

Step 1: Inquiry Approaches to Teaching Pigs and Chickens Sample Lesson Plan

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Engagement

Estimated time: 3 minutes

Teacher and Student Activity	Probing Questions (Questions that make student thinking visible), Predicted Student Answers (to a few questions), Misconceptions
<p>1. Ask students about their favorite animals, and guide the conversation toward barnyard animals.</p> <p>Note: To increase participation, the teacher can ask students to write down 3 examples of their favorite animal.</p>	<p>1. "What is your favorite animal? Why do you like that animal?"</p> <p>"Write down your three favorite animals."</p> <p>"I heard someone mention _____, did anyone else list a farm animal?" "What is your favorite farm animal?"</p> <p><i>(Accept all responses.)</i></p>
<p>2. Teachers with a high threshold for noise and chaos may wish to have students imitate the sounds their favorite animals make.</p>	
<p>3. Transition to the problem:</p> <p>Teacher will transition from the initial questioning to focus on the context of pigs and chickens.</p>	<p>3. "Speaking of barnyard animals, my friend Fred, the farmer, has a problem about the number of animals in his barnyard... and he would like our help. Do you think you could help him out?"</p>
<p>4. Project and read the story shown at right.</p> <p>The teacher should answer any questions about the problem prompt.</p> <p>Note: The teacher should make sure that the students understand that a pig has 4 legs and a chicken has 2 legs.</p>	<p>4. "Once upon a time, there was a farmer who raised pigs and chickens. One morning, the farmer looked into the barnyard and counted 24 heads and 80 feet. How many pigs and how many chickens are in the barnyard?"</p> <p>NOTE: This kind of problem usually appears around the time that students are learning about systems of equations. In that context, solving such problems becomes a fairly formulaic exercise. This lesson presents the problem to much younger students, however, which can provide an opportunity for them to be creative in how they approach a solution.</p>

Transition

"I'd like you to work with your partner for about 5 (or 10) minutes to see if you can figure out how many pigs and how many chickens are in the barnyard."

Exploration

Estimated time: 10 minutes

Teacher and Student Activity	Probing Questions (Questions that make student thinking visible), Predicted Student Answers (to a few questions), Misconceptions
<p>1. Materials management:</p> <p>The teacher will assign 1 person from each group to come pick up a white board, marker, and eraser.</p>	<p>1. "With the members of your group, determine who has the most (or least) number of siblings. This person will be the materials manager for today's lesson. The materials manager should come pick up one white board, one marker, and one eraser."</p>
<p>2. Teacher circulates and guides student groups using the questions at right.</p> <p>Note: In addition to circulating the room and asking probing questions, the teacher should be identifying potential methods or strategies used (to help facilitate the explanation section.)</p>	<p>2. "How did/will you begin?"</p> <p>Some students may be stuck about how to get started. Consider prompting students with one or more of the following questions:</p> <p>"Do you suppose the barnyard could contain one pig and one chicken? Why or why not?" <i>No, because the farmer counted 24 heads. If there were just one pig and one chicken, that would be only 2 heads.</i></p> <p>"If there were only one pig and one chicken in the barnyard, how many feet would there be?" <i>Six feet, since the pig has four feet and the chicken has two feet.</i></p> <p>"What is one combination of pigs and chickens that would give us the right number of heads? How many feet would there be in that case?"</p> <p>"Do you think it is possible to have all pigs? What about all chickens?" <i>No, that would not be possible because we would have too few/many legs.</i></p> <p>There are many possible combinations that will give the correct number of heads. In any case, guide students to see that each pig has four feet and each chicken has two feet.</p>

Teacher and Student Activity	Probing Questions (Questions that make student thinking visible), Predicted Student Answers (to a few questions), Misconceptions
	<p>Suppose students guess 12 pigs and 12 chickens, which would result in $(12 \times 4) + (12 \times 2) = 48 + 24 = 72$ feet. Follow up with:</p> <p>"So, have we found the answer yet? How do you know?"</p> <p><i>No, we need 80 feet but we only have 72 feet.</i></p> <p>"What should we try next?"</p> <p>Students might make another random guess, or might notice that since we currently have too few feet, we need to add pigs and take away chickens.</p>
	<p>The questions above suggest a guess-and-check approach. Students might need some help in organizing their data.</p> <p>"How might we organize our guesses?"^[SEP]Suggest may suggest an organized list or a table like the one shown below, but don't force students into a particular representation.</p> <p>"What patterns can you see in your data?"</p> <p><i>The number of pigs plus the number of chickens always equals 24. When we trade one pig for one chicken, the number of feet goes down by 2 because we take away four feet (from the pig), but add two feet (from the chicken). So, in the end, we lose two feet.</i></p> <p>Encourage students to work forward and answer the question based on the pattern they have discovered: "Can we use this pattern to answer the question? How will we know when we have arrived at the answer?"</p>
	<p>As an alternative to guess-and-check, students might solve this problem by drawing a picture.</p> <p>"Can we draw a picture to represent this situation? How could we represent the 24 heads?"</p> <p><i>We could draw 24 circles (or some other representation).</i></p>

Teacher and Student Activity	Probing Questions (Questions that make student thinking visible), Predicted Student Answers (to a few questions), Misconceptions
	<p>"How could we represent the feet?"</p> <p><i>We could add lines to the circles (or some other representation).</i></p> <p>"How will we know when we're done?"</p> <p><i>We will have a total of 80 lines (for the feet).</i></p> <p>Students can proceed down a number of paths here. Some possible paths include:</p> <p>Adding two lines to each circle (since each animal has at least two feet), for a total of 48 feet. Follow-up question: ^[SEP]"What does this picture represent?" This picture represents a barnyard with only chickens.</p> <p>Then, adding two feet at a time to some animals and counting up by twos until reaching 80 feet.</p> <p>Or, realizing that there are $80 - 48 = 32$ feet yet to be drawn, and that we will add feet in pairs. So, we must add $32 \div 2 = 16$ additional pairs of feet.</p> <p>In any case, in the end we will have a picture that shows 24 circles, some of which have two lines attached, and some with 4 lines attached. We can then count the number of two-line circles (this is the number of chickens) and the number of four-line circles (this is the number of pigs).</p>

Transition

While monitoring the groups, watch for the end of the Exploration and announce the one-minute mark. This could be either:

- (a) When the allotted time is almost up, or...
- (b) When most of the student groups have found a productive strategy (whether or not they have solved the ^[SEP]problem completely). Groups that finish early can be presented with the Extension Problems below.

After an additional minute, call the group back to order.

Explanation

Estimated time: 10 minutes

Teacher and Student Activity	Probing Questions (Questions that make student thinking visible), Predicted Student Answers (to a few questions), Misconceptions
<p>1. Ask students to share their ideas – both for the answer to the problem and for their approaches. Students can hold up their white boards to show their work and help facilitate the presentation.</p> <p>Note: The focus here should be on the methods that students used to organize their data and solve the problem. The teacher should use the information gained while circulating to help call on students and/or highlight certain methods. (“I saw a couple of groups that tried _____. Would anyone like to show this method?”</p>	<p>1. “How did you approach the problem?”</p> <p><i>We decided to start with the heads.</i></p> <p><i>I just guess and checked different combinations.</i></p> <p><i>We tried to do half chickens and half pigs, but that didn’t work so we then…”</i></p> <p>“How many pigs and how many chickens are in the barnyard? ”</p> <p><i>There are 16 pigs and 8 chickens in the barnyard.</i></p>
<p>2. Focus students attention on specific points of each approach, and connect the different approaches with each other.</p>	<p>2. “Consider the guess where we have 12 pigs and 12 chickens. That makes 72 feet. What should our next guess be? Why?”</p> <p><i>We should make a guess that includes more pigs and fewer chickens because we need to increase the total number of feet. Increasing by one pig (and decreasing by one chicken) will give us an increase of two feet.</i></p> <p>“How is this reflected in the table?”</p> <p><i>If we increase in the “pigs” column, the “chickens” column decreases and the total number of feet goes up by 2.</i></p> <p>“How is this reflected in the drawing?”</p> <p><i>We can change a “chicken” into a “pig” by adding two lines/feet to one of the circles/heads. This means the total number of feet goes up by 2 (because we added two feet to the drawing).</i></p>
<p>3. Once the students have the opportunity to share, the teacher will address any misconceptions and fill in any missing vocabulary.</p>	<p>3. “What are the various strategies that we saw?”</p> <p>“How did this help us reach the correct solution?”</p>

Transition

“You did a fantastic job! I can not wait to tell my friend Fred, the farmer the answer to his problem!”

“Now, I have another problem that I need your help with!”

Elaboration

Estimated time:

Teacher and Student Activity	Probing Questions (Questions that make student thinking visible), Predicted Student Answers (to a few questions), Misconceptions
<p>Depending on the background knowledge of the students, their success on the previous problem, and the amount of time remaining in the lesson, the teacher can choose one of the following options below.</p> <p>(Problem 1, about strategies, could be included as an extension to the Explanation section given above or as an Elaboration. Problems 2 and 3 are more clearly Elaboration: they introduce story problems with "too little information" and open up the possibility of multiple correct answers.)</p>	
<p>1. An extension about strategies:</p>	<p>1. In a terrarium of spiders and crickets, I counted 60 heads and 412 feet. How many of each animal are there? Which strategy would you choose to solve this problem? Why? Are there other strategies we haven't thought of yet? (Note for those who aren't bug fanciers: spiders have 8 feet and crickets have 6 feet.)</p>
<p>2. An extension about a more ambiguous story:</p>	<p>2. In a barnyard that contains only pigs and chickens, a farmer counts 110 feet. How many pigs and how many chickens could there be? Is there more than one possible combination of animals? Find as many solutions as you can to this problem. Is there a pattern in these solutions?</p>
<p>3. A really challenging ambiguous story:</p>	<p>3. A really challenging ambiguous story: A hobby shop sells model airplanes for 7 dollars each and model train sets for 18 dollars each. Yesterday they made 208 dollars selling only those two items. How many of each item could have been sold? Is there a solution? Is there more than one possible solution?</p>

Transition

“Remember the materials manager who picked up the materials? Well this time the other partner is in charge of returning the supplies to the back table.”

“I have been very impressed with the work you have done today! I have one more task where I would like you to show me all of the great things that you have learned today!”

Evaluation

Estimated time:

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<p>Note: The majority of the evaluation occurs throughout the lesson.</p> <p>*During Engagement: What animals are they interested in? Do they know about pigs and chickens? Do they know that a pig has 4 legs and a chicken 2?</p> <p>*Before starting the Exploration: Do the students understand the task? Are the materials managed efficiently and safely?</p> <p>*During the Exploration: Are students able to get started on the problem? What strategies are they using? How are they organizing data? Which groups are similar?</p> <p>*During the Explanation: What explanations are provided? What strategies are used? What strategies are not used? What vocabulary are the students using? What are they not using?</p> <p>*During the Elaboration: Which elaboration problem best suits the students? Do the students understand the differences between this and the original problem? How are they attempting to solve this problem? Do the same strategies appear? Are these appropriate?</p>	
<p>Formal evaluation (time permitting):</p> <p>The teacher will pose a question for the students to answer individually (or in small groups)</p>	