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STUDENTS' KNOWLEDGE AND ATTITUDES TOWARD SCIENCE: ITS CORRELATION ON STUDENTS' DISBELIEF IN NON-SCIENTIFIC MISINFORMATION

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ABSTRACT

Immense students' belief in misinformation indicates the less optimized quality of science education. However, research that analyzes the predictors of this problem is still rarely done. Biology knowledge (BK) depicts the level of biological information mastered by students; attitude toward science (ATS) is related to students' views when participating in science learning; while disbelief in conspiracy theories (DiCT) describes a person's ability to examine information that contradicts scientific truth. The current research was aimed at analyzing BK, ATS, and DiCT among Biology students, as well as the correlation between the three. The data collection instrument used was an online questionnaire comprising four main sections: demographic items, 15 Biology, and the General Public Questionnaire items, 40 ATS test items, and 8 DiCT items. Analysis was conducted on data from 820 respondents collected from February-March 2022. Some techniques for data analysis were applied, including frequency and percentage estimation, Kruskal-Wallis H test analysis, Dunn's test analysis, Kendall's Tau Correlation, and rank-based estimation regression. This research found that: 1) student's ages and genders did not significantly contribute to any, while institutional status and study years did to BK and DiCT; 2) study program significantly contributed to ATS, and 3) ATS was found to not correlate significantly with DiCT, but BK was significant by the DiCT. Therefore, BK becomes the main competency that can protect students from unscientific conspiracy theories. This study has revealed a novelty framework about the position of knowledge and attitude in predicting students' abilities when examining misinformation.

Keywords: conspiracy theory; pseudoscience; scientific attitudes; science education; scientific literacy

INTRODUCTION

Science education is so critical to making students equipped with scientific knowledge. Scientific knowledge improves students' awareness of environmental issues (Hadzigeorgiou & Skoumios, 2013; Illahaqi et al., 2021). In addition, science education can be an ideal health education platform that educates students to live more healthily (Rangel et al., 2014; Fitriyah et al., 2021). More than that, by studying science, students can understand and respond accurately to any natural phenomena that happen around them (Shtulman & Valcarcel, 2012; Iwuanyanwu, 2019). Considering its critical role, science education must be considered one of the top-priority curriculum components, from preschool to informal education levels in the middle of wide society (Adams et al., 2018).

One of the competencies students should acquire after attending science education is mastery of Biology concepts. Even though it belongs to the lower-order thinking skills category, acquiring basic concepts will be a good capital for

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students to achieve higher-order thinking skills (Tikhonova & Kudinova, 2015; & Pramesti et al., 2022). On the importance of Biology concept acquisition, such competence is still majorly found as one of the primary dependent variables included in most of the education research in some countries (Zion & Klein, 2015; Connell et al., 2016; Fan et al., 2018; Wernecke et al., 2018). Many biology researchers have used varied evaluative instruments to assess students' concept acquisition (Wulandari et al., 2020). By possessing Biology knowledge (BK) and attending Biology instructions, students acquire good capital to analyze any Biology phenomena that exist around them (Chamany et al., 2008). They are even able to determine which information is relevant to scientific truths and which one is not (Sharon & Baram-Tsabari, 2020). In addition, they will also be able to give reasonings for existing governmental policies because, most recently, most public policies are based upon scientific evidence (Spruijt et al., 2014; Amaratunga et al., 2020; Williams et al., 2020).

Nowadays, one of the happening Biology phenomena in society is the COVID-19 Pandemic. By understanding Biology, one can understand and give good reasonings for COVID-19's possible causes, mode of transmission, and effects (Li et al., 2020; Yesudhas et al., 2021). Furthermore, Biology development has also led scientists to a series of analyses on how to prevent, cure, and develop vaccines for COVID-19 (Borah et al., 2021; Prasansuklab et al., 2021). Unluckily, in times of pandemic, there has been much misinformation about COVID-19, which is found to violate the values of scientific truths (Cuan-Baltazar et al., 2020; Verma et al., 2020). Misinformation is usually spread through diverse social media platforms, e.g., Facebook (Ahmed et al., 2020), Twitter (Krittanawong et al., 2020), and WhatsApp (Bowles et al., 2020). Besides, misinformation about COVID-19 is also easily found broadcasted on some video-sharing platforms, like YouTube (Moon & Lee, 2020) and TikTok (Basch et al., 2021).

Conspiracy theory (CT) about the COVID-19 pandemic is considered part of non-scientific misinformation, which is found to have vastly aired and believed in by many people (Shahsavari et al., 2020). Such individual misunderstanding about basic concepts and scientific principles has become the utmost reason why one easily believes in CT (Rutjens et al., 2021). Many conspiracies dictate people's disbelief in scientific truths, often dragging them down to committing unnecessary and less impactful things (Hughes et al., 2022). For instance, a group in a community who believes in CT about COVID-19 may feel ignorant about health protocols, making them unwilling to wear the mask and obey the other necessary protocols (Kroke & Ruthig, 2022; van Prooijen et al., 2021). Further, the CT believers have also clearly refused vaccination held by the government (Jolley & Douglas, 2014). Most of them, in fact, roughly accept the CTs without further inspection of their valid scientific truth.

Moreover, attitudes toward science (ATS) can be restrictive for one to believe in non-scientific misinformation. ATS is linked to the scientific attitude, and the latter is connected with individual habits in receiving scientific truths. In such a condition, one's accurate attitude toward science will determine their level of belief in science (Wintterlin et al., 2022). In line with it, community ATS is crucial to preserve the sustainability of science and technology development (de Jong et al., 2020). According to the instructional aspect, ATS correlates with cognitive learning outcomes (Kristiani et al., 2016) and students' science achievements (Mao et al., 2021). Undoubtedly, in addition to enhancing understanding of science, the existence of science education is fully expected to reinforce students' ATS.

Nonetheless, the problem is that massive information aired during the pandemic has also probably influenced Biology students through several conspiracies that are categorized as non-scientific. Many students access the internet as the primary source of information regarding COVID-19 (Fauzi et al., 2020). The internet is where misinformation and CT grow and get massive (Cuan-Baltazar et al., 2020). Further, it is also found that students tend to read more information on the internet than to understand scientific findings published in journals. That BK and ATS are the potential to protect students from CT, and sustainable evaluation of these competencies is necessary.

Apart from how the actual condition is, research on BK and ATS concerning the COVID-19 pandemic cannot be found yet. Research on BK is typically limited to the influence of instructional models (Connell et al., 2016; Ristanto et al., 2020), instructional media (Fan et al., 2018), or its correlation with thinking skills (Amanda et al., 2021). Research on ATS, during the recent decade, has been more focused on studying the influences of genders and grade levels (Lee & Chung, 2014; Zeidan & Jayosi, 2014; Kristiani et al., 2016; Fulmer et al., 2019), or even only on mapping student's ATS categories (Hacieminoglu, 2016; Astalini et al., 2019). Meanwhile, other

research attempts to study science instruction models that potentially optimize students' ATS, like ILD (Ananda et al., 2019) and CPI (Sunarti et al., 2018). Moreover, some publications on students' refusals or disagreements over CT in science are still of enormous rarity.

From the literature that has been described, currently, many people believe in information that is contrary to science. This condition occurs not only among the general public but also in the academic community and students with a science education background. This problem is influenced by the onslaught of misinformation in today's digital era. Several studies have attempted to raise this issue, but the research that seeks to solve the problem directly is still challenging to find.

The situation's complexity is the cause of the difficulty of directly solving this problem. The first step that can be taken to respond to these problems is to identify predictors that affect a person's level of trust in misinformation. Predictor identification is needed as an initial effort to overcome problems from upstream. If efforts to identify predictors are not carried out, efforts to reduce the level of public and student trust in misinformation are challenging to formulate. If predictors are identified successfully, problem-solving can be formulated better in future research.

When predictors cannot be revealed and belief in misinformation is growing among students, many are easily provoked to distrust science. As a result, they are reluctant to comply with the recommendations given by the government and scientists. This condition causes various natural disasters such as environmental damage to pandemics to be challenging to overcome.

Based on the initial explanation, although no research has examined the relationship between BK and ATS on the level of misinformation, it is indicated that both of them can affect students' DiCT levels. For that reason, the ultimate aim of the current research is to analyze BK, ATS, and disbelief in CT (DiCT) among Biology students. In addition, analysis to find correlation among those three aspects is the other aim of the research.

Notably, this research is critical since its findings can be bases for quality evaluation of scientific instructions in this misinformation era. The admission rate of students with a science background toward non-scientific CT will reflect on to what extent science education can build students equipped with scientific attitudes. Comparative and correlational analyses made in the research can also provide information about any factors that possibly contribute to students' reasoning power on CT. In addition, as this kind of research is still rare, publication of such research will provoke other typical research on how science education quality seems to be, mainly based on students' competency at information analysis over the information they receive.

Apart from the novelty and urgency of this research, the limitations also need to be considered. First, this research only involved students from study programs related to biology. Second, the research is limited to the territory of Indonesia by only involving Indonesian students. Third, the conspiracy theories that focus the discussion are related to health, especially those discussing the COVID-19 pandemic.

METHODS

This survey research is aimed to map Biology knowledge, students' scientific attitudes, and disbelief in non-scientific conspiracy theories. A survey was conducted in February-March 2022, with students throughout Indonesia appearing to be the population target. This survey is assessment-based on the population's immeasurable knowledge and attitudes. As many as 10,000 students were recruited as the target research population. Consistent with Krejcie and Morgan Table (Krejcie & Morgan, 1970), on the degree of confidence of 95% and margin of 5%, the minimum sample size to achieve was supposed to be a total of 370 respondents.

A purposive sampling technique was applied to define the survey's respondents. For the inclusive criteria, respondents had to be active students majoring in any fields related to Biology and Indonesian. In addition, exclusive criteria were also applied, including students who dropped out; post-graduate students; students with incomplete demographic data; and students not filling out informed consent as respondents.

Data about BK were collected using Biology and the General Public Questionnaire (BGPQ) developed by Schanker (1995). This knowledge questionnaire consisted of 15 question items, and the respondents were required to identify each of the statements by selecting one out of two options: (1) agree and (2) disagree. The instrument, moreover, was already adapted into an Indonesian-generated instrument and validated by three validators, namely: an expert in instructional evaluation (a lecturer of Instructional Evaluation Course); an expert in instructional media (a lecturer of Science Education-Biology); and a language expert (a lecturer from Indone-

sian Language Department). All BK questions were declared valid by involving 600 students in the item analysis process.

Moreover, data about ATS were collected using the Attitude towards Science Test (ATST) instrument developed by Chin and Lim (2016). The instrument was a form of a questionnaire comprising 40 question items that accessed the respondents' perceptions of science. There were five options provided for the respondents to select for each of the statements: (1) strongly disagree; (2) disagree; (3) not sure; (4) agree; and (5) strongly agree. Similar to BGPQ, before ATST was used, three validators validated the instrument in terms of evaluative, material, and linguistic aspects. Through the Rasch model, ATST is considered to have good psychometry (based on fit statistics, correlations, diagnostic rating scale, and person-item reliability and separation).

At last, data about students' disbelief in non-scientific misinformation were measured using the Conspiracy Theory about COVID-19 (CT-C19) instrument. It was a questionnaire that consisted of eight statements regarding COVID-19 non-scientific conspiracies. Furthermore, the respondents were provided with three options, (1) agree, (2) neutral, and (3) disagree, and they had to choose one. Unlike BGPQ and ATST, CT-C19 was an instrument designed and developed by the researcher, which had been tested in advance in previous research (Fauzi et al., 2022). In respect of factor analysis results, this instrument could measure respondent's disbelief in CT for it acquired recommended GOF values, including: χ^2/df= 2.527; RMSEA SRMR= 0.014; CFI=0.964; GFI= 0.969; AGFI= 0.940; TLI= 0.947; and NFI= 0.943.

The research begins with determining the target sample and how to access it. The determination of the sample was analyzed using the steps described in the "Research Design and Respondents" sub-section. Next, the data collection instrument was prepared. The instruments from previous studies (BGPQ and ATST) were analyzed for validity using a validator assessment, while the CT-C19 instrument was analyzed using factor analysis. Furthermore, all those three instruments were integrated as one, separated into four sections, i.e., respondent's demography, BK, ATS, and DiCT.

During data collection, Indonesia was still suffering from the COVID-19 pandemic. Due to the rise in the COVID-19 case rate, mainly due to the Omicron variant, most lecturing sessions were conducted remotely (online). In response to such a condition, directly collecting sample data from the participating institutions was impossible. Thus, the survey was also administered online, and the data collection instrument was transformed into an online questionnaire using the Google Form platform. The link to the survey was disseminated to several lecturers in some participating institutions. Moreover, lecturers who received the link were to share it with their students. After the data were collected and processed, various data analysis techniques were carried out, which will be explained in the following sub-section.

Survey data were downloaded in Comma Separated Values (CSV) format. Before the analysis, data pre-processing was carried out using Microsoft Excel. Further, a list of students with incomplete data, not meeting the inclusive criteria, and belonging to exclusive criteria were removed from the research. Afterward, the number of students for each demographic group was calculated. For BK, the 'agree' response was scored 1, and 'disagree' 0. For ATS, 'strongly agree' was scored 5, 'agree' 4, 'not sure' 3, 'disagree' 2, and 'strongly disagree' 1. At last, regarding DiCT, 'agree' was scored 2, 'disagree' 1, and 'neutral' 0. After that, the score total from the three variables was converted into a single score on a scale of 0-100. In addition, the average scores attained from each demographic group were compared. To make sure that no gaps existed in each group's achievements, the Kruskal-Wallis H test was conducted (MacFarland & Yates, 2016). If the analysis showed a significant difference, further test using Dunn's test was carried out (Dunn, 1964). After that, BK, ATS, and DiCT were analyzed to inspect the correlation using Kendall's Tau Correlation (Kendall, 1948). Next, any predictors that appeared to correlate significantly were further analyzed using rank-based estimation regression (Kloke & McKean, 2012). The use of those nonparametric tests was based on the distribution of the data obtained in this study. Data analysis was thoroughly carried out using RStudio (the R script used in analyzing the research data can be accessed at the following link: https://bit.ly/3QgeDxt).

RESULTS AND DISCUSSION

After the instrument was distributed in some participating Higher Education institutions, 821 students were willing to join the survey. There was one that did not meet the inclusive and exclusive criteria, which made the students get eliminated. Of the rest respondents, the majority were 19 years old, female, and senior (fourth-

year) students. Furthermore, respondents from private institutions were more dominant than those from public ones. Besides, the number of Biology Education Department students was smaller than that of other departments. In detail, students' demographic distribution is shown in Table 1.

After the score data were processed, the distribution of students' BK scores (M = 50.41) was lower than their ATS ones (M = 75.59). The distribution of those three variables was presented in the histogram depicted in Figure 1. Moreover, this student's BK score achievement was still not optimized. Referring to the minimum standard criteria of completion applied in most educational institutions in Indonesia, most students were still beyond the criteria. Several statements in BGPQ constituted basic concepts of Biology that were supposed to be fully acquired by students. Items related to a topic about the stomach as the central spot for the digestive system were the items attaining the highest frequency of incorrect answers. In fact, students' low score achievement in Biology knowledge was congruent to previous research findings demonstrating that many students felt hard when learning numerous Biology concepts (Ozcan et al., 2014; Fauzi et al., 2021).

Table 1. Demography of Students Participating in the Research (n = 820)

Variables	Freq (n)	%
Age (years old)		
< 19	120	14.6
19	227	27.7
20	181	22.1
21	169	20.6
> 21	123	15.0
Gender		
Male	236	28.8
Female	584	71.2
Institutional Status		
Public	356	43.4
Private	464	56.6
Department		
Biology Education	258	31.5
Biology and Applied Biology	264	32.2
Biomedical	298	36.3
Year of Study (Year)		
First	120	14.6
Second	67	8.2
Third	115	14.0
Fourth	427	52.1
Above Fourth	91	11.1

Unlike BK, despite being less maximum, students' ATS score achievement was better. Such a finding was in line with some previous research on typical conditions. The past research did not only work with Indonesian students (Astalini et al., 2019; Tanti et al., 2021) but also with those from other countries, such as Palestine (Zeidan & Jayosi, 2014) and Nigeria (Sakariyau et al., 2016). Furthermore, the research finding indicated that Biology students generally possessed a positive perspective on science. Regarding any indicators included in the instrument used, the students were shown to: have good self-concept toward science, understand the social implications of science, scientifically perceive a phenomenon, acquire positive attitudes toward scientific inquiry, get interested in science, and feel comforted when attending science instructions (Chin &

Lim, 2016). More importantly, positive perception demonstrated by students on science is so critical since it potentially influences their science learning outcomes (Mao et al., 2021).

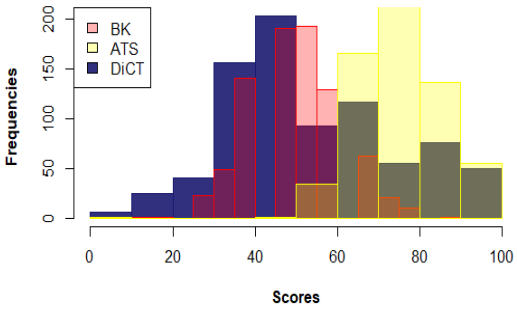

Figure 1. Histogram of Student's Score Distribution on Knowledge (BK), Attitude (ATS), and Disbelief in Conspiracy (DiCT) Variables

On the other hand, the score distribution of the DiCT variable was broader than those of two other variables despite close average typicality with BK (M = 54.50). The DiCT instrument used in the research raised some conspiracies regarding the COVID-19 pandemic. The low level of students' disbelief in those conspiracies was consistent with previous research reporting that level of literacy on COVID-19 phenomena demonstrated by Biology students in Indonesia was still low (Fauzi et al., 2020). In addition, the other researchers also found that students' knowledge about the pandemic was still less satisfactory (Adli et al., 2022; Sondakh et al., 2022). Nevertheless, such a finding did not align with other foreign research showing that students could identify whichever information based on natural science falls into fake news about the COVID-19 (Puig et al., 2021).

Regarding students' responses, CT on the pharmaceutical industry constituted the most believed conspiracy among the students. Consistent with the finding, this sort of CT was the most broadcasted conspiracy in the communities (Ladini, 2021). In addition, this health CT was, in fact, existent even before the pandemic began (Blaskiewicz, 2013; Singler, 2015). Because of believing in such a conspiracy, one would not only have negative perceptions on the pharmaceutical industry but also tend to disbelieve in health experts and officials.

The other CT attaining much belief from students was a conspiracy about SARS-CoV-2 as a biological weapon designed by superpower countries. The issue has been a hot topic since the beginning of these COVID-19 phenomena until recently (Nie, 2020; Knight, 2021). As a part of science education, students were educated to acquire scientific attitudes. In addition, students were not allowed to get trapped in any non-scientific evidence easily. In line with this conspiracy, no scientific evidence was found supporting that the virus causing COVID-19 was a biological weapon. Based on research carried out by some Biology experts, this virus existed more logically due to natural mutation in the virus genome (Khan et al., 2020; Li et al., 2020). In fact, genetic mutation constituted one of several topics in Genetics and Evolution courses that had to be offered in any department of Biology. The student's strong belief in this conspiracy topic about biological weapons clearly indicated a weak acquisition of concepts in Genetics and Evolution topics. The indication corresponded to previous research that unveiled student's low understanding and high misconception rate on genetics (Kılıç et al., 2016; Queloz et al., 2017) and evolution (Queloz et al., 2017; Karataş, 2020) topics. Similar to it, Genetics and Evolution were reportedly considered the two most difficult subjects for most Biology students (Fauzi et al., 2021).

Furthermore, the other interesting CT to be discussed was vaccination. Despite items on this topic gaining the highest average of correctness according to students' responses, the rate of their correct responses was only below 50%. Similar to the conspiracy on the pharmaceutical industry, the one on vaccines had massively grown before the pandemic (Jolley & Douglas, 2017). In times of pandemic, this sort of CT was also the most found conspiracy disseminated via social media platforms, such as YouTube (Ginossar et al., 2022) and Twitter (Jamison et al., 2020). Individual belief in these conspiracies could make people too ignorant to vaccinate themselves (Jolley & Douglas, 2014; Ullah et al., 2021). Regarding biology concepts, vaccination was studied through virus and immune system topics. Unluckily, the latter was also deemed one of the most complicated subjects for the students to study (Fauzi et al., 2021). Undoubtedly, many students acquired less satisfactory input about the topic, making it easy to believe in a vaccine conspiracy.

Furthermore, related to respondents' demography, any demographic variables unlinked to education background did not significantly contribute to students' achievement scores. As mentioned in advance, demographic variables encompassed students' age and gender. In more detail, the average score from each student's demographic group and descriptions of Kruskal-Wallis

(MacFarland & Yates, 2016) and Dunn's tests (Dunn, 1964) are shown in Table 2. The absence of significant difference among age groups was caused by age's lack of association with the year of study. In other words, students with older ages indefinitely had a more extended year of study. It was because age could not be a limitation when one was supposed to get registered in Higher Education. Moreover, even though gender contributed less significantly, female students' ATS was higher than that of males. This finding was positive to previous research demonstrating that female students reflected ATS more positively than males (Nurfina et al., 2022), both of which indicated no significant difference (Olasehinde & Olatoye, 2014).

Table 2. Student's Average Scores for Three Variables under Research based on Demography Data

Variables	Biology Knowledge			Attitudes toward Science			Disbelief in Conspiracy Theories		
	Mean[1]	SD	*H*[2]	Mean[1]	SD	*H*[2]	Mean[1]	SD	*H*[2]
Age (years old)									
< 19	49.94	11.33	9.359	75.33	7.57	2.373	55.83	18.91	4.401
19	49.93	10.44		75.37	8.30		56.42	21.38	
20	50.61	10.47		75.78	8.55		53.83	20.29	
21	52.11	10.66		75.78	9.32		53.00	21.57	
> 21	49.16	12.44		75.72	11.83		52.74	20.65	
Gender									
Male	50.54	11.40	0.031	75.27	11.13	0.264	53.47	20.93	1.449
Female	50.37	10.79		75.72	8.08		54.92	20.66	
Institutional Status									
Public	52.13[b]	10.84	17.465*	76.23	8.32	2.190	59.32[b]	21.83	33.447*
Private	49.09[a]	10.88		75.10	9.57		50.81[a]	19.07	
Department									
Biology Education	50.85	11.05	0.568	78.01[b]	8.47	22.212*	55.50	21.34	2.254
Biology and Applied Biology	50.35	11.46		74.41[a]	10.21		53.27	20.58	
Biomedical	50.09	10.44		74.55[a]	8.04		54.74	20.34	
Year of Study (Year)									
First	53.61[b]	11.31	13.809*	76.62	7.82	7.818	59.84[b]	19.51	16.204*
Second	51.44[ab]	9.63		77.81	10.27		58.49[ab]	23.30	
Third	50.96[ab]	10.53		75.68	11.03		55.43[ab]	21.69	
Fourth	49.62[a]	11.15		74.79	8.69		52.20[a]	19.85	
Above Fourth	48.50[a]	10.28		76.26	8.31		54.19[ab]	21.75	

1 = The difference in notation (alphabet superscript) after the mean value shows a significant difference at the 0.05 level.

2 = An asterisk (*) after the *H* value indicates a significant difference at the 0.05 level.

Moreover, some demographic variables related to the educational condition could significantly influence one or two researched variables. The institutional status of Higher Education where students were studying could significantly contribute to BK [H (1) = 17.465, $p < 0.001$] as well as DiCT [H (1) = 33.447 $p < 0.001$], in which scores of public university students were always significantly higher than those of private one. This fact was in line with the research of Sondakh et al. (2022), informing that institutional status could influence students' competence

(Hendajany, 2016). In addition, public and private universities in Indonesia were also reported to be different in terms of quality and regulation (Welch, 2007). In fact, such a condition had to be seen as impactful on students' input and output qualities. The difference in students' input would naturally affect the average performance of students' competence in an education institution (Newhouse & Beegle, 2005). In addition, most public universities in Indonesia usually possess more complete infrastructure than private ones, which could influence student empowerment (Zainuddin & Subri, 2017).

Moreover, the difference in terms of study program attended also significantly contributed to student's ATS [$H(2) = 22.212$, $p < 0.001$], with Biology Department students acquiring significantly higher average scores than those from the two other departments. This significant difference could be caused by instructional models applied in each department. As reported in previous research, instructional models could help optimize students' ATS (Sunarti et al., 2018; Ananda et al., 2019; Fulmer et al., 2019). Compared to the other departments, Biology Education Department had often implemented various innovative models of instruction. The reason was that most of the lecturers in the department had acquired a sense of pedagogical and andragogical backgrounds more deeply than those in the non-education departments. More importantly, most lecturers in education departments had been consistently learning and researching education topics, which was implied in the way how they designed their classes for lecturing.

Furthermore, the visualization of Kendall's Tau test (Kendall, 1948) results is depicted in Figure 2. Following it, when DiCT was placed as a criterion variable, only BK correlated with DiCT significantly ($r_\tau = 0{,}101$, $p < 0.001$). Because only BK showed a significant correlation, therefore, it was only BK that was positioned as the predictor of DiCT for rank-based estimation regression analysis.

((*) indicates a significant correlation between the two variables)

Figure 2. Visualization of Kendall's Tau Rank Correlation

The resume of the regression analysis is presented in Table 3. Shown in the table, the regression equation constituted DiCT = 37.5 + 0.313BK. The intercept and BK appeared to significantly contribute to the regression model generated ($p < 0.001$). In addition, either correlational or regression analysis indicated that BK positively correlated with DiCT. The regression equation had informed that a one-point increase in a BK score would raise a DiCT score by 0.313 points.

Table 3. Resume of Rank-based Estimation Regression Analysis

	Estimates	Std. Error	t	Sig.
Intercept	37.500	4.365	8.590	<0.001
BK	0.313	0.084	3.721	<0.001

Reduction in Dispersion Test: 9.43296, p-value: 0.0022

The correlation that occurred between knowledge (BK) and disbelief in conspiracy theories (DiCT) divulged in the research was in line with previous research demonstrating the existence of a relationship between strong belief in CT and weak knowledge (Đorđević et al., 2021). Regarding the high percentage level of Biology students' belief in conspiracies about COVID-19, such a problem was in great need of proper solutions. Students were expected to acquire a deep understanding and good and positive attitudes towards numerous biological phenomena around the communities (Sondakh et al., 2022). In addition, due to a vast number of myths, pseudoscience, misinformation, and conspiracies concerning natural phenomena and diseases in the Indonesian communities, students were highly supposed to be able to become an agent of change. Instead of supporting, they were highly required to be capable of straightening any misinformation and misconceptions. By education background they possessed close to science, students were responsible for delivering the correct information about any natural phenomena based on scientific truths.

Referring to correlational and regression analyses, the variable BK could be categorized as a crucial competence that could help predict students' scientific belief in conspiracy theories. This finding indicated that enhanced basic knowledge could minimize students' acceptance rate of non-scientific information. For that reason, integrating enhanced knowledge and science literacy could become an ideal strategy to prepare students for life in this digital era where misin-

formation and pseudoscience typically exist massively. Knowledge (Đorđević et al., 2021), together with literacy, was so obvious to significantly contribute to enhancing students' thinking skills in analyzing misinformation (Sharon & Baram-Tsabari, 2020). Without the adequate acquisition of science, students would get hard to differentiate scientific information from non-scientific one.

In line with science education enhancement and thinking skills, optimization in designing science instructions in science departments is critical (both in educational and non-educational fields of study). Implementing Problem-based Learning (PBL) and Project-based Learning (PjBL) in science instructions must be recommended exclusively for any of the Biology Departments. The second reason is that the models are ideal for facilitating science instructions (Allchin, 2013; Rahardjanto et al., 2019). These models can facilitate students in solving some contextual problems (Yaqinuddin, 2013; Borhan, 2014). Students can be assigned to make some analyses over numerous problems, which stimulates the enhancement of their critical thinking skills (Ramdiah et al., 2018; Kardoyo et al., 2020). By designing instructions in such models, lecturers can provide students with more diverse biological problems rich in conspiracies in the class and help them promote their analysis and evaluation skills.

In addition to improving learning outcomes through PBL and PjBL, other attempts to enhance students' belief in science are still necessary. Although the belief in science is not considered and measured as a variable in this research, the variable might potentially become a predictor. One of several reasons one believes in conspiracy theories is their disbelief in science (Miller, 2020; Agley & Xiao, 2021). In response to it, Inquiry-based Learning (IBL) can be recommended as a solution to attain a more massive trend in Biology lecturing sessions. Though IBL has been reported several times for its significant contribution to Biology and science instructions (Şen & Veklri, 2016), implementation of IBL in Indonesia is still less massive (Effendi-Hasibuan et al., 2019). Practically, implementing IBL is effective in helping students understand the principles of scientific performance. By understanding how scientific performance works, students will get easier to receive and believe scientific truths.

Moreover, despite this research already informing critical findings of possible impacts of information and technology development on students' science competence, the research is still imperfection. The ATS instrument used in this research consisted of items about attitudes, all of which were written in positive sentences. It is recommended that other types of instruments access scientific attitudes from other indicators to be planned and used for upcoming research. Furthermore, the research only consists of two variables as predictors of DiCT. Some other variables have the probability of being significant predictors of DiCT. Thus, for the following research, it is suggested that several variables other than the included, such as belief in CT, science literacy, and behavior seeking, be included for analysis. Besides, the research only recruited Biology students. Therefore, for a more holistic evaluation of science instructions, it is necessary to plan to include non-Biology and non-science Department students as respondents.

CONCLUSION

This survey research had fruitfully collected data about knowledge, attitudes, and disbelief in non-scientific misinformation. Only the attitude domain has a rather satisfactory score. The fact that students' disbelief in non-scientific misinformation was low indicated less optimized science instructions this far. Meanwhile, age and gender did not significantly contribute to students' scores, whilst institutional status and year of the study did, especially to knowledge and disbelief in conspiracy theory. Thus, only demographics related to academic conditions contribute to knowledge and belief in misinformation. Further, the department where students took their studies influenced their attitude toward science. Regarding Kendall's Tau analysis, it was indicated that knowledge significantly correlated with students' disbelief in non-scientific misinformation. Therefore, the high level of acceptance of students and society toward misinformation – the main problem highlighted in this study – is caused by their low level of knowledge. A positive correlation between knowledge and disbelief in non-scientific misinformation indicated the importance of students' understanding of scientific concepts in facing non-scientific misinformation invasions. Quality improvement in science education should be prepared as optimum as possible to help students deal with misinformation and pseudoscience. It is because science competence plays a critical role in elevating the quality of a nation. Moreover, further research that includes more varied respondents and analyzes demographic factors and numerous predictors needs to be held as a basis for education curriculum reformulation. In addition, other research focused on analyzing levels of students' disbelief in science upon scien-

tific truths and their acceptance of pseudoscience is also necessary to be designed as the most potential continuation of the current research. Several previous studies reported that attitudes toward science were related to science learning outcomes. On the other hand, the findings of this study are significant because they have revealed the absence of a strong correlation between attitudes towards science and students' acceptance of information that contradicts science. Thus, attitudes may play a more role as an antecedent variable than an independent variable from the level of trust in misinformation. The findings of this study also open up opportunities for other researchers to confirm the position of attitudes in this model. Besides having theoretical implications, the findings of this study also have practical implications. The findings of this research contribute significantly to the implementation of science education, especially in the current digital era. The results of the study have reported the presence of knowledge as a significant predictor. Thus, when educators realize the high level of student confidence in misinformation and pseudoscience, they can assume that their scientific knowledge is less than optimal.

REFERENCES

Adams, J., Avraamidou, L., Bayram-Jacobs, D., Joujaoude, S., Bryan, L., Christodoulou, A., Couso, D., Danielsson, A., Dillon, J., & Erduran, S. (2018). *The role of science education in a changing world* (Issue January). Lorentz Center Leiden.

Adli, I., Widyahening, I. S., Lazarus, G., Phowira, J., Baihaqi, L. A., Ariffandi, B., Putera, A. M., Nugraha, D., Gamalliel, N., & Findyartini, A. (2022). Knowledge, attitude, and practice related to the COVID-19 pandemic among undergraduate medical students in Indonesia: A nationwide cross-sectional study. *PLOS ONE*, *17*(1), e0262827.

Agley, J., & Xiao, Y. (2021). Misinformation about COVID-19: evidence for differential latent profiles and a strong association with trust in science. *BMC Public Health*, *21*(1), 89.

Ahmed, N., Shahbaz, T., Shamim, A., Shafiq Khan, K., Hussain, S. M., & Usman, A. (2020). The COVID-19 infodemic: A quantitative analysis through Facebook. *Cureus*, *12*(11), 1–9.

Allchin, D. (2013). Problem- and case-based learning in science: An introduction to distinctions, values, and outcomes. *CBE—Life Sciences Education*, *12*(3), 364–372.

Amanda, F. F., Sumitro, S. B., Lestari, S. R., & Ibrohim, I. (2021). Analysis of the relationship between concept mastery and problem-solving skills of pre-service biology teachers in Human Physiology Courses. *Jurnal Pendidikan Sains Indonesia*, *9*(3), 421–432.

Amaratunga, D., Fernando, N., Haigh, R., & Jayasinghe, N. (2020). The COVID-19 outbreak in Sri Lanka: A synoptic analysis focusing on trends, impacts, risks and science-policy interaction processes. *Progress in Disaster Science*, *8*, 100133.

Ananda, S. R., Suhandi, A., & Rahman, T. (2019). Students' attitude toward science in junior high school after follow science learning used ILD model assisted science magic. *Journal of Physics: Conference Series*, *1157*, 022060.

Astalini, A., Kurniawan, D. A., Kurniawan, N., & Anggraini, L. (2019). Evaluation of student's attitude toward science in Indonesia. *Open Journal for Educational Research*, *3*(1), 1–12.

Basch, C. H., Meleo-Erwin, Z., Fera, J., Jaime, C., & Basch, C. E. (2021). A global pandemic in the time of viral memes: COVID-19 vaccine misinformation and disinformation on TikTok. *Human Vaccines & Immunotherapeutics*, *17*(8), 2373–2377.

Blaskiewicz, R. (2013). The Big Pharma conspiracy theory. *Medical Writing*, *22*(4), 259–261.

Borah, P., Deb, P. K., Al-Shar'i, N. A., Dahabiyeh, L. A., Venugopala, K. N., Singh, V., Shinu, P., Hussain, S., Deka, S., Chandrasekaran, B., & Jaradat, D. M. M. (2021). Perspectives on RNA vaccine candidates for COVID-19. *Frontiers in Molecular Biosciences*, *8*.

Borhan, M. T. (2014). Problem Based Learning (PBL) in teacher education: a review of the effect of PBL on pre-service teachers' knowledge and skills. *European Journal of Educational Sciences*, *1*(1), 76–87.

Bowles, J., Larreguy, H., & Liu, S. (2020). Countering misinformation via WhatsApp: Preliminary evidence from the COVID-19 pandemic in Zimbabwe. *PLoS ONE*, *15*(10 October), 1–11.

Chamany, K., Allen, D., & Tanner, K. (2008). Making biology learning relevant to students: Integrating people, history, and context into college biology teaching. *CBE—Life Sciences Education*, *7*(3), 267–278.

Chin, S. F., & Lim, H. L. (2016). Validation of an adapted instrument to measure students' attitude towards science. *Asia-Pacific Forum on Science Learning and Teaching*, *17*(2), 1–28.

Connell, G. L., Donovan, D. A., & Chambers, T. G. (2016). Increasing the use of student-centered pedagogies from moderate to high improves student learning and attitudes about biology. *CBE Life Sciences Education*, *15*(1), 1–15.

Cuan-Baltazar, J. Y., Muñoz-Perez, M. J., Robledo-Vega, C., Pérez-Zepeda, M. F., & Soto-Vega, E. (2020). Misinformation of COVID-19 on the internet: Infodemiology study. *JMIR Public Health and Surveillance*, *6*(2), 1–9.

de Jong, S. P. L., Ketting, E., & van Drooge, L. (2020). Highly esteemed science: An analysis of attitudes towards and perceived attributes of science in letters to the editor in two Dutch newspapers. *Public Understanding of Science*, *29*(1), 37–52.

Đorđević, J. M., Mari, S., Vdović, M., & Milošević, A. (2021). Links between conspiracy beliefs, vaccine knowledge, and trust: Anti-vaccine behavior of Serbian adults. *Social Science & Medicine*, *277*, 113930.

Dunn, O. J. (1964). Multiple comparisons using rank sums. *Technometrics*, *6*(3), 241–252.

Effendi-Hasibuan, M. H., Harizon, Ngatijo, & Mukminin, A. (2019). The inquiry-based teaching instruction (IbTI) in Indonesian secondary education: What makes science teachers successful enact the curriculum? *Journal of Turkish Science Education*, *16*(1), 18–33.

Fan, L. C., Salleh, S., & Laxman, K. (2018). Embedding video technology in enhancing the understanding of the biology concept of breathing: A Brunei perspective. *E-Learning and Digital Media*, *15*(5), 217–234.

Fauzi, A., Husamah, H., Miharja, F. J., Fatmawati, D., Permana, T. I., & Hudha, A. M. (2020). Exploring COVID-19 literacy level among biology teacher candidates. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(7), em1864.

Fauzi, A., Rosyida, A. M., Rohma, M., & Khoiroh, D. (2021). The difficulty index of biology topics in Indonesian Senior High School: Biology undergraduate students' perspectives. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *7*(2), 149–158.

Fauzi, A., Saefi, M., Adi, W. C., Kristiana, E., & Lestariani, N. (2022). Instrument evaluation of conspiracy theory about COVID-19: Exploratory factor analysis and confirmatory factor analysis. *International Journal of Evaluation and Research in Education (IJERE)*, *11*(2).

Fitriyah, I. J., Setiawan, A. M., & Mualifah, S. (2021). The role of science learning in providing health education especially during COVID-19 pandemic. *AIP Conference Proceedings*, *2330*(March), 060013.

Fulmer, G. W., Ma, H., & Liang, L. L. (2019). Middle school student attitudes toward science, and their relationships with instructional practices: A survey of Chinese students' preferred versus actual instruction. *Asia-Pacific Science Education*, *5*, 1–21.

Ginossar, T., Cruickshank, I. J., Zheleva, E., Sulskis, J., & Berger-Wolf, T. (2022). Cross-platform spread: vaccine-related content, sources, and conspiracy theories in YouTube videos shared in early Twitter COVID-19 conversations. *Human Vaccines & Immunotherapeutics*, 1–13.

Hacieminoglu, E. (2016). Elementary school students' attitude toward science and related variables. *International Journal of Environmental and Science Education*, *11*(2), 35–52.

Hadzigeorgiou, Y., & Skoumios, M. (2013). The development of environmental awareness through school science: Problems and possibilities. *International Journal of Environmental and Science Education*, *8*(3), 405–426.

Hendajany, N. (2016). The effectiveness of public vs private schools in Indonesia. *Journal of Indonesian Applied Economics*, *6*(1), 66–89.

Hughes, J. P., Efstratiou, A., Komer, S. R., Baxter, L. A., Vasiljevic, M., & Leite, A. C. (2022). The impact of risk perceptions and belief in conspiracy theories on COVID-19 pandemic-related behaviours. *PLOS ONE*, *17*(2), e0263716.

Illahaqi, A. A. D., Nurcahyo, H., & Panjaitan, M. H. (2021). Advancing students' environmental sustainability awareness through science mobile learning: A literature review. *Proceedings of the 6th International Seminar on Science Education (ISSE 2020)*, 795–800.

Iwuanyanwu, P. N. (2019). What we teach in science, and what learners learn: A gap that needs bridging. *Pedagogical Research*, *4*(2), 1–12.

Jamison, A. M., Broniatowski, D. A., Dredze, M., Sangraula, A., Smith, M. C., & Quinn, S. C. (2020). Not just conspiracy theories: Vaccine opponents and proponents add to the COVID-19 'infodemic' on Twitter. *Harvard Kennedy School Misinformation Review*.

Jolley, D., & Douglas, K. M. (2014). The effects of anti-vaccine conspiracy theories on vaccination intentions. *PLoS ONE*, *9*(2), e89177.

Jolley, D., & Douglas, K. M. (2017). Prevention is better than cure: Addressing anti-vaccine conspiracy theories. *Journal of Applied Social Psychology*, *47*(8), 459–469.

Karataş, A. (2020). Preservice science teachers' misconceptions about evolution. *Journal of Education and Training Studies*, *8*(2), 38–46.

Kardoyo, K., Nurkhin, A., Muhsin, M., & Pramusinto, H. (2020). Problem-based learning strategy: Its impact on students' critical and creative thinking skills. *European Journal of Educational Research*, *9*(3), 1141–1150.

Kendall, M. G. (1948). *Rank correlation methods*. Charles Griffin and Company. https://books.google.co.id/books/about/Rank_Correlation_Methods.html?id=hiBMAAAAMAAJ&redir_esc=y

Khan, M., Kazmi, S., Bashir, A., & Siddique, N. (2020). COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses. *Journal of Advanced Research*, *24*, 91–98.

Kılıç, D., Taber, K. S., & Winterbottom, M. (2016). A cross-national study of students' understanding of genetics concepts: Implications from similarities and differences in England and Turkey. *Education Research International*, *2016*(c), 1–14.

Kloke, J. D., & McKean, J. W. (2012). Rfit: Rank-based estimation for linear models. *R Journal*, *4*(2), 57–64.

Knight, D. (2021). COVID-19 pandemic origins: Bioweapons and the history of laboratory leaks. *Southern Medical Journal*, *114*(8), 465–467.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, *30*(3), 607–610.

Kristiani, N., Susilo, H., & Aloysius, D. C. (2016). The correlation between attitude toward science and cognitive learning result of students in different biology learnings. *Journal of Baltic Science Education*, *14*(6), 723–732.

Krittanawong, C., Narasimhan, B., Virk, H. U. H., Narasimhan, H., Hahn, J., Wang, Z., & Tang, W. H. W. (2020). Misinformation dissemination in twitter in the COVID-19 era. *The American Journal of Medicine*, *133*(12), 1367–1369.

Kroke, A. M., & Ruthig, J. C. (2022). Conspiracy beliefs and the impact on health behaviors. *Applied Psychology: Health and Well-Being*, *14*(1), 311–328.

Ladini, R. (2021). Religious and conspiracist? An analysis of the relationship between the dimensions of individual religiosity and belief in a big pharma conspiracy theory. *Italian Political Science Review/Rivista Italiana Di Scienza Politica*, 1–18.

Lee, J., & Chung, Y. (2014). An analysis of structural relationship among the attitude toward science, science motivation, self-regulated learning strategy, and science achievement in middle school students. *Journal of The Korean Association For Research In Science Education*, *34*(5), 491–497.

Li, T., Liu, D., Yang, Y., Guo, J., Feng, Y., Zhang, X., Cheng, S., & Feng, J. (2020). Phylogenetic supertree reveals detailed evolution of SARS-CoV-2. *Scientific Reports*, *10*(1), 22366.

MacFarland, T. W., & Yates, J. M. (2016). Kruskal–Wallis H-Test for oneway analysis of variance (ANOVA) by ranks. In *Introduction to Nonparametric Statistics for the Biological Sciences Using R* (pp. 177–211). Springer International Publishing.

Mao, P., Cai, Z., He, J., Chen, X., & Fan, X. (2021). The relationship between attitude toward science and academic achievement in science: A three-level meta-analysis. *Frontiers in Psychology*, *12*.

Miller, B. L. (2020). Science denial and COVID conspiracy theories. *JAMA*, *324*(22), 2255.

Moon, H., & Lee, G. H. (2020). Evaluation of Korean-Language COVID-19–related medical information on YouTube: Cross-sectional infodemiology study. *Journal of Medical Internet Research*, *22*(8), e20775.

Newhouse, D. L., & Beegle, K. (2005). The effect of school Type on academic achievement: Evidence from Indonesia. *SSRN Electronic Journal*.

Nie, J.-B. (2020). In the shadow of biological warfare: conspiracy theories on the origins of COVID-19 and enhancing global governance of biosafety as a matter of urgency. *Journal of Bioethical Inquiry*, *17*(4), 567–574.

Nurfina, S., Aznam, N., & Paidi, P. (2022). Attitudes towards science: A study of gender differences and grade level. *European Journal of Educational Research*, *11*(2), 599–608.

Olasehinde, K. J., & Olatoye, R. A. (2014). Scientific attitude, attitude to science and science Achievement of senior secondary school students in Katsina State, Nigeria. *Journal of Educational and Social Research*, *4*(1), 445–452.

Ozcan, T., Ozgur, S., Kat, A., & Elgun, S. (2014). Identifiying and comparing the degree of difficulties biology subjects by adjusting it is reasons in elemantary and secondary education. *Procedia - Social and Behavioral Sciences*, *116*(266), 113–122.

Prasansuklab, A., Theerasri, A., Rangsinth, P., Sillapachaiyaporn, C., Chuchawankul, S., & Tencomnao, T. (2021). Anti-COVID-19 drug candidates: A review on potential biological activities of natural products in the management of new coronavirus infection. *Journal of Traditional and Complementary Medicine*, *11*(2), 144–157.

Pramesti, D., Probosari, R., & Indriyanti, N. (2022). Effectiveness of Project Based Learning Low Carbon STEM and Discovery Learning to Improve Creative Thinking Skills. *Journal of Innovation in Educational and Cultural Research, 3*(3), 444-456.

Puig, B., Blanco-Anaya, P., & Pérez-Maceira, J. J. (2021). "Fake news" or real science? Critical thinking to assess information on COVID-19. *Frontiers in Education*, *6*.

Queloz, A. C., Klymkowsky, M. W., Stern, E., Hafen, E., & Kohler, K. (2017). Diagnostic of students ' misconceptions using the Biological Concepts Instrument (BCI): A method for conducting an educational needs assessment. *Plos One*, *12*(5), 1–18.

Rahardjanto, A., Husamah, H., & Fauzi, A. (2019). Hybrid-PjBL: Learning outcomes, creative thinking skills, and learning motivation of preservice teacher. *International Journal of Instruction*, *12*(2), 179–192.

Ramdiah, S., Abidinsyah, H., & Mayasari, R. (2018). Problem-based learning: Generates higher-order thinking skills of tenth graders in ecosystem concept. *Jurnal Pendidikan Biologi Indonesia*, *4*(1), 29.

Rangel, C. N., Nunn, R., Dysarz, F., Silva, E., & Fonseca, A. B. (2014). Teaching and learning about food and nutrition through science education in Brazilian schools: an intersection of knowledge. *Ciência & Saúde Coletiva*, *19*(9), 3915–3924.

Ristanto, R., Rahayu, S., & Mutmainah, S. (2020). Conceptual understanding of excretory system: Implementing cooperative integrated reading and composition based on scientific approach. *Participatory Educational Research*, *8*(1), 28–47.

Rutjens, B. T., van der Linden, S., & van der Lee, R. (2021). Science skepticism in times of COVID-19. *Group Processes & Intergroup Relations*, *24*(2), 276–283.

Sakariyau, A., Taiwo, M. O., & Ajagbe, O. W. (2016). An investigation on secondary school students' attitude towards science in Ogun state , Nigeria. *Journal of Education and Practice*, *7*(28), 125–128.

Schanker, N. B. (1995). Biology questionnaires: Grabbing student interest the first week! *The American Biology Teacher*, *57*(5), 286–287.

Şen, C., & Veklri, G. S. (2016). The impact of inquiry based instruction on science process skills and self-efficacy perceptions of pre-service science

teachers at a university level biology laboratory. *Universal Journal of Educational Research*, *4*(3), 603–612.

Shahsavari, S., Holur, P., Wang, T., Tangherlini, T. R., & Roychowdhury, V. (2020). Conspiracy in the time of corona: automatic detection of emerging COVID-19 conspiracy theories in social media and the news. *Journal of Computational Social Science*, *3*(2), 279–317.

Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life? *Science Education*, *104*(5), 873–894.

Shtulman, A., & Valcarcel, J. (2012). Scientific knowledge suppresses but does not supplant earlier intuitions. *Cognition*, *124*(2), 209–215.

Singler, B. (2015). Big Bad Pharma. *Nova Religio*, *19*(2), 17–29.

Sondakh, J. J. S., Warastuti, W., Susatia, B., Wildan, M., Sunindya, B. R., Budiyanto, M. A. K., & Fauzi, A. (2022). Indonesia medical students' knowledge, attitudes, and practices toward COVID-19. *Heliyon*, *8*(1), e08686.

Spruijt, P., Knol, A. B., Vasileiadou, E., Devilee, J., Lebret, E., & Petersen, A. C. (2014). Roles of scientists as policy advisers on complex issues: A literature review. *Environmental Science & Policy*, *40*, 16–25.

Sunarti, T., Wasis, Madlazim, Suyidno, & Prahani, B. K. (2018). The effectiveness of CPI model to improve positive attitude toward science (PATS) for pre-service physics teacher. *Journal of Physics: Conference Series*, *997*(1).

Tanti, T., Kurniawan, D. A., Kurniawan, N., & Anggraini, L. (2021). Attitudes toward science based on analysis and correlation: Learning enjoyment & leisure interest on science. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *11*(1), 113–126.

Tikhonova, E., & Kudinova, N. (2015, August 26). Sophisticated thinking: lower order thinking skills. *2nd International Multidisciplinary Scientific Conference on Social Sciences and Arts*.

Ullah, I., Khan, K. S., Tahir, M. J., Ahmed, A., & Harapan, H. (2021). Myths and conspiracy theories on vaccines and COVID-19: Potential effect on global vaccine refusals. *Vacunas*, *22*(2), 93–97.

van Prooijen, J.-W., Etienne, T. W., Kutiyski, Y., & Krouwel, A. P. M. (2021). Conspiracy beliefs prospectively predict health behavior and well-being during a pandemic. *Psychological Medicine*, 1–25.

Verma, A., Singh, M. K., & Pareek, A. (2020). Information, misinformation, and disinformation about COVID-19: A content study of closed-cross platform messaging using Whatsapp. *International Journal of Advance Science and Technology*, *29*(10), 7797–7804.

Welch, A. R. (2007). Blurred vision?: Public and private higher education in Indonesia. *Higher Education*, *54*(5), 665–687.

Wernecke, U., Schütte, K., Schwanewedel, J., & Harms, U. (2018). Enhancing conceptual knowledge of energy in biology with incorrect representations. *CBE Life Sciences Education*, *17*(1), ar5.

Williams, B. G. A., Díez, S. M. U., Figueras, J., & Lessof, S. (2020). Translating evidence into policy during the COVID-19 pandemic: bridging science and policy (and politics). *Eurohealth*, *26*(2), 29–33.

Wintterlin, F., Hendriks, F., Mede, N. G., Bromme, R., Metag, J., & Schäfer, M. S. (2022). Predicting public trust in science: The role of basic orientations toward science, perceived trustworthiness of scientists, and experiences with science. *Frontiers in Communication*, *6*.

Wulandari, T., Ramli, M., & Muzzazinah. (2020). The assessment of understanding biological concepts: a systematic review. *Journal of Physics: Conference Series*, *1563*(1), 012030.

Yaqinuddin, A. (2013). Problem-based learning as an instructional method. *Journal of the College of Physicians and Surgeons Pakistan*, *23*(5), 83–85.

Yesudhas, D., Srivastava, A., & Gromiha, M. M. (2021). COVID-19 outbreak: History, mechanism, transmission, structural studies and therapeutics. *Infection*, *49*(2), 199–213.

Zainuddin, H. A. bin, & Subri, F. binti. (2017). The school facilities towards the improvement of students' academic achievement: Case study-secondary schools in Klang. *Journal of Modern Education Review*, *7*(9), 647–653.

Zeidan, A. H., & Jayosi, M. R. (2014). Science process skills and attitudes toward science among Palestinian secondary school students. *World Journal of Education*, *5*(1), 13–24.

Zion, M., & Klein, S. (2015). Conceptual understanding of homeostatis. *International Journal Of Biology Education*, *4*(1), 1–27.