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COVID-19 prevention intentions of pre-science science teachers from South African and Indonesian universities

R. Ahmad Zaky El Islami [1], Moleboheng Ramulumo [2], Indah Juwita Sari [3], Lindelani Mnguni [4*]

[1] Department of Science Education, Faculty of Teacher Training and Education, Universitas Sultan Ageng Tirtayasa, Serang, INDONESIA
[2] Department of Science & Technology Education, College of Education, University of South Africa, Pretoria, SOUTH AFRICA
[3] Department of Biology Education, Faculty of Teacher Training and Education, Universitas Sultan Ageng Tirtayasa, Serang, INDONESIA
[4] Center for Health Sciences Education, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, SOUTH AFRICA

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Abstract

Science teachers could play a vital role in promoting health literacy and safe behaviors to limit the spread of communicable diseases. However, there is limited research concerning their attitudes and behavioral intentions toward diseases, such as COVID-19. Using the theory of planned behavior as a framework, we employed a non-experimental survey to compare the behavioral intentions towards adopting COVID-19 preventative measures among pre-service science teachers from South African (n=87) and Indonesian (n=93) universities. Data were collect data using a closed-ended questionnaire. Results show that the behavioral intentions toward COVID-19 between South African and Indonesian pre-service science teachers are similar. Safe attitudes, subjective norms, perceived behavioral control, behavioral, and normative beliefs that support safe behavioral intentions toward COVID-19 were reported, even though vaccine hesitancy may occur. We extrapolate that interventions should be implemented to enhance pre-service teachers' behavioral intentions and enhance their role in health education.

Keywords: COVID-19, planned behavioral intentions, pre-service science teachers

INTRODUCTION

The impact of the COVID-19 pandemic around the world is a reminder that there needs to be effective strategies to prevent the spread of communicable diseases. The great influenza pandemic (Spanish flu), HIV/AIDS epidemic, and the COVID-19 pandemic are some of the major global health crises that highlight the need for a coordinated, multidisciplinary effort to disease prevention. Literature suggests that each pandemic presents lessons that could be used to deal with future pandemics (e.g., Avafia et al., 2020; Somse & Eba, 2020). For example, Somse and Eba (2020, p. 371) highlight that "the four decades of response to the HIV epidemic offer lessons that are vital for the fight against" COVID-19. Thus, while the COVID-19 pandemic has ended, there are several lessons that could be learn in how the world responded to the COVID-19 pandemic, which may be useful in future.

One of the significant lessons concerns the importance of a multidisciplinary approach to public health. Several approaches to prevent the spread of communicable diseases including COVID-19 have been explored. These include practicing hand hygiene, social distancing, improving ventilation, wearing high-quality mask, and vaccination. However, it has been demonstrated that a biomedical approach alone may not be sufficient to address the spread of communicable diseases (Becchetti et al., 2021). This is because factors such as poverty, illiteracy, and misinformation play a significant role in the spread of COVID-19 and other communicable diseases. Therefore, a multidisciplinary

✉ zakyislami@untirta.ac.id ✉ ramulmm@unisa.ac.za ✉ indah.juwitasari@untirta.ac.id
✉ lindelani.mnguni@wits.ac.za **(*Correspondence)**

Contribution to the literature

- We compared the behavioral intentions towards COVID-19 prevention of pre-service science teachers from South African and Indonesian universities to understand their potential role in promoting health literacy and safe behavioral practices in a multidisciplinary health education approach. Pre-service science teachers from South Africa and Indonesia had generally safe and comparable behavioral intentions towards COVID-19 and likely to adopt safe behavioral intentions, including vaccination, wearing masks, and practicing social distancing.
- Attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs towards vaccination were lowest in the South African sample compared to wearing masks and social distancing. Attitudes towards vaccination were significantly associated with vaccination status in both samples.
- The recorded safe behavioral intentions towards COVID-19 among pre-service science teachers could help promote health literacy and safe behavioral intentions among students and parents.

approach that emphasizes education is required to limit the spread of these diseases. Similarly, science teachers could be essential in advancing health education as reliable sources of scientific information and authoritative figures in the community (Marimwe & Dowse, 2019; Underwood et al., 2019). Through science teachers as health advocates and agents of change, health authorities could administer a "social vaccine" to communities (Newman et al., 2012; Okan et al., 2022).

A social vaccine is a socio-political mobilization process led by government and non-government organizations to promote health literacy and safe behavioral intentions through sociocultural and structural interventions (Newman et al., 2012; Okan et al., 2022). A social vaccine allows health authorities to tackle various social determinants of health, including illiteracy and socioeconomic factors (Becchetti et al., 2021; Horton, 2020). Thus, social vaccines consist of health education through formal and nonformal platforms and mass media campaigns. Social vaccines effectively address various healthcare issues, such as prevention, vaccination, and disease management (Newman et al., 2012). In the case of HIV/AIDS, research shows that social vaccines were effective in reducing stigma, remediating conspiracy theories and misinformation, and enabling individuals and communities to make health-related decisions based on scientific knowledge, thereby preventing the spread of disease (e.g., Newman et al., 2012).

Given the sociocultural and structural factors affecting the spread of COVID-19, health authorities have explored several preventative measures, including health warnings, educational programs, and legal restrictions (Van den Broucke, 2020). In addition, numerous biomedical programs, such as vaccination, were promoted. While some of these strategies proved effective, Okan et al. (2022) suggest that social vaccines, that integrate health literacy and health education in science education can be effective in preventing the spread of communicable diseases like coronavirus. Consequently, the role of the science curriculum and science teachers in social vaccines that promote health literacy and adoption of safe behavioral intentions require thorough investigation.

Strategies to Promote COVID-19 Health Literacy and Safe Behavioral Intentions

During the COVID-19 pandemic, governments utilized various platforms to educate communities about the pandemic and related prevention strategies. For instance, due to its global reach, social media has been used extensively to disseminate information about COVID-19 (Anwar et al., 2020). Some educational materials about preventive measures such as wearing masks, social distancing, and vaccination have been distributed (Banerjee & Meena, 2021). Anwar et al. (2020) report that social media usage increased 87.0% during the COVID-19 lockdown. Researchers (e.g., Glasdam et al., 2022; Huynh et al., 2020; Mishra et al., 2020) report that social media is used as a knowledge node in various countries, where healthcare workers rely on social media to inform themselves about COVID-19. However, because social media information is not always verified, Banerjee and Meena (2021) warn that this social vaccine risks promoting a "digital infodemic" in which information pollution, misinformation, and conspiracy theories spread uncontrollably. For this reason, access to validated scientific information for health education is necessary.

Credible scientific information about COVID-19 has also been disseminated via academic platforms, scientific research articles, textbooks, and official government communication channels, including radio, newspapers, and television. According to Ali et al. (2020), traditional media sources (television, radio, podcasts, and newspapers) were the primary sources of reliable COVID-19 information in the United States. Fridman et al. (2020) also report that the public trusts government information sources. The relationship between trust in government sources and accurate knowledge of COVID-19 and safe behavioral intentions was positive.

In light of the above, it is critical to explore the role of teachers in ensuring that students and communities have access to scientifically valid information. Given their social status and reach, teachers can play a critical role in health education by counteracting misinformation spread through social media and other unreliable sources.

Role of Teachers in Social Vaccines and Their Behavior Towards COVID-19

While healthcare is not the primary responsibility of teachers, in some developing countries such as Indonesia and South Africa with low levels of scientific literacy (Nuangchalerm et al., 2022; Ramli & Susanti, 2022), science teachers could play a crucial role in promoting health education and safe behavior. This is because there is a strong correlation between health literacy and science literacy, which can be enhanced through science and health education (Marimwe & Dowse, 2019; Mnguni, 2017). Additionally, teachers and students interact frequently, thus increasing the opportunities for students to access scientific information through their teachers (Underwood et al., 2019). Through the curriculum, teachers can integrate health education as socio-scientific issues aimed at providing students with actionable knowledge that can enhance adopting safe behavioral intentions (Mnguni & Abrie, 2012; Wolff & Mnguni, 2015).

As trusted authorities in science education, teachers can, directly and indirectly, influence students' worldviews, including their perceptions of safe behavioral intentions (Estrela et al., 2022). In this regard, researchers (e.g., Estrela et al., 2022) suggest that through a hidden curriculum, teachers' behavioral choices, such as vaccination, can influence students to adopt similar behaviors. This is why teachers are encouraged to model safe behavioral intentions (Estrela et al., 2022). In light of this, we posit that it is crucial to understand the factors influencing teachers' health-related behavioral intentions (Estrela et al., 2022; Zeyer, 2019). Understanding their perceptions, beliefs, and attitudes regarding health issues, such as COVID-19 vaccination, could aid health authorities in developing relevant interventions, which will affect students. This could also positively affect the community through the influence of teachers.

While science teachers' potential role in health education is widely acknowledged, little is known about their attitudes toward health education and health in general. Nonetheless, during the COVID-19 pandemic, several researchers observed significant teacher vaccine hesitancy. For instance, Gurwitz (2021) reports low vaccination acceptance rates among teachers in Israel. Similarly, Chen et al. (2022) report that a sizeable proportion of teachers in China reported vaccine reluctance. Chen et al. (2022) also discovered that teachers were more skeptical of vaccines than their students; arguing that "perceptions of the safety of COVID-19 vaccines, attention to and awareness of vaccine news, and chronic medical conditions were the primary determinants of reluctance to receive COVID-19 vaccines" (p. 1). On the contrary, Handebo et al. (2021) and Racey et al. (2021) report that many teachers intend to receive the COVID-19 vaccines in Ethiopia and Canada, respectively. In Canada, "vaccine intention in teachers was higher compared to recent national data" (Racey et al., 2021, p. 3). These reports necessitate further research into teachers' behavioral intentions concerning COVID-19 and health in general.

Aim and Research Question

Given the role and status of science teachers in communities, there is a need to understand their potential role in promoting health literacy and safe behavioral intentions toward health, particularly in developing countries such as Indonesia and South Africa. Determining the extent to which teachers adopt safe behavioral intentions is required as a preliminary effort in this endeavor. Factors affecting teachers' behavioral intentions must also be explored. In light of this, the current research aimed to compare the behavioral intentions towards COVID-19 of pre-service science teachers from South African and Indonesian universities as a preliminary effort to understand the role teachers could play in promoting health literacy and safe behavioral intentions. The research question being explored was, *how do the behavioral intentions towards adopting COVID-19 preventative measures among pre-service science teachers from South African and Indonesian universities compare*?

By determining the extent to which teachers adopt safe behavioral intentions and exploring the factors that affect their intentions, this study can inform the development of effective strategies to integrate health education into science education. By comparing the behavioral intentions towards COVID-19 of pre-service science teachers from two different countries, this research can identify the similarities and differences in their attitudes towards disease prevention, which can be used to inform the design of culturally relevant and effective health education programs. Ultimately, this research can contribute to the long-term multidisciplinary disease prevention through science education that integrates health education, which can help to promote health literacy and safe behavioral intentions among students and communities in developing countries.

THEORETICAL FRAMEWORK

The theory of planned behavior was used as a theoretical framework for the research. This theory has been used widely to study health-related behaviors (e.g., Conner et al., 2002; Godin & Kok, 1996; Mnguni et al.,

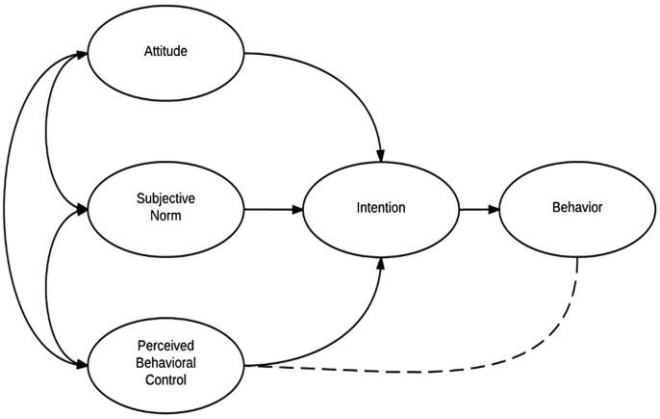

Figure 1. Theory of planned behavior (Ajzen, 1991).

2016). Researchers (e.g., Patwary et al., 2021; Shmueli, 2021) have used this theory to predict the general population's intention to receive the COVID-19 vaccine. According to the theory of planned behavior (Ajzen, 1991), an individual's actions are determined by their behavioral intentions (**Figure 1**). Behavioral intentions refer to the individual's attitude toward behavior (Kuther, 2002). Intention includes motivational factors that influence behavior, willingness to try and the effort individuals are willing to exert to carry out such behavior (Ajzen, 1991). Planned behavior is also affected by subjective norms, which are the perceived views of others regarding the behavior. This implies that behavior will depend on facilitating factors, opportunity context, internal and external resources, and action control.

Perceived behavioral control also affects behavior (Ajzen, 1991). This is the individual's subjective belief about their behavior abilities (Hansen et al., 2004). Ajzen (1991) suggests that beliefs also affect behavior (**Figure 1**). For example, beliefs about the likely consequences of behavior affect behavior attitudes. Furthermore, normative beliefs influence subjective norms. Ajzen (1991) adds that control beliefs about factors that facilitate or impede behavior affect perceived behavioral control. Behavioral, normative, and control beliefs influence each other, he argues. Ajzen (1991) asserts that behavior requires strong actual behavioral control. Behavioral control refers to the skills and resources needed to perform a behavior. A behavior requires both intention and behavioral control. The theory of planned behavior was used as a framework for the current research due to its wide use in predicting health-related behaviors and its recent use in studies exploring behaviors related to COVID-19.

METHOD

We conducted the present research using a positivist research paradigm. This is because positivism as a research paradigm permits using quantitative research methods to gather information about many participants to explore and describe a phenomenon prior to its qualitative explanation (Creswell, 2014). For this reason, a quantitative research methodology was chosen for this preliminary investigation. To this end, a non-experimental survey-based comparative quantitative research strategy was employed to collect data via a closed-ended questionnaire.

The research question was exploratory and did not involve manipulation of variables or intervention. Instead, the researchers sought to collect data from participants through surveys and compare the results between the two groups. As suggested by Draugalis et al. (2008) and Ponto (2015), a survey-based approach is appropriate for this type of research as it provides a standardized way of collecting data from large samples, thereby reducing bias and improve the reliability of the results. A comparative approach was chosen because the study aimed to identify differences and similarities in behavioral intentions towards COVID-19 preventative measures between pre-service science teachers from South Africa and Indonesia. This approach enabled us to draw conclusions about relative effectiveness of different approaches to promoting health literacy and safe behavioral intentions towards health.

Study Context and Sampling

For data collection, an online survey questionnaire was administered to pre-service science teachers from Indonesia and South Africa. These nations were selected as case studies based on the high prevalence of COVID-19 cases in their respective regions. Despite implementing several preventative measures, South Africa registered the highest COVID-19 cases in Africa (Katoto et al., 2022). According to the National Institute for Communicable Diseases (2022), by February 2022, over 3.6 million cases had been reported in South Africa. Similarly, according to Center for Strategic and International Studies, Indonesia registered the highest COVID-19 cases in Southeast Asia by February 2022 (i.e., over 5.4 million cases). These statistics suggest that it is necessary to investigate the underlying causes of the spread of COVID-19 in both countries.

A non-probability purposive sampling method (Creswell & Creswell, 2017) was deemed appropriate for this research as we wanted to select participants who meet specific criteria and have certain characteristics that are relevant to the research question. In this case, were interested in pre-service science teachers who are in the process of obtaining a degree in science education. Non-probability sampling methods do not involve random selection of participants, which may reduce the representativeness of the sample (Creswell, 2014; Creswell & Creswell, 2017). However, the goal of this research was not to generalize the findings to the larger population, but rather to gain insights into similarities and differences in the behavioral intentions towards COVID-19 preventative measures among pre-service science teachers from South Africa and Indonesia.

To determine the suitable sample size, therefore we used Taherdoost's (2017) formula ($n=[p(100-p)z^2]/E^2$ to estimate the minimum sample size. In this regard, we wanted to determine the number of participants required with a 10.0% margin of error at a 95% confidence interval, which is generally acceptable in social sciences (Taherdoost, 2017). As Bartlett et al. (2001) suggested, we used 50.0% as an estimate of *p*, as this will maximize variance and produce the maximum sample size. Based on this, we determined that a sample size of 90 participants would be suitable.

Using a non-probabilistic purposive sampling method the study comprised of 87 (10 males, 75 females, two preferred not to state their gender) South African and Indonesian 93 (12 males, 81 females) pre-service science teachers. All participants were aged 18 and above. The sample size reflects the total number of pre-service life sciences teachers in South Africa. According to Simkins' (2015) report for Center for Development and Enterprise, South Africa produced 15,628 Bachelor of Education (BEd) graduates in 2021. Of these, an estimated 7.9% are trained to teach life sciences (biology) through which scientific knowledge of viruses and vaccines is taught. On this basis, about 1,235 science teachers graduate with a bachelor's degree in education for teaching life sciences. Given that the study was a preliminary case study, we selected participants from one university, which trains most science teachers in South Africa. Using the South African estimates, we surveyed a similar sample size in Indonesia to allow for comparison.

Both groups of participants were final-year students in teacher training at their local universities. They studied animal diversity, zoology, cell biology, cytogenetics and embryology, and animal physiology during their undergraduate training. They also studied research methodology and educational studies in their senior years. Through these courses, participants gained knowledge of viruses and vaccinations. The current study was conducted between October and November 2021, the final two months of the participants' academic year. Everyone who took part in the study did so voluntarily.

Data Collection and Analysis

The theory of planned behavior served as a proxy for determining the likelihood that participants would adopt COVID-19 preventative measures, specifically, vaccination, wearing masks, and social distancing. Therefore, we developed and validated a closed-ended questionnaire for data collection. To do this, we used the theory of planned behavior as a framework to determine participants' attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs regarding COVID-19 preventative measures, specifically vaccination, mask-wearing, and social distancing. According to the theory of planned behavior, these variables (i.e., attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs) can be used to predict variables that are difficult to measure *in vivo,* such as behaviors.

The questionnaire comprised of 30 items. Six items measured attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs. In each of these six areas, two items focused on each of vaccination, mask-wearing, and social distancing. For example, two items assessed participants attitudes towards vaccines, two assessed attitudes towards wearing masks, and two assessed attitudes towards social distancing. Additionally, participants were asked to provide their demographic data and vaccination status at the time of data collection.

A subset of students (n=30) with the same traits as the target population participated in the pilot study to validate the instrument. Additionally, a panel of nine experts considered the instrument against the research objectives and determined its validity. The experts comprised of two education experts (with PhDs), two science education experts (with PhDs), an English language expert (with a masters in English), two pre-service science teachers, and two in-service science teachers. These experts and the pilot group considered the instruments to determine its face, content, and criterion-related validity as defined by Taherdoost (2016). Face validity involved ensuring that the survey questions are relevant to the research question and that participants understand the questions and can provide meaningful responses. Content validity ensured that the survey questions cover all relevant aspects of the behavioral intentions towards adopting COVID-19 preventative measures among the participants. Criterion-related validity involved assessing whether the survey responses can accurately predict the future health behaviors of pre-service science teachers, such as their willingness to adopt preventative measures for COVID-19. Ensuring the face, content, and criterion-related validity of the instruments used in this research is important for ensuring the accuracy and reliability of the data collected. The reports from the pilot group and the panel of experts confirmed the validity of the instrument.

Data were analyzed using SPSS. This included descriptive and inferential statistics. The Mann-Whitney U test was used to compare attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs between the two samples because these variables were measured on an ordinal scale and the two samples were independent of each other. The Mann-Whitney U test is a non-parametric test used to determine whether there is a significant difference between two independent groups (McKnight & Najab, 2010; Smalheiser, 2017). It is appropriate for data that are measured on an ordinal scale and assumes that the data are independent and come from populations with

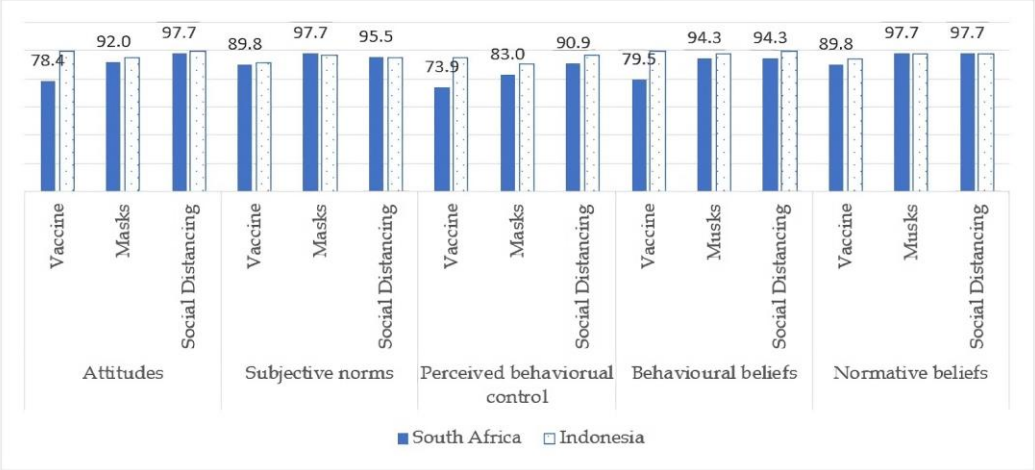

Figure 2. Proportion (%) of South African & Indonesian participants reporting positive attitudes, subjective norms, perceived behavioral control, & behavioral & normative beliefs concerning measures for reducing spread & impact of COVID-19 (Source: Authors' own elaboration)

similar shapes and variances (McKnight & Najab, 2010; Smalheiser, 2017). Additionally, regression analyses were performed to determine if attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs are predictors of vaccination status of the teachers; as well as the relationship between attitudes and subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs toward vaccination. Regression analyses are a useful for identifying predictors and relationships between variables (Tonidandel & LeBreton, 2011). Ordinal regression models allow for the investigation of relationships between ordinal dependent variables and one or more independent variables, while considering the order of the categories in the dependent variable (Williams & Quiroz, 2020; Winship & Mare, 1984).

RESULTS

Testing for validity and reliability was prioritized because of the investigation's quantitative nature. Concerning validity, the panel of experts was asked to assess the instrument's validity using a four-point rating scale. Their responses were then used to calculate the content validity index (CVI) as suggested by Hyrkäs et al. (2003). CVI was found to be 0.83, in agreement with the validity of the instrument; 83.0% is within the range indicating that validity (Hyrkäs et al., 2003). The reliability coefficient from the pilot group was calculated to be .801. Additionally, internal consistency was assessed separately for South African and Indonesian samples from the main data samples. For the South African and Indonesian samples, Cronbach's alpha values were .894 and .876, respectively. These values indicate reasonable internal consistency.

Vaccination Status of the Participants

At the time of data collection, 38.6% (n=34) of the South African sample reported receiving at least one COVID-19 vaccine, compared to 92.6% (n=87) of the Indonesian participants. In South Africa, 6 out of 10 male participants (60.0%) and 27 out of 76 female participants (35.5%) reported receiving at least one COVID-19 vaccine. In Indonesia, all male participants (12 in total) and 74 out of 81 females (91.4%) reported receiving at least one COVID-19 vaccine. Although a smaller percentage of males participated in the survey, the findings imply that more males had received vaccinations in South Africa and Indonesia than females.

Behavioral Intentions of the Participants

Data were also analyzed to determine attitudes, subjective norms, perceived behavioral control, behavioral and normative beliefs concerning measures for reducing the spread and impact of COVID-19.

Results (**Figure 2**) indicate that in the South African sample, attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs concerning vaccination were lowest compared to wearing masks and social distancing. Among Indonesians, more participants reported positive attitudes towards vaccination than masks and social distancing. Trends for perceived behavioral control towards vaccination, masks, and social distancing were similar to attitudes for both samples. Similar results were also observed for behavioral beliefs and normative beliefs. Subjective norms towards vaccination, masks, and social distancing were almost identical for South Africans and Indonesians. Overall, results from both samples suggest that most participants had positive intentions toward vaccination, masks, and social distancing.

The results (**Table 1**) suggest that while generally positive in both groups, the attitudes towards vaccination and social distancing were significantly different, with the Indonesian sample reporting more positive attitudes ($p<0.001$).

Table 1. A comparison of attitudes, subjective norms, perceived behavioral control, behavioral & normative beliefs between two samples

	Vaccination	WM	SD
Attitudes			
Mann-Whitney U	2,563.500	4,069.500	2,892.000
Wilcoxon W	6,479.500	7,985.500	7,357.000
Z	-4.775	-0.248	-4.159
A. Sig. (2-tailed)	0.000	0.804	0.000
Subjective norms			
Mann-Whitney U	3,839.000	2,968.000	2,774.000
Wilcoxon W	8,304.000	7,433.000	7,239.000
Z	-0.875	-3.661	-4.166
A. Sig. (2-tailed)	0.381	0.000	0.000
Perceived behavioral control			
Mann-Whitney U	3,642.500	3,582.500	3,090.500
Wilcoxon W	7,558.500	8,047.500	7,555.500
Z	-1.440	-1.633	-3.105
A. Sig. (2-tailed)	0.150	0.102	0.002
Behavioral beliefs			
Mann-Whitney U	3,412.000	3,382.500	3,210.500
Wilcoxon W	7,328.000	7,847.500	7,675.500
Z	-2.152	-2.327	-2.848
A. Sig. (2-tailed)	0.031	0.020	0.004
Normative beliefs			
Mann-Whitney U	4,027.000	2,950.500	2,883.000
Wilcoxon W	8,492.000	7,415.500	7,348.000
Z	-0.322	-3.614	-3.796
A. Sig. (2-tailed)	0.748	0.000	0.000

Note. Grouping variable: Country of origin; A: Asymptotic; WM: Wearing masks; & SD: Social distancing

The same pattern was observed regarding subjective norms for wearing masks and social distancing and normative beliefs towards wearing masks and social distancing. There was no significant difference in the attitudes towards wearing masks, subjective norms towards vaccination, perceived behavior towards vaccination and wearing masks, behavioral beliefs concerning vaccination and wearing masks, and normative beliefs towards vaccination ($p>0.001$).

Relationship Between Vaccination Status and Behavioral Intentions

A regression analysis (**Table 2**) indicated that attitudes towards vaccination, perceived behavioral control towards vaccination, and behavioral beliefs about vaccination were significant predictors of vaccination status for South African participants (i.e., $p<.001$). The attitude towards vaccination was the only significant predictor of vaccination status for the Indonesian participants.

Given the significant association between vaccination status and attitudes toward vaccination in both samples (**Table 2**), we investigated the association between attitudes toward vaccination and subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs. This was an attempt to determine factors that may influence attitudes.

Table 2. A regression analysis of attitudes, subjective norms, perceived behavioral control, behavioral beliefs, & normative beliefs as predictors of vaccination status

Country of origin	Variable	UC		SC	t	Sig.
		Beta	SE	Beta		
South Africa	(Constant)	1.350	0.332		4.063	0.000
	Attitude: Vaccination	-0.157	0.039	-0.446	-4.072	0.000
	Attitude: Masks	0.038	0.063	0.078	0.601	0.549
	Attitude: Social distancing	0.139	0.095	0.198	1.463	0.147
Indonesia	(Constant)	1.425	0.182		7.813	0.000
	Attitude: Vaccination	-0.165	0.039	-0.465	-4.219	0.000
	Attitude: Masks	0.035	0.028	0.129	1.231	0.222
	Attitude: Social distancing	0.054	0.038	0.158	1.398	0.166
South Africa	(Constant)	1.576	0.302		5.219	0.000
	Subjective norms: Vaccination	-0.103	0.051	-0.242	-2.006	0.048
	Subjective norms: Masks	0.038	0.096	0.064	0.395	0.694
	Subjective norms: Social distancing	0.060	0.091	0.110	0.661	0.510
Indonesia	(Constant)	1.143	0.139		8.205	0.000
	Subjective norms: Vaccination	-0.064	0.028	-0.262	-2.246	0.027
	Subjective norms: Masks	0.060	0.046	0.197	1.282	0.203
	Subjective norms: Social distancing	-0.019	0.045	-0.066	-0.416	0.679
South Africa	(Constant)	1.589	0.179		8.861	0.000
	Perceived behavioral control: Vaccination	-0.163	0.041	-0.441	-3.963	0.000
	Perceived behavioral control: Masks	0.093	0.050	0.256	1.845	0.069
	Perceived behavioral control: Social distancing	0.054	0.053	0.141	1.026	0.308
Indonesia	(Constant)	1.137	0.137		8.288	0.000
	Perceived behavioral control: Vaccination	-0.095	0.041	-0.325	-2.337	0.022
	Perceived behavioral control: Masks	0.057	0.039	0.218	1.453	0.150
	Perceived behavioral control: Social distancing	0.020	0.047	0.062	0.433	0.666

Table 2 (Continued). A regression analysis of attitudes, subjective norms, perceived behavioral control, behavioral beliefs, & normative beliefs as predictors of vaccination status

Country of origin	Variable	UC		SC	t	Sig.
		Beta	SE	Beta		
South Africa	(Constant)	1.402	0.231		6.075	0.000
	Behavioral belief: Vaccination	-0.181	0.037	-0.517	-4.873	0.000
	Behavioral belief: Masks	-0.055	0.054	-0.117	-1.009	0.316
	Behavioral belief: Social distancing	0.253	0.062	0.499	4.103	0.000
Indonesia	(Constant)	1.223	0.160		7.648	0.000
	Behavioral belief: Vaccination	-0.060	0.039	-0.194	-1.542	0.127
	Behavioral belief: Masks	0.020	0.045	0.066	0.441	0.660
	Behavioral belief: Social distancing	0.005	0.050	0.015	0.092	0.927
South Africa	(Constant)	1.263	0.278		4.549	0.000
	Normative beliefs: Vaccination	-0.147	0.050	-0.351	-2.939	0.004
	Normative beliefs: Masks	0.017	0.101	0.030	0.173	0.863
	Normative beliefs: Social distancing	0.191	0.101	0.342	1.893	0.062
Indonesia	(Constant)	1.197	0.149		8.015	0.000
	Normative beliefs: Vaccination	-0.020	0.046	-0.071	-0.444	0.658
	Normative beliefs: Masks	0.016	0.065	0.049	0.254	0.800
	Normative beliefs: Social distancing	-0.027	0.066	-0.086	-0.417	0.677

Note. UC: Unstandardized coefficients; SC: Standardized coefficients; SE: Standard error; & Dependent variable: Vaccination status for COVID-19

Table 3. Relationship between attitudes & subjective norms, perceived behavioral control, behavioral beliefs, & normative beliefs toward vaccination

Country of origin		Sum of squares	df	Mean square	F	Sig.
South Africa	Regression	79.617	4	19.904	18.752	<.001[b]
	Residual	88.099	83	1.061		
	Total	167.716	87			
Indonesia	Regression	7.705	4	1.926	3.915	.006[b]
	Residual	43.785	89	0.492		
	Total	51.489	93			

Coefficients

Country of origin		UC		SC	t	Sig.
		Beta	SE	Beta		
South Africa	(Constant)	0.302	0.444		0.682	0.497
	Subjective norms	0.162	0.124	0.134	1.303	0.196
	Perceived behavioral control	0.211	0.120	0.201	1.753	0.083
	Behavioral beliefs	0.325	0.130	0.327	2.507	0.014
	Normative beliefs	0.184	0.135	0.155	1.357	0.179
Indonesia	(Constant)	2.840	0.435		6.535	0.000
	Subjective norms	0.048	0.082	0.070	0.588	0.558
	Perceived behavioral control	0.067	0.090	0.081	0.741	0.461
	Behavioral beliefs	0.206	0.104	0.237	1.981	0.051
	Normative beliefs	0.091	0.097	0.112	0.944	0.348

Note. [a]Dependent variable: Attitude towards vaccination; [b]Predictors: (Constant), normative beliefs, perceived behavioral control, subjective norms, & behavioral beliefs; UC: Unstandardized coefficients; SC: Standardized coefficients; & SE: Standard error

Results (**Table 3**) show that collectively, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs have a significant association with attitudes towards vaccination, particularly for the South African sample (i.e., $p<.001$). However, when examined individually, none of these variables significantly affect attitudes ($p>.001$). Our findings suggest that attitudes rather than other variables significantly influence vaccination.

DISCUSSION

The current research sought to explore the potential role of science teachers in promoting health literacy and safe behavioral intentions toward communicable diseases. This was done by comparing the behavioral intentions of pre-service science teachers towards COVID-19 as a preliminary effort to understand the role teachers could play in promoting health literacy and safe behavioral intentions.

While the COVID-19 pandemic has ended, lessons can be drawn from it, which could be useful in addressing future health crises. Consequently, findings of the current study could inform the development of effective strategies to integrate health education into science education and contribute to the long-term multidisciplinary disease prevention through science education.

In response to the research question and the aim of the study, our study has demonstrated that the behavioral intentions towards COVID-19 of pre-service science teachers from South African and Indonesian universities are generally safe and comparable even though there are context-specific factors that may influence health-related behavioral attitudes. The findings are significant in our understand of the role teachers could play in promoting health literacy and safe behavioral intentions towards communicable diseases such as COVID-19.

Our study revealed that most participants reported attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs that support safe behavioral intentions toward COVID-19. These results suggest that pre-service science teachers are likely to adopt safe behavioral intentions, including vaccination, wearing masks, and practicing social distancing. These findings are significant given the high incidences of vaccine hesitancy among teachers reported in other countries (e.g., Chen et al. (2022; Gurwitz (2021). The findings, however, corroborate with Handebo et al. (2021) and Racey et al. (2021), who found that many teachers intend to receive the COVID-19 vaccines in Ethiopia and Canada. As reported by Estrela et al. (2022) teachers can exert a strong influence over students and parents. Therefore, the recorded safe behavioral intentions toward COVID-19 among pre-service science teachers could help instill safe behavioral intentions among students and parents.

While we found generally safe behavioral preferences, our findings show that the in the South African sample, attitudes, subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs towards vaccination were lowest compared to wearing masks and social distancing. Among Indonesians, more participants reported positive attitudes towards vaccination than masks and social distancing. Trends for perceived behavioral control towards vaccination, masks, and social distancing were similar to attitudes for both samples. Similar results were also observed for behavioral beliefs and normative beliefs. Subjective norms towards vaccination, masks, and social distancing were almost identical for South Africans and Indonesians. Overall, results from both samples suggest that most participants had positive intentions toward vaccination, masks, and social distancing. Given the role of teachers in promoting health literacy and safe behavioral intentions toward health (e.g., Estrela et al., 2022; Underwood et al., 2019) these findings suggest that the participants may be effective in promoting and modeling are behaviors to their students and their communities. However, the finding that attitudes, beliefs, and norms toward vaccination were lower in the South African sample compared to wearing masks and social distancing suggests that targeted interventions may be needed to increase vaccine uptake and promote positive attitudes toward vaccination in this population.

Our research found that while the participants' attitudes towards vaccination differed significantly between the two samples, the subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs towards vaccination were not significantly different. These findings suggest that there may be shared contextual factors between the two samples, which lead to similarities in subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs toward vaccination. Further research is required to identify these factors. It is likely that sources of information, such as social media, government communique, and scientific publications related to COVID-19, are similar and therefore have a similar effect on both samples. Researchers have reported that some countries adopt similar prevention strategies against COVID-19 (e.g., Jabeen et al., 2020). However, we posit that factors affecting attitudes require further analysis. This is crucial, given that attitudes towards vaccination were significantly associated with vaccination status in both samples. Notably, for the Indonesian sample, none of the planned behavior variables were significantly associated with the vaccination status of the participants, except for their attitudes towards vaccination. This was an important finding given that, per the theory of planned behavior, attitudes towards a behavior may be associated with subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs. We found that subjective norms, perceived behavioral control, behavioral beliefs, and normative beliefs are significantly associated with attitudes toward vaccination. However, when looked at individually, they do not have a significant association with attitudes. Our findings suggest that attitudes rather than other variables significantly influence vaccination.

Our research shows that vaccination was the least supported by both sets of participants because of the different prevention strategies. Previous research has also shown high incidences of vaccine hesitancy, particularly towards COVID-19 vaccines (e.g., Acheampong et al., 2021; Dzinamarira et al., 2021). Determinants of vaccine hesitancy include "complex interaction of environmental (external) factors, agent factors (vaccine) and the host (parents) specific factors. The determinants of vaccine hesitancy are numerous and context-specific and are presented separately but it

is important to understand and acknowledge their interrelatedness". In light of this, further research is required to understand vaccine hesitancy among science teachers.

CONCLUSIONS

In conclusion, this study aimed to understand the role that pre-service science teachers could play in promoting health literacy and safe behavioral intentions towards communicable diseases, with a focus on COVID-19. The study compared the behavioral intentions towards COVID-19 of pre-service science teachers from South African and Indonesian universities. Overall, the results showed that pre-service science teachers had safe and positive behavioral intentions towards COVID-19, including vaccination, wearing masks, and social distancing. However, some contextual factors influenced health-related behavioral attitudes, particularly with regards to vaccination, which was less supported by both sets of participants. The findings suggest that pre-service science teachers can play a significant role in promoting safe behavioral intentions among students and parents, and targeted interventions may be needed to increase vaccine uptake and promote positive attitudes towards vaccination in certain populations.

The findings of this research have several implications for teacher training and health education in relation to communicable diseases. Firstly, teacher education programs could incorporate health education modules that provide pre-service teachers with the knowledge, skills, and strategies to promote safe behavioral intentions among their students and communities. Secondly, the study highlights the need for targeted interventions to increase vaccine uptake and promote positive attitudes towards vaccination among pre-service teachers, particularly in contexts, where vaccine hesitancy is high. Teacher training programs could incorporate strategies for addressing vaccine hesitancy, including evidence-based information provision, communication skills training, and addressing vaccine myths and misinformation. Thirdly, the study suggests that teachers can play a crucial role in promoting health literacy and safe behavioral intentions towards communicable diseases. Given the influence that teachers have on their students and communities, pre-service teachers could be trained to be effective models and promoters of safe behaviors. This could contribute to the long-term multidisciplinary prevention of communicable diseases through science education.

Future research should explore these contextual factors further to develop effective strategies to integrate health education into science education and contribute to long-term multidisciplinary disease prevention through science education.

We recommend future to identify the contextual factors that influence health-related behavioral attitudes towards COVID-19 prevention measures among pre-service science teachers from different countries. Further investigation can explore the sources of information that influence attitudes towards communicable diseases. Additionally, research could investigate the effectiveness of interventions targeted at increasing vaccine uptake and promoting positive attitudes towards vaccination among pre-service science teachers from different contexts. Research could also focus on the role of science education in promoting health literacy and safe behavioral intentions towards communicable diseases.

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