

**STEM Is Your Friend: Learn How To Integrate STEM Education In Your  
MIDDLE AND HIGH SCHOOL Physical Education Class The FUN Way!**

By Dr. Joanne Margaret Hynes Hunter  
Dr.joanne\_hunter@yahoo.com

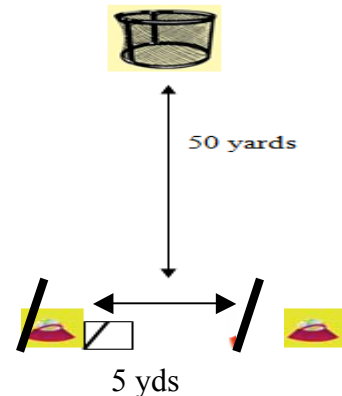
**ABSTRACT**

STEM Education is a new movement in Education to help teachers and students understand how the academic disciplines of Science, Technology, Engineering and Mathematics impact their world. STEM allows students to engage in real world problems and experiences through project-based, experiential learning activities that lead to higher level thinking. Secondary aged students participating in these activities will learn STEM concepts through ACTIVE game play and FUN developmentally appropriate activities. Secondary aged students also engage in authentic student assessments rooted in NASPE's best practices. Teachers are provided with tools needed to assess student learning using quick, easy to read evaluations. These activities provides everything teachers need to construct a learning environment where students are given the opportunity to experience, talk, debate, discover, design, create, and build.

**1. Name of Game:** Understanding 3<sup>rd</sup> Class Levers

**How To Play:**

- A. Choose students to read each in-class worksheet section aloud. Have students explain what the sections or vocabulary words mean.
- B. Students perform experiments & write down results on worksheet. Answer questions at the bottom of the worksheet.
- C. Students raise hands if they have a question and you will come to them to answer the question.
- D. Remind students to be safe when retrieving the equipment from the goals.
- E. In class worksheets will be collected at the end of the class period. Their work will be graded: each correct answer = 10 points, and that a passing grade is 70% or higher. They are to complete their own work. No cheating!



**Check This Out:**

- A. Perform other striking or sports skill experiments using the same lever principles (tennis, lacrosse, bowling, badminton, etc).
- B. Have student's graph the results of the experiments.
- C. Break up the experiments (i.e. experiment 1 & 2 day 1; experiments 3 & 4 Day 2).
- D. Perform fewer/more repetitions of each lab activity depending on student skill level.

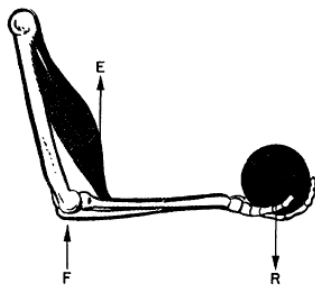
**Understanding 3<sup>rd</sup> Class Levers In Class Worksheet**

Directions: Read and perform each lab experiment. After you completed all the experiments, answer the questions listed below. Each correct answer is worth 10 points. You need a 70% or higher to pass. Good luck and have fun!

**LEVERS:** Movement in the body is produced by a system of levers. These levers work together to produce coordinated action.

There are 3 types of levers” *first, second, and third class*. The difference is where the fulcrum (F) and applied force (Effort) are, in relation to the load (Resistance). Each class works differently, and is used to do different jobs. In this experiment, we are focusing on the 3<sup>rd</sup> class lever.

The third class lever is the strangest and the one used most! The fulcrum is at one end of the lever, the load (Resistance) is at the other, and you apply a force (Effort) in between. Your arm is a third-class lever. This lever makes it possible for you to flex your arm.



Your elbow is the fulcrum. Your biceps muscle, which ties onto your forearm about an inch below the elbow, applies the effort; your hand is the resistance, located about 18 inches from the fulcrum.

Sometimes you want to speed up the movement of the resistance (e.g. ball, bat) even though you have to use a large amount of effort. This is what 3<sup>rd</sup> class levers are for.

**For all experiments:** One partner will be in the field with the domes. The other partner stays by the batting tee/equipment.

The partner by the equipment will perform the experiment 1 with the partner in the field using the domes to record where the ball first landed (NOT rolled). After all the balls are in the field, measure the distance between the batting tee and each dome and record the distances on the worksheet (1 step = 1 yard). After the experiment has been performed 3 times by one partner, partners switch roles with the batting tee partner going out to the field and the field partner going to the batting tee to perform the experiment. Continue to rotate in this manner until all the experiments have been completed.

**Experiment 1:**

Throw each ball toward the goal from a standing position. Record distance results in the table. Perform 3 times. Rotate positions with your partner.

**Experiment 2:**

Punt or kick each ball toward the goal from the batting tee. Record the distance results in the table (1 step = 1 yard). Perform this task 3 times. Rotate positions with your partner.

**Experiment 3:**

Hit ball toward the goal CHOCKING UP ON THE BAT. Record the distance results in the table (1 step = 1 yard). Perform this task 3 times. Rotate positions with your partner.

**Experiment 4:**

Hit ball toward the goal GRIPPING THE BAT AT THE KNOB. Record distance. Perform this task 3 times. Rotate positions with your partner.

<b><u>Experiment</u></b>	<b><u>Distance 1</u></b>	<b><u>Distance 2</u></b>	<b><u>Distance 3</u></b>
1			
2			
3			
4			

**QUESTIONS:**

1. Where is the fulcrum for each of the skills performed?
  - a. Throwing:
  - b. Kicking:
  - c. Batting:
2. Where is the force?
3. What's the resistance for each skill?
  - a. Throwing/Kicking:
  - b. Batting:
4. Using your knowledge of 3<sup>rd</sup> class levers, what do you need to do to swing the bat faster?
5. Look at the picture. Correct the 2 things wrong with her technique (HINT: 1 of the answers includes your knowledge of 3<sup>rd</sup> class levers).
  - a.
  - b.



**Understanding 3rd class levers In-Class Worksheet: ANSWERS**

1. Where is the fulcrum for each of the skills performed?
  - a. Throwing: SHOULDER OR ELBOW
  - b. Kicking: HIP OR KNEE
  - c. Batting: SHOULDER
2. Where is the force? THE MUSCLES
3. What's the resistance for each skill?
  - a. Throwing/Kicking: THE BALL
  - b. Batting: THE BAT
4. Using your knowledge of 3<sup>rd</sup> class levers, what do you need to do to swing the bat faster? CHOKE UP
5. Look at the picture below. Correct the 2 things wrong with her technique (HINT: 1 of the answers includes your knowledge of 3<sup>rd</sup> class levers).
  - a. KNEES BENT AND/OR STANDING IN ATHLETIC POSITION
  - b. CHOKE UP ON THE RACKET BECAUSE HE SWINGING TOO SLOW

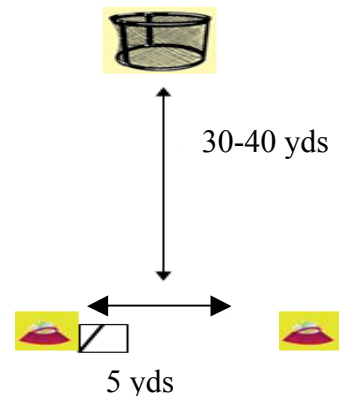
2. **Name of Game:** Taking on Newton

**How to Play:**

- A. Students read worksheet sections. Have the students explain in their own words what each law means.
- B. Students perform experiments, write down results, & answer questions at the bottom of worksheet.

**Check This Out:**

- A. Perform additional experiments using similar sport skills.
- B. Perform fewer/more repetitions of each lab activity depending on student skill level.
- C. Move goals closer/further away based on student skill level.



### Taking on Newton In Class Worksheet

Directions: Read and perform each lab experiment. After you completed all the experiments, answer the questions listed below.

**1<sup>st</sup> Law: Inertia.** An object at rest stays at rest and an object in motion stays in motion until acted upon by a force.

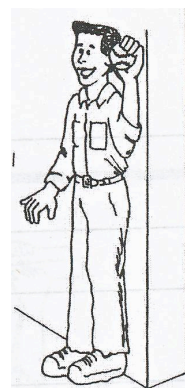
**2<sup>nd</sup> Law: Acceleration.** Acceleration refers to the speed at which an object moves. This speed depends on the amount of force applied to the object. The more force used, the faster the object will move. Newton's second law gives a formula telling us how much force is needed and states that the force needed to accelerate an object equals the mass of the object multiplied by its acceleration, or:  $\text{Force} = \text{Mass} \times \text{Acceleration}$ .

**3<sup>rd</sup> Law: Action/Reaction.** For every action there is an equal and opposite reaction. The terms action and reaction refer to forces. The key to getting this law right is understanding action-reaction pairs. Pair means two, so only two objects are in an action-reaction pair. For example, when throwing the ACTION is to throw the ball in an upward and forward direction. To do this the REACTION of the legs is to push down and backwards with the legs.

**EXPERIMENT 1:** Throwing

Step 1:

1. Stand against wall. Hold ball in dominant hand. Bend your arm at the elbow so your upper arm is against the fence.
2. From this position, throw the ball toward the goal and note where the ball first landed (NOT where it rolled to) and approximate how long it took to get there (i.e. 1 second).
3. While safely retrieving the ball, count the number of steps between the wall to where the ball first landed (1 step = 1 yard). Return back to dome with ball & record the number of steps in the appropriate table section along with the approximate time it took for the ball to land (e.g. 4 yards/1 second).
4. Perform the same activity 2 (3) times, recording the distance in yards & time in seconds after each throw.



Step 2:

1. Stand 3 steps away from the wall (so you're closer to the goal).
2. Keep both feet on the ground, pull your arm back and throw the ball toward the closest goal naturally (do not add extra force).
3. Note where the ball first landed and approximate how long it took to get there.
4. Retrieve the ball, counting the number of steps between the wall to where the ball first landed, return back to your dome with the ball and record results.
5. Perform 2 times, recording the distance in yards and time in seconds after each throw.

Step 3:

1. Repeat Step 2, but this time, pull your arm back while lifting the opposite leg before releasing the ball (as a baseball pitcher would throw a ball). After releasing the ball, continue moving your arm forward.
2. Note where the ball first landed and approximate how long it took to get there.
3. Retrieve the ball, counting the number of steps between the wall to where the ball first landed, return back to your dome with the ball and record results.
4. Perform 2 times, recording the distance in yards and time in seconds after each throw.

	Distance/time: 1 <sup>st</sup> attempt	Distance/time: 2 <sup>nd</sup> attempt
Throwing w/arm against wall		
Throwing 3 steps away w/feet on ground		
Pitching the ball		

**EXPERIMENT 2:** Rolling

Step 1:

1. Stand up against the wall. Hold the ball in your dominant hand and against the fence.
2. From this position, roll the ball toward the closest goal. Note where the ball stopped.
3. Retrieve ball, counting the number of steps between the fence to where the ball stopped, return back to your dome with the ball and record results.
4. Perform 2 times, recording the distance in yards after each roll.

Step 2:

1. Stand 3 steps away from the wall (so you're closer to the goal).
2. Keep both feet on ground, pull arm back and roll the ball naturally (do not add extra force) toward the goal releasing the ball at your leg. Note where the ball stopped.
3. Retrieve the ball, counting the number of steps between the wall to where the ball stopped, return back to your dome with the ball and record results.
4. Perform 2 times, recording the distance in yards after each roll.

Step 3:

1. Repeat Step 2, but this time, take one step toward the goal while rolling the ball. After releasing the ball, continue moving your arm forward. Note where the ball stopped.
2. Retrieve the ball, counting the number of steps between the wall to where the ball stopped, return back to your dome with the ball and record results.
3. Perform 2 times, recording the distance in yards after each roll.

	Distance: 1 <sup>st</sup> attempt	Distance: 2 <sup>nd</sup> attempt
Rolling w/hand against wall		
Rolling 3 steps away w/arm back		
Rolling the ball with 1 step and arm moving forward		

**QUESTIONS:**

1. What do we have to change about our motion to make a ball go further? \_\_\_\_\_
2. What law applies force to a ball? \_\_\_\_\_
3. What 2 parts of the body exert force when pitching a ball? \_\_\_\_\_ and \_\_\_\_\_
4. Calculate the force (Newtons) of an 8lb bowling ball leaving the hand (accelerating) 5 miles per hour (show your work). \_\_\_\_\_
5. Knowing Newton's 2<sup>nd</sup> law of acceleration, a heavier bowling ball will take more or less force to accelerate? \_\_\_\_\_

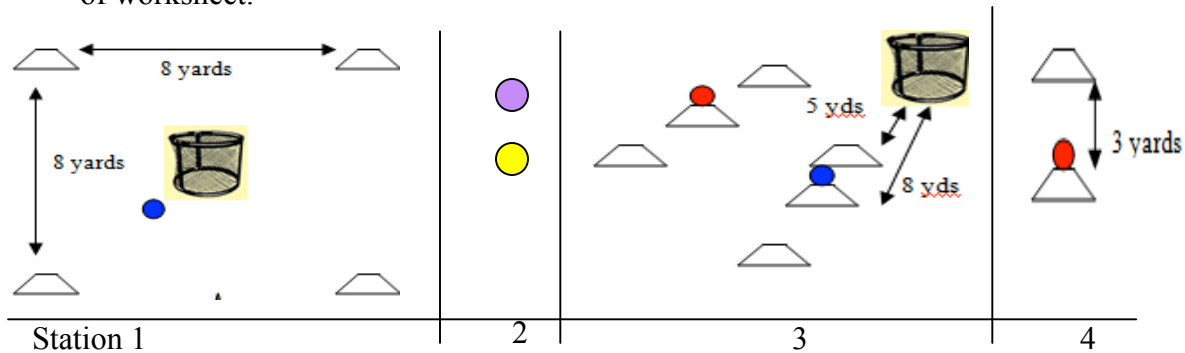
**ANSWERS:**

1. What do we have to change about our motion to make a ball go further? FOLLOW THROUGH
2. What law applies force to a ball? FIRST: INERTIA
3. What 2 parts of the body exert force when pitching a ball? ARMS and LEGS
4. Calculate the force (Newtons) of an 8lb bowling ball leaving the hand (accelerating) 5 miles per hour (show your work). 8 X 5 = 40 NEWTONS
5. Knowing Newton's 2<sup>nd</sup> law of acceleration, a heavier bowling ball will take more or less force to accelerate? MORE

**3. Name of Game:** Healthy Heart

**How to Play:**

- A. Students read worksheet sections. Have the students explain in their own words what each law means.
- B. Students perform experiments, write down results, & answer questions at the bottom of worksheet.



**Check This Out:**

- A. Have the students complete the questions at the end of the worksheet as homework.

**Activity Modifications:**

EASIER:

- A. Reduce the number of stations.
- B. Reduce the time spent at each station.
- C. Divide the stations to span over 2 days.

HARDER:

- A. Challenge students to perform skills with their non-dominant hand/foot, shorten distances thus decreasing reaction time (ONLY if students are skilled and safety is not compromised!!!!), juggle 4+ items and/or different objects.
- B. Increase the amount of time spent at each station (divide the stations to span over 2 days if needed).

**Healthy Heart in Class Worksheet**

Directions: Today we are going to explore (1) the effect posture and speed of movement have on heart rate, (2) what our individual minimum threshold training is, and (3) the type of activities that develop cardiovascular endurance the best.

We will be monitoring and recording our heart rate after each activity in the table below. The teacher will tell us when to start counting and when to stop (it will be a 6 second interval). We will multiply the number by 10. That number is what is recorded in the table as how many beats our heart is beating given 1 minute time. We will take and record our heart rate after each station.

**For all station experiments:**

- 1. Make sure you follow all the directions for each station as stated on the worksheet!
- 2. BE SAFE!! There's a lot going on. Place clipboards by the cone. Rotate clockwise.

**Data Sheet:**

<u>Activity</u>	<u>Heart Rate</u>
Laying down	
Sitting up	
Standing up at attention	
Station 1	
Station 2	
Station 3	
Station 4	
Station 5	
Station 6	
Station 7	
Station 8	

**Station 1:**

Play a soccer game of 1 vs. 1. Goals can be scored through the top or the sides from anywhere. You must stay within the dome boundaries. When a goal is scored, switch offense/defense positions. If the ball is taken away from the offensive player, positions are automatically reversed and a goal can be scored by the team in possession of the ball! So you must act fast as to who will goal tend. (Only 1 person on a team is allowed to tend goal). Only goalies are allowed to touch the ball with their hands.

**Station 2:**

Foot juggle (like hacky sac) individually, with partner (and/or as a group). See how many you can do in a row. Try to beat that score. What tricks can you do?

**Station 3:**

Each person stands at a dome with a ball. You will self toss and try to head the ball into the goal. Choose which dome you want to challenge yourself from. After each trial, decide if you want to move to the first, second or third dome. For an added challenge, have your partner loft the ball to you and try to time and head the ball into the goal.

**Station 4:**

Each person gets into a push up position by the dome with partners facing one another. The partner with the ball tries to score by rolling the ball between the arms of the opposing partner. You both must stay in push up position the entire time. Use only your hands to block the shot from going between your arms. You may be in a modified or full push up position.

**Questions:**

1. What happened to your heart rate as you changed body positions?
2. Explain why the heart changed.
3. Calculate your target heart rate based on your fitness goals: (a) Fat loss: Maximum heart rate is between 50 and 70 percent; (b) Cardiovascular training: Maximum heart rate is between 70 and 85 percent.  $220 - \text{age} = \underline{\hspace{2cm}}$  (Max heart rate)  
 $\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$   
 (max heart rate) (lowest percent: .5 or .7) (low target heart rate zone range)  
 $\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$   
 (max heart rate) (highest percent: .7 or .85) (high target heart rate zone range)
4. What would your target heart rate zone be if you were 45 years old? Show your work and circle your answer.

5. What conclusion can you draw about the target heart rate and increasing age?
6. Which of the activities we did today help develop YOUR cardiovascular endurance (i.e. which activities got your heart rate up between your calculated target heart rate zone)? If none, then what would you need to do to get your target heart rate up
7. List 3 additional sport activities not performed today will help develop your cardiovascular endurance?

**ANSWERS:**

1. What happened to your heart rate as you changed body positions? HEART RATE WENT UP
2. Explain why the heart changed. HEART WORKS HARDER PUMPING BLOOD THROUGH A BODY THAT IS SITTING AND TWICE AS HARD HAVING TO PUMP BLOOD THROUGH A STANDING BODY.
3. (CHECK CALCULATIONS)
4. What would your Cardiovascular Training target heart rate zone be if you were 45 years old? Show your work and circle your answer.

$$220 - 45 = 175.$$

$$175 * .7 = 122.5$$

$$175 * .85 = 148.75$$

5. What conclusion can you draw about the target heart rate and increasing age?  
TARGET HEART RATE DECREASES WITH AGE
6. (ANSWERS WILL VARY)
7. (ANSWERS WILL VARY)

# ACTIVITY #2:

## GenMove Team Handball

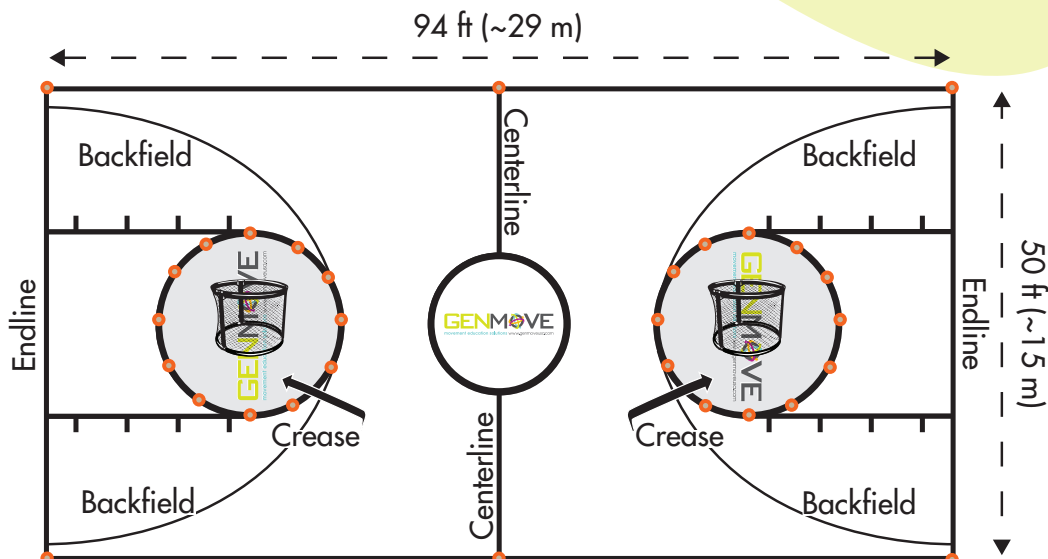
**Skill Concepts:** Teamwork, Communication, Throwing, Catching

**Standard:** NASPE Standard 2 (Demonstrates understanding of movement concepts, principles, strategies, and tactics as they apply to the learning and performance of physical activities)

**Equipment:** 2 MultiGoals, 24 polypots or disc cones, 1 ball, 12 pinnies (all 1 color), whistle

### Set Up:

1. Place the MultiGoals on opposite ends in the middle of the activity area, spacing them approximately 55 feet (17 meters) apart (if playing on a basketball court, place the goals on the free throw lines).
2. Position the MultiGoals so that one of the upright posts on each goal is facing the post on the other.
3. Place polypots on opposite sides of the court to mark the centerline, sidelines, and baselines (approximately 20-30 feet [6-9 meters] behind the goals).
4. Put half the remaining polypots in a circle around each MultiGoal, spacing them approximately 10 feet (3 meters) away from the goal, to mark the goal area. Only defenders will be allowed in this area.
5. Divide students into 2 teams, with one team wearing the pinnies.



## How To Play:

1. Explain the guidelines for attacking and defending players:

### Attacking players:

- Throw and catch the ball using their hands and arms
- Pass the ball to a teammate in order to break through the defense and create a scoring chance
- May not charge into a defensive player
- Can take a maximum of 3 steps
- May not hold the ball for more than 3 seconds
- May not enter the goal area

### Defending players:

- Use their hands and arms to block the ball
- Use the upper body to obstruct an opponent with or without the ball
- May not pull, hit, or punch the ball using their hands to knock the ball out of the hands of an opponent
- May not block the ball using their feet
- May not use the goal area as a defense position to prevent a clear scoring chance – no standing
- Must stay approximately 10 feet (3 meters) away from the attacking player when executing a throw to (re)start the game

2. Decide which team will start with the ball, and have each team take its position in its own half of the court, with the defense approximately 10 feet (3 meters) away from the ball.
3. Blow the whistle to signal the start of play. At the whistle, have a player on the starting team take a Throw-Off, passing the ball from center court to a teammate to begin play.
4. Have players repeat the Throw-Off after every goal scored and after halftime.
5. Award a Throw-In whenever the ball goes out of bounds on a sideline or when the ball is last touched by a defensive player and goes out of bounds over the endline. The Throw-In is taken from the spot where the ball crossed the sideline, or from the nearest corner if it crossed the endline. The thrower must place one foot on the sideline to execute the throw, and all opposing players must stay approximately 10 feet (3 meters) away from the ball.
6. Award Free-Throws for minor fouls or violations. A Free-Throw is taken at the exact spot the foul took place. The thrower must keep one foot in contact with the floor, then pass or shoot.
7. Have players follow these rules of play:
  - No contact is allowed.
  - If the ball touches the ground on a pass, it is a turnover (the opposing team gains possession).

- A shot on goal is not considered a pass, and the offense can maintain possession if they retrieve the ball first, even if it touches the ground.
  - A play ends when a ball goes out of bounds, there is a turnover, or a point is scored.
- 8.** To score, award 1 point for scoring on the front two sides of the goal, 2 points for scoring in the back side of the goal, and 3 points for scoring in the top. A goal may be scored from any throw (Free-Throw, Throw-In, or Throw-Off).

## Check This Out

- 1.** If the class size is large, divide the class into 4 equal groups and pair the groups to form two teams (groups 1 and 3 make up a team, and groups 2 and 4 make up a team). When group 1 is on the field playing, group 3 will be on the sidelines and vice versa. When group 2 is on the field playing, group 4 will be on the sidelines opposite group 3. The sideline groups are not allowed to move or score, but they can keep possession for their team by catching the ball and passing it back into play or passing it to another sideline player. After an allotted amount of time and/or a score, have the groups on the sidelines and the field switch positions.

## Activity Modifications

### EASIER

- 1.** Increase the size of the field.
- 2.** Allow students more than three seconds with the ball.
- 3.** Allow students more than three steps with the ball.

### HARDER

- 1.** Have students play with only their non-dominant hand.
- 2.** Require that a minimum number of passes be made before taking a shot.
- 3.** Allow students only one second with the ball.