5 Sample project

This Maths Studies project has been graded by a moderator. As you read through it, you will see comments from the moderator in boxes like this:

Moderator's comment:

At the end of the sample project is a summary of the moderator's grades, showing how the project has been graded against all the criteria A to G. These criteria are explained in detail in chapter 13 of the Mathematical Studies textbook.

Reading projects and the moderator's comments will help you to see where marks are gained and lost, and will give you helpful tips in writing your own project.

Is there a connection between gender, maths grade, hair colour and eye colour?

Moderator's comment:
The project has a title.

Contents

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Introduction

This project discusses if there is any connection between gender, hair colour, and eye colour and maths grades. This is to find out if gender and hair colour does matter when it comes to maths grades, and if hair colour and eye colour are independent.

I collected my data using a questionnaire, and went around the school distributing it at random to get the data I needed. Below is a copy of my questionnaire:

Circle the answers that apply to you

1 What is your gender?
Male
Female

2 Hair colour?
Brown
Blonde
Black
Ginger

3 Eye colour?
Brown
Blue
Green
Grey

4 Maths grade at the end of last year (please write it down below)

I gave my questionnaire to many different people of different ages but age is not relevant in this investigation. On the questionnaire there are four simple questions; what their gender is, their eye colour from a choice of three (brown, blue and green), what their hair colour is from a choice of four (brown, blonde, black and ginger), and what their maths grade was at the end of last year. Because some of the grades received were letters instead of numbers I have translated them using this model:

A* = 7, A = 6, B = 5, C = 4, D = 3, E = 2, F = 1

All of my raw data can be found in the data collection.

I will find the overall mean and standard deviation of the grades and I will use these values to determine the groups for math grade for the chi-squared test to see if maths grade is independent of gender. I will draw bar charts to give me an overall picture of the number of males and females with different colour hair and eyes. Then I will find the mean maths grade for the various hair colours to find out if the stereotype that blondes are bad at maths is valid in my sample of students.

I will test if the eye colour and hair colour are independent or not by performing a chi squared test and similarly with gender and maths grade.

Moderator's comment:
There is a title, a statement of the task and a plan. This is not detailed enough to award 3 marks.

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Data collection

Gender	Hair	Eye	Grade
M	BROWN	BROWN	5
M	BLACK	BLACK	3
F	BLONDE	BLUE	6
M	BLACK	BROWN	7
F	BROWN	BROWN	4
F	BLACK	BROWN	1
M	BLACK	BROWN	5
F	BROWN	BROWN	3
M	BLACK	BROWN	1
F	BROWN	BROWN	6
M	BROWN	GREEN	4
F	GINGER	BROWN	5
F	BLACK	BLUE	3
F	BLONDE	GREEN	5
F	BROWN	BROWN	4
M	BLACK	BROWN	3
M	BLONDE	BROWN	3
M	BLONDE	BLUE	3
F	BLACK	BROWN	5
F	GINGER	GREEN	3
F	BLONDE	GREEN	5
F	BROWN	BROWN	5
F	BROWN	GREEN	3
M	BLACK	BROWN	5
F	BROWN	BROWN	6
F	GINGER	BLUE	5
F	BLONDE	BLUE	6
F	BLACK	BROWN	2
M	BLACK	BROWN	4
F	BLONDE	GREEN	7
M	BLACK	BROWN	1

Gender	Hair	Eye	Grade
M	BROWN	BROWN	5
F	BLONDE	BLUE	5
M	BROWN	BROWN	3
M	BROWN	GREEN	4
F	BROWN	BLUE	5
F	GINGER	BLUE	6
F	BROWN	BROWN	6
F	BROWN	BLUE	6
M	BLACK	BROWN	6
M	GINGER	BROWN	3
F	BROWN	BROWN	4
F	BROWN	BROWN	2
F	BLONDE	BLUE	5
F	BROWN	BLUE	4
M	GINGER	BROWN	5
F	GINGER	GREEN	2
M	BLONDE	BLUE	2
M	BROWN	BROWN	5
F	BLACK	BLUE	7
F	BROWN	GREEN	4
F	BLACK	BROWN	4
F	BLONDE	GREEN	6
M	BROWN	BROWN	5
M	BROWN	BROWN	5
F	BROWN	GREEN	4
M	BROWN	GREEN	6
F	BROWN	BROWN	4
F	BROWN	BROWN	6
M	BROWN	BROWN	4
M	BLONDE	GREEN	2
F	BLONDE	BLUE	6

Moderator's comment:
The data collected is relevant and sufficient in quantity but it is not quality data. It has also been set up for use in the chi-squared tests.

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Analysis

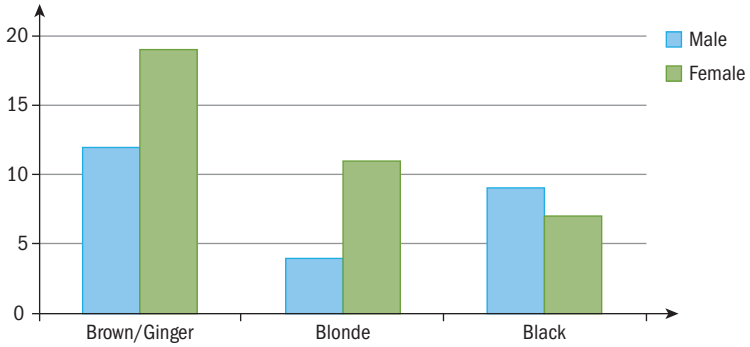
The mean maths grade is 4.34 and the standard deviation is 1.51. I will be using these values later on in a chi-squared test.

Moderator's comment: Simple mathematics

Next follows some bar charts of hair colour and gender and eye colour and gender. These bar charts are based on the table below

	MALE	FEMALE	TOTAL
Hair colour	————	————	———
Brown/Ginger	12	22	34
Blonde	4	9	13
Black	9	6	15
Total	25	37	62
Eye colour	————	————	———
Brown	20	16	36
Blue	2	9	11
Green	3	12	15
Total	25	37	62

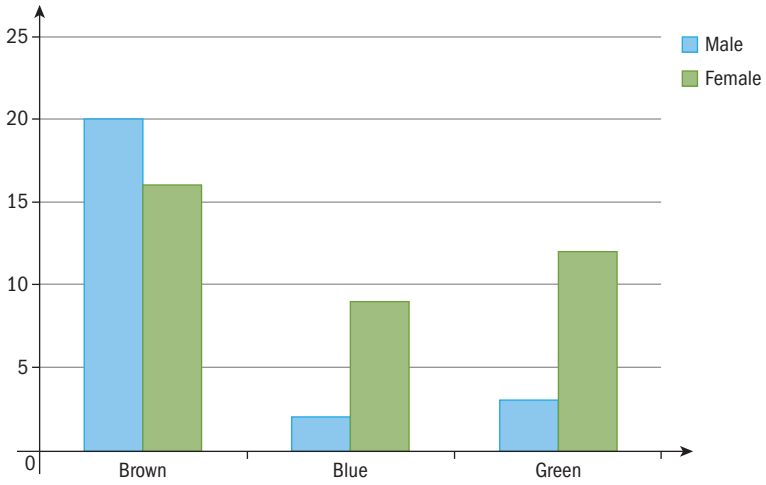
Gender and hair colour



Moderator's comment: Simple mathematics.

As can be seen from the bar chart females have more brown, blonde and ginger hair than the males but the males have more black hair than the females.

Gender and eye colour



Males seem to have the largest amount of brown eyes while the females seem to have the largest amount of both green and blue eyes, but this

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could just be due to the fact that there were more results from females than there were for males.

Next I shall find the average grade for each hair colour. The formula for this is $\frac{\Sigma G}{T}$ the sum of all the grades in a hair colour divided by the amount of people with brown hair, where T is total frequency of hair colour, and G is the grades.

Moderator's comment: Simple mathematics.

The average grade for brown/ginger haired people is:

$$\frac{5+4+3+6+4+4+5+3+6+5+3+4+5+6+6+4+2+4+5+4+5+5+4+6+4+6+5+3+5+6+3+5+2}{34} = \frac{147}{34} = 4.32$$

The average grade for black haired people is:

$$\frac{3+7+1+5+1+3+3+5+5+2+4+1+6+7+4}{15} = \frac{57}{15} = 3.8$$

The average grade for blondes is:

$$\frac{6+5+3+3+5+6+7+5+5+2+6+2+6}{13} = \frac{61}{13} = 4.69$$

So according to my results blondes have the highest average grade, brown/ginger haired people have the highest after that and black haired people have the lowest. This shows that, in my sample, the stereotype of blondes being bad at maths is wrong in this case.

Next I will be investigating if hair colour and eye colour are independent of each other. To do so I will be performing a chi squared test at 5% significance level. My observed data is set up in the contingency table below.

	BROWN/ GINGER	BLONDE	BLACK	TOTAL
BROWN	21	1	13	35
BLUE/GREEN	13	12	2	27
TOTAL	34	13	15	62

My null hypothesis and alternative hypothesis is:
H_0: hair colour is independent of eye colour.
H_1: hair colour is not independent of eye colour.

First I must find the degrees of freedom, the formula is

$(R - 1)(C - 1)$ = degrees of freedom

Where R is the amount of rows, not including total and C is the amount of columns not including the total. We are looking at table 3 so the degree of freedom would be calculated as:

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

From the information booklet, the critical value at 5% for 2 degrees of freedom is 5.991.

Now we can proceed onto the chi squared test.

The formula for the chi squared test is: $\chi^2 = \sum \frac{(0-E)^2}{E}$

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Where O is the observed values, the ones from the table, and E is the expected values. Which means I need to find the expected values: the formula for expected values is $\frac{(TR \times TC)}{T}$ where TR represents total row, TC represents total column and T shows the total value:

	Brown/ginger	Blonde	Black
Brown	$\frac{35\times34}{62}$	$\frac{35\times13}{62}$	$\frac{35\times15}{62}$
Blue/green	$\frac{27\times34}{62}$	$\frac{27\times13}{62}$	$\frac{27\times15}{62}$

So the table of expected values would be:

	Brown/ginger	Blonde	Black
Brown	20.32	6.96	8.7
Blue/Green	10.16	5.62	6.53

So the chi squared test statistic is:

$$\chi^2 = \frac{(21-20.32)^2}{20.32} + \frac{(1-6.96)^2}{6.96} + \frac{(13-8.7)^2}{8.7} + \frac{(13-10.16)^2}{10.16} + \frac{(12-5.62)^2}{5.62} + \frac{(2-6.53)^2}{6.53} = 18.53$$

Because 18.53 > 5.991 I will reject my null hypothesis, which shows that hair colour and eye colour are not independent of each other.

Moderator's comment:
Further process.

Here I shall be using a chi squared test at 5% significance level whether grade and gender are independent. Once again I will need to calculate degrees of freedom, find the critical values, and calculate the expected values and then do a chi squared test to find if my null hypothesis is correct. Here I will use the fact that the mean Maths grade is 4.34 and the standard deviation is 1.51 to decide on my groupings. 4.34 –1.51 = 2.83 so I will use 0 – 3 for the first group. 4.34 + 1.51 = 5.85 so I will use 6 – 7 for the third group. That leaves 4 – 5 for the middle group. With this grouping my observed values are:

	1–3	4–5	6–7	TOTAL
MALE	8	12	4	24
FEMALE	7	18	13	38
TOTAL	15	30	17	62

My null hypothesis and alternative hypothesis are:

H_0: gender is independent of maths grade
H_1: gender is not independent of maths grade

First degrees of freedom since we are now focusing on the table above the degrees of freedom formula would be:

(2 – 1)(3 – 1) = 2

Then the critical value would be 5.991.

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The expected values formulas would be:

	1–3	4–5	6–7
Male	$\frac{24\times15}{62}$	$\frac{24\times30}{62}$	$\frac{24\times17}{62}$
Female	$\frac{38\times15}{62}$	$\frac{38\times30}{62}$	$\frac{38\times17}{62}$

So the answers would be:

	1–3	4–5	6–7
Male	5.8	11.61	6.58
Female	9.19	18.38	10.41

Now that we know the expected values we can do the chi squared test to find out whether gender and maths grade is independent or not. The formula would look like this:

$$\chi^2 = \frac{(8-5.8)^2}{5.8} + \frac{(12-11.61)^2}{11.61} + \frac{(4-6.58)^2}{6.58} + \frac{(7-9.19)^2}{9.19} + \frac{(18-18.83)^2}{18.83} + \frac{(13-10.41)^2}{10.41} = 3.06$$

Seeing as $3.06 < 5.991$, I will accept my null hypothesis, that grade and gender are independent of each other.

Moderator's comment: Further process.

Validity

In order to accept any of my hypotheses I used chi squared test to determine if the two variables are independent or not. To do this I calculated the expected values which were all greater than 5 and so the tests were valid. I also found the critical value and the degrees of freedom, knowing that it is at a 5% significance in both cases.

The data I collected can never be 100% reliable, because I have to assume that in some cases people lied about their grade or hair colour, although it is impossible to find out which ones it was, without going and asking everyone who did the questionnaire, we can say that my findings are not completely reliable.

Another reason why it may not be entirely reliable is because some of the grades may be at different levels, because I had to translate letter grades into number grades, and one cannot be sure if the matrix I used was completely appropriate.

Also people can get better at maths and get better grades, so this grade could have just been one bad one in a string of good ones. I can also say that it is not entirely reliable because some people have dyed their hair and put that colour down as opposed to their natural colour, which makes the results of the hair colour/eye colour tests unreliable.

I could have specified on the questionnaire that they should write down their original hair colour, but that may not have been effective because they could put their dyed hair colour down anyway.

Moderator's comment: There is a reasonable attempt to discuss validity.

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Conclusion

In conclusion, as I have said, I have found that hair colour and eye colour are not independent of each other and that gender and grades are independent. So I have rejected my null hypothesis for hair colour and eye colour, and accepted my null hypothesis for gender and grade, and found out that hair colour and eye colour are dependent upon each other and the gender and grade are independent upon each other. I have also found that the stereotype of blondes with bad grades was not the case in my sample because they had the highest average grade.

Moderator's comment: The conclusions are consistent with the processes used but the project is too simple for these to be thorough.

Bibliography

Bedding, Stephen, Jane Forrest, De Tokman, Paula. Waldman, Beryl Fussey, and Mal Coad. *Mathematical Studies: Course Companion*. Oxford: Oxford UP, 2007.

Summary of moderator's comments

Criterion	Grade	Comment
A	2	The project does have a title, a statement of the task and a description of the plan. The plan is not detailed. The student needs to explain clearly how they are going to collect the data, any selection processes in order to ensure that the data is random, explain all the mathematical processes that they will use and why they are using them. (2 marks awarded, out of a possible 3.)
B	2	Relevant data has been collected. The data is sufficient in quantity but not in quality. The data has been set up for the bar charts and the chi-squared tests. The student is restricted in the number of mathematical processes that they can perform with the data that they have collected. (2 marks awarded, out of a possible 3.)
C	5	There are two simple mathematical processes that are relevant and correct. There is also one further process that is relevant and correct. (5 out of 5 marks awarded.)
D	2	The interpretations are consistent with the processes used but there is no meaningful discussion. The project is too simple to have a meaningful discussion. (2 marks awarded, out of a possible 3.)
E	1	There is an attempt made to discuss validity. The student recognizes that the expected values in the chi-squared test must be greater than 5 and also questions the validity of the data collected. (1 out of 1 mark awarded.)
F	1	The project has been structured but it is a fairly simple project. It is not obvious in this project that the full amount of time allocated for project work has been fulfilled. A simple project cannot receive more than 1 mark for this criterion. (1 mark awarded, out of a possible 3.)
G	2	The notation and terminology are correct throughout the project. (2 out of 2 marks awarded.)

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