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The Association Between the Academic Level of Biology Education Students at A Private University and Their Level of Trust in Conspiracy Theories Related to COVID-19

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Abstract

A low level of scientific literacy and application leads students to believe in conspiracy theories (CTs). The purpose of this study was to analyze the accuracy of biology education students' responses to CTs about COVID-19 and its association with their academic level. The population of this survey research was 134 students at the Department of Biology Education, from a private university located in East Java, Indonesia. The research sample included twenty students with the highest GPA (high academic group) and twenty students with the lowest GPA (low academic group). A CT questionnaire about COVID-19 was used as a data collection instrument. Less than half of the students correctly answered five of the eight CT questions asked. Only four CT items had a response accuracy above 50 percent. Spearman's rho test revealed that there was no significant correlation between GPA and students' distrust of CTs. Based on the results of the Kruskal-Wallis H test analysis, the GPA of high and low academic students was significantly different. However, Chi-Square analysis showed that students' distrust of all CTs asked was not significantly associated with students' academic level. Concerning the findings of this study, it is necessary for suggesting to reformulate the curriculum for science and biology education to improve the scientific literacy and information literacy of prospective teachers.

Keywords: *conspiracy theory, COVID-19 pandemic, misinformation, science literacy*

Introduction

In every country, science subject is a major part of the education curriculum (Childs, 2015; Faisal & Martin, 2019; Harlen, 2017). The purpose of science education is to teach students about scientific evidence and phenomena that occur in the surrounding environment (James et al., 2012; Knekta et al., 2022; Westwell & Panizzon, 2018). Students will understand the causes and impacts of, and ways to prevent, various scientific phenomena that can negatively affect the welfare of society. By studying science, students can also learn how to improve human well-being (Rull, 2014). Therefore, science education has a positive impact on the people of a country (Kola, 2013; Kyle, 2020; Reddy, 2021).

Science education aims to improve students' scientific literacy (Roberts & Bybee, 2014). Scientifically literate students are students who understand the concepts and principles of science (Singh & Singh, 2016). With scientific literacy, students have skills that can be used to solve science-based problems (Jgunkola & Ogunkola, 2013; Primasari et al., 2020; Scherer & Beckmann, 2014). They also assume will not easily believe hoax information that often embellishes various scientific phenomena that occur around them (Howell & Brossard, 2021).

Unfortunately, students' scientific literacy in Indonesia is still not optimal. Based on a cross-country literacy measurement project, Indonesia is one of the countries with low literacy levels (Nugrahanto & Zuchdi, 2019). These findings are in line with several studies reported by researchers in several regions in Indonesia, such as in Karanganyar Regency (Murti et al., 2018) and Surakarta (Nur'aini et al., 2018). In line with these conditions, the scientific attitude of some students in Indonesia is not as developed as expected. The findings are based on their answers to information that is inconsistent with scientific laws/theories/facts (Fauzi & Sa'diyah, 2019). The low level of scientific literacy and scientific attitude causes students to be less precise in dealing with various natural phenomena that occur around them (L. He et al., 2021; Mujayapura et al., 2021; Sharon & Baram-Tsabari, 2020).

One of the natural phenomena that has occurred to date is the COVID-19 pandemic. COVID-19 is a virus related disease that attacks the respiratory system and has caused a global pandemic since March 2020 (Cucinotta & Vanelli, 2020). This disease is caused by the SARS-CoV-2 virus (Naqvi et al., 2020; Wu et al., 2020) which can enter human cells through the ACE-2 receptor (Medina-Enríquez et al., 2020). These receptors are not only found in the respiratory organs (Zhang et al., 2020) but are scattered in other organs, such as the heart (Chen et al., 2020), kidneys (Q. He et al., 2020) and pancreas (Liu et al., 2020). Not surprisingly, this virus does not only infect the respiratory system but also other organs outside the human respiratory system (Ahmadian et al., 2021; Liu et al., 2020). Furthermore,

SARS-CoV-2 is a highly contagious (Mahase, 2020; Tang et al., 2020) and easily mutated virus (Kaushal et al., 2020; Pachetti et al., 2020). Therefore, COVID-19 is easily transmitted and many variants have emerged (Karim & Karim, 2021; Lauring & Malani, 2021).

In line with the rapid transmission and mutation of SARS-CoV-2, several hoax news items also emerged and spread rapidly (Brashier & Schacter, 2020; Goreis & Kothgassner, 2020; van der Linden et al., 2020). Misinformation about COVID-19 is scattered across various social media platforms, such as WhatsApp (Soares et al., 2021; Verma et al., 2020), Facebook (Ahmed et al., 2020; Bruns et al., 2020) and Twitter (Krittanawong et al., 2020; Stephens, 2020). Video-sharing platforms also contain content that lead the public to believe a range of conspiracy theories about COVID-19 (Ginossar et al., 2022; Li et al., 2020). Various CTs have been spread, ranging from conspiracy theories about the involvement of the global elite (Fuchs, 2021; Kearney et al., 2020) to the involvement of the giant pharmaceutical industry (Ladini, 2021) as masterminds behind the COVID-19 pandemic.

The emergence of various CTs about COVID-19 can harm the entire community. Some CTs lead the public to believe that COVID-19 is just a game of the global elite. Other conspiracy theories discuss the COVID-19 vaccine (Bertin et al., 2020). People's beliefs in vaccine-related conspiracies will prevent them from participating in vaccination activities (Bertin et al., 2020; Romer & Jamieson, 2020). In addition, people will be reluctant to seek treatment and will not believe in the existence of COVID-19 if they believe that the pandemic is just a trick of scientists and the pharmaceutical industry. By trusting CTs, people are also reluctant to comply with health protocols (Allington et al., 2020; Bierwiaczonek et al., 2020; Freeman et al., 2020; Georgiou et al., 2020; Romer & Jamieson, 2020), harming the people in the community. By not adhering to health protocols, the people around them will be more prone to contracting COVID-19 (Chu et al., 2020; Islam et al., 2020; Kim, 2020).

In connection with the large number of CTs during the pandemic, Biology Education Study Program students should not easily believe such misinformation. The higher their academic level, the harder it should be for them to believe misinformation. Biology education students as prospective educators should not easily spread false news that can mislead the public. Students learn concepts about infectious diseases, viruses and evolution during several courses in their study program. Their GPA is an illustration of their level of concept mastery during lectures. So, supposedly, the higher their GPA, the lower would be their acceptance of CTs. However, these predictions must be confirmed so that universities can take action if the prediction is not validated.

Responding to the importance of the level of understanding of students about COVID-19 who are majoring in education, several studies have been carried out. At the beginning of the pandemic, research was conducted to access the COVID-19 literacy of biology education students (Fauzi et al., 2020). Other studies have also measured students' knowledge about COVID-19 (Dilucca & Souli, 2020; Gohel et al., 2021; Olaimat et al., 2020). On the other hand, several studies have also investigated the students' perspectives (Aker & Mıdık, 2020; Olum et al., 2020) and awareness (Modi et al., 2020) about COVID-19. However, the scope of these studies has never touched on CTs about COVID-19. Therefore, the purpose of this study was to analyze the response of biology education students to CTs. Not only that, student responses will be associated with their academic level. This research is urgent because it can provide an overview of the acceptance or rejection of students towards CTs. The findings depict students' level of scientific literacy and their scientific attitude as well as their thinking skills towards the natural phenomena they face. This research also provides a basis for universities to modify their science education curriculum if the findings need to be followed up.

Method

Research Design and Participants

This survey research was conducted by involving students from one private university located in East Java, Indonesia. Data collection was carried out online during 2020 because the COVID-19 pandemic was still occurring at that time. The population of this study was 134 students in the fifth semester of the Department of Biology Education. The fifth-semester students were chosen because they had taken several courses related to the COVID-19 pandemic, namely basic science, microbiology, genetics and evolution. The academic level was positioned as an independent variable in this study.

Data Collection Instrument

The data collection instrument for this study was a questionnaire developed in previous research (Fauzi et al., 2022) dealing with conspiracy theories about COVID-19. This questionnaire consists of eight statements of agreement regarding CTs that emerged in the era of the COVID-19 pandemic. Sequentially, the eight CT items that were asked concerned: 1) biological weapons; 2) WHO; 3) vaccines; 4) population control; 5) 5G network; 6) misinformation from experts; 7) global elite; and 8) pharmaceutical industry. The questionnaire has a tiered level of approval response, from disagreeing to strongly agreeing on the CT. When the student gives an accurate response, the respondent will get a score of 1. If the response is incorrect, the students will get a score of 0. The instrument has a low Chi-Square

value so that the instrument being tested is considered good ($\chi 2/df = 2.527$). The instrument also has a Goodness of Fit Index (GFI) value above 0.80 (GFI = 0.969) so that the instrument is classified as good fit. The RMSEA value obtained is below 0.08 (RMSEA SRMR = 0.014) so the model shows a close fit of the model based on the degree of freedom. In addition, the instrument also has an incremental fit indices value above 0.90 (CFI = 0.964 and NFI = 0.943) so that the instrument is said to be good. Because students were still taking distance lectures, the instrument was transformed into an online questionnaire using Google Forms. The Google Form link was then distributed throughout the class.

Furthermore, the GPA of all students was collected to determine groups of students with high and low academic levels. Twenty students with the highest GPA and twenty students with the lowest GPA were included as samples of this study.

Data Analysis

In this study, several statistical analyses were carried out. First, the percentage of students who had a score of 1 to 8 was calculated and visualized into a pie graph. Then, the percentage of correct answers for each CT was calculated and visualized using a bar graph. Furthermore, to find out whether there is a significant correlation between the GPA and students' distrust of the CT, the total score of each student was calculated. Then, Spearman's rho analysis was carried out on the GPA with the student's total score. As well, Chi-Square analysis was carried out to analyze the association of academic level with response accuracy for each CT. If the Chi-Square assumption was not met, the analysis was transferred to the Fisher's Exact Test. As a note, to ensure that there is a significant difference in the GPA between high and low academic students, the Kruskal-Wallis H Test on the GPA was carried out before the Chi-Square was run.

Results and Discussion

During the COVID-19 pandemic, various CTs have sprung up. CTs can not only incite the cloud society but can also incite academics who have a background in biology. Figure 1 presents a comparison of the percentages of students based on the number of accurate responses to the CTs. Based on the graph, none of the students responded accurately to all CT items (0%). Only ten percent of students gave an accurate response to the seven CTs. On the other hand, the largest percentage of students were those only able to respond accurately to four CT items (37.5%).

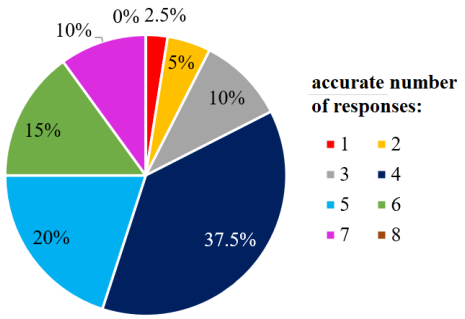

Figure 1. *Distribution of Student Percentages Based on the Number of Accurate Responses (n = 40)*

Furthermore, the distribution of the percentage accuracy of student responses to each CT is presented in Figure 2. The eighth item (which concerned the involvement of the pharmaceutical industry) is the CT with the largest percentage of inaccuracy. On the other hand, the sixth item that addressed the CT about experts' intention to mislead the public had the highest accurate response (92.5%).

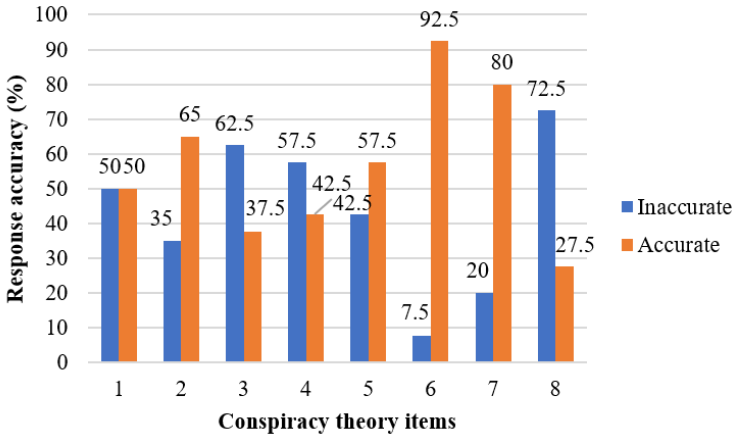

Figure 2. *The Percentage of the Accuracy of Student Responses in Each CT*

Moreover, Spearman's rho analysis was carried out to find the relationship between a students' GPA and the student's total score. The results of the analysis are presented in Table 1. Based on Table 1, GPA was not significantly correlated with the total score obtained by students [$r_s(38) = -0.087$, $p = 0.594$].

Table 1. *The Results of Spearman's Rho Analysis on GPA and Students' Total Score*

	Value
Correlation Coefficient	-0.087
Sig. (2-tailed)	0.594
n	40

This study positions the academic level as an independent variable. The Kruskal-Wallis H test was carried out to ensure a significant difference in GPA between the high-level and low-level academic groups. The results of the analysis reveal that the GPA between groups of high and low academic students is significantly different [$H(1) = 29.354$, $p < 0.001$]. The results of the Kruskal-Wallis H test are presented in Table 2.

Table 2. *The Summary of Kruskal-Wallis H Test Result (Grouping Variable: Academic Level)*

	Value
Kruskal-Wallis H	29.354
df	1
Asymp. Sig.	<0.001

Finally, a Chi-Square analysis was conducted to see the association between academic level and the accuracy of the responses in each CT. The summary of the results of the Chi-Square analysis is presented in Table 3. Based on Table 3, none of the CTs had a significant association with students' academic level. ($p > 0.05$).

Table 3. *The Summary of Chi-Square Test Results between Academic Level and Students' Response Accuracy*

Academic level	Response accuracy n (% within academic level)		*p*-value
	Inaccurate	Accurate	
Biological weapons belonging to the superpower country			
High	10(50)	10(50)	>0.99
Low	10(50)	10(50)	
WHO covers up the facts			
High	7(35)	13(65)	>0.99
Low	7(35)	13(65)	
Vaccines have been prepared before the pandemic			
High	13(65)	7(35)	0.744
Low	12(60)	8(40)	
Population control by certain parties			
High	10(50)	10(50)	0.337
Low	13(65)	7(35)	
Linkage to 5G			
High	7(35)	13(65)	0.337
Low	10(50)	10(50)	
Experts intentionally mislead the public			

Academic level	Response accuracy n (% within academic level)		*p*-value
	Inaccurate	Accurate	
High	2(10)	18(90)	>0.99*
Low	1(5)	19(95)	
Global elite engagement			
High	4(20)	16(80)	>0.99*
Low	4(20)	16(80)	
Pharmaceutical industry as the mastermind of the pandemic			
High	15(75)	5(25)	0.723
Low	14(70)	6(30)	

**results of Fisher's exact test due to 2 cells have expected count less than 5*

Based on the results obtained, the distrust of biology education students towards CTs was still low. None of the students was able to get a perfect score (Figure 1). From the graph presented in Figure 1, only 45 percent of students had a score above 4. The results of this study are in line with previous reports that record a low COVID-19 literacy of biology education students (Fauzi et al., 2020). Other studies also report that Indonesian students' knowledge of COVID-19 is less than optimal (Adli et al., 2022; Sondakh et al., 2022).

The CT about the pharmaceutical industry is the CT most trusted by students (Figure 2). This CT is one of the most widely distributed CTs in the community (Ladini, 2021). Belief in this conspiracy will lead someone to be reluctant to seek treatment or to trust health workers. Conspiracies about the pharmaceutical industry had already developed (Blaskiewicz, 2013; Singler, 2015) even before the COVID-19 pandemic occurred. If biology education students believe in the conspiracy, their families and people around them will also be affected. The reason is that people think that biology education students have a better understanding of health than they do.

Another CT that many students believe in was the vaccine-related conspiracy. More than 50 percent of students believe in a conspiracy about vaccines. This conspiracy theory is also spread through various platforms, such as on Twitter (Jamison et al., 2020) and YouTube (Ginossar et al., 2022). Belief in this CT will cause people to be reluctant to take vaccinations (Jolley & Douglas, 2014; Ullah et al., 2021). Many students do not fully understand how vaccines work, so it is easy to believe the CT about the vaccine. In biology lectures, vaccines are discussed in the immune system topic. However, the immune system is one of the difficult topics for students to learn (Fauzi et al., 2021).

The findings of this study also demonstrate that GPA was not significantly correlated with the level of student confidence in CTs (Table 2). This finding is quite

interesting because it is not in line with some previous studies. Several previous studies reported that students' academic achievement had a significant effect on students' learning outcomes (Karmana, 2011) and a significant correlation with thinking skills (Nur'azizah et al., 2021). Students' academic achievement in science is also significantly correlated with their scientific literacy (Jufrida et al., 2019). Therefore, students with high academic abilities should have high literacy and understanding of various natural phenomena that occur around them. The research also found that there was no significant association between academic level and student confidence in the eight CTs asked in this study (Table 3). Determination of the academic level in this study is based on the students' GPA. The results of the different tests also show that the GPA of high and low academic students is significantly different (Table 2). GPA is the level of achievement obtained in each course taken by students. In determining the level of achievement, the lecturer takes measurements of student competencies during lectures. In response to the findings of this study, the techniques, methods and instruments for evaluating lectures need to be modified. Evaluation could be more directed to measure student competence when facing more contextual characteristics. Measurements based on memorization and mastery of theoretical concepts are minimized and measurements of higher-order thinking skills are maximized.

Despite the absence of a significant association between academic level and belief in CTs, the percentage of students with high academic ability who believe in the conspiracy theory about biological weapons is the same as those of low academic ability. Half of the students at both academic levels believe that COVID-19 is a biological weapon of a superpower country. This CT is one of the fastest-spread CTs during the pandemic (Okediya, 2020; Shahsavari et al., 2020). This belief is an indication of the weak mastery of the concepts of evolution and genetics in many students. In line with these findings, evolution and genetics are subjects that are considered difficult for students to study (Cimermanová, 2018; Fauzi et al., 2021; Morris, 2018).

From the overall results of the analysis that has been carried out, academic level has no effect on the level of acceptance of CTs. GPA as an academic level parameter used in this study was not found to be a factor and predictor of students' responses to CTs. This finding indicates that the lectures students receive are not yet empowering their thinking skills. The grades they get and accumulate in the GPA are still based on the level of understanding and mastery of concepts, however their analytical and critical thinking skills are still poorly reflected in the GPA obtained. In fact, thinking skills are the main competencies in analyzing the information they receive.

On the other hand, the lectures that have been received by students are still not optimally empowering information literacy and digital literacy. In the era of the pandemic, information has become more massively spread in the digital world. Someone who is not competent in information literacy and digital literacy will easily accept all the information that is spread on social media. They do not have the ability to sort and analyze reliable and untrustworthy information. They also pay less attention to the source of the information obtained.

The high percentage of students who believe in conspiracy theories is an important problem that is dangerous if left unchecked. As prospective educators in the field of science, mastering science concepts is one of the main assets for students before entering their profession. Mastery of concepts is one of basic competencies that must be possessed by science teachers (Bybee, 2014). Acceptance of CTs is an indication of their low conceptual mastery (Fasce & Picó, 2019). If the teacher's mastery of concepts is low, then the learning they will hold in the future is not optimal (Hakim, 2015; Kleickmann et al., 2013).

The high level of CT acceptance also questions the level of students' scientific attitude, literacy (Miller, 2020; Mujayapura et al., 2021) and thinking skills (Machete & Turpin, 2020). From a scientific point of view, CTs are difficult to accept because the statements made in conspiracy theories are not based on scientific evidence. As academics, students must adhere to a scientific approach. They should not easily trust information that comes from less reliable sources. Students with good scientific literacy also can distinguish between science-based information and non-science-based information (Jgunkola & Ogunkola, 2013; Primasari et al., 2020; Scherer & Beckmann, 2014). In addition, if they have high thinking skills, they will be able to digest information critically so that they can decide whether the information they receive is correct or incorrect (Binkley et al., 2012; Crowley, 2015).

In connection with the duties of students majoring in education as prospective teachers, science learning must empower students' scientific literacy and scientific attitudes. Scientific literacy is one of the main competencies of the twenty-first century that must be mastered by students (Turiman et al., 2012). Furthermore, a scientific approach has a relationship with scientific process skills. Teachers will not be able to teach a competency to their students if they do not master the competence themselves. Likewise, teachers will not be able to improve the scientific literacy and scientific attitude of students if they themselves do not master these two competencies

Regarding the findings of this study, reflection and reformulation of biology learning needs to be undertaken. The application of several contextual problem-oriented learning models needs to be carried out in biology lectures. Problem-based learning (PBL) is one of the recommended learning models to be applied. Through

PBL, lecturers can bring contextual problems into the classroom (Borhan, 2014; Yaqinuddin, 2013). This learning method can train students to learn new material and to recognize typical examples of that material in real life. PBL is also reported to improve students' literacy (Febriasari & Supriatna, 2017; Flores, 2018) and thinking skills (Kardoyo et al., 2020; Ramdiah et al., 2018). Not surprisingly, PBL is often applied in various lectures in the health department to train health students to learn and solve several health problems (Car et al., 2019; Jackson, 2016; Kong et al., 2014).

Besides PBL, project-based learning (PjBL) is also recommended in biology education lectures. Similar to PBL, several previous studies have reported the strength of PjBL as a learning model that can improve students' literacy (Winarni & Purwandari, 2020) and thinking skills (Issa & Khataibeh, 2021). The creativity of students can also be empowered through this learning model (Rahardjanto et al., 2019). Both PBL and PjBL syntax depart from contextual problems that need to be solved by students. However, in PjBL, students make creative products as alternative solutions to the problems they face (Kokotsaki et al., 2016). In fact, by using the PjBL model, lecturers can raise problems related to the rise of CTs during the pandemic. Students can be asked to design products that can overcome these conditions.

In addition to contextual problem-oriented learning, learning that can empower students' scientific attitudes and skills also needs to be applied. Inquiry-based learning (IBL) is one of the recommended learning models. IBL has a positive effect on students' science process skills (Şen & Veklri, 2016). Through IBL, students have the opportunity to study science through the scientific method used by researchers when developing science (Crawford, 2015). This kind of learning activity can provide experience for students related to the process of a scientist discovering concepts to build theories. Through this experience, students will realize that theories must be built by strong scientific evidence. Therefore, the application of IBL is expected to strengthen students' scientific attitudes and skills to fortify them not to easily trust CTs.

Apart from the important findings, this study also has some limitations that should be noted. First, this study only involved students from one private university. Further research involving students from various universities needs to be carried out so that the mapping of CT acceptance rates can be wider. Second, this study only involved biology education students. Research that also involves education students from other study programs, from science education to primary school teacher education, needs to be carried out to ensure the literacy level of prospective student teachers. Students majoring in health could also be involved and positioned as a comparison. In addition, this study involved only one instrument which focused

its measurement on CTs. Therefore, future research needs to involve several other related instruments, ranging from information literacy to thinking skills instruments.

Despite some limitations, this study has provided crucial findings. It has revealed the low level of distrust of biology education students towards CTs. This finding indicates that students' scientific literacy and scientific attitude are still not optimal. They have not been able to use their thinking skills when analyzing information related to natural phenomena around them. This study also revealed that there was no significant correlation and association between academic level and students' response accuracy to CTs. The results of the analysis are not in line with predictions and theories because academic levels should have a significant effect on the literacy, scientific attitudes and thinking skills of students. From the various findings reported in this study, the quality and curriculum of biology education need to be reformulated so that students can analyze information better.

Conclusion

A survey study that aims to explore the level of accuracy of biology education students in responding to conspiracy theories about COVID-19 has been carried out in this research. The results showed that many students believed in the various CTs that were spread during the COVID-19 pandemic. The number of students who were able to respond correctly to more than four CTs did not reach half. CTs about the pharmaceutical and vaccine industries are the two CTs most trusted by students. The study also concluded that GPA was not significantly correlated with student scores. Furthermore, the academic level was also not significantly associated with the accuracy of students responding to each CT. The inability of GPA to be a predictor and factor that affects the level of acceptance of CTs due to GPA only describes the level of understanding and mastery of students' concepts after attending lectures. On the other hand, in the face of the massive spread of CTs during the pandemic, thinking skills and information literacy as well as digital literacy (that is not reflected in the GPA) are important predictors in analyzing information spread in the digital world.

Based on the findings of this study, several recommendations need to be made. First, evaluations and assessments conducted in lectures need to be modified to be able to access student competencies more broadly and accurately. Second, biology education lectures need to apply contextual-based learning and inquiry-based learning. The implementation of these methods is expected to empower students' literacy, scientific attitude and thinking skills before they become biology teachers. In addition, further research using a wider sample and more diverse instruments is also recommended.

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