Lesson 22: Evaluating Reports Based on Data from a Sample

Student Outcomes

- Students interpret margin of error from reports that appear in newspapers and other media.
- Students critique and evaluate statements in published reports that involve estimating a population proportion or a population mean.

Lesson Notes

In this lesson, students read and comment on examples from the media (newspaper and Internet) that involve estimating a population proportion or a population mean. Students calculate the margin of error and compare their calculations with the published results. In addition, students interpret the margin of error in the context of the article and comment on how the survey was conducted.

Classwork

Exercises 1–5 (12 minutes): Election Results

Before starting these exercises, consider discussing the formulas for the margin of error for estimating both a population mean and a population proportion. In addition, review the importance of conducting a survey using a random sample.

Students should work in small groups (two or three students per group). Allow about 10 minutes for students to complete Exercises 1 through 5. Then, discuss answers as a class.

Scaffolding:

- As students work to articulate critiques, it may be useful to have sentence frames or sentence stems to organize and begin their writing.
- In particular, if students struggle with interpreting the margin of error, display an example sentence frame on the classroom board for students to refer to during the lesson.
- Use the sample response from Exercise 2 as a guide, with _____ (empty spaces) for percentages.

Exercises 1–5: Election Results

The following is part of an article that appeared in a newspaper:

> **With the election for governor still more than a year away, a new poll shows the race is already close. The Republican governor had 47%, and the Democratic challenger had 45% in a poll released Tuesday of 800 registered voters.**

> **"That's within the poll's margin of error of 3.5 percentage points, making it essentially a toss-up," said the poll's director.**

1.   Why don't the two percentages add up to 100%?

The other 8% might be undecided voters or voters who want to vote for a third-party candidate.

2.   What is meant by the margin of error of 3.5 percentage points?

It is unlikely that the estimate of 47% of the proportion of all voters who would vote for the Republican candidate will be farther from the actual population proportion than the margin of error of 3.5%, or the proportion of all voters who would vote for the Republican candidate is likely between 43.5% and 50.5%.

MP.2

3. Using the sample size of 800 and the proportion 0.47, calculate the margin of error associated with the estimate of the proportion of all registered voters who would vote for the Republican governor.

   0.035

4. Why did the poll director say that the election is "essentially a toss-up"?

   Even though the sample proportion who preferred the Republican governor is 0.47, this is just an estimate, and it might be too high by as much as 0.035. If this was the case, the Democratic challenger would win.

5. If the sample size had been $2,500$ registered voters, and the results stated 47% would vote for the Republican governor, and 45% said they would vote for the Democratic challenger, what would the margin of error have been? Could the director still say that the election was a toss-up?

   The margin of error would be 0.02. The director could still say the election was a toss-up.

Exercises 6–8 (10 minutes): Chocolate Chip Claim

In these exercises, students estimate a population mean by finding a margin of error. While introducing the scenario of the Nabisco Company claim, point out to students that this claim could be restated as, "Nabisco claims that on average there are at least 1,000 chocolate chips in every 18-ounce bag."

Students should work in small groups (two or three students per group). Allow about 10 minutes for students to complete Exercises 6 through 8. Then, discuss answers as a class.

Exercises 6–8: Chocolate Chip Claim

The Nabisco Company claims that there are at least $1,000$ chocolate chips in every 18-ounce bag of their Chips Ahoy! cookies. An article in a local newspaper reported the efforts of a group of students in their attempt to validate the Nabisco claim. The article reported that the students randomly selected 42 bags of cookies from local grocery stores and counted the number of chocolate chips in the cookies in each bag. The students found the sample mean was $1,261.6$ chips, and the sample standard deviation was 117.6 chips. The article stated that the students' data supported the Nabisco Company claim.

MP.2

6. Using the students' results, calculate the margin of error associated with the estimate of the mean number of chocolate chips in an 18-ounce bag of Chips Ahoy! chocolate chip cookies. Write a sentence interpreting the margin of error.

   The margin of error is 36.3. The population mean number of chocolate chips in an 18-ounce bag is likely between $1,225.3$ and $1,297.9$.

MP.3

7. Do you agree that the student data supported the Nabisco Company claim? Explain.

   Students should agree with the claim. The population mean number of chocolate chips is likely in the range 1261.6 ± 36.3, or between $1,225.3$ and $1,297.9$. This range is consistent with the claim of at least $1,000$ chocolate chips in each 18-ounce bag.

8. Comment on the procedure that the students used to collect their data.

   It was important that the 42 bags were randomly selected. Since they were all collected from local grocery stores, it might not be reasonable to extend the conclusion to beyond the local grocery stores.

Exercises 9–15 (15 minutes): Understanding a Poll

These exercises are similar to Exercises 1–5, estimating a population proportion. The difference is how the data are presented. In this example, students first read a graph and discuss key points in the graph. After this discussion, consider presenting to students how the Gallup organization conducts its polls. Show students the Gallup website (http://www.gallup.com). However, preview the site before suggesting students examine it, as there are topics involved in the polls that on occasion may not be desirable to discuss with the class. The site incorporates polls related to current issues, which are difficult to predict.

Students should work in small groups (two or three students per group). Allow approximately five minutes for students to complete Exercises 9–11. When students have finished, discuss the answers as a class. Then, direct students to read how Gallup conducted the poll, and have them complete Exercises 12–15. When students have finished, discuss answers as a class.

Scaffolding:
- If possible, it might be useful for English language learners to analyze examples that are in their L1 (first) language.
- Many websites have translated versions of reports available.

Exercises 9–15: Understanding a Poll

George Gallup founded the American Institute of Public Opinion (Gallup Poll) in 1935. The company is famous for its public opinion polls, which are conducted in the United States and other countries.

Gallup published a graph in May 2013 titled *Percent in U.S. Who Exercise for at Least 30 Minutes Three or More Days per Week*. Use the graph found on the Gallup website (http://www.gallup.com/poll/162194/americans-exercise-habits-worsen-slightly-2013.aspx) to answer the following questions:

9. **What percent of those surveyed said that they exercise at least 30 minutes three or more days a week at the start of 2013?**

   Approximately 48%

10. **Describe the patterns that you observe in the graph.**

    The percent of adults who say they exercise at least 30 minutes three or more days a week follows an up-and-down cycle; at the beginning of the year, the percent is low; by midyear, the percent rises to its highest; by the end of the year, the percent goes back down.

11. **Give some reasons why you think the graph follows the pattern that you described.**

    The pattern seems to be following the seasons of the year. During the winter, the percent is low; during the summer, the percent reaches its peak.

Following are the survey methods that Gallup used to collect the data:

   Results are based on telephone interviews conducted as part of the Gallup-Healthways Well-Being Index survey June 1–30, 2013, with a random sample of 15,235 adults, aged 18 and older, living in all 50 U.S. states and the District of Columbia.

   For results based on the total sample of national adults, one can say with 95% confidence that the maximum margin of sampling error is ±1 percentage point.

12. **Using the value of 0.538 for the proportion of those surveyed who said they exercise at least 30 minutes three or more days a week in the most recent poll, calculate the margin of error. How does your margin of error compare to the value reported by Gallup?**

    The margin of error is 0.008, which rounds up to 0.01.

13. Interpret the phrase "margin of sampling error is ± 1 percentage point."

It is very likely that the proportion of all adults who said they exercise at least 30 minutes three or more days a week is within 0.01 of the sample proportion 0.538.

14. Why is it important that Gallup selects a random sample of adults?

It helps to ensure that the sample taken is representative of the population.

15. If Gallup had used a random sample of 1,500, what would happen to the margin of error? Explain your answer.

The margin of error would increase to 0.026.

$$ME = 2\sqrt{\frac{0.538(1-0.538)}{1500}}$$

Closing (3 minutes)

- Refer back to the first exercise set about the election results. What do you think would be an appropriate headline for the story?

  □ *Race for Governor in a Dead Heat; Gubernatorial Race Too Close to Call*

Ask students to summarize the main ideas of the lesson in writing or with a neighbor. Use this as an opportunity to informally assess comprehension of the lesson. The Lesson Summary below offers some important ideas that should be included.

Lesson Summary

- The estimated margin of error when a sample proportion from a random sample is used to estimate a population proportion is $ME = 2\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$, where $\hat{p}$ is the sample proportion.
- The estimated margin of error when a sample mean from a random sample is used to estimate a population mean is $ME = 2\left(\frac{s}{\sqrt{n}}\right)$, where s is the sample mean.
- It is important to interpret margin of error in context.
- It is unlikely that the estimate of a population proportion or mean will be farther from the actual population value than the margin of error.

Exit Ticket (5 minutes)

Name _____   Date _____

Lesson 22: Evaluating Reports Based on Data from a Sample

Exit Ticket

The Gallup organization published the following results from a poll that it conducted.

> As health experts increasingly focus on the medical benefits of a healthy lifestyle and preventative healthcare, Americans say their doctor does commonly discuss the benefits of healthy habits with them. Specifically, 71% say their doctor usually discusses the benefits of engaging in regular physical exercise, and 66% say their doctor usually discusses the benefits of eating a healthy diet. Fewer Americans, 50%, say their doctor usually discusses the benefits of not smoking, although that number jumps to 79% among smokers.
>
> **Survey Methods**
>
> Results for this Gallup poll are based on telephone interviews conducted July 10–14, 2013, with a random sample of 2,027 adults, aged 18 and older, living in all 50 U.S. states and the District of Columbia.
>
> For results based on the total sample of national adults, one can say with 95% confidence that the margin of sampling error is ±3 percentage points.

Source: http://www.gallup.com/poll/163772/americans-say-doctors-advise-health-habits.aspx

1. The headline of the article is "Smokers Much More Likely Than Nonsmokers to Say Doctor Discusses Not Smoking." Do you agree with this headline? Explain your answer.

2. Using the data "71% say their doctor usually discusses the benefits of engaging in regular physical exercise," calculate the margin of error. Show your work.

3. How do your results compare with the margin of error stated in the article?

4. Interpret the margin of error in this context.

Exit Ticket Sample Solutions

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> Results for this Gallup poll are based on telephone interviews conducted July 10–14, 2013, with a random sample of $2,027$ adults, aged 18 and older, living in all 50 U.S. states and the District of Columbia.
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> For results based on the total sample of national adults, one can say with 95% confidence that the margin of sampling error is ± 3 percentage points.

Source: http://www.gallup.com/poll/163772/americans-say-doctors-advise-health-habits.aspx

1. The headline of the article is "Smokers Much More Likely Than Nonsmokers to Say Doctor Discusses Not Smoking." Do you agree with this headline? Explain your answer.

    Yes, I agree with this headline because 79% of smokers say their doctor usually discusses the benefits of nonsmoking, while less than 50% of nonsmokers say their doctor discusses not smoking. The margin of error associated with these estimates is only 3%.

2. Using the data "71% say their doctor usually discusses the benefits of engaging in regular physical exercise," calculate the margin of error. Show your work.

    $$ME = 2\sqrt{\frac{(0.71)(0.29)}{2027}} = 0.02$$

3. How do your results compare with the margin of error stated in the article?

    This value is lower than the stated value of 0.03.

4. Interpret the margin of error in this context.

    It is very likely that the proportion of all adults who would say that their doctor usually discusses the benefits of engaging in physical exercise is within 3% of the sample proportion 0.71.

Problem Set Sample Solutions

1. The *British Medical Journal* published a study whose objective was to investigate estimation of calorie content of meals from fast food restaurants. Below are the published results.

   Participants: $1,877$ adults and 330 school-age children visiting restaurants at dinnertime (evening meal) in 2010 and 2011; $1,178$ adolescents visiting restaurants after school or at lunchtime in 2010 and 2011

   Results: Among adults, adolescents, and school-age children, the mean actual calorie content of meals was 836 calories (SD 465), 756 calories (SD 455), and 733 calories (SD 359), respectively. Compared with the actual figures, participants underestimated calorie content by means of 175 calories, 259 calories, and 175 calories, respectively.

   Source: http://www.bmj.com/content/346/bmj.f2907

   a. Calculate the margin of error associated with the estimate of the mean number of actual calories in the meals eaten by each of the groups: adults, adolescents, and school-age children.

      Margin of error for adults: 21.47

      Margin of error for adolescents: 26.51

      Margin of error for school-age children: 39.52

   b. Write a sentence interpreting the margin of error for the adult group.

      It is very likely that the sample mean of 836 calories is within 21.47 of the actual mean number of calories in meals eaten by all adults.

   c. Explain why the margin of error for the estimate of the mean number of actual calories in meals eaten by adults is smaller than the margin of error of the mean number of actual calories in meals eaten by school-age children.

      The size of the sample for the school-age children is considerably smaller than the sample size for the adults.

   d. Write a conclusion that the researchers could draw from this study.

      The mean number of calories in a meal consumed by adults is greater than the mean number of calories in a meal consumed by adolescents.

2. The Gallup organization published the following results from a poll that it conducted:

   By their own admission, many young Americans, aged 18 to 29, say they spend too much time using the Internet (59%), their cell phones or smartphones (58%), and social media sites such as Facebook (48%). Americans' perceptions that they spend "too much" time using each of these technologies decline with age. Conversely, older Americans are most likely to say they spend too much time watching television, and among all Americans, television is the most overused technology tested.

   Results are based on telephone interviews conducted as part of Gallup Daily tracking April 9–10, 2012, with a random sample of $1,051$ adults, aged 18 and older, living in all 50 U.S. states and the District of Columbia.

   For results based on the total sample of national adults, one can say with 95% confidence that the maximum margin of sampling error is ± 4 percentage points.

   Source: http://www.gallup.com/poll/153863/Young-Adults-Admit-Time-Cell-Phones-Web.aspx

   a. Write a newspaper headline that would capture the main idea from the poll.

      Answers will vary. An example is "U.S. Young Adults Admit Too Much Time on Cell Phones, Web."

b. **Use the phrase from the article, "their cell phones or smartphones (58%)," to calculate the margin of error. Show your work.**

$$ME = 2\sqrt{\frac{(0.58)(0.42)}{1051}} = 0.03$$

c. **How do your results compare with the margin of error stated in the article?**

This value is less than the stated value of 0.04.

d. **Interpret the statement "the margin of sampling error is ± 3 percentage points."**

It is very likely that the sample proportion 0.58 *is within* 0.04 *of the proportion of all adults who would say that they use their cell phones too much.*

e. **What would happen to the margin of error if Gallup had surveyed 100 people instead of the $1,051$?**

The margin of error would increase to 0.10.

3. **The Holiday Inn Resort Brand conducted the Kid Classified survey. $1,500$ parents and children nationwide were interviewed via an online survey.**

The results of the survey state

While many parents surveyed say they have some financial savings set aside specifically for vacation travel, more than half of parents in the survey (52%) noted that saving enough money was the biggest challenge to planning a family vacation, more so than coordination of family schedules (19%) or taking time off of work (12%).

Source: http://www.lodgingmagazine.com/holiday-inn-resorts-catering-to-kids/

a. **Calculate the margin of error associated with the estimate of the proportion of all parents who would say that saving enough money is the biggest challenge to planning a family vacation.**

The margin of error is 0.026.

b. **Write a sentence interpreting the margin of error.**

It is very likely that the sample proportion of 0.52 *is within* 0.026 *of the proportion of all parents who would say that saving enough money is the biggest challenge to planning a family vacation.*

c. **Comment on how the survey was conducted.**

This was an online survey. It is not known if this was a random sample. Only individuals who have Internet access could take this survey, which would eliminate anyone who did not have Internet access.