

Research Article

The understanding of male and female students on the basic concepts of evolution

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ABSTRACT

Students' understanding of the concepts that underlie evolution are often less than optimal and make it difficult for them to accept the theory of evolution. The aimed of this study were to: 1) map students' knowledge of Mutation and Recombination (M and R); and 2) analyze the effect of gender on their chairperson. This survey research involving 42 Biology Education students at the University of Muhammadiyah Malang was conducted in April 2021. An online questionnaire containing 34 items related to six aspects of M and R was used as an instrument for data announcements. The results, only 30.95% in the category of good knowledge. The aspect of knowledge related to the causes of M and R has the highest average accuracy of answers, while the aspect of the difference between M and R is the lowest. Only three aspects were significantly correlated with each other. Furthermore, gender has no significant effect on all aspects of student knowledge. The low knowledge of students reported in this study needs to be followed up by improving the quality of Genetics lectures to strengthen students' basic understanding of evolution.



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INTRODUCTION

Evolution is a branch of science in Biology that often provides benefits, various benefits, such as providing recommendations on how to protect natural resources (Parker et al., 2018) to be useful in the medical field (Grunspan et al., 2018). According to the concepts studied in evolution, today's biodiversity is the result of evolution (Geeta et al., 2014). All existing species are related to each other and undergo slight changes in trait over time. The trait of living things is governed by their genetic material and genetic material is a structure that naturally can be easily changed (Snustad & Simmons, 2012). Therefore, changes in the nature of living things are a common occurrence.

In general, changes in genetic material are caused by two main events, i.e. mutation and recombination (M and R). In the event of a mutation, the genetic material in the natural or artificial changes in which the changes are not regulated by the cell (Ripley, 2013). In contrast to mutation, recombination is a process of changing genetic material that involves various enzymes that are regulated by cells (D. Carroll, 2013).

Although both have different causes and mechanisms, both cause changes in the structure of the genetic material. Changes in genetic material are conditions that underlie changes in traits. Therefore, mutations and recombination are considered the basic ingredients of evolution (Arenas et al., 2018).

In biology, evolution is the most debated topic (Paz-Y-Miño-C & Espinosa, 2015). Many people do not accept the theory of evolution. Among students, not a few of them also do not accept the theory of evolution (Betti et al., 2020; Teixeira, 2019). These conditions may be caused by their low knowledge because attitudes are significantly correlated with knowledge (Carter et al., 2015; Carter & Wiles, 2014; Weisberg et al., 2018).

In line with the information presented in the previous paragraph, evolution is a topic that is considered difficult by high school students to college students (Fauzi et al., 2021). Many students have low understanding of evolution (Coleman et al., 2015). Furthermore, the topic of evolution is often a source of misconceptions (Karataş, 2020; Yasri, 2014; Yates & Marek, 2014). Because of low and inaccurate knowledge, not a few students difficult to accept the theory of evolution.

In relation to learning outcomes, gender factors sometimes affect students' academic achievement. Gender is considered to be able to affect students' academic achievement where male students often perform better than female in science learning (Lin, 2015). On the other hand, female students' scientific literacy was reported to be better than male students (Kristiyasari et al., 2018). However, other research findings inform that gender does not have a significant effect on student competence (Glock & Krolak-Schwerdt, 2013; Piraksa et al., 2014). Therefore, gender studies are one of the interesting studies in the field of education because general conclusions regarding the influence of gender on learning are still difficult to formulate.

In order to ascertain the effect of gender, several researchers have conducted studies analyzing the effect of gender on science achievement (Jia et al., 2020), science literacy (Kristiyasari et al., 2018), science performance (Lin, 2015), and scientific reasoning ability (Piraksa et al., 2014). However, studies that specifically look at the effect of gender on students' knowledge of evolution have never been carried out. In relation to research on the topic of evolution, some research is limited to studying students' understanding levels (Coleman et al., 2015) and misconceptions (Karataş, 2020; Yasri, 2014; Yates & Marek, 2014). Most studies only focus on the concepts and theories of evolution but there are no studies that have analyzed students' prior knowledge of the basics of the concept of evolution. Mutation and recombination are two concepts that should be mastered by students before studying the concept of evolution. Therefore, the purpose of this study was to analyze the level of students' knowledge of the concepts of mutation and evolution and its relation to their gender differences. This research is necessary because it can evaluate the quality of the biology education curriculum. In addition, the findings of this study can also be used as a basis and input in reformulating evolutionary biology learning in universities.

METHOD

This survey research was conducted at the Department of Biology Education, Universitas Muhammadiyah Malang. A total of 42 students who take the Evolution course were involved as research respondents. Student gender was positioned as the independent variable, while the level of knowledge about the basics of evolution was positioned as the dependent variable. Data collection was carried out during April 2021.

Knowledge data was collected using a questionnaire about the concept of M and R. The questionnaire consisted of 34 statements which were divided into five aspects, i.e. causes of M and R (three items), frequency of M and R (six items), difference between M and R (eight items), impact of M and R (13 items), as well as M and R's relationship with evolution (four items). Each respondent was asked to analyze the accuracy of **each statement by selecting the "correct", "incorrect", and "do not know" options. The questionnaire was entered into the Google Form and the link was distributed to the students who were involved as research respondents.**

After all respondents filled out the questionnaire, the research data was downloaded in CSV format. Then, student answers were labeled with a score of 1 (if the answer was correct) and 0 (if the answer was incorrect). The accuracy score of each student's answer was then determined by calculating the average score of each individual which was then multiplied by 100. Students will be categorized as having good knowledge if their score reaches 70, while students who do not reach 70 were categorized as having not good knowledge. The average accuracy of answers in each aspect was also calculated and compared to identify which aspects were the least mastered by students. Next, a correlation test using Pearson Product Moment was run to see the

relationship between each aspect that was measured. Finally, to analyze the effect of gender on student knowledge, the independent samples t-test was conducted.

RESULTS AND DISCUSSION

Students' knowledge of the basic concepts of evolution will determine their attitude and level of acceptance of evolution. This research has succeeded in collecting data on the level of knowledge about M and R from students who take the Evolution course. After the data was processed, only 30.95% of students whose knowledge was in the good category. Although the highest score obtained by students reached 94.12, the average overall score of students was still unsatisfactory. In more detail, the distribution of student knowledge categories is presented in Figure 1.

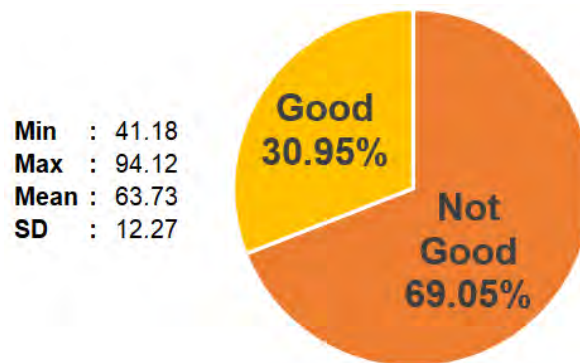


Figure 1. Distribution of student knowledge categories about the concept of M and R

M and R are two topics that make up Genetics which the respondents of this research have studied in the previous semester. The low knowledge of most students about M and R is in line with previous study that analyze students' knowledge about the concepts of Genetics (Kılıç et al., 2016). The low knowledge of genetic concepts is in line with the findings of other studies which report the low knowledge of students about evolution (Coleman et al., 2015). In line with all these findings, along with Genetics, Evolution is a subject (and biology topic) that is reportedly difficult for high school students and college students to study (Fauzi et al., 2021).

Furthermore, to see the level of student knowledge in each aspect of M and R, the visualization of the student's average score is presented in bar chart in Figure 2. Based on Figure 2, the cause of M and R is the aspect with the highest average score. On the other hand, the lowest occurs in the aspect of difference of M and R. This finding indicates that many students are still unable to distinguish between mutation and recombination phenomena. These two phenomena cause changes in genetic material so that not a few think that these two phenomena are different phenomena. In fact, mutation is an event that is beyond the control of the cell, recombination is an event designed by the cell.

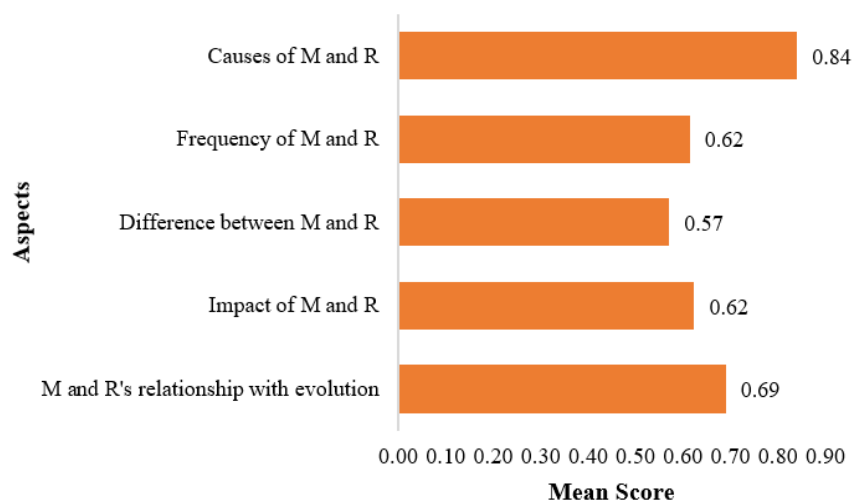


Figure 2. Comparison of students' knowledge levels between aspects of M and R

Furthermore, to determine the correlation between aspects of the evolutionary material accessed in this study, the Pearson Product Moment test was carried out. The summary of the results of the correlation test is presented in Table 1. Based on Table 1, the difference between M and R, the impact of M and R, and M and R's relationship with evolution aspects were significantly correlated with each other.

Then, Table 2 presents a summary of the results of the t-test to analyze the difference in scores for each aspect between male and female students. Based on Table 2, the significant difference was only occurred in the impact of M and R aspect [$t(40) = 2.084, p = 0.044$]. On the other hand, the mean scores in the other four aspects did not show a significant difference ($p > 0.05$). When examined in more detail, although there are significant differences, the significance value in the impact of M and R aspects is also close to 0.05. These results indicate that gender in general has not had a significant effect on the overall level of students' knowledge, especially on the topic of M and R.

Table 1. Summary of correlation test results between aspects of M and R

Aspects	Causes of M and R*	Frequency of M and R	Difference between M and R	Impact of M and R
Frequency of M and R	-0.119			
Difference between M and R	0.009	0.067		
Impact of M and R	0.076	0.240	0.475*	
M and R's relationship with evolution	-0.024	0.128	0.329*	0.371*

*. Correlation is significant at the 0.05 level (2-tailed).

Table 2. Comparison of knowledge levels between male and female students

Aspects	Mean Score		Mean Difference	df	t	p
	Male	Female				
Causes of M and R*	0.79	0.89	-0.10	33.6	1.205	0.237
Frequency of M and R	0.61	0.62	-0.01	40	0.137	0.892
Difference between M and R	0.58	0.56	0.02	40	0.421	0.676
Impact of M and R	0.68	0.57	0.11	40	2.084	0.044
M and R's relationship with evolution	0.76	0.62	0.14	40	1.895	0.065

*Equal variances not assumed

The absence of the effect of gender differences on the average knowledge score of the majority of aspects measured in this study is in line with several previous studies that also analyzed gender. Research in Indonesia reports that student gender has no effect on decision making skills in biology problems (Hermawan et al., 2018). Research in other locations also reported that gender had no effect on students' thinking skills and biology learning outcomes (Sulistiyawati & Andriani, 2017). The findings of this study also strengthen research reports from other countries that inform similar findings (Glock & Krolak-Schwerdt, 2013; Piraksa et al., 2014).

Regarding the topics asked in this research instrument, mastery of the M and R concepts is an important asset for students to study evolution. Although they have different mechanisms and are triggered by different causes (D. Carroll, 2013; Ripley, 2013), both mutations and recombination can produce changes in the structure of genetic material that can be passed on to the next generation (Arenas et al., 2018). The change in genetic material is a prerequisite for changes in the trait of living things (Andersson et al., 2015; Snustad & Simmons, 2012). This condition is an absolute prerequisite for the emergence of subspecies to new species so as to give rise to the biodiversity that exists today. Without understanding the causes, mechanisms, and effects of M and R, students will difficult to understand the basics of evolution. As a result, students will difficult to accept evolution. The problem is, the basic concepts of evolution which are closely related to genetic concepts are often obstacles for students in studying biology. Not surprisingly, not a few students blame the theory of evolution and easily believe information that is not in line with the theory of evolution.

Strengthening the understanding of evolutionary concepts is a joint task of educators and researchers in the field of Biology education. Although evolution is often a concept that widely denied by the community, the application of the concept of evolution provides many benefits for humans. Some of these benefits include in the medical field (Grunspan et al., 2018), providing recommendations on how to protect natural resources (Parker et al., 2018) and to contribute the other global challenges (S. P. Carroll et al., 2014). By not trusting and mastering the concepts in evolution, it will close the possibility for them to utilize or develop applications of those evolutionary concepts. Therefore, the implementation of learning that is able to improve learning outcomes or students' understanding of evolution needs to be done. Several learning models that are

reported to be able to make a positive contribution, such as project-based learning (Cook et al., 2012) and dual situated learning model (Helmi et al., 2019).

Responding to the findings and discussion of this research, further research needs to be done to improve students' understanding of the basics of evolution. Research that optimizes and tests innovative learning models for genetics and evolution courses needs to be done. In addition, further research aimed at evaluating students' understanding of other concepts of evolution needs to be planned. Wider involvement of respondents as well as broader topics of evolution also need to be done. To support these studies, valid and reliable instruments to measure student competence related to genetics and evaluation need to be developed.

CONCLUSION

This study has analyzed the level of knowledge of students on the topic of M and R which is the basic concept of evaluation. As many as 69.05% of students have knowledge that the category was still not good. The causes the M and R phenomenon aspect has the highest average accuracy, while the difference between M and R aspect was the lowest. The results of the Pearson Product Moment analysis inform the difference between M and R, the impact of M and R, as well as M and R's relationship with evolution aspect were significantly correlated with each other. Furthermore, the results of the independent samples t-test concluded that the knowledge of male and female students was not significantly different in every aspect that was asked.

Following up on the findings of this study, students' knowledge of M and R should be optimized before they study evolution. Genetics courses need to be reformulated so that the empowerment of knowledge related to the concepts that underlie evolution is more optimal. If these concepts are less than optimal, then students are more likely not to be able to master and accept the theory of evolution. Furthermore, with regard to the gender variables studied in this study, studies involving larger samples need to be conducted to confirm the findings. It is also necessary to expand the concepts involved in the data collection instrument. However, if based on research findings, lecturers do not need to distinguish the form and assignment of lectures between male and female students.

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