## Soccer Shootout Problems A Primary-Grade Introduction to Probability

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When a soccer game ends in a tie, there is an overtime period. If the score is still tied after the overtime period, then a "shootout" occurs. Five players are selected from each team. These players each take turns shooting at the goal from the top of the goal arch while the other team's goalie defends the goal.

If the score is still tied after the first five from each team shoot, the next five from each team shoot, continuing on if needed with the third five, and, if needed, rotating through the top five again, and so on until the tie is broken.

Clearly, it is advantageous if a coach knows who the team's good shootout kickers are. Two such imaginary coaches have tested their teams with 24 practice kicks and recorded the results.

Their soccer teams have fifteen players each. The uniform numbers are listed below, along with the estimated probability of each player scoring a goal in a shootout situation.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Т	19	3		11	3	1	13	5	1	11		1	11	7	1		5		2
В	24	8		24	4	8	24	8	6	24		4	12	24	$\overline{2}$		12		3
Ν	13		5	1	3	1	7	5	1	3	17		7	1		11		1	3
J	24		6	$\overline{12}$	8	4	12	24	$\overline{2}$	8	24		8	$\overline{3}$		24		$\overline{2}$	4

**Project 1** (any grade): Set up a shootout. Rank order the members of the Thunderbolts in terms of their shootout ability. When finished, rank-order the Ninjas.

**Project 2** (any grade). Create models of players and teams. Get 30 wide-mouth canning jars, paper sacks, or other such containers, and 200 beads or marbles of one color and 200 more of another color. Label each jar with the team name and the uniform number of the player it represents. Then put balls in the jars to model that player's ability to score during a shootout, per the following example, where blue balls represent goals and red balls represent misses:

Player #16 for the Ninjas will score 11 goals in 24 attempts. Put 11 blue marbles and 13 red marbles in the jar labeled Ninjas #16.

Do the same for each player on each team.

**Project 3** (any grade). Use the model to show probability in action. Play a shootout. Two members of the class are chosen to draw a ball at random from the best five player-jars for each team. If the score is still tied after the first five, go on into another round with the second five's until the tie is broken. Record the final score.

**Project 4** (any grade). Generate a data set. Assign class members to beforeschool shootouts, with two class members going through one shootout on a given day. Keep a record of wins and losses and scores. On the outside of each jar, record each player's actual goals and misses.

Related question: when each day's shootout is over, should the balls drawn out be put back or left out until all balls are drawn out for each player?

**Project 5** (Grade 4 or above): Evaluate the model. At the end of the year, compare the theoretical probability assigned to each player with the actual number of goals scored by drawing out beads.

**Project 6** (any grade): Do a superficial check for team balance. Give each player's probability a denominator of 24. Does the sum of the first five's favorable outcomes match that of the other team's first five? The second fives'? The third?

<u>Advanced (secondary-grade) problem</u>: Is this sufficient to show balance? Compare the number of first-five wins for each team.

**Project 7** (any grade): Maintain perspective. Update (improve) selected probabilities every nine weeks to reflect improved skills. For example, the player with only three goals in 24 attempts has had nine weeks to practice, enough to improve. Pick three members of each team who had been among the weakest, and improve their tryout results by the same amount. Rank-order the teams again, and keep this nine-weeks data separate from that of the previous.

**Project 8** (high school): Address a real-world complication. It was once the case that another tournament game was to be played after the Thunderbolt-Ninja Shootout. The officials called the game before everyone shot in the first shootout round because the Thunderbolts were ahead 3-1 with one player remaining to shoot for each team. Find the probability that under such time constraints, the game will be declared over after just three players shoot, then after four players shoot, then after two players shoot.

**Project 9** (high school): Find the probability that there will still be a tie after the first round of a shootout.

rank	1	2	3	4	5	б	7	8	9	10	11	12	13	14	15		
ТВ	13	1	5	19	8	7	15	4	10	17	2	14	12	9	6		
Р	11	19	3	2	5	13	1	11	11	5	3	7	1	1	1		
	12	24	4	$\overline{3}$	8	24	$\overline{2}$	24	24	$\overline{12}$	8	24	4	6	8		
NJ	13	3	19	11	7	1	9	18	16	5	10	14	6	8	4		
Р	7	5	3	17	7	13	1	1	11	3	3	1	1	5	1		
	8	6	4	24	12	24	$\overline{2}$	$\overline{2}$	24	8	8	3	4	24	$\overline{12}$		

Answer to rank-order question: (Second and fourth rows are uniform numbers.)