Genetics and Statistics

Probability and Statistics Series

Instructor's Guide

Table of Contents

Developed by the Teaching and Learning Laboratory at MIT
for the Singapore University of Technology and Design

Introduction

When to Use this Video

- In Soph 304, at home/in class/in recitation, after lecture number #6: Mendelian Genetics
- Prior knowledge: general understanding of probability distributions; definition of genotype, phenotype, homozygous, and heterozygous; use of Punnett squares to predict expected results of Mendelian crosses

Key Information

Duration: 18:30
Narrator: Lourdes Aleman, Ph.D.
Materials Needed:
• paper
• pencil

Learning Objectives

After watching this video students will be able to apply Chi square hypothesis testing to experimental data obtained from genetic experiments.

Motivation

This video motivates the use of the Chi Square Test for Goodness of Fit by applying it to a genetics experiment.

Student Experience

It is highly recommended that the video is paused when prompted so that students are able to attempt the activities on their own and then check their solutions against the video.

During the video, students will:

- Use Punnett squares to predict the expected results of Mendelian crosses.
- Calculate Chi square test statistics and use them to support or reject hypotheses.
- Determine the degrees of freedom in a set of data.

Video Highlights

This table outlines a collection of activities and important ideas from the video.

Time	Feature	Comments
1:07	Prerequisite Knowledge and Learning Objectives	
1:44	Chapter 1: The Chi Square Test for Goodness of Fit	This statistical test is explained and applied to the coin flipping experiment introduced at the beginning of the video.
3:50	The general calculation for the Chi square statistic is explained.	
8:57	Chapter 2: Application to Genetics	The Chi Square test is applied to a genetics experiment.
9:34	Student activity	Students are asked to pause the video and use a Punnett square to predict the expected results of a cross.
11:40	Student activity	Students are asked to pause the video and calculate a Chi square test statistic for a genetics experiment.
12:44	Student activity	Based on their calculated Chi square test statistic, students are asked whether or not there is support for the null hypothesis.
15:19	Student activity	After rejecting the original null hypothesis, students are asked to formulate a new hypothesis.

Video Summary

This video introduces students to Chi square hypothesis testing. The Chi square test for goodness of fit is used to analyze experimental data from a basic coin flipping experiment. Students then use what they learned to better understand experimental data obtained from genetic experiments.

Soph 304 Materials

Pre-Video Materials

When appropriate, this guide is accompanied by additional materials to aid in the delivery of some of the following activities and discussions.

1. Punnett square problem - Make a cross between a heterozygous tall pea plant and a homozygous short pea plant.

(a) What theoretical distribution of genotypes will the cross produce?

(b) What theoretical distribution of phenotypes will the cross produce?

2. A curly-winged phenotype is a dominant trait for a fruit fly. What experiment(s) would you propose if you wanted to know the genotype of a curly-winged fly?

Post-Video Materials

1. StarGenetics - http://star.mit.edu/genetics/index.html
StarGenetics is a Mendelian cross simulator developed by MIT that allows students to simulate mating experiments and learn about genetic experimental design and genetics concepts. This tool is featured in Chapter 2 of the video.

Instead of having students watch the entire video, you may wish to have them watch Chapter 1 of the video and then download the StarGenetics tool (http://star.mit.edu/genetics/index.html) and perform the exercise featured in Chapter 2 of the video. Detailed instructions for the exercise can be found on this site:

http://star.mit.edu/genetics/problemsets/index.html

under the headers Fruit Fly Exercises -> Chi-Square Test -> Fruit Fly Exercise 1 - Level 2.

Additional Resources

References

The following paper discusses common difficulties students may have in understanding basic statistical concepts.

- Batanero, C., Godino, J. D., Vallecillos, A., Green, D., & Holmes, P. (1994). Errors and difficulties in understanding elementary statistical concepts. *International Journal of Mathematical Education in Science and Technology, 25*(4), 527-547.

The MIT StarGenetics simulation tool and associated resources can be found here:

- http://star.mit.edu/genetics/index.html

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