Life Is a Bell Curve

Sampling Distribution and the Central Limit Theorem

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

Essential Question

What is central limit theorem? Why is an understanding of the central limit theorem essential to statistics?

Summary

In this lesson, students will explore the concepts of sampling distributions and the central limit theorem through hands-on activities and practical application in the Deadly Distribution digital game-based learning (DGBL) module.

Snapshot

Engage

Students use the Anchor Chart strategy to demonstrate what they already know about the concepts of sampling distribution and the central limit theorem.

Explore

Students play the first two missions of the Deadly Distributions DGBL module to get introduced to its mechanics and start exploring the core statistical concepts.

Explain

Students use the Inside Out strategy to produce deeper thinking about the concepts before explaining the concepts in greater depth.

Extend

Students extend their understanding of the concepts by playing the third mission of the Deadly Distribution DGBL module.

Evaluate

Students use the Always, Sometimes, Never True strategy to demonstrate knowledge of the statistical concepts.

Standards

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

CCSS.Math.Content.HSS-ID.A.2: Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

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)

A2.D.1.1: Use the mean and standard deviation of a data set to fit it to a normal distribution (bell-shaped curve).

Attachments

- Always, Sometimes, Never True Worksheet - Teacher—Life is a Bell Curve.docx
- Always, Sometimes, Never True Worksheet - Teacher—Life is a Bell Curve.pdf
- Always, Sometimes, Never True Worksheet - Student—Life is a Bell Curve - Spanish.docx
- Always, Sometimes, Never True Worksheet - Student—Life is a Bell Curve - Spanish.pdf
- Always, Sometimes, Never True Worksheet - Student—Life is a Bell Curve.docx
- Always, Sometimes, Never True Worksheet - Student—Life is a Bell Curve.pdf
- Deadly Distribution Instructors Guide 2015-07-29—Life is a Bell Curve.pdf
- Game Portal Guide v1.2—Life is a Bell Curve.pdf
- Inside Out—Life is a Bell Curve - Spanish.docx
- Inside Out—Life is a Bell Curve - Spanish.pdf
- Inside Out—Life is a Bell Curve.docx
- Inside Out—Life is a Bell Curve.pdf

Materials

- Deadly Distribution Instructor's Guide (attached)
- K20 Game Portal accounts or iPad apps of Deadly Distribution for each student
- Game Portal Guide v1.2 (attached)
- Always, Sometimes, Never True Worksheet - Teacher (attached)
- Always, Sometimes, Never True Worksheet - Student (attached)
- Inside Out handout (attached)
- Student devices with internet access
- Paper
- Whiteboard or large poster paper
- Writing utensils

10 minutes

Engage

Teacher's Note: Spanish Handouts

The learner handouts are available in English and Spanish to meet your students' needs. Keep in mind that the AP exam is only administered in English.

Teacher's Note: Prerequisite Knowledge

It is important that students have certain prerequisite knowledge before attempting this lesson. This includes a solid understanding of algebra and an introduction to sampling and data, descriptive statistics, and probabilities. The lesson itself, and the DGBL module, provide instruction covering sampling, normal distributions, the central limit theorem, and confidence intervals.

To start the lesson, ask your students to write down anything they know about the central limit theorem, specifically focusing on terms and concepts and how they relate to each other. You can have them do this individually or in small groups.

Give them around 5 minutes to do this, and then discuss the terms and concepts they've come up with as a class. Using the Anchor Chart strategy, draw a chart of the concepts your students have come up with on the board or on a large piece of poster paper. Keep this chart available and visible for your students throughout the rest of the lesson.

Discuss concepts such as sample, mean and median, standard deviation, margin of error, confidence interval, and of course, the actual central limit theorem.

45 minutes

Explore

After this initial introduction and exploration of your students' knowledge of the topics, introduce them to the Deadly Distributions DGBL module. Click here to learn more about the game. It is recommended that you play through the game at least once before teaching with it so you have a general understanding of the story and how the game's mechanics function.

Teacher's Note: Accessing The Game

For your students to play Deadly Distribution, you'll need to set up a class in the K20 Center Game Portal ahead of time. Go to games.k20center.ou.edu and create an account. After you log in, you'll be able to create a class and invite students. For more information, refer to the Game Portal Guide in the Attachments section. If you experience any issues, go to games.k20center.ou.edu/support to contact user support.

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.

Have your students play through the first two missions of the game. This should take them 30-45 minutes. The first mission is a short tutorial that introduces most of the game's mechanics, and the second mission begins to introduce the actual learning content.

Teacher's Note

Deadly Distribution consists of four missions, and each one is progressively more challenging. Because of the length of the game, this lesson breaks game play up into two sections. The first section covers the first two missions, and the second covers the third mission. The forth mission of the game acts as a review, but it is also the longest and most challenging level. You may have your students play this if you wish, but for the purposes of time, this lesson does not require it.

45 minutes

Explain

Using a modified version of the Inside Out strategy, gauge your students' understanding and set them up for some deeper explanations. Give each student a copy of the **Inside Out** handout available in the Attachments section.

Prompt them with a question about what the central limit theorem means. Have them write their thoughts in the innermost circle of the worksheet. Once all of the students have done this, have them find a partner and share this information, copying their partner's responses in the second circle.

Once all of your students have finished the worksheet, discuss some of their thoughts focusing on their understanding of the central limit theorem, making sure to watch for and correct any misconceptions. Some definitions that may be useful are listed below.

- Sample Size: the number of observations or recordings that will be taken when collecting a statistical sample
- Random Sampling: the random selection of a subset of individuals within a statistical population, thus allowing for a smaller subset of samples to represent a larger total population for statistical inference
- Sampling Distribution: the set of all mean values of possible samples
- Central Limit Theorem: regardless of the underlying distribution of the population, with a large enough sample size, the means, or proportions, of all samples from the same population will be equal to the mean, or proportion, of the population and that the distribution of the sample means, or proportions, will be a normal distribution

45 minutes

Extend

Now, have your students to go back and play mission three of Deadly Distribution so they can continue to apply what they have learned so far. This should take around another 30-45 minutes to complete. As mentioned previously, it is not required that players complete mission four, but if you have students who complete mission three very quickly, you can have them continue on to the final mission. It is much more challenging, however, and takes roughly another 30-45 minutes to complete.

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.

Evaluate

Give each student an **Always, Sometimes, Never True Worksheet - Student** and have them determine if each statement on the worksheet is always, sometimes, or never true. Make sure that they write a justification for their choice that is based on information presented over the course of the lesson. Once everyone has completed the worksheet, discuss each statement as a class. Read a statement and then have students raise their hands to show whether they decided if the statement is always, sometimes, or never true. Discuss the right answer for each statement, and if any students have a wrong answer, have them explain their thinking.

Resources

- K20 Center. (n.d.). Always, Sometimes, Never True. Strategies. https://learn.k20center.ou.edu/strategy/145
- K20 Center. (n.d.). Anchor Chart. Strategies. https://learn.k20center.ou.edu/strategy/58
- K20 Center. (n.d.). Deadly Distribution [Game]. Authentic Lessons for 21st Century Learning. https://learn.k20center.ou.edu/game/1036
- K20 Center. (n.d.). Inside Out. Strategies. https://learn.k20center.ou.edu/strategy/93