining their reasoning  | To encourage student explanations of their reasoning, ask:* What did you count?
* What two things did you compare when you “just counted?”

Write the words “thumb” and “thumbed” on the board and clarify the difference. “Thumb” refers to a specific finger on your hand and “thumbed” refers to the thumb that is on top when we each clasp our hands. Ask your students to repeat each word so they can hear/feel the difference.Write summary of vote using total number of students under each column of tick marks (i.s. For ten people, we have seven left thumbed people. For ten people, we have three right thumbed people.) To the right of the tick marks, write a statement comparing the left and right thumbed people (i.e. There are seven left thumbed people and three right thumbed people”)Write out word for the numbers used (i.e. “seven” as opposed to “7”)Write the following question on the board, “Are we more right- thumbed or left-thumbed as a class? Explain why.”  | Students demonstrate understanding through their answers to the “prove it” question.Are students explaining the dominant thumb in the class using both parts and wholes?  |
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| Step 3.Mentally triple the total students in the class. 1. Ask the class how many students they would expect to be left thumbed in a class that had a total number of students three times bigger than theirs. For example, if there were ten students in the class, you would ask, “How many left thumbed students would you expect in a class that had 30 people in it?”2. Ask students, “How can we visualize the larger group?”3. Once the tick marks representing the class 3x the size are up, ask students “Which group is more left-thumbed, our class or the larger class?” |  Some students may think there is not way to say anything about the larger groupStudents will begin to apply proportional reasoning, hopefully recognizing if the total is increased by there, that the number of left thumbed people would be proportionally increased.When answering question 3, some students may say that the larger class is more left-thumbed because it will have more left-thumbed people. Other students will say the two classes are equal when it comes to left-thumbedness. | If students do not believe there is a connection between the two different class sizes, you can say something like, “Based on the observations we’ve made, what can we say about the larger class?” Try to get students to explain their thinking – ask them, “How could we visualize the larger group?”If students do not use the model of the tick marks already on the board, ask students explicitly how that could be done.If students can’t explain how to use the tick mark picture, model this by drawing two additional rows underneath the row of tick marks representing the class. (These visuals should remain up for the rest of class, either on the board or on a piece of newsprint).It is a very important moment when you ask the class, “Which group is more left-thumbed, our class or the larger class?” It is a way of drawing out a common student challenge Make sure to ask students who say the two groups are equally left-thumbed to explain – ask them ‘How are they equal?” | One goal of this step is to introduce students to the idea of “For every \_\_\_ students, there are \_\_\_\_\_ students who are left-thumbed” It is also to give students a strategy of building up/chart makingThe goal is to have the initial row of tick marks created in Step 2, tripled on the board with three identical rows.For students to make a connection between visualization/pictures as a way of explaining one’s thinking |
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| Step 4.Teacher breaks the class up into small groups of 2-3 students. Each group should get a piece of newsprint. Teacher directs students to divide newsprint in half. Have them label the left side, “Messy Stuff”, and the right side “Problem, Process, Solution”To save time, if possible, you can prepare a model version of the newsprint and have students copy it. | Getting into groupsPreparing newsprint | Once every group’s newsprint is ready, tell class they will be given an opportunity[[1]](#footnote-1) and they should do all their work on the left side of the page. Emphasize that they should not write anything on a separate piece of scrap paper – the left side of the newsprint is their scrap paper. Every time they get stuck, they should circle where they are. Tell them not to cross anything out – in fact, if they feel the urge to cross anything out, encourage them that that is a good moment to circle whatever they are working on instead.Tell each group they will be explaining their work to the rest of the class. Make sure to ask if there are any questions.\*\*\*While students are preparing their newsprint, look ahead to Step 5 and prepare the opportunity/activity based on the instructions there.\*\*\*Note: Students will be working on the right side of their paper in Step 6. Once they have worked through the opportunity on the left side, they will call you over. Once you give the ok, they should work on the right side. For the right side, they should try to organize the thinking they have done, write out and explain the steps they took to solve the opportunity, so that other people can understand what they did.  | Correctly prepared newsprintStudents doing all their work on the right side of the page and not using their own scrap paper |
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| Step 5.You will be creating a problem based on the results of step 1.If there are 10, 14 or 20 people in the class, the teacher will use a comparison class of with 20 left thumbed and 15 right thumbed students.If there are 12 or 18 people in the class, teacher will use a comparison class of 20 left thumbed and 10 right thumbed people.If there are 16 people in class, teacher will use a comparison class with 25 left and 15 right.If there are 22 people in class, teacher will use comparison class with 16 left and 4 right. “A survey of a previous class showed that they had \_\_ Left-thumbers and \_\_ Right-thumbers. Is our class more or less “Left-thumbed” than the previous class? Give evidence for your answer.”  | Think-Pair-Share- Students attempt the opportunity on their own-then they will share with a neighborExpected Responses/Reaction:* Uncertainty around how to begin and/or about what makes one class more or less left-thumbed than another
* Adding the R thumbed people and L thumbed people to get the whole
* The second class-because there are more L thumbs
* Mistakenly make Additive comparison
* Find a percent
* Multiplicative comparison
* Draw a picture
* Make chart looking for common multiples
 | Before they begin, tell students to focus on the messy side and to call you over before going to the right sideMonitor frustration level and progress to determine amount of time spent individually working on the questionMonitor whether students are considering whether the total of students surveyed in their reasoning? Could it be because there are just more people? If additive comparisons are being made, teacher can refer students to tick mark model on the board from Step 3Idea is to try to pivot back to its not about the ultimate number as they exist alone, its about the relationship of the quantities as they exist together; the relationship is consistent-the parts are not independent of each other. The part-part-whole work together. Question to elicit understanding of the quantities as the exist in relation to the “whole”Identify students who are employing certain strategies as we are coaching individually. Students who are using informal and/or quantitative reasoning should be identified to show their work first during the group presentations. | Struggle and to persevere while struggling-recognize and re-enforce For students to understand that part part whole are not independent and when comparing, the total or whole mattersIndividual feedback from students as they are working aloneMonitor defense of strategies and explanations in groups or as a classStudents share on board after the individual and group time is overExamining student methods - Identify multiplicative, %, pictures, charts (multiple strategies) Able to defend reasoning when asked questions |
| Step 5. ContinuedThe following chart is to help you “spontaneously” create the opportunity in Step 5.

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| **Number of Students in Your Class** (including you if necessary to create an even total) | **Number of Left-Thumbed Students in Comparison Class** | **Number of Right-Thumbed Students in Comparison Class** |
| 10 | 20 | 15 |
| 12 | 20 | 10 |
| 14 | 20 | 15 |
| 16 | 25 | 15 |
| 18 | 20 | 10 |
| 20 | 20 | 15 |
| 22 | 16 | 4 |

As mentioned in the materials section, you should have a class set of the pre-made/backup opportunity available in the case of the following situations:1. If there is an even spilt between right and left-thumbed students in your class
2. If your entire class is either left-thumbed or right-thumbed
3. You have fewer than 10 or more than 22 students (including you)

You may opt to use the pre-made/backup handout even if your class numbers do not fall into any of the situations above. |
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| Step 6.As groups finish the messy side, encourage them to start working on the right side of their newsprint. Repeat the directions that they should write and explain each step they took to come up with their solution. Remind them they should write enough so that other students (and the teacher) will be able to read it and understand what they did |  Group discussions about what is important and what is not important to write in the right columnSome students may want to just take what they wrote on the left side and re-write it on the left | Walk around room, listening to student conversations about what to include on right sideEncourage groups to elaborate on their steps, and not just re-write them from the left to the right side.Be on the lookout for moments where groups skip an important step they took and do not write it on the right side.  | Final product of each group’s newsprint:* Rough draft/messy side with missteps, ideas
* Right side with step by step explanation of group’s method
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| Step 7:Teacher asks each group to present the right column of their newsprint. While each group presents, teacher should sit in the seat of one of the presenters.After each group presentation, the teacher should ask the other students if they have any questions about the way the group solved the problem. If there are no questions, teacher should ask at least one question about group’s process. Teacher may also try to ask the rest of the class about the method presented – for example, “I thought this was an interesting step. Why do you think they did this?” Teacher should also ask class what they like/appreciate most about each group’s presentation. After other students have made observations, teacher should add 1 or 2 more things they liked about the method. Teacher may appreciate a helpful mistake that was made/realized on messy side | Present their work as a groupAnswer questions about their processAsk questions about the process of other studentsTry to understand the Think about and share what they like about different methods Some student reluctance to ask questions about methods of other studentsCertain students in group doing all the talking | Try to record the questions students ask each other and the name of the student who asks itMake a note of the things appreciated about each method.Make sure every member of group is getting an opportunity to speak/demonstrate their understandingWhere students have work circled on the messy side, demonstrating a place where they got stuck, teacher can ask how group got “unstuck”If there is time after all student work has been presented, teacher can ask class to discuss what similarities they see in any of the ways different groups approached the problem.  | Is every student in each group able to explain what the group did to come up with their answers?What kinds of questions students ask each other?What kind of comments of appreciation do students make about the different methods?Are students able to answer teacher questions about the methods of other students? |

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| Closing/Recap: Pass out reflection, which asks, 1. Describe one thing you learned today.
2. How did you feel working on the today’s opportunities?
3. Why did you/do you feel that way?
 | There are no right or wrong answers to this. We want students to be honest and let us know what they are thinking and feeling. | Gain insight into what students can talk about as the main takeaways from the lesson  |

1. Please note, this lesson plan refers to mathematical problems as “opportunities”, not as “problems” [↑](#footnote-ref-1)