ARCADE ENTREPRENEUR · 6TH GRADE SYSTEMS CHALLENGE

Planning Guide

Duration: ~9 Class Periods | Grade 6

Activity Overview and Pacing

Activity	Name	Day	Time	Essential Question
1	Pat's Follow-Up and Odds of Winning	Day 1	~50 min	What does it mean for a game to have the right odds of winning?
2	Meet the Catapult and Force Diagram	Day 2	~50 min	How does a torsion catapult store and release energy?
3	Launch Activity 1: Establishing a Procedure	Day 3	~50 min	Why does following a procedure matter when collecting data?
4	Launch Activity 2: Data Collection	Day 4	~50 min	How does a consistent procedure change what the data looks like?
5	Target / Landing Zone Design	Day 5	~50 min	How do we use data to design a landing zone that meets the win-percentage targets?
6	Validation Testing	Day 6	~50 min	How do we know our design actually meets Pat's requirements?
7	Prizes and Profit	Day 7	~50 min	Can we make Storm-the-Castle profitable for Pat?
8	Poster Build	Day 8	~50 min	How do we communicate a data-backed design clearly on a single page?
9	Gallery Walk and Cliffhanger	Day 9	~50 min	What can we learn from each other's designs?

Activity Descriptions and Materials

Activity 1 — Pat's Follow-Up and Odds of Winning | Day 1 | ~50 min

Essential Question: *What does it mean for a game to have the right odds of winning?*

Students reconnect with the Data Challenge, read Pat's follow-up RFP introducing Storm-the-Castle, then rotate through four sample carnival game stations (ring toss, bean bag toss, bounce cup, coin slide) recording wins and losses. They calculate the odds of winning for each station and discuss how odds affect a game's appeal and profitability.

Materials:

- Handout 1 — Pat's Follow-Up RFP Letter
- Handout 2 — Odds of Winning Data Sheet
- Sample game station materials (ring toss, bean bag toss, bounce cup, coin slide)

Activity 2 — Meet the Catapult and Force Diagram | Day 2 | ~50 min

Essential Question: *How does a torsion catapult store and release energy?*

Students are introduced to the Pitsco torsion catapult: they identify parts, observe a live demonstration, and annotate a force diagram with the forces acting on the projectile at launch. A class consensus diagram is built to establish shared vocabulary.

Materials:

- Pitsco torsion catapult kits (pre-assembled, one per group). Available at https://www.pitsco.com/products/catapult-kit
- Handout 3 — Catapult Force Diagram Template
- Pompoms for projectiles
- Safety glasses

Activity 3 — Launch Activity 1: Establishing a Procedure | Day 3 | ~50 min

Essential Question: *Why does following a procedure matter when collecting data?*

Groups launch without a shared procedure and discover that their landing data is inconsistently scattered. Through discussion, the class identifies the sources of variability and co-creates a standardized launch procedure that will be used for all subsequent activities.

Materials:

- Catapults, pompoms, safety glasses
- Butcher paper for initial launch area
- Tape, meter sticks or rulers

Activity 4 — Launch Activity 2: Data Collection | Day 4 | ~50 min

Essential Question: *How does a consistent procedure change what the data looks like?*

Using the class procedure from Activity 3, each group runs 10 timed launches and records landing coordinates on a grid. They plot their data and compare charts across groups, noticing that consistent procedure produces more predictable landing distributions.

Materials:

- Handout 4 — Launch Data Sheet
- Catapults, pompoms, safety glasses
- Graph paper (standard grid for student data plots)
- The class procedure poster from Activity 3

Activity 5 — Target / Landing Zone Design | Day 5 | ~50 min

Essential Question: *How do we use data to design a landing zone that meets the win-percentage targets?*

Students analyze their launch data distributions to find natural landing clusters, then design a 6-section landing zone on graph paper that meets Pat's win-percentage targets (approx. 40% small prize, 10% large prize). They use the Validation Equations to check whether their design math holds.

Materials:

- Handout 5 — Landing Zone Design Sheet
- Handout 6 — Validation Equations
- Completed Launch Data Sheets from Activity 4
- Graph paper, rulers, colored pencils

Activity 6 — Validation Testing | Day 6 | ~50 min

Essential Question: *How do we know our design actually meets Pat's requirements?*

Groups run 25 validation launches using the class procedure, plot results on their landing zone design, and calculate actual win percentages. If their design does not meet Pat's targets they revise and document the iteration on their Landing Zone Design Sheet.

Materials:

- Handout 4 — Launch Data Sheet (fresh copy)
- Handout 5 — Landing Zone Design Sheet from Activity 5
- Catapults, pompoms, safety glasses
- Erasable colored pencils

Activity 7 — Prizes and Profit | Day 7 | ~50 min

Essential Question: *Can we make Storm-the-Castle profitable for Pat?*

Students select prizes from a constrained prize menu, then use validated win percentages to calculate expected daily profit for their redesigned game. They compare results across groups and discuss trade-offs between prize appeal and profitability.

Materials:

- Handout 7 — Prize Menu and Profit Calculation Sheet
- Calculators or pre-built spreadsheets
- Completed Validation Data from Activity 6

Activity 8 — Poster Build | Day 8 | ~50 min

Essential Question: *How do we communicate a data-backed design clearly on a single page?*

Groups build a one-page poster summarizing their design process, landing zone, validation data, prize selection, and profit calculation. The template scaffolds the layout; students may scale up to 11x17 or 24x18 paper.

Materials:

- Handout 8 — One-Page Poster Template (printed 11x17 or 24x18)
- Markers, colored pencils, rulers
- All completed data sheets from prior activities

Activity 9 — Gallery Walk and Cliffhanger | Day 9 | ~50 min

Essential Question: *What can we learn from each other's designs?*

Groups post their posters and rotate to give structured feedback using Gallery Walk Feedback Slips. A class debrief surfaces the range of design decisions and trade-offs. The cliffhanger teases the Design Challenge: students have proven the game can work — now they get to build a custom part for it.

Materials:

- Handout 9 — Gallery Walk Feedback Slips
- Posters from Activity 8

Standards Alignment

This unit was designed to support the Next Generation Science Standards (NGSS) Engineering Design performance expectations and Science & Engineering Practices, and the Common Core State Standards for Mathematical Practice (SMP). The tables below summarize the strongest alignment points and where they show up in the challenge. The NGSS engineering design performance expectations map cleanly to most state engineering and technology standards. If your state uses different standards (e.g., Georgia Standards of Excellence, TEKS, NYS Next Generation Standards), align using the descriptions in the tables below.

NGSS Engineering Design Performance Expectations

Standard	Description	Where It Shows Up	Classroom Connection
MS-ETS1-2 Engineering Design	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	Activities 5 and 6	Students design candidate landing zones and evaluate them against Pat's win-percentage requirements using validated launch data.
MS-ETS1-3 Engineering Design	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each.	Activities 6 and 9	Students analyze test data, revise designs based on validation results, and compare designs across groups during the gallery walk.
MS-ETS1-4 Engineering Design	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process.	Activities 3, 4, and 6	The catapult-and-landing-zone setup is itself a model. Students use launch data to iteratively design and refine their landing zone.

Science and Engineering Practices

Practice	Where It Shows Up	Classroom Connection
Practice 3 Planning and Carrying Out Investigations	Activity 3	Students confront the cost of inconsistent procedure and collectively establish a class-wide launching procedure to reduce variability.
Practice 4 Analyzing and Interpreting Data	Activities 4, 5, and 6	Students plot landing data, calculate win percentages, and use patterns in the data to make design decisions.
Practice 5 Using Mathematics and Computational Thinking	Activities 1, 5, 6, and 7	Students calculate odds, win percentages, and per-day profit for the redesigned game.

Common Core Standards for Mathematical Practice

Standard	Where It Shows Up	Classroom Connection
SMP 1 Make Sense of Problems and Persevere	Throughout	Pat's RFP is open-ended — students wrestle with the design across multiple sessions and revise based on testing.
SMP 2 Reason Abstractly and Quantitatively	Activities 5 and 6	Students move between concrete launch positions (x, y coordinates) and abstract win-percentage targets.
SMP 4 Model with Mathematics	Activities 5 and 7	Students build a mathematical model (landing distribution → win percentages → profit) and use it to choose a design.
SMP 5 Use Appropriate Tools Strategically	Activities 3-6	Students choose how to use the catapult, graph paper, calculators, and launch data to inform design decisions.
SMP 6 Attend to Precision	Activity 3	Activity 3 is built around the importance of precise, repeatable procedure. Students see firsthand how imprecision destroys the usefulness of data.
SMP 8 Look for Regularity in Repeated Reasoning	Activities 4 and 6	Across the launch activities, students notice that more trials reveal stable patterns — the foundation for the validation work in Activity 6.

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