Aplication of The Hardy-Weinberg Balancing Formulation Using Mathematical Modelling

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Abstract. The Hardy-Weinberg balance principle, states that alleles and genotype frequencies in a population will remain constant from generation to generation without any other evolutionary influence, this principle is mathematically written by G. H. Hardy and Wilhelm Weinberg to be $(p + q)^2 = 1$. This research was conducted to determine the ability of students to compile mathematical models in solving biological problems relating to Hardy-Weinberg balance. The research design used was a one-shot case study experimental design. To determine the ability of students to compile mathematical models, and complete mathematical models used a test description of the proportion of alleles if there is dominance, the proportion of alleles multiple, and the proportion of sex-linked alleles, test items are arranged based on aspects in the cognitive domain. Students are considered correct in arranging mathematical models if in the student answers for each item there are all components included in the category of composing mathematical models, namely symbolizing known elements, formulating the elements in question, and determining the relationships between variables. It can be concluded that the ability of students to arrange mathematical models was moderate, and the ability to complete mathematical models was lacking.

Keywords: Mathematical Modeling, Hardy-Weinberg Balancing Formulation

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1. Introduction

Mathematics has great benefits both in daily life and in the development of other sciences. However, many people consider mathematics as a difficult and unpleasant subject (Ruseffendi, 2006). Likewise, Gewati (2018) in kompas.com writes that mathematics seems to be a frightening specter for Indonesian children so that it often makes their report cards red.

The development of science and technology today is happening so fast that human efforts to improve the level of their lives require accuracy in analysis so that the actions taken are taken through careful consideration and in this case are based on quantitative methods.

To explain the simplification of a system, symbolic models are needed which can be illustrated in the form of mathematical equations. Symbolic models are models that use mathematical symbols to represent object behavior, such models are called mathematical models (Anderson, 1970). The most widely used mathematical models are mathematical equations (Dimyati&Mudjiono, 2006). This model can be considered as an attempt to abstraction of problems in the form of mathematical equations that must be solved mathematically. For example in biology with a mathematical model $X = 2^n - 2$ in mind will draw an idea which is a way to calculate new homozygous combinations of dihybrid marriages.

To get an idea of the role of mathematical models in biology, the following describes the use of mathematical models in population genetics. In the human population it is known that there are quite a lot of hereditary traits, for example, the state of color blindness caused by genes found on the X chromosome, so that color blindness is more often found in male than female individuals (Suryo, 2010) using the Hardy-Weinberg formula in the form the equation p + q = 1 can be known the percentage of women who are color blind.

In solving problems mathematically according to Sudjono (1988) the stages in the problem-solving process are understanding the problem, making a plan for solving it, carrying out a plan for solving it and doing a re-examination.

2. Method

This research is a quasi-experimental study using a One-shot case study design, classes that are taking genetic courses are used as an experimental class. The class was given treatment in the form of learning to solve population genetic problems with the preparation of mathematical models. The material provided is the Hardy-Weinberg balance and calculation of the proportion of alleles. At the end of the lecture, a final test in the form of a description is given to obtain data about the ability of students to develop mathematical models.

The research subjects were 29 students of the Biology Education Study Program FKIP University of Muhammadiyah Palembang who were taking genetic courses in 2018/2019, after the final test score data was obtained by analyzing the data by calculating the average scores for each component in the category of compiling and completing mathematical models, i.e., symbolizing known elements, formulating known elements, determining relationships between variables, and writing answers. Average final test scores are categorized into 3 levels of ability, namely good, moderate, and less (Arikunto, 2013) with the ability criteria as in table 1 below:

Table 1. Criteria of students' capability

Category	X/X max (%)
Well	76-100
Fair	50-75
Less	0-49

3. Result and Discussion

Students are considered correct in compiling and completing mathematical models if the answers to each test item have all the components in the category of compiling and completing mathematical models. All components in each item are analyzed based on data that has been processed using the SPSS program, the results of the analysis are as in table 2.

Table 2. Score of the ability to compile and complete mathematical models

Component	X	sd	$\dot{X}$ / X maks (%)	Category
Symbolize a known element	3.36	1.68	56	Fair
Formulate known elements	3.16	1.55	52.67	Fair
Determine the relationship between variables	3.02	1.51	50.33	Fair
Write down the answers	2.56	1.47	42.67	less

In developing mathematical models, most students have difficulty in determining the relationship between variables, this happens because students do not do the previous steps correctly. In order to symbolize the elements that are known and formulate the elements that are asked students must first master the concept of genetics. If students do not master the concept of genetics, they certainly will not be able to symbolize known elements, because to be able to symbolize the genotype of albino people, for example, students must know the concepts of genotype and albino. This is similar to the results of Syaiful's research (1996) which revealed that students tend to have difficulty in converting statements in questions into symbols and difficulty in understanding terms, as well as Lawson's (1988) research's conceptual statement that genetics is difficult to understand the student.

4. Conclusion

Based on the results of the analysis of research data, it can be concluded that the ability of students in developing mathematical models is not good, this causes the lack of students' ability to solve genetic problems.

The lack of ability to solve problems is also caused by poor mathematical abilities, most students are weak in arithmetic operations, which causes errors in answers, and students are also not accustomed to doing re-examination which results in errors in arithmetic operations unknown.

5. Referensi

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