Puttshack Student Onsite Lab Guide - Grade 5

Variable Testing: Surface vs Distance (Trackaball™)

Lab Question

How does the surface (turf vs another approved surface) change how far the Trackaball™ travels when we use the same force?

Variables

Independent variable (we change)	Surface (A vs B)
Dependent variable (we measure)	Distance traveled (inches)
Controls (we keep the same)	Same Trackaball™, same start point, same pull-back mark, same direction

Procedure Checklist (Follow Precisely)

1. Find two approved surfaces: Surface A (turf) and Surface B (approved border/rough patch).
2. Mark the start point and keep it the same for every trial.
3. Pull the putter back to the same mark each time (your consistent force).
4. Putt straight forward. Measure from start to where the ball stops (in inches).
5. Record the distance. Complete 5 trials on Surface A, then 5 trials on Surface B.
6. Use the game screen at the hole (Trackaball™ feedback) to stay on the correct trial number and keep hit tracking organized.

Surface testing note:

The turf is consistent across holes. If you need a comparison surface, consider approved flooring areas around the game (as allowed by staff). As an alternate investigation focus, many holes include ramps/obstacles (some moving and some not).

Variable testing tip:

Because the Trackaball™ tracks hits while the ball is in play, run trials in clean sets: have Student A complete all trials for Variable A first, then Student B complete the same number of trials for Variable B (keeping controls the same).

Data Collection T-Chart

Surface A = _____ Surface B = _____

Record 10 trials (5 per surface)

Trial	Surface (A/B)	Pull-back mark	Distance traveled (in)	Stopped at	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Create Dot Plots (6.SP.B.4)

Dot Plot - Surface A

0	5	10	15	20	25	30	35	40	45	50	55	60

Place one dot in the box above the number for each trial distance. If two distances match, stack dots.

Dot Plot - Surface B

0	5	10	15	20	25	30	35	40	45	50	55	60

Place one dot in the box above the number for each trial distance. If two distances match, stack dots.

Compare and Explain

- Which surface made the ball travel farther most of the time? _____
- What evidence from your dot plots supports that? _____
- In your own words, what is friction? _____
- Claim + Evidence sentence: Surface ___ had (more/less) friction because _____.
- Trackaball™ Tech Reflection
- How did Trackaball™ and the game screen help your team during the experiment? (circle one)
- [ ] It helped us track trials [ ] It gave feedback [ ] It kept us honest [ ] Other: _____

Puttshack On-site STEM Lesson (Grades 5-6)

Variable Testing: How Surface Affects Ball Travel

Time	45-60 minutes
Setting	On-site (Puttshack venue)
Led by	Teacher
Materials	Puttshack provides gameplay, putters, Trackaball™ balls; bring clipboards, pencils, student guides, measuring tape/string

Standards Alignment

- CCSS Math 6.SP.B.4: Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- CCSS ELA RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- ISTE 1.3.d Knowledge Constructor: Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

Program Context

At Puttshack, students play mini-golf using Trackaball™ technology. The Trackaball™ ball tracks each hit while the ball is in play, and a game screen at each hole updates hit count during play and shows points score at the end of the hole. At the 9th hole, the game screen shows final scores and a ranking once all players are done. Scoring is points-based: players try to earn as many points as possible (more info: https://www.puttshack.com/blog/happenings/9-hole-scoring/). In this lab, students use the game screen as a feedback tool for validation (trial/hit tracking) while collecting their own measurement data to compare how two approved surfaces affect travel distance.

Learning Targets

- I can identify variables in an experiment (independent, dependent, controlled).
- I can follow a multistep procedure and take consistent measurements.
- I can compare two data sets and represent them on number-line plots (dot plot; optional box plot for extension).
- I can use evidence from data to explain which surface creates more or less friction (slower/faster travel).

Materials

- Puttshack putters and Trackaball™ balls (provided onsite)
- Measuring tape OR pre-marked string (inches)
- Masking tape (optional) to mark a consistent pull-back point on putter shaft
- Clipboards, pencils, student guides (Grade 5 or Grade 6)

Supplies note
Puttshack provides gameplay, a putter, and a Trackaball™ golf ball for each player. Bring all other supplies listed in this lesson/worksheet.

Safety and Site Notes

- Use only surfaces approved by Puttshack staff (do not test on restricted or unsafe areas).
- Keep putters below waist height. One tester swings at a time.
- Choose a flat path with enough space for the ball to roll and stop safely.

Trip staffing note
Puttshack associates support the trip (safety, logistics, and general assistance). Teachers lead instruction and run the lessons.

Surface testing note
The turf is consistent across holes. If you need a comparison surface, consider approved flooring areas around the game (as allowed by staff). As an alternate investigation focus, many holes include ramps/obstacles (some moving and some not).

Key Vocabulary

- Variable, independent variable, dependent variable, controlled variable
- Trial, data set, measurement, dot plot, median, quartile (Grade 6 extension)
- Friction, surface, consistent force
- Trackaball™ feedback (game screen at the holes)

45-60 Minute Script (Teacher)

0:00-0:03	Welcome + safety
0:03-0:08	Puttshack tech connection (Trackaball™ feedback) + lab mission
0:08-0:15	Define variables + procedure overview (model one trial)
0:15-0:20	Team roles + practice measurement
0:20-0:35	Data collection: Surface A (5 trials)
0:35-0:50	Data collection: Surface B (5 trials)
0:50-0:56	Build plots (dot plots) + compare
0:56-1:00	Share-out + exit reflection
Optional	If time: compute center (mean/median) and spread; Grade 6 box plot extension

Optional	If time: quick redesign - change only one control and predict outcome

Scripted Facilitation

0:00-0:03 | Welcome + Safety

- Welcome to Puttshack! Today we are running a real experiment.
- Safety check: putters stay below waist height, we walk, and only one person swings at a time.

0:03-0:08 | Puttshack Tech Connection

- At Puttshack, the Trackaball™ system tracks play and the game screen at the holes update in real time.
- In our lab, the screens are our feedback tool: they help us confirm each trial happened, but we will measure distance ourselves.

0:08-0:15 | Variables + Procedure Overview (RST.6-8.3)

- Independent variable: the surface (Surface A vs Surface B).
- Dependent variable: how far the ball travels.
- Controlled variables: same ball (Trackaball™), same start point, same pull-back distance (force), same direction.

Teacher says: 'W*e must follow the steps exactly so our data is fair.'*

1. Pick two approved surfaces: Surface A (putting turf) and Surface B (border/rough patch approved by staff).
2. Mark the start point (tape or a fixed reference) and do not move it.
3. Set a consistent force: pull the putter back to the same mark each time (use tape on the putter shaft if available).

Variable testing tip
Because the Trackaball™ tracks hits while the ball is in play, run trials in clean sets: have Student A complete all trials for Variable A first, then Student B complete the same number of trials for Variable B (keeping controls the same).

4. Putt straight forward. Do not aim for the hole - this is a distance test.
5. Measure from the start point to where the ball stops (in inches).
6. Record the measurement in the T-chart for the correct surface and trial.
7. Repeat for 5 trials on Surface A, then 5 trials on Surface B.

0:15-0:20 | Team Roles + Practice

Assign roles (rotate after Surface A):

- Launcher: performs the putt using the same pull-back mark
- Measurer: measures travel distance in inches
- Recorder: writes data in the student guide
- Tech Checker: watches the game screen at the hole to confirm each trial happened and keeps the team on trial number

0:20-0:50 | Data Collection (Surface A then Surface B)

Teacher says (before each set):

- Remember: change only one thing - the surface.
- Use the same Trackaball™ ball and the same pull-back mark every time.
- Measurer calls the distance. Recorder repeats it back and writes it down.

0:50-0:56 | Represent the Data (6.SP.B.4)

- Create a dot plot for Surface A and Surface B on your number lines.
- Compare: Which surface has larger typical distances? Which has more spread?
- Optional: Grade 6 - create a box plot using the five-number summary.

0:56-1:00 | Share-Out + Exit

- Share one claim with evidence: 'Surface __ made the ball travel farther because our distances were mostly ___.'.
- Explain friction in student-friendly terms: 'More friction means the ball slows sooner.'
- Exit ticket: One control we kept the same was ___. One thing we changed was ___.

Facilitator Notes (Quick Differentiation)

- Support: Use fewer trials (3 per surface) and focus on dot plots only.
- Challenge: Add a third surface or compute mean/median; Grade 6 adds box plot.
- If students ask about Trackaball™: highlight feedback and consistency (same ball, same system) even though distance is measured manually.

Optional venue video (Pittsburgh): https://www.youtube.com/watch?v=z9KY-mgEeCw

Puttshack Post-visit Activity (20 minutes): Golf Course Analyst

Grades 5-6 | Theme: Friction, Resistance, and Variables

Time	20 minutes
Setting	Post-visit (classroom)
Led by	Teacher
Materials	Student worksheet, student lab guide data, pencils; optional rulers/highlighters

Purpose: Students analyze field trip data by creating a bar graph (histogram-style) comparing how far a ball rolled on different surfaces. Students then write a conclusion paragraph explaining how friction (resistance) acted as an unbalanced force that slowed the ball, referencing Newton's First Law.

Standards Alignment

- CCSS Math (6.SP.B.4): Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
- CCSS ELA (RST.6-8.3): Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- ISTE (1.3.d Knowledge Constructor): Build knowledge by actively exploring real-world issues and problems, developing ideas and theories, and pursuing answers and solutions.

Materials

- Student Lab Guide data from the Puttshack field investigation (Surface A vs Surface B, or multiple surfaces if recorded).
- Golf Course Analyst student worksheet (provided).
- Pencils, rulers (optional), colored pencils/highlighters (optional).
- Board/chart paper for class model (optional).

Puttshack technology and gameplay (quick notes)

- Trackaball™ (the ball) tracks each hit while the ball is in play.
- A game screen at each hole shows hit count during play and shows points score at the end of the hole.
- At the 9th hole, the game screen shows final scores and a ranking once all players are done.
- Scoring is points-based: players try to earn as many points as possible. More info: https://www.puttshack.com/blog/happenings/9-hole-scoring/
- Gameplay flow: players complete each hole start-to-finish before the next player goes.

Trip staffing note
Puttshack associates support the trip (safety, logistics, and general assistance). Teachers lead instruction and run the lessons.

Supplies note
Puttshack provides gameplay, a putter, and a Trackaball™ golf ball for each player. Bring all other supplies listed in this lesson/worksheet.

Optional venue video (Pittsburgh): https://www.youtube.com/watch?v=z9KY-mgEeCw

Teacher Script With Time Stamps
0:00-0:02 | Welcome Back + Recall

Says:
"Today we are Golf Course Analysts! We are going to use our Puttshack data to prove something about friction."

"At Puttshack, we played with the Trackaball™ golf ball. The Puttshack technology helped track play and gave feedback on the game screen at each hole. Today, we'll use our measurement data to analyze how surfaces changed the ball's motion."

0:02-0:05 | Mini-Review: Friction = Resistance

Ask:
"Which surface usually has more friction: rough or smooth? Why?"

Expected responses: "Rough," "It slows the ball," "It's harder to roll."

Say:
"Friction is a force that resists motion. It's an unbalanced force that can slow a moving ball down."

0:05-0:08 | Connect to Newton's First Law

Say:
"Newton's First Law says: An object in motion stays in motion unless acted on by an unbalanced force."

"Today, our unbalanced force is friction. Friction keeps stealing the ball's motion until it stops."

0:08-0:11 | Model the Graph (Histogram-Style Bar Graph)

Say:
"We are going to make a bar graph to compare distances rolled on different surfaces. Our distance axis is a number line. That makes our graph match the kind of display we learn in 6.SP.B.4."

"Step 1: Find the average distance for each surface. Step 2: Shade the bar to match the average distance. Step 3: Title your graph and label units."

0:11-0:16 | Students Create Their Graph

Do:
Students complete the data table (including averages) and shade the graph grid on the worksheet.

Teacher moves around and prompts:

- *"Which surface is your slowest (most friction)? How do you know from your numbers?"*
- *"What units are you using: inches or centimeters? Write it on your graph."*
- *"Are you shading to the same scale for every surface?"*

0:16-0:19 | Conclusion Paragraph (CER)

Say:
"Now you'll write a conclusion paragraph. Use the words friction, resistance, unbalanced force, and Newton's First Law."

"Your paragraph should include: (1) what your data shows, (2) why it happened, and (3) one suggestion for future testing."

0:19-0:20 | Share + Exit Ticket

Say:
"Turn to a partner: Which surface had the most friction in your data? How do you know?"

Exit ticket (optional): "One way the Puttshack surface changed the ball's motion was _____."

Differentiation

Support
- Provide a pre-filled example row and model one average together.
- Allow students to use two surfaces (Surface A vs Surface B) if they only collected two.
- Offer a word bank: friction, resistance, unbalanced force, motion, stop, surface, rough, smooth.

Extend

- Have students compute the difference between surfaces and describe it as a percentage.
- Challenge: Convert the bar graph to a dot plot on a number line using the same data.
- Ask students to propose a new surface to test and justify why it might change friction.

Puttshack Post-visit Worksheet: Golf Course Analyst

Name: _____ **Date:** _____ **Class/Team:** _____

Reminder: At Puttshack, the Trackaball™ ball tracked each hit while the ball was in play. A game screen at each hole showed hit count and points score. At the 9th hole, the game screen showed final scores and a ranking once everyone finished. Today, you will use your measurement data to analyze how different surfaces changed the ball's motion.

Part 1: Organize Your Data (Distances Rolled)

Directions: Use your field trip measurements. Record distances for each surface. If you only tested two surfaces, fill Surface A and Surface B and leave the others blank.

Surface	Trial 1 (distance)	Trial 2 (distance)	Trial 3 (distance)	Average (mean)
Turf (putting green)				
Brick/Concrete border				
Wood				
Sand/Rough patch				
Other surface: _____				

Units used (circle one): Inches Centimeters

Part 2: Create a Bar Graph (Histogram-Style)

Directions: Use the graph grid below. Shade each bar to show the AVERAGE distance for that surface. Your x-axis is a number line (0 to 60).

Surface / Avg.	0	10	20	30	40	50	60
Turf							
Brick/Concrete							
Wood							
Sand/Rough							

Graph Title: _____

Part 3: Conclusion Paragraph (Friction + Newton's First Law)
Use these required words at least once: friction, resistance, unbalanced force, motion.

Sentence starters (optional):

- My data shows that the ball rolled the farthest on _____ and the shortest on _____.
- This happened because _____ has (more/less) friction, which is a type of resistance.
- Newton's First Law says an object in motion stays in motion unless acted on by an unbalanced force.
- In our experiment, the unbalanced force was _____.
- Next time, to make the test better, we should _____.

Write your conclusion paragraph here:

Quick Check (circle one): The surface with the MOST friction in my data was:

Turf Brick-Concrete Wood Sand-Rough

Puttshack Pre-visit Activity (20 minutes)

Surface Detectives - Friction, Resistance, and Variables

Time	20 minutes
Setting	Pre-visit (classroom)
Led by	Teacher
Materials	Surface Detectives worksheet, pencils; optional demo ball + 2-3 classroom surfaces

Purpose

Students prepare for their Puttshack field trip by learning how different surfaces change a ball's speed and distance. Students act like engineers by making predictions, ranking surfaces by friction, and writing a testable hypothesis.

Puttshack technology and gameplay (quick notes)

- Trackaball™ (the ball) tracks each hit while the ball is in play.
- A game screen at each hole shows hit count during play and shows points score at the end of the hole.
- At the 9th hole, the game screen shows final scores and a ranking once all players are done.
- Scoring is points-based: players try to earn as many points as possible. More info: https://www.puttshack.com/blog/happenings/9-hole-scoring/
- Gameplay flow: players complete each hole start-to-finish before the next player goes.

Trip staffing note
Puttshack associates support the trip (safety, logistics, and general assistance). Teachers lead instruction and run the lessons.

Supplies note
Puttshack provides gameplay, a putter, and a Trackaball™ golf ball for each player. Bring all other supplies listed in this lesson/worksheet.

Surface testing note
The turf is consistent across holes. If you need a comparison surface, consider approved flooring areas around the game (as allowed by staff). As an alternate investigation focus, many holes include ramps/obstacles (some moving and some not).

Optional venue video (Pittsburgh): https://www.youtube.com/watch?v=z9KY-mgEeCw

Materials

- Student worksheet: "Surface Detectives" (one per student)
- Pencils
- Optional quick demo: a small ball or marble + 2-3 classroom surfaces (tile/desk, carpet/rug, towel/sand tray if available)
- Optional: chart paper or board for class ranking

Key Vocabulary

- Friction: a force that slows things down when they rub together
- Resistance: anything that makes motion harder (rough surfaces create more resistance)
- Surface: what something rolls on (turf, brick, wood, sand, tile, carpet)
- Variable: one thing we change on purpose in an experiment
- Prediction: what we think will happen
- Hypothesis: a prediction with a reason ("I predict... because...")

STEM Connection: Agronomy

Explain that the science of grass and turf is called agronomy. In golf (and at Puttshack), the texture of a surface (smooth vs rough) changes how the ball rolls. Engineers and course designers choose materials on purpose to make a hole easier or harder.

20-Minute Script

Time	Script (Teacher says / does)
0:00-0:02	"Today we are getting ready for our Puttshack STEM field trip! At Puttshack, the special Trackaball™ golf ball and the screens give feedback during play. Our job as scientists is to predict what will happen, then test it later during our trip."
0:02-0:05	"Surface Detectives, what is a surface?" (Take 2-3 answers.) "A surface is what the ball rolls on. Different surfaces can make the ball go faster or slower."
0:05-0:08	"Friction is a force that slows motion when two things rub together. Rough surfaces have MORE friction and slow the ball. Smooth surfaces have LESS friction and let the ball roll farther." Optional gesture: rub hands fast (friction) then slide hands smoothly (less friction).
0:08-0:10	"In golf science, people study grass and turf. That science is called agronomy. Turf can be smooth or a little rough, and that changes the game. Puttshack designers choose materials to make holes interesting."
0:10-0:14	Hand out the worksheet. "You will do a ranking challenge called Rank the Roll. You will predict which surface creates the MOST friction (slowest) and which creates the LEAST

	friction (fastest). Work quietly for 3 minutes. If you finish early, write a reason for your #1 and #4 choices."
0:14-0:16	Quick share-out: "Turn and talk: Which surface did you rank as slowest? Which did you rank as fastest?" Call on 2-3 students and record class ideas on the board (optional).
0:16-0:19	"Now we write a hypothesis like scientists. A hypothesis is a prediction plus a reason." Read the sentence frame on the worksheet aloud. "Remember: In a fair test, we change ONE variable at a time. Today our variable is the surface."
0:19-0:20	"On our Puttshack trip, we will test surfaces and use the Trackaball™ feedback and screens to help us notice differences. Exit question: Which surface do you predict has more friction - turf or brick? Why?"

Teacher Notes (quick)

- Keep language concrete: smooth = faster/farther; rough = slower/shorter.
- If students struggle with percent, allow a simple estimate (10%, 25%, 50%) or use "a little / some / a lot" as a scaffold.
- Connect to field trip: "We will test this at Puttshack with the Trackaball™ ball and use the game screen to help us stay organized."

Surface Detectives (Pre-Visit Worksheet)

Friction, Resistance, and Variables - Preparing for Puttshack

Name: _____

Date: _____ Class: _____

Part 1: What is friction?

Circle the best answer:

1. Friction is a force that...
   - makes things move faster
   - slows things down when they rub
   - makes things float
2. A rough surface usually has...
   - more friction
   - less friction

Part 2: STEM in Mini-Golf

- At Puttshack, the Trackaball™ golf ball is the main technology component—it tracks each hit while the ball is in play. A game screen at each hole shows your hit count as you play and shows your points score at the end of the hole. At the 9th hole, the game screen shows final scores and a ranking once everyone has finished.

- Scoring is points-based: your goal is to earn as many points as possible. Learn more: https://www.puttshack.com/blog/happenings/9-hole-scoring/
  The putting turf is consistent across holes, but you may notice different flooring around the game and holes with ramps/obstacles (some moving and some not).

Part 3: Rank the Roll (Prediction)

Predict how the ball will roll on each surface. Rank them from:

1 = MOST friction (slowest) 4 = LEAST friction (fastest)

Surface	Rank (1-4)	Why? (texture clue)
Tile (smooth)	_____	_____
Carpet (soft/rough)	_____	_____
Sand (very rough)	_____	_____
Grass (turf)	_____	_____

Most friction (slowest): _____

Least friction (fastest): _____

Part 4: Hypothesis (Prediction with a reason)

Complete the hypothesis sentence frame:

I predict the ball will travel _____ % farther on an approved hard surface (like brick/concrete or flooring) than on TURF because _____.

My variable (the thing I change) is: _____

What I will keep the same for a fair test (circle all that apply):

- Same ball (Trackaball™ at Puttshack)
- Same starting point
- Same pull-back distance (same force)
- Same direction/aim

Part 5: Quick Physics Check (Newton's Laws - simplified)

Circle the best answer:

3. If you want the ball to travel farther, you usually need a...
    - Bigger push (more force)
    - Smaller push (less force)

Exit sentence: At Puttshack, I think the ball will go farthest on _____ because

_____.

Puttshack Student Onsite Lab Guide - Grade 6

Variable Testing: Surface vs Distance (Trackaball™)

Lab Question

How does the surface (turf vs another approved surface) change how far the Trackaball™ travels when we keep force consistent?

Variables

Independent variable	Surface type (A vs B)
Dependent variable	Distance traveled (inches)
Controls	Same Trackaball™, same start point, same pull-back mark, same direction, same measurer method

Multistep Procedure (RST.6-8.3)

1. Select two approved surfaces and label them A and B.
2. Set a fixed start point and record it (describe or sketch).
3. Mark your pull-back distance on the putter (tape) and use it every trial.
4. Run 5 trials on Surface A, measuring distance in inches (include halves/quarters if possible).
5. Run 5 trials on Surface B the same way.
6. Record each distance and note anything that could affect results (bumps, slope, accidental extra push).
7. Use the game screen at the hole (Trackaball™ feedback) to verify each trial happened and to keep trial count accurate.

Surface testing note:

The turf is consistent across holes. If you need a comparison surface, consider approved flooring areas around the game (as allowed by staff). As an alternate investigation focus, many holes include ramps/obstacles (some moving and some not).

Variable testing tip:

Because the Trackaball™ tracks hits while the ball is in play, run trials in clean sets: have Student A complete all trials for Variable A first, then Student B complete the same number of trials for Variable B (keeping controls the same).

Data Table (Surface A vs Surface B)

Surface A = _____ Surface B = _____

Record 10 trials (5 per surface)

Trial	Surface (A/B)	Pull-back mark	Distance traveled (in)	Stopped at	Notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Represent the Data (6.SP.B.4)

Dot Plot - Surface A

0	5	10	15	20	25	30	35	40	45	50	55	60

Place one dot in the box above the number for each trial distance. If two distances match, stack dots.

Dot Plot - Surface B

0	5	10	15	20	25	30	35	40	45	50	55	60

Place one dot in the box above the number for each trial distance. If two distances match, stack dots.

Optional Extension: Five-Number Summary and Box Plot

Complete for each surface.

Surface	Min	Q1	Median	Q3	Max
A					
B					

Box plot sketch (optional): Draw a number line and plot min, Q1, median, Q3, max for each surface.

Analysis (Claim - Evidence - Reasoning)

- Claim: The surface with more friction was _____.
- Evidence: In our data, Surface A distances were _____ and Surface B distances were _____.
- Reasoning: More friction slows the ball sooner, so we saw _____.

Tech Reflection (Trackaball™)

- How did Trackaball™ and the game screen help you construct knowledge today?

  _____