Candy Pieces

ID: 9997

Time required
45 minutes

Activity Overview

This activity introduces the statistics concept of hypothesis testing. Students are given information on the number of pieces of candy in a bag according to color. They are asked to consider whether the bag came from a manufacturing process designed to produce equal portions of each color. Students will then use a chi-square test for goodness-of-fit to determine if there is a significant difference between the proportions they find in the sample and the proportions they would expect if the manufacturer produced equal proportions of each color.

Topic: Hypothesis Testing

- *Use a X^2 goodness-of-fit test to test the hypothesis that an observed frequency distribution fits an expected frequency distribution.*

Teacher Preparation and Notes

Tell students that this activity is only an informal introduction to the concept of hypothesis testing, a major topic in statistical inference. Hypothesis tests work in a manner similar to a jury in a criminal trial. In the American system of justice, a defendant is presumed innocent. If the evidence is convincing enough, the jury finds the defendant guilty. A jury never finds a defendant innocent—just guilty or not guilty. In a similar way, at the outset, a statistician assumes that there is no statistical difference between the observed data and the expected results. Statisticians use hypothesis tests to make inferences about a population based on random samples. With hypothesis tests, statisticians determine whether there is enough evidence to reject the hypothesis that the difference can be due to chance, or decide there is not enough evidence to reject it.

- *Actual bags of candy can be used in the exercise questions instead of using the supplied data.*
- *Notes for using the TI-Nspire™ Navigator™ System are included throughout the activity. The use of the Navigator System is not necessary for completion of this activity.*
- ***To download the student and solution TI-Nspire documents (.tns files) and student worksheet, go to education.ti.com/exchange and enter "9997" in the keyword search box.***

Associated Materials

- *CandyPieces_Student.doc*
- *CandyPieces.tns*
- *Candy Pieces_Soln.tns*

Suggested Related Activities

To download any activity listed, go to education.ti.com/exchange and enter the number in the keyword search box.

- *Chi Square Distributions (TI-Nspire technology) — 9738*
- *How Far am I Off? (TI-Nspire technology) — 12442*

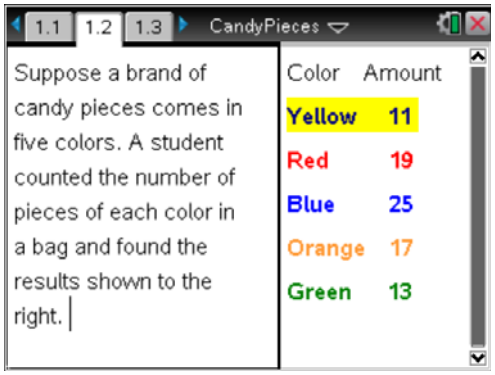
Introduction

Calculating chi-square is one of many procedures statisticians use for testing hypotheses. The starting hypothesis (called a null hypothesis) in this case assumes there is no statistical difference in the distribution of colors. The data are inspected to see if they support this assumption and chi-square is the statistical tool used to make a decision. The alternate hypothesis is that the proportions of colors are not all equal. In this brief activity, it is not possible to cover all of the nuances of a chi-square test.

In courses like AP® Statistics, students learn that three assumptions need to be checked before using a chi-square test for goodness-of-fit: the samples need to be chosen randomly, the samples need to be independent, and the sample should be large enough so that the expected values should each be at least 5. For example, if you toss a 6-sided die 12 times, the expected numbers for each outcome would be 2; if you tossed the die 60 times, the expect outcome for each face would be 10.

Problem 1 – Activity

On page 1.3, students are given data from a bag of candy. To find the expected number of candies of each color, students are to add up the number of pieces of each color (85) and then divide by the number of colors (5). They should get 17 pieces.



TI-Nspire Navigator Opportunity: *Quick Poll*

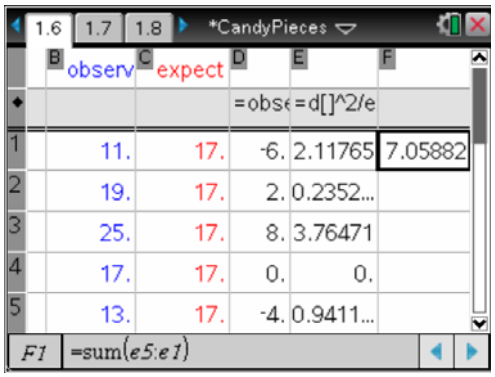
See Note 1 at the end of this lesson.

On page 1.6, students are to calculate the **Observed – Expected** values for each color in Column C.

Answering the question on page 1.9, some students will realize that the sum of the differences is 0 because the sum of the observed values and the sum of the expected values are equal: both 85.

Then in Column D, they will calculate $\frac{(O-E)^2}{E}$ for each color. One way of explaining the use of $\frac{(O-E)^2}{E}$ is that it makes the values positive and gives a way of measuring the relative sizes of differences.

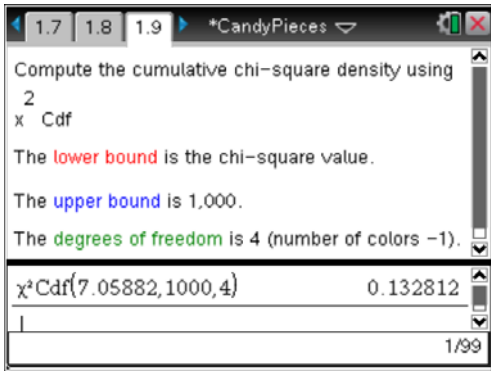
Students will finish by finding the chi-square in cell E1.



TI-Nspire Navigator Opportunity: *Live Presenter*

See Note 2 at the end of this lesson.

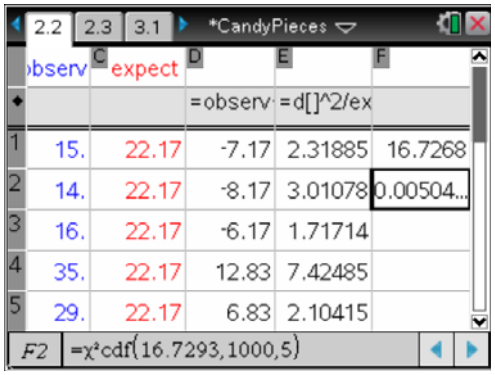
On page 1.12, students are to calculate the cumulative chi-square density using the **X^2 Cdf** command (**MENU > Statistics > Distributions > X^2 Cdf**). They will need to use the lower bound, upper bound, and degrees of freedom discussed on the previous page.



This value, 0.132813, is also the *p*-value that students will use to not reject the hypothesis that the colors were manufactured in equal numbers.

Problem 2 – Exercises

Students will need to first find the number of expected candies for each color. If there are supposed to be equal numbers for each color, you would expect 22.17 candies.



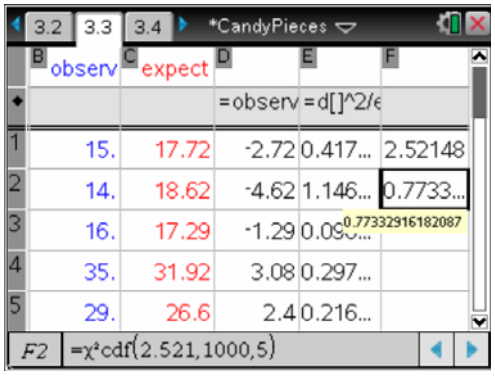
On page 2.2, students are to calculate the chi-square (16.729). They can use either the spreadsheet or the calculator to find the *p*-value (0.00504).

Since the *p*-value is less than 0.05 there is enough evidence to reject the hypothesis that the colors were manufactured in equal numbers.

TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 3 at the end of this lesson.

Students should be careful with this exercise because they are testing an unequal distribution. To find the expected number of candies, students need to use the proportions given on page 2.4.



Chi-square of 2.407, *p*-value 0.7904. Since the *p*-value is greater than 0.05 there is not enough evidence to suggest that the bag of candy did not come from a process that produced the stated proportion of colors.

TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 4 at the end of this lesson.

TI-Nspire Navigator Opportunities

Note 1
Problem 1, *Quick Poll*

Send a *Quick Poll* to gather the class responses to the question on page 1.7. Use the results to guide the discussion as to why you would not use it to describe the total difference. Try to lead students to the idea that squaring the differences will avoid the problem of positive and negative values canceling each other out.

Note 2
Problem 1, *Live Presenter*

Use *Live presenter* to help students navigate how to complete the *Lists and Spreadsheet* on page 1.6

Note 3
Problem 2, *Quick Poll*

Send a *Quick Poll* asking students for the *p*-value and if they reject or fail to reject the null hypothesis.

Note 4
Problem 3, *Quick Poll*

Send a *Quick Poll* asking students for the *p*-value and if they reject or fail to reject the null hypothesis.