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Authors	Purwanti Pratiwi Purbosari, Destri Ratna Ma'rifah
Title	Knowledge and Attitude of Biology Teacher Candidate Students towards Genetically Modified Organisms (GMOs)
Original file	9173-25592-1-SM.DOCX 2021-10-22
Supp. files	None
Submitter	Purwanti Pratiwi Purbosari
Date submitted	October 22, 2021 - 09:28 AM
Section	Articles
Editor	Dede Sahrir
Author comments	hopefully this article can publish in december, 2021
Abstract Views	0

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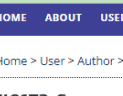
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 Title: Knowledge and Attitude of Biology Teacher Candidate Students towards Genetically Modified Organisms (GMOs)
 Section: Articles
 Editor: Dede Sahrir

Peer Review

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Knowledge and Attitude of Biology Teacher Candidate Students towards Genetically Modified Organisms (GMOs)

article info	abstract
Article history: Received: dd mm yyyy Received in revised form: dd mm yyyy Accepted: dd mm yyyy Available online: dd mm yyyy Keywords: GMO Knowledge Attitude Biology teacher candidates	Genetically Modified Organisms (GMOs) provide many benefits but also promote public debate regarding their safety and risks. The specific researches focused on biology teacher candidates' knowledge and attitude towards GMOs are very scarce. This study aimed to describe the knowledge and attitude of biology teacher candidate students towards GMOs. The data was obtained by distributing an online questionnaire. The students' knowledge and attitude scores were analyzed using an independent sample t-test to analyze the presence of genetic course effect on knowledge and attitude of biology teacher candidate students towards GMOs. Pearson correlation was used to see the correlation between students' knowledge and their attitudes towards GMOs. As a result, genetic course do not have a significant effect on knowledge or attitude of biology teacher candidate students towards GMOs. Positive correlation was found between knowledge and attitude of biology teacher candidate students towards GMOs.

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1. Introduction

One of the developments in genetic is research related to genetic engineering (in plants, animals, and microorganisms). Scientists have developed much research related to genetic engineering, even this researches have been applied to genetically engineered products released

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 the importance of this research has not been found on prospective teachers. can be further linked to developments in the field of genetics

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One of the developments in genetic is research related to genetic engineering (in plants, animals, and microorganisms). Scientists have developed much research related to genetic engineering, even this researches have been applied to genetically engineered products released by many countries for public consumption. The first commercialization of genetically modified crops occurred in 1994 (FlavrSavr tomato). In 2011 already 59 countries used products from genetically modified organisms (GMOs). It is recognized that genetic engineering results help increase agricultural productivity, food production, reduce the use of pesticides, and produce products with specific desired properties (Du & Rachul, 2012). Even engineered organisms play an essential role in bioremediation, namely in the remediation of industrial waste, reducing the toxicity of some harmful compounds, and helping to eliminate pollution by hydrocarbons and the use of oily fuels (Kumar et al., 2018). However, the use of GMOs is feared to contain risks to health and the environment, as well as ethical violations (Du & Rachul, 2012). Therefore, GMOs still have pros and cons in society.

Several studies have captured people's knowledge, perceptions, and attitudes towards GMOs. For example, the knowledge related to genetic engineering from the general public as consumers in America (Hallman et al., 2013) and Latvia (Aleksejeva, 2014); Knowledge, attitudes and perceptions of the general public regarding GMOs in Zimbabwe (Chagwena et al.,

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the importance of this research has not been found on prospective teachers. can be further linked to developments in the field of genetics

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The Chi-square analysis was held to ensure the existence of significant association between the differences of genetic course background variable and students' response towards the asked information. Fisher-Freeman-Halton exact test was used when the cell with the total number of the data less than five for 2x2 contingency table, and Kolmogorov Smirnov test for more than 2x2 contingency table. The score of 14 items in knowledge questionnaire were summed as the knowledge score of each student. Student knowledge level was grouped based on Bloom cut-off point as "good", "moderate", or "low". The score of 14 items in attitude questionnaire were summed as the attitude score of each student. Student attitude level was also grouped based on Bloom cut-off point a "negative", "neutral", or "positive" attitude (Seid & Hussien, 2018). The frequency of knowledge and attitude levels of each student's group based on genetic course were then served in pie chart. Each students' knowledge and attitude scores were analyzed using independent sample t-test to analyze the presence of genetic courses' effect on knowledge and attitude of biology teacher candidate students towards GMOs. Furthermore, the Pearson correlation was used to see the correlation between students' knowledge and their attitudes towards GMOs.

3. Result and Discussion

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Figure 2. The different profile of attitude level of biology teacher candidate students based on genetic course group

The majority of students, have taken genetic courses or not, have a neutral attitude towards GMOs. The total biology education student who have positive attitude towards GMOs only 7,94%. This is not in line with previous research, which stated that students studying biological material should have a more positive attitude towards biotechnology, including GMOs (Tegegne et al., 2013).

Table 2. The results of independent sample t-test.

Levene's Test for Equality of Variances		t-test for Equality of Means					
F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference

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							Lower	Upper		
Knowledge	Equal variances assumed	.002	.967	-1.548	61	.127	-.79522	.51367	-1.82237	.23193
	Equal variances not assumed			-1.538	52.748	.130	-.79522	.51691	-1.83212	.24168
Attitude	Equal variances assumed	.011	.915	-1.462	61	.149	-2.14865	1.46932	-5.08674	.78944
	Equal variances not assumed			-1.450	52.259	.153	-2.14865	1.48222	-5.12260	.82530

Based on the independent sample t-test, it is known that genetic courses have no significant effect on students' knowledge ($\text{sig}=0,127>0,05$) or attitudes ($\text{sig}=0,149>0,05$) towards GMOs. This result indicates that there may be a need for unique methods in genetic course to improve students' understanding and attitudes towards GMOs, such as several studies that have been carried out that have succeeded in increasing students' knowledge and attitudes towards GMOs through direct practicum activities (Klop et al., 2010) (Witzig et al., 2013), the use of rebuttal texts (Heddy et al., 2016), or case studies (Dori et al., 2003). Table 2 presents the results of independent sample t-test.

Table 3. The results of Pearson Correlation analysis.

		Pengetahuan	Sikap
Knowledge	Pearson Correlation	1	.359**
	Sig. (2-tailed)		.004
	N	63	63
Attitude	Pearson Correlation	.359**	1
	Sig. (2-tailed)	.004	
	N	63	63

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Knowledge	Pearson Correlation	1	.359**
	Sig. (2-tailed)		.004
	N	63	63
Attitude	Pearson Correlation	.359**	1
	Sig. (2-tailed)	.004	
	N	63	63

** Correlation is significant at the 0.01 level (2-tailed).

Pearson Correlation analysis was used to analyze the correlation between students knowledge and their attitudes towards GMOs. Based on the results of that analysis, it is known that there is a positive correlation between students' knowledge and their attitudes towards GMOs, although the correlation is relatively weak ($\text{sig} < 0,05, r = 0.359$). This is in line with previous research that showed a positive correlation between students' knowledge of genetically modified foods and their attitudes towards it (Heddy et al., 2016), as well as the knowledge and attitudes of high school students related to biotechnology which also discussed genetically modified products (Klop et al., 2010).

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