5E Lesson Plan
Cornhole: Predict the Perfect Pitch

Subject area / course / grade level:

Learning Standards

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Materials (listed throughout)

Safety awareness: Students will encouraged to throw Corn bags while participating in this activity.
Allows for competition and socialization without the need for physical interaction between players.

Engage and Introduce		
Purpose: • to convey the context of the lesson/unit by conveying an important Key Question • to engage students in investigations via brainstorming that reveal their thinking to themselves and the teacher • to record initial ideas of students • to engage student interest in the activity		
Time	**Description**	**Materials**
50 minutes for full activity.	• "Play" Cornhole in either of the follow ways (can do both but adds 15 minutes to the activity) ○ Provide students access to Scratch coding game * (and/or)	*Computer with Scratch game #Cornhole board with bags PowerPoint Presentation

	○ Allow each student the opportunity to toss a corn bag # • Define all of the necessary terms and background information necessary to participate in the activity ○ Share official Cornhole rules ○ Identify important terms (e.g., Airmail, Ace, etc.) • Brainstorm: Ask the question, what factors influence a Cornhole toss? ○ Provide 2 minutes for students to write down ideas independently. ○ Create groups of 3 or 4 students; identify a scribe and a presenter for each. ○ Share out by letting each group shares an idea. Have students raise hands in their groups if/when another team mentions their idea. ○ Create a group "mind map" facilitated by the teacher using a tool like coggle.it or the board at the front of the room.	Cornhole Challenge – Getting Started worksheet Ideally use both # & * if time and materials are available
Explore		
Purpose: • to test ideas and develop knowledge using explorations, investigations and experiments • to modify and record ideas as the change based on experimentation • to develop new questions and testable hypotheses • to engage in sensitivity analysis, specifically by exploring how changes to parameter values affect model outcomes.		
Time	**Description**	**Materials**
100 minutes for full activity. • 50 minutes for model build and Excel testing • 50 minutes for Cornhole data collection	• Identify/build and initial model. ○ Recognize all student contributions from the mind map by saving all and/or making assumptions regarding their use right now. ○ Identify factors that the full group considered most important ○ Highlight student contributions that relate to trajectory and rules for Cornhole as shared in earlier presentation. ○ Build an initial solution from which assumptions can be removed and/or altered to better represent reality. • Share how to use the model in Excel and demonstrate how to fill out the worksheet ○ Students work in groups to test different values while using the Excel spreadsheet model. Assign one angle to each group member so each individual will vary velocities to find velocity solutions. ○ Teams hypothesize on successful velocity values for the angle(s) that weren't assigned to an individual. Group works together to find the solutions.	PowerPoint Presentation Bean Bag Toss Theory worksheet Collecting Data worksheet Computer with Excel Cornhole board with bags Portable device with video capture capabilities and any one of the following: • VidAnalysis app (Android) • Vernier Video Physics app (iOS) • https://physlets.org/tracker/ (web)

	○ Group discussion why do different velocities work at different angles? ○ Share student developed “Target Speed” graphs and make comparisons. • Play cornhole and collect data in groups ○ Group members are assigned with a role: 2 cornhole players, 1 video recorder, 1 notetaker. ○ The match between the two cornhole players is recorded using a portable device with video capture capabilities. ○ Ideally each group records (at least) 1 miss, 1 Ace and 1 Airmail ○ Group uses the class approved application (see list) and to turn recording of at least three throws into a spreadsheet form for future evaluation.	
Explain (and Evaluate model effectiveness)		
Purpose: • to assess the effectiveness of the model. • to understand and describe why the model might not predict all outcomes.		
Time	**Description**	**Materials**
30 minutes	• Analyze the effectiveness of the model ○ In groups students input data from their throws into Excel and have the model plot the outcome. ○ Have groups consider the following questions: ▪ How does the model’s prediction compare to the observed outcome? ▪ If it’s different, why did that happen? ▪ If it’s the same, do you think it will also be correct? ▪ Is the model “good”? Why or why not? ○ Groups report out on the ability of the model to “predict” the results of their throws.	Computer with Excel

<table>
<tr><th colspan="3">Extend and/or Elaborate</th></tr>
<tr><td colspan="3">Purpose:
to identify approaches to improve the model
to identify a situation in which there are multiple “correct” solutions
to interpret the meaning of graphs with non-traditional (for middle school) variables on the x and y axes.
to connect real world phenomena with mathematical concepts.</td></tr>
<tr><th>Time</th><th>Description</th><th>Materials</th></tr>
<tr><td>30 minutes</td><td>Each group identifies one assumption from the class’ initial brainstorming session that if changed might alter the model’s predictive ability. How would it alter the model?
Each group identifies one thing they like about the model and one change they would like to make to the model.
As an interdisciplinary with mathematics you may want to consider the following exploration.
Students investigate the graphs created by the movement of the cornbag vertically and horizontally over time as well as the “Target Speeds” graph that relates angle (on the “x” axis) to speed (“y” axis). They work independently to address the following questions:
While looking at the “Target Speeds” graph
Identify 2 different “Angles of release” that result in an Ace.
Identify 2 different “Initial velocity”
Compare these results with Vmax and Vmin students determined while working on the Bean Bag Toss worksheet.
Which functions are represented by the shapes in the two graphs that show the vertical and horizontal movement of the cornbag over time?
What do the graphs represent in the real world?
If time allows, play more Cornhole!</td><td>Computer with Excel</td></tr>
<tr><th colspan="3">Evaluate</th></tr>
<tr><td colspan="3">Formative: Student responses to in class worksheets.
Comprehensive: Student groups present their results, with graphs and answers to the in class questions. (Rubric provided)</td></tr>
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