

## Lesson 13.3 - Using Your GDC to Calculate $\chi^2$ Statistic

### EXAMPLE #1

Suppose you want to find out whether there is a link between hair colour and eye colour. Do most people with black hair have brown eyes?

The following data is collected from a sample of 63 people.

	Black hair	Brown hair	Blonde hair
Blue eyes	5	7	12
Brown eyes	15	10	2
Green eyes	3	4	5

1. State the hypotheses. Remember that the null hypothesis,  $H_0$ , always assumes **independence** of the factors.
2. Decide on the significance level you are going to use. **We usually use the 5% significance level.**
3. Now use your GDC to calculate the statistic. Follow the steps on your calculator handout.

Remember that:

- If the  $\chi^2$  statistic  $>$   $\chi^2$  critical value, then **reject** the null hypothesis.
- If the  $\chi^2$  statistic  $<$   $\chi^2$  critical value, then **accept** the null hypothesis.

Also Know that:

- If the  $p$ -value  $<$  significance level, then then **reject** the null hypothesis.
- If the  $p$ -value  $>$  significance level, then **accept** the null hypothesis.

$H_0$ : Eye color + hair are independent.

$H_1$ : Eye color + hair color are dependent.

Calculator Output

$$\chi^2_{\text{stat}} = 13.3$$

$$p\text{-val} = .0101$$

$$df = 4$$

$$\boxed{\text{Pg. 404}} \rightarrow \chi^2_{\text{crit}} = 9.488$$

$$\chi^2_{\text{stat}} > \chi^2_{\text{crit}} + p\text{-val} < \text{sig level}$$

Reject the null hypothesis.

Eye color is dependent on hair color.

## EXAMPLE #2

Katya has collected data about the types of movie that students in her year group particularly enjoy. She predicts that the preferences will be the same for boys and girls.

Here are her results:

	Adventure	Romance	Comedy	Animation
Male	11	3	9	8
Female	6	9	7	7

(a) State Katya's null hypothesis and her alternative hypothesis.

$H_0$ : Movie preference + gender are independent.

$H_1$ : Movie preference + gender are dependent.

(b) Find the expected frequency for the number of females who prefer adventure movies.

$$f_E = \frac{\text{row total} \times \text{column total}}{\text{total}} = \frac{29 \times 17}{60} = 8.22$$

(c) Using your GDC, find the chi-squared statistic for Katya's data.

$$\chi^2_{\text{stat}} = 4.73$$

(d) Using your GDC, find the p-value for this data.

$$p\text{-val} = .193$$

(e) Show that the number of degrees of freedom for this data is 3.

$$df = (2-1)(4-1) = 1(3) = 3$$

(f) If  $\chi_{5\%}^2 = 7.815$ , give Katya's conclusion.

$$\chi^2_{\text{stat}} < \chi^2_{\text{crit}}$$

$$p\text{-val} > \text{sig level}$$

Accept the null hypothesis.

Movie preference is not determined by gender.

### **Lesson 13.4 - Restrictions on Using the $\chi^2$ Test**

- The categories for each variable cannot occur at the same time.
- The expected frequencies should not be too small:
  - In a 2 x 2 contingency table, no cell should contain an expected frequency of 5 or less.
  - In a larger contingency table (bigger than a 2 x 2), no cell should contain an expected frequency of 1 or less, and no more than 20% of the expected frequencies should be less than 5.
  - If there are expected frequencies in a table that do not satisfy the above conditions, combine cells so that the required limits are reached.