Beanbag Toss

Lesson Setup

Real-World Context	Possible Math Tools
Students divide into groups, and each group designs a beanbag toss game. The game must be fair enough to attract players, and challenging enough to keep them invested. Students use the resources at their disposal to design a carnival game, and use data to set an appropriate level of challenge by changing player accuracy. Students may brainstorm one of many different modeling problems: • How big should the target be? • How far should a player stand from the target? • What kind of obstacles should be in the way?	6 – 8 students: Functions, probabilities and distributions

Possible Learning Objectives:

Students use division and percentages to calculate accuracy. They should also be able to use fractions and decimals when measuring distance and area.

Cross-curricular Connections:

This lesson could be inspired by a field trip or icebreaking game; for example, students might create a carnival stand as a crafts project, and then consider how to improve their game.

Materials List:

At least 1 bean bag per student, tall plastic bottles or construction paper, tape, markers, or stickers.

Additional Notes:

This is a data-driven project: each group should select and work on a reasonable set of values. Guide students in deciding what sort of tests are needed (example: Try moving the target 2, 2.5, 3, 3.5, and 4 meters away.)

When the students are collecting data, advise them to let every member of the group try the bean bag toss, and add together their "hits" and "misses" before calculating accuracy. This ensures that no student is excluded from playing the game. By the end of the lesson, each group should have a single bean bag target, and a list of possible variations with corresponding difficulties.

Height of Obstacle	Accuracy
0.5 m	90%
1.0 m	85%
1.5 m	75%
2.0 m	60%
2.5 m	60%
3.0 m	50%
3.5 m	30%
4.0 m	25%

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Hypothesis: $A = 100 - 20h$

If there is enough time, assign the class a cumulative goal: build a complete carnival game, multiple targets and all. After the separate groups finish their single targets, have them select one of the settings they tried, and propose how many "points" that target should be worth, given the difficulty. Then have all the groups set their targets next to each other, in a way that reflects their work.

Anticipate:

Where might students go with the provided context?

These questions are adapted from the GAIMME report – Guidelines for Assessment and Instruction in Mathematical Modeling Education. You can freely download the report here: http://www.siam.org/reports/gaimme.php.

What questions might students ask to **define a focused problem** from the broader real-world context?	What turns an "activity" into a "game?" What kinds of challenges could a bean bag toss involve? Which ones can be quantified? How? How should points be awarded? Should a target be more valuable if it's harder to hit? Do taller or stronger players have an advantage?
What **information** might students need, and who will provide/find that information?	The teacher will provide necessary values; for example, the various heights a player could be. Students should find values which correspond to their chosen materials; for example, the area of a target.
What **vocabulary** should students learn before they begin the task?	Accuracy, challenge, score, quality, value
What **assumptions or generalizations** might students make using the information they have?	Students may assume that the player will throw with consistent accuracy, so their accuracy can be estimated with only a few trials.
What **mathematical tools** might your students gravitate towards?	Students might design their target in a way that "seems" right, without calculating accuracy. Make sure they're able to quantitatively justify their work at each step.
Which parts of the modeling process should happen in **small groups** and which with the **whole class**?	The whole class should brainstorm what qualities could affect the game, and any special rules which could affect the difficulty. The actual modeling and data-taking should be done in small groups. Each group should focus on a single quality, setting it to different values and trying out the game.
How will students **record** their ideas? In what format will they **present**?	Students present their tables and corresponding difficulties, and the class decides which version they like best.