TEACHING NEWTON's BINOMIAL WITH GENETICS

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Introduction

The teaching of Combinatorial Analysis is still done in a very mechanical way by some teachers who, for the most part, memorize formulas without real content domain. This practice is repeated superficially, thus not stimulating combinatorial reasoning [1]. The vast majority of books and websites present this content only through formulas, without showing their relationship to applicability, making it difficult for students to learn. Thus, we present an application of Newton's Binomial, as a way of intuitively teaching such content. Since the binomial is used in many areas, we choose an interdisciplinary study with Biology, more specifically, in Genetics. In this work, we show how the binomial is presented in Genetics and why it is so important to understand certain characteristics inherited from our ancestors, such as the color of the eyes. We use concepts of Polygenic (or Quantitative) Inheritance [2].

Objective

The aim of this work is to present a new way of teaching Newton's Binomial through an interesting application related to Genetics, without the early use of formulas. In addition, we show the relationship between the binomial and the combinatorial analysis: how is the combination present in terms of the binomial and what do they represent in its expansion?

Methodology

The methodology consisted of studying applications in genetics that involve Newton's Binomial; choosing an application and developing playful material for teaching the content which included simulations and short films.

Application

In genetics, phenotype refers to characteristics of the individual that can be visible or detectable, and polygenes are groups of genes that produce repeated variations. Polygenic inheritance refers to a single inherited *phenotypic trait* that is controlled by two or more different *genes*. The interaction that occurs between genes (polygenes) that convey the inherited characteristics happens in such a way that each one of them is responsible for a portion of the resulting phenotype. The pattern of inheritance distribution, in this case, follows the pattern of Newton's Binomial, $(p + q)^n$, where n is the number of polygenes, p represents the dominant genes (B and G) and q represents the recessive (b). In our study, we develop Newton's binomial for the eye color problem [3].

The eye color results from at least two genes. The first, OCA2 (oculocutaneous albinism II), comes in two forms: B (brown) and b (blue). The second gene, called GEY (green eye color), comes also in two forms: G (green) and b (blue). The first thing to notice is that the gene B is dominant over both G and b. And, as well, G is dominant over b (recessive). In other words, a person heterozygote BbGb, despite having the gene G, she has brown eyes. Thus, we could calculate the probability of their progenies being born with brown, green or blue eyes shown in Table 1 [4]. Other genes produce spots, rays, rings and pigment diffusion patterns.

Table 1: Cross between two heterozygotes

	BB	Bb	bB	bb
GG	BBGG	BbGG	bBGG	bbGG
Gb	BBGb	BbGb	bBGb	bbGb
bG	BBbG	BbbG	bBbG	bbbG
bb	BBbb	Bbbb	bBbb	bbbb

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