

Instrument evaluation of conspiracy theory about COVID-19: Exploratory factor analysis and confirmatory factor analysis

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ABSTRACT

Students' beliefs toward conspiracy theory (CT) of COVID-19 can be the indication of science education quality. However, a validated instrument to measure the level of students' acceptance on the CT about COVID-19 still remains unexplored. This study aimed to evaluate the questionnaire of CT about COVID-19. The questionnaire consisted of 14 items and delivered online to the 400 students of Biology education in Indonesia. The data was analyzed using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). All items have standard deviation between 1.60 and 2.63, but one item was revealed to have insignificant correlation. The EFA result indicated that the other 13 items had loading factor 0.5 and were categorized into three dimensions. The third dimension was eliminated after the administration of CFA due to only one item in the dimension ($\lambda > 0.5$). There were three items in the first dimension and two items in the second dimension resulted in $\lambda < 0.5$. The correlated model from CFA disclosed good values of goodness of fit (GOF), $\chi^2/df=2.527$, root mean square error of approximation (RMSEA) standardized root mean square residual (SRMR)=0.014, comparative fit index (CFI)=0.964, goodness-of-fit index (GFI)=0.969, adjusted goodness of fit (AGFI)=0.940, Tucker-Lewis index (TLI)=0.947, and normed fit index (NFI)=0.943. Therefore, the questionnaire is strongly recommended to measure the level of students' beliefs toward the CT of COVID-19.

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1. INTRODUCTION

Science education plays a role in providing a foundation for students to have a scientific attitude and can do scientific reasoning [1]. Science education also plays a role in empowering students' nature of science [2]. By mastering these competencies, students are able to think scientifically when faced with various natural phenomena. They will get used to believing scientific truths and not easily believe in baseless

opinions to pseudoscience related to various natural phenomena, including those related to COVID-19 pandemic.

COVID-19 is a contagious disease caused by SARS-CoV-2 [3] and has been determined as a global pandemic by World Health Organization (WHO) since March, 2020 [4]. Although COVID-19 has low case fatality rate compared to severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) [5] and most of its victims do not have severe symptoms [6] or asymptomatic [7]. The global pandemic has restricted human mobility and activities. The need of performing physical distancing results in major changes in almost all human fields including in education sector [8] and becomes a primary challenge for teachers [9], students [10], and parents [11]. Therefore, to deal with the global pandemic, pharmaceutical companies from various countries around the world are developing vaccine [12]–[14], and some countries such as United States, England, and Indonesia have begun the vaccination programs.

Along with the massive impact of COVID-19 and the beginning of vaccination programs, misinformation and conspiracy theory (CT) have spread and provided negative influence on the society. CT about COVID-19 is not only about vaccination programs but also about the linkage of 5G with COVID-19 transmission [15] as well as the involvement of Bill Gates in this global pandemic [16]. In fact, conspiracy about COVID-19 has appeared since the invention of this contagious disease in which some people claim that it is a biological weapon developed on a certain purpose in a laboratory [17], [18]. Several CTs and misinformation spread out in the various social media platforms such as Facebook [15] and Twitter [19]. In addition, some videos available at YouTube also contain misinformation and CTs about COVID-19 [20].

Believing the CT cannot only hinder the government in handling the pandemic but also provide other negative impacts. Individuals who support CT often make conjunction fallacy so that they slightly understand a certain phenomenon [21]. Although they have been shown scientific facts and truth about COVID-19, they will not believe the government [22] and scholars [23]–[25]. This attitude gives serious consequence toward their own health and their environment [26] because they do not have health protective behaviors [27], [28].

Due to the negative impacts of believing the conspiracy, students should be able to differentiate between trustworthy information and information containing conspiracy. The level of society beliefs on the CT was reported to have a negative correlation with the understanding level [29] and education level [30], [31]. Education equips individuals with knowledge and experiences that can prevent them from believing such CT and misinformation about COVID-19. In accordance to this conspiracy, Biology is one of the sciences that can be used to protect individuals from the uncertain conspiracy. Thus, Biology students are expected to be a group of society who can encounter the CTs and misinformation in the society.

Unfortunately, previous studies reported that students' level of COVID-19 literacy have not been optimal, both Medical Science and Biology students [32]. Their level of understanding about this contagious disease is not always good [33]. Moreover, they consider social media as the main sources of information about COVID-19 [32]. Social media has been full with misinformation and CT about COVID-19 [34]. Therefore, research examining Biology students' perspectives on CT about COVID-19 should be conducted. The results of this kind of research can be used as a basis of evaluation to enhance the acquisition of Biology concept, critical skill, and scientific behavior. However, to the best of the authors' knowledge, a validated instrument examining respondents' belief about CT of COVID-19 has not been developed. Instrument development of CT was often limited to general CTs [35], [36] and the development of COVID-19 instrument was still in the form of knowledge, attitudes, and practices (KAP) [37]. Hence, the purpose of this study aims to develop instrument of CT about COVID-19 and analyze the instrument using factor analysis.

2. RESEARCH METHOD

2.1. Literature review and question item formulation

In this stage, literature on CTs about COVID-19 was collected from several contents in social media, news in mass media, videos in video platform, and articles in journals that discuss about the CTs. CTs that were collected contained information about the origin of COVID-19, reasons behind its emergence, the government and WHO falsehood, distrust toward pharmaceutical industry, relation between technology advancement and virus transmission, and the involvement of global elite in global pandemic. The literature review resulted in questionnaire of CT about COVID-19 consisting of 14 items as shown in Table 1. These 14 items were divided into seven positive statements and seven negative statements. Each question has three choices of responses, i.e., “strongly agree”, “agree”, and “disagree”.

Table 1. Order of items and statements in the questionnaire

Item number	Statements
1	It is impossible that SARS-CoV-2 is intentionally made by human.
2	SARS-CoV-2 is a biological weapon used by a superpower country to confront and take a down on another superpower country.
3	SARS-CoV-2 is not intentionally made, but it comes from another virus whose genome is manipulated by human.
4	We can directly believe the information from the government and public health offices when a patient is confirmed to be infected by COVID-19 from the result of RT-PCR test.
5	SARS-CoV-2 existed since long time ago but WHO tries to cover up the information.
6	We must believe experts when they say that SARS-CoV-2 is a dangerous disease.
7	In my opinion, it is impossible for people to think that SARS-CoV-2 vaccine has already prepared before the COVID-19 pandemic.
8	If it is observed carefully, SARS-CoV-2 comes from the careless treatment in the laboratory of Wuhan Institute of Virology.
9	It is impossible if COVID-19 is intentionally made by Pirbright Institute and the former founder of Microsoft, Bill Gates, as a scenario to control human population in the world.
10	The 5G network is impossibly related to the spread of SARS-CoV-2.
11	COVID-19 experts intentionally delude us for the sake of their own benefit, in fact, COVID-19 is not more dangerous than a common flu.
12	It is impossible if the number of COVID-19 victims is intentionally exaggerated to increase people's anxiety around the world.
13	COVID-19 does not exist, it is only a tool used by global elite to restrain our freedom.
14	It seems that the actor of COVID-19 outbreak is the pharmaceutical companies that want to obtain benefits from the selling of vaccines and medicine related to COVID-19.

2.2. Instrument trial

The respondents of this study were undergraduate students of Biology education and Biology study programs throughout Indonesia. The data collection was by an online survey. The developed survey was transformed into Google Form. The minimum target of respondents was 350 students. The number of respondents had met the minimum sample benchmark required for the factor analysis.

2.3. Data analysis

The instrument being developed was not based on the previous study; subsequently, the questionnaire was not in the known dimension. Therefore, the exploratory factor analysis (EFA) was required to determine the dimension and item components of each dimension. The Kaiser-Meyer-Olkin (KMO) test was initially conducted to measure the sample adequacy for further analysis. Subsequently, Bartlett's test of sphericity was applied to determine that the observed correlation matrix was not the identity matrix. The next step was to conduct the EFA to determine the number of generated dimensions. Eventually, each item's loading factor was observed, and the items with factor loading less than 0.5 were eliminated. After conducting the EFA, the items that were not eliminated were analyzed by using confirmatory factor analysis (CFA). The analysis was carried out to test the fit item. The model measurement was by statistic obtained from the goodness of fit (GOF). The items that had the standardized regression weight (λ) 0.5 were eliminated.

3. RESULTS AND DISCUSSION

3.1. Descriptive statistics

The average value of questionnaire items was between 1.60 and 2.63 with the standard deviation from 0.54 to 0.67. There was no item having standard deviation 2.5, meaning that all items fulfilled the requirement. Moreover, the results of descriptive statistics revealed that Pearson correlation score of all items was between 0.08 and 0.60. It was further found that one item did not have a significant correlation (I12), and the item was eliminated. The other 13 items were significant since the correlation values still fulfilled the requirement, that was lower than 0.80.

3.2. EFA and CFA

The measurement of sample adequacy using KMO by involving 400 respondents resulted in 0.796 (very good). Bartlett's test yielded χ^2 (78)=1127.3117, $p < 0.001$, meaning that the data could be proceeded to the further analysis. Meanwhile, the result of EFA analysis depicted three dimensions with a total of variance explained 51.28% from the rest 13 items. All the items yielded factor loading values 0.5, so that no item was eliminated. In detail, the summary of EFA result is presented in Table 2.

Table 2. Exploratory factor analysis questionnaire of conspiracy theory about COVID-19

Dimension	Items	Components		
		1	2	3
Dimension 1	Item 2	0.737		
	Item 14	0.716		
	Item 11	0.689		
	Item 5	0.656		
	Item 13	0.640		
	Item 8	0.608		
Dimension 2	Item 3	0.582		
	Item 9		0.747	
	Item 7		0.708	
	Item 10		0.676	
Dimension 3	Item 1		0.508	
	Item 4			0.714
	Item 6			0.674
	Eigenvalue	3.339	2.164	1.164
	Percentage of variance	25.685	16.648	8.952
	Cumulative	25.685	42.333	51.285

The result of CFA analysis using correlated model in Figure 1 shows good results of GOF, i.e., $\chi^2/df=2.527$, root mean square error of approximation (RMSEA) standardized root mean square residual (SRMR)=0.014, comparative fit index (CFI)=0.964, goodness of fit index (GFI)=0.969, adjusted goodness of fit (AGFI)=0.940, Tucker-Lewis index (TLI)=0.947, and normed Fit Index (NFI)=0.943. An item in the third dimension did not reach the Standardized Regression Weights (λ) 0.50, therefore, this dimension was eliminated. Moreover, the findings also indicated that three items in the first dimension and one item in the second dimension had λ value no more than 0.50. Thus, these items were also eliminated. The detailed λ values of all items are presented in Table 3.

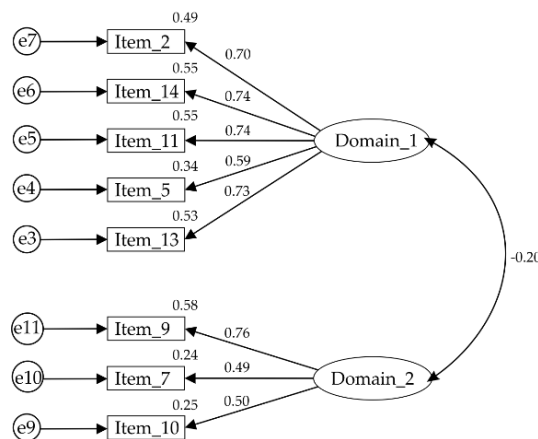


Figure 1. Correlated model resulted from CFA

Table 3. CR, AVE, and α values of all items in the questionnaire of conspiracy theory about COVID-19

Dimension	Items	λ	Criteria		
			CR	AVE	α
Dimension 1	Item 2	0.698	0.83	0.50	0.83
	Item 14	0.745			
	Item 11	0.738			
	Item 5	0.585			
	Item 13	0.727			
Dimension 2	Item 9	0.764	0.62	0.36	0.60
	Item 7	0.500			
	Item 10	0.503			
Total					0.61

3.3. Discussion

The massive spread of CT and misinformation about COVID-19 indicates that research examining this issue is crucial to be conducted. To address the issue, there is a need to develop good instrument to measure people's beliefs toward the CT. Therefore, this study examined the instrument that measures respondents' beliefs toward CT about COVID-19 using factor analyses. The results showed that all questionnaire items have fulfilled the average of standard deviation, only one of them had an insignificant correlation. After eliminating the item, EFA was conducted to determine the dimension [38].

The result of EFA revealed that the other 13 questionnaire items have loading factors that fulfill the requirement, so that there was no eliminated item. Furthermore, these items are categorized into three dimensions. The first dimension consists of seven items indicating the level of respondents' acceptance toward the CT. The second dimension comprises four items stating inelegant about COVID-19 CT. The third dimension contains two items having representing the level of respondents' beliefs toward official information established the government and public health offices. After the administration of EFA, CFA was conducted to determine the goodness level of the data based on the proposed model [38], [39]. On one hand, the correlated model resulted in good values of GOF. However, one item in the third dimension, three items in the first dimension, and one item in the second dimension were eliminated due to the λ values of these five items did not fulfil the requirement based on the results of CFA. Hence, the first dimension remains five items, the second dimension remains three items, and the third dimension was omitted.

The instrument developed in the present study will be beneficial as a tool of data collection in future studies that examine respondents' beliefs toward CT about COVID-19. Future studies addressing this issue are crucial to be conducted since in the present-day era of digital, people cannot be separated from social media. Whereas, social media plays role as a technological vehicle to spread the CT [34]. Several previous studies have also revealed that social media platforms have been flooded with CTs about COVID-19 [15], [19], [20]. People who are not familiar to do a fact-check toward any kind of information will easily believe to the CT in social media [40]. Consequently, the more a person engages in social media activities, the more he/she is contaminated with the CT. Thus, it was not surprising that the level of people beliefs was reported to have a positive correlation with the frequent use of social media as sources of information [28].

Several CTs encourage people to believe that SARS-CoV-2 is a biological weapon [17], [18], [41]. The presence of 5G is also believed to contribute to the COVID-19 outbreak [15]. There are also many people who believe that COVID-19 does not exist and they also think that this virus does not give an anxious treat [18]. They put themselves difficult to believe any kind of information about COVID-19 established by the government. WHO, public health offices, and scholars [42], [43]. Finally, together with the group of anti-vaccine, a number of people deliver a rejection against vaccination program using various excuses [44]–[46]. In this case, CT about vaccine becomes the primary challenge for the government and public health offices [47], particularly due to the fact that vaccine is one of the promising solutions to deal with the global pandemic [12]–[14]. Some anti-vaccine groups believe that COVID-19 vaccine is dangerous for human health and some others argue that the vaccine is inserted with certain microchip.

Rejection toward vaccination program is a consequence of the society beliefs on the CT about COVID-19. Their beliefs toward the theory of conspiracy also becomes the reason for those people to not to perform preventive behaviors against COVID-19. Several previous results have reported that people who believe in the CT tend to be careless to do physical distancing [48] and wash their hands regularly [27]. The negative effects of believing the CT have also been reported by studies conducted before the pandemic of COVID-19. The existence of the CT can decrease the society trust toward the government [22]. The believers of this theory are also not aware to regularly check their health condition [49]. In addition, they are easily suspicious to pharmaceutical industries [50] and hardly accept the scientific truth [24].

The distrust of the people who believe in the CT toward the scientific truth indicates the low level of their literacy. This is in line with the statement that scientific literacy can be used as a foundation to prevent misinformation [51]. In addition the scientific literacy, the low level of digital literacy also contributes to the people's decision to select which information is credible [52] and which one is untrustworthy [53]. Another factor that becomes a reason for people to believe in the CT is their educational backgrounds [29]–[31]. They do not understand the research principal that puts scientific method and behavior to reach findings. As a result, they prefer to develop their own thoughts and prejudices instead of scientific findings resulted from research process. It indicates that the quality of education and science teachings is not optimally implemented in their countries. To deal with this issue, education practices that can foster literacy and scientific behaviors should be implemented to prevent the massive spread of CT.

This study successfully developed an instrument that can measure the level of students' beliefs toward CT about COVID-19. It is undeniable that this instrument has been validated using CFA and EFA. However, several limitations of this study should be acknowledged. A greater number of students should be involved in future studies, so the data can be analyzed using other types of analyses. Moreover, the validation

process of this instrument is limited to the students of Biology. Therefore, the involvement of other demographic segments of the society is highly necessary to measure the fit and proper use of this instrument.

4. CONCLUSION

This study validated a questionnaire used as an instrument to measure the level of students' beliefs toward the CT about COVID-19. In the beginning of the stages, there were 14 item statements in the questionnaire. However, after the process of validation using CFA and EFA, eight item statements remained. Furthermore, the results of factor analysis concluded that these eight items could be grouped into two dimensions: "acceptance of CT" and "inelegant of CT". The first dimension consists of five items and the second dimension comprises three items. The validated instrument is strongly suggested to be used in research, education, and government evaluation. The evaluation is highly necessary as the primary step to control the massive spread of CT and its influence to handle the pandemic of COVID-19. The survey results become a foundation to reformulate educational curricula that facilitate students deal with digital era which is flooded with the CTs.

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