Shuffleboard Data Game

Teacher Facilitation Guidelines

If you have not done so already, please play *Shuffleboard* and watch the short student and teacher videos before or as you read these notes. Also, you should look at the student worksheet for *Shuffleboard*.

Learning Goals

- Strengthen student understanding of how linear equations can model real-world situations. (The relevant CCSSM standards are listed at the end of this document.)

Prior to Students Playing

- Set a goal for students to complete a certain level by the end of the activity. This creates some urgency and accountability for students and motivates them to focus on mastering the game and the underlying mathematics. In *Shuffleboard*, it might be appropriate for Algebra 1 students to aim to unlock the third level by the end of the period. The scores needed to unlock each level are shown in the Levels dialog box on the game screen. **Note: The student worksheet for *Shuffleboard* guides students only until they have unlocked the third level.**
- Depending on your students' experiences, consider giving them a real-world problem involving a $y = mx + b$ model prior to playing this game. For example:

  > Tony needs to drive from San Francisco to Los Angeles for a business trip, about 400 miles down Interstate 5. To get a head start, he'll drive to Tracy and stay there the night before, about 70 miles away from San Francisco. If he thinks he can travel 55 miles per hour on the rest of the trip, how long will it take him to reach Los Angeles?

- Check if students have any prior experiences with the real-world Shuffleboard game, and elicit from them similarities and differences with this Data Game. A key similarity is that making your disk come to rest on a scoring pad earns you points. A key difference is that disks do not collide with each other here.
- For suggestions on how to prepare to play Data Games with students, go to the Teacher FAQ section of the Data Games website (http://play.ccssgames.com/faq-page).

During Gameplay

- **Overall notes**
  - *Shuffleboard* consists of levels of increasing mathematical challenge. Students usually try to use a guess-and-check approach for as long as it helps them succeed, rather than using the data or the math skills they have learned. The game is designed so they can succeed with this approach for the first level; but by the second and third levels, it will be difficult to win without analyzing the data and applying the math they have learned. The desire to perform well and advance to higher levels usually motivates them to analyze the data.

- The secret teacher shortcut to unlock levels is to hold down the Option+Shift keys (Mac) or the Alt+Shift keys (Windows) while clicking the red circle next to the level you want to unlock.
- An interesting aspect of *Shuffleboard* is that *push* is the independent variable here, and it is shown in the graph in the usual placement for the independent variable, on the horizontal axis. But in *Shuffleboard*, students know the end position and are trying to find *push*. In $y = mx + b$ form, we know y and are trying to find x. Often we do the opposite of this, where we know the independent value on the x-axis, and try to determine the dependent value on the y-axis. So students need to think of the inverse operation, and divide to find *push*. They don't need to use the word "inverse" or discuss it formally here though.
- Because students score only when a disk lands on a pad, and not when it scoots past the end even by a little, they should figure out that it's better to round down a little when calculating their pushes.

- **Level 1: Washington**
  - On this level, the starting position of each disk is 15, and the distance per unit of push is a constant 4.9, so there is an underlying equation relating end position and *push*: *endPos* = 4.9 * *push* + 15. Many students figure out the best push for each scoring pad, and then share these four numbers around the classroom. That's okay, because this approach won't work on the next level!
  - We've seen a number of students spend time competing to get the highest score on the first level. This is not the most valuable way for students to spend their time, so encourage them to move on and unlock that third level.
- **Level 2: Adams**
  - On this level, the starting position remains a constant of 15, but the distance per amount of push changes for every game and every player. So the slope of the underlying equation changes, and there is no longer a common rule that students can share. They need to rely on the math skills they've learned.
  - Make sure by this level that all students have chosen **Show Movable Line** from the Gear menu of the Graph, and are dragging the line to fit the data. The game provides the equation of this movable line. Students may then use this equation to determine the *push* for each desired end position. This is similar to solving for x, given y, m, and b, in a $y = mx + b$ equation.
  - To find each desired end position, students need to hover the cursor over each pad to see the right edge position. These are the values they'll substitute in to the equation for *endPos* four times to find the four *push* values. This is one of the hints given in the student worksheet that they can use if they need it.
  - Students are likely to need help realizing that they can find one point on the line without making a shot—the starting position. The student worksheet offers a hint to consider the end position for the disk when there is a 0 push. They can get this data by hovering the cursor over the disk at the starting position.
  - In addition to the starting position, they only need to make one guess *push* to have all the information they need to fit their movable line. They can adjust their line to pass through the new point and keep the desired y-intercept.

- Support students in using the *Clear Data* button between every game on this level, so they can focus only on the data from their current game. The software prompts them to clear their data only when they switch from the first to the second level, in the hope that they will realize on their own the importance of using this action at appropriate times in the future. There is a hint to this effect in the student worksheet if they need it. Alternatively, they can select a row of the table to see only that game's data highlighted in the graph.

- **Level 3: Jefferson**
  - On this level, the locations of all the pads change with each game, and the disk starting position changes with each new shot. So students need to look at the disk starting position and desired ending position before each push to calculate the desired distance. The y-intercept therefore changes with each new shot, but the distance traveled per unit of push remains constant throughout each game.
- **Level 4: Polk**
  - This level introduces some variability of the slope. The disk starting position, 15, remains constant throughout all games here, as do the locations of the pads. There is one underlying linear equation that stays the same from game to game, but not all data points lie exactly on it. Students need to keep adjusting the movable line to fit the data points.
- **Level 5: Roosevelt**
  - This level combines the challenges from the previous two levels.
- **Possible Extensions**
  - Discuss with students why in *Proximity* it takes only one wild guess to determine the line. The Data Game *Shuffleboard* also only requires one wild guess, whereas two guesses are required in *Cart Weight*. The reason is that in *Proximity* and *Shuffleboard*, the y-intercept, or starting position, is already known, while in *Cart Weight* the y-intercept cannot be found without an additional guess. The underlying mathematical axiom is the same in every game: "Two points determine a line."
  - Reinforce students' Algebra skills by asking how they could come up with the equation of the line on the graph if the computer didn't provide it.

Answers to Student Worksheet Questions

- "(Q1) What do you think is the highest possible score you can get in each game?" – **500**
- "(Q2) If you land two disks on the same pad, which of their points counts toward your total score?" – **The disk that lands further to the right on the pad**
- "(Q3) Describe briefly how playing on the Adams level is different than playing on the Washington level." – **The distance that the disk moves for the same amount of *push* (the slope of the equation of the line) changes from game to game, and is different for all students.**
- "(Q4) Looking at the data points for the most recent game on the graph, what type of relationship or function does there seem to be between *push* and *endPos*?" – **Linear**

- "(Q5) What does the slope of your movable line represent in this game?" – **The distance the disk travels per amount of push, or how far it goes for a push of 1**
- "(Q6) What does the *y*-intercept of your movable line represent in this game?" – **The starting position of 15**
- "(Q7) Explain to a new student how to score over 300 points on the Adams level of this game." – **Explanations will vary, but should include the steps of finding the starting position, making one guess, fitting the movable line through the two data points, finding the value of the right edge of each pad, and using the equation to substitute in values for each desired end position to find each push.**

Challenges Introduced on Each Level

Level	Slope changes with each game	Slope variability (distance changes slightly each push)	Variability in starting disk position and pad locations with each shot
1: Washington			
2: Adams	⊗		
3: Jefferson	⊗		⊗
4: Polk		⊗	
5: Roosevelt	⊗	⊗	⊗

Relevant Common Core State Standards for Mathematics

- Analyze proportional relationships and use them to solve real-world and mathematical problems (6.RP.1, 6.RP.2, 6.RP.3, 7.RP.1, 7.RP.2)
- Understand the connections between proportional relationships, lines, and linear equations. (8.EE.5)
- Use functions to model relationships between quantities (8.F.4)
- Investigate patterns of association in bivariate data (8.SP.1–interpret scatter plots and describe patterns of linear association; 8.SP.2—fit a line to data; 8.SP.3—interpret slope and intercept in linear model to solve problems)
- Represent and solve equations and inequalities graphically (A.REI.10)
- Interpret functions that arise in applications in terms of the context (F.IF.4)
- Interpret expressions for functions in terms of the situation they model (F.LE.5)
- Summarize, represent, and interpret data on two categorical and quantitative variables (S.ID.6)
- Interpret linear models (S.ID.7)
- Make sense of problems and persevere in solving them (Standard for Mathematical Practice - 1)
- Model with mathematics (Standard for Mathematical Practice - 4)
- Use appropriate tools strategically (Standard for Mathematical Practice - 5)
- Attend to precision (Standard for Mathematical Practice - 6)