
# Do Placebos Kill Minotaurs?

## Formulating Statistical Hypotheses and Hypothesis Testing

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| **Grade Level** | 11th – 12th Grade | **Time Frame** | 3-4 class period(s) |
| **Course** | AP Statistics | **Duration** | 180 minutes |

## Essential Question

How do we formulate hypotheses, and more importantly, how do we test them once we have them?

## Summary

In this lesson, students will explore the concepts of statistical hypotheses by looking at what a statistical hypothesis is, how they are formed, and some methods of testing them. Once they have been introduced to the basic concepts, they will be able to apply these concepts by playing Potions!, a digital game-based learning (DGBL) module, followed by a chance to extend what they've learned by applying the concepts to a real-world question. This lesson includes optional modifications for distance learning. Resources for use in Google Classroom are included.

## Snapshot

### Engage

Use the Examples and Non-examples Strategy to gauge the current understanding of students about what a hypothesis is and how you determine if an experiment supports a hypothesis or not.

### Explore

Students play the first two levels of the Potions! DGBL module as a further introduction and chance to apply the concepts they've learned so far.

### Explain

Students use the DOK Question Stems learning strategy to develop deeper thinking about the concepts they've learned and compare their understanding of those concepts.

### Extend

Students extend their understanding of the concepts by playing the third and fourth studies in the Potions! DGBL module.

### Evaluate

Students evaluate understanding using the Strategy Harvest learning strategy.

# Standards

*Common Core State Standards for Mathematics (High School — Statistics and Probability)*

**CCSS.Math.Content.HSS-IC.A:** Understand and evaluate random processes underlying statistical experiments
**CCSS.Math.Content.HSS-IC.A.1:** Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
**CCSS.Math.Content.HSS-IC.A.2:** Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.
**CCSS.Math.Content.HSS-IC.B:** Make inferences and justify conclusions from sample surveys, experiments, and observational studies
**CCSS.Math.Content.HSS-IC.B.3:** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
**CCSS.Math.Content.HSS-IC.B.4:** Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
**CCSS.Math.Content.HSS-IC.B.5:** Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
**CCSS.Math.Content.HSS-IC.B.6:** Evaluate reports based on data.

*Next Generation Science Standards (Grades 9, 10, 11, 12)*

**HS-ETS1-4:** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

*Oklahoma Academic Standards for Mathematics (Grades 9, 10, 11, 12)*

**A1.D.1.1:** Describe a data set using data displays, describe and compare data sets using summary statistics, including measures of central tendency, location, and spread. Know how to use calculators, spreadsheets, or other appropriate technology to display data and calculate summary statistics.
**A1.D.2.3:** Calculate experimental probabilities by performing simulations or experiments involving a probability model and using relative frequencies of outcomes.
**A1.D.2.4:** Apply probability concepts to real-world situations to make informed decisions.

# Attachments

- DOK Question Stems - Spanish.docx
- DOK Question Stems.docx
- Potions Teacher Guide.pdf
- Strategy Harvest Worksheet - Spanish.docx
- Strategy Harvest Worksheet.docx

# Materials

- Computers with Internet access or an iPad for each student
- K20 Game Portal accounts or iPad apps of Potions! for each student
- Whiteboard
- Writing materials - pen, pencil, paper, etc.
- DOK Question Stems (link in the lesson)
- Strategy Harvest Worksheet
- Fun Size package of M&M's (one for each student)

# Engage

Use the Examples and Non-Examples strategy to gauge your students' current understanding of the concepts. On a whiteboard, or a similar space, write Hypothesis, and then, have your students write what they think that term means on sheets of paper. Then, give one example of what the term is and one of what the term is not.

### Teacher's Note

Encourage students to think outside of the box and provide their examples, not just in words but also with diagrams or illustrations.

Once students have finished writing, discuss the term and the examples students came up with as a class.

Write the term Hypothesis Testing on the board and complete the exercise again.

### Teacher's Note

You can expect many students to answer with educated guesses and present many misconceptions, but do not correct them at this time. Instead, make sure to take note of these misconceptions for discussion later in the lesson, after students have had time to explore the concepts through the Potions! DGBL module.

Below are definitions for some other important terms you may wish to emphasize during this exercise:

- Hypothesis—an assumption made about a population parameter that may or may not be true
- Hypothesis Testing—the formal methods and procedures used to determine if a hypothesis should be accepted or rejected
- Sample—a set of collected data
- Population—the entire pool from which a sample is drawn

### Optional Modification For Distance Learning

To make this activity accessible for online or distance learning, you can use a website such as VoiceThread. This allows you to upload the term ahead of time for students to view. They can then choose whether they would like to make a quick video, a voice memo, or a written note to provide their definitions, examples, and non-examples. Download all attachments to use this lesson in Google Classroom.

# Explore

Now that you have introduced the topics and gotten students thinking about them, introduce them to the Potions! DGBL module. Click here to learn more about the game.

### Teacher's Note: Accessing The Game

You will need to have game access set up ahead of time. If you are using the iPad app, you only need to install the app to be ready to go. If, however, you need students to play the game via computer, contact either Will Thompson (will.thompson@ou.edu) or Javier Elizondo (elizondoj@ou.edu) directly at the K20 Center to be granted access. Further contact information can be found at the end of the teacher's guide in the Attachments section.

Help students set up their computers or tablets to play the game and then have them play through the first two studies, which should take roughly 30-45 minutes. You do not need to give them further instructions here. The game will introduce them to its mechanics, concepts, and story. At this point, take time to walk around the room, helping students who are confused or stuck, observing their progress. The instructor's guide (located under Attachments) provides information on the game's interface to help you.

### Teacher's Note: Game Tips And Advice

If you students are having problems, make sure they are focusing on the means of the potions, that they are using sufficient sample sizes (20-30 is recommended), that placebos do not use up their resources, and if they are having trouble saving one of the creatures, they can always switch and try to save a different one. It is not possible to save everyone. Also, if your students are having problems in study one, specifically, there is a little hint you can give them: "Placebos kill minotaurs"

### Teacher's Note: Alternative For Technology Limitations

If it is not possible to supply each student with access to the game, having students play the game in small groups will also work. It is recommended that these groups have no more than four students apiece.

### Teacher's Note

Potions! consists of five studies. For the purposes of this lesson, students will only need to play through the first four. This will take roughly an hour to an hour and a half of total class time, split into two class sessions. You can have students who finish faster than others attempt the final study, if you wish. However, it should be noted that this level is significantly more difficult.

**Teacher's Note: Tracking Student Progress**

If you are having the students play the game on computers, it is possible to track student progress through the Game Portal Teacher Dashboard where you accessed the game. Unfortunately, this functionality does not exist for the iPad version of the game.

# Explain

Once your students have all finished the first few studies of Potions!, you can start going a bit deeper in explaining the concepts. Use the DOK Question Stems strategy to help your students formulate some questions related to what they've learned so far. Pass out copies of the DOK Question Stems worksheet (located in the attachments) to each student and have them come up with 1–2 questions from levels 1, 2, and 3. Then, pair your students up and have them quiz each other on the questions they've asked.

Have them note any questions they weren't able to answer. Then, have pairs join together into four-person groups and quiz each other again, again noting any questions their group was not able to find an answer to. While this is going on, walk around the room and correct any wrong answers or misconceptions you hear.

After all the groups have finished, discuss any questions they couldn't answer and see if any other groups can offer answers to those questions, answering and explaining the concepts, yourself, if none of the other students can. Again, make sure to correct any misconceptions your students may have about the concepts.

### Optional Modification For Distance Learning

Using a web-based or digital platform such as Quizlet, students can create their own flashcards with questions on one side of the cards and answers on the other. Once they have completed their questions, students can share their flashcard sets with the class. Download all attachments to use this lesson in Google Classroom.

# Extend

Now, give your students a chance to spend more time applying what they've learned. Have them play through the third and fourth studies of the Potions! DGBL module. This should take them another 30 to 45 minutes to complete. If you have any students who complete the game significantly faster than their peers, you can have them attempt the fifth study as well, but keep in mind, this study is designed to be significantly more challenging.

**Teacher's Note**

Again, having students play the game in small groups will also work if it is not possible to provide each student with individual access. It is recommended that these groups have no more than four students apiece.

As before, you should spend this time to walk around the room and help students who may be having trouble. The same tips mentioned in the Explore section will be helpful here as well. Make sure they are focusing on the means and comparing them, that they are using sufficient sample sizes, that placebos do not use up their resources, and remind them that they can't save every creature. So, if one creature is proving to difficult to save they can always switch to a different one.

# Evaluate

To evaluate your students' understanding of the concepts, use the Strategy Harvest strategy. Give each student a package of M&M's and a Strategy Harvest Worksheet (located under Attachments). Have them develop a hypothesis about the package of M&M's and then think about how they would test that hypothesis, other than just counting how many M&M's are in the bag.

If your students are having trouble coming up with hypotheses, here are some examples:

- Fun Size M&M's are 20% orange.
- The average number of M&M's in a Fun Size package equals 18.
- A Fun Size bag of M&M's will have an equal distribution of colors.

Once students have each written down their strategy and hypothesis, have them find a partner to compare with, taking notes on each other's strategies and hypotheses. Then, have them repeat this process with a second student, again making sure to take notes.

Once students have compared strategies with two other students, have them return to their seats and put their original strategy into practice to determine if their hypothesis is supported by the results. Have students share their results with the class and discuss them.

### Optional Modification For Distance Learning

To make this activity accessible for online or distance learning, you can use an online randomizer for students who may not have access to a package of M&Ms at home. Download all attachments to use this lesson in Google Classroom.

## Resources


- K20 Center. (n.d.). DOK Question Stems. Strategies. https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5079186
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