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COVID-19 vaccine acceptance prediction: The roles of students' attitude towards science and mathematics and knowledge of COVID-19 pandemic

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ABSTRACT

The study explored the roles of attitude towards science and mathematics, and knowledge of COVID-19 pandemic in prediction of secondary school students' COVID-19 vaccine acceptance in Nsukka Education Zone, Enugu State Nigeria. The study employed a correlation survey research design. The population of the study comprised 3,789 secondary school three (SS3) students in the zone. The sample size of the study was 350 students selected through multi-stage sampling procedure. Three hypotheses, tested at 0.05 level of significance guided the study. Three adapted instruments, (1) student' attitude towards science and mathematics questionnaire (ATSMQ), (2) students' knowledge of COVID-19 pandemic questionnaire (KCPQ), and (3) students' COVID-19 vaccine acceptance questionnaires (CVAQ), were used for collection of data. The estimate of internal consistency of the instruments were determined using Cronbach's alpha. The obtained reliability coefficients of ATSMQ, KCPQ, and CVAQ were 0.78, 0.89, and 0.91, respectively. Simple and multiple regression analysis were performed to test the hypotheses at 0.05 level of significance using R, R^2, and regression analysis of variance (ANOVA). The findings revealed, among others, that attitude towards science and mathematics and knowledge of COVID-19 pandemic were significant predictors of COVID-19 vaccine acceptance. It is recommended, among others, that teachers, government at all levels, non-governmental organizations, and members of the task force on COVID-19 prevention, should carry out aggressive campaign to increase knowledge of COVID-19 pandemic among the students.

Keywords: attitude towards science, mathematics, COVID-19 pandemic, vaccine, vaccine acceptancy

INTRODUCTION

COVID-19 has become one of the greatest threats to wellbeing of individuals and nations in recent times. In fact, coronavirus has ushered in a new normal in the day-to-day activities of individuals, organizations, and nations. The term coronavirus is an umbrella name for viruses that have been reported to cause severe acute respiratory syndrome (SARS) and middle east respiratory syndrome (MERs) [1]. The first outbreak of the SARS-CoV was between 2002 and 2003, in China in which the most means of transmission was only animal to human with reported fatal rate of about 10% [2]. The virus resurfaced for second time in 2012, in Saudi-Arabia in which the infected person showed similar symptoms of SARS-CoV but with a high fatal rate of 36% [2]. In December

2019, in Wuhan City, China, the current (novel) coronavirus was reported, and associated illness is termed COVID-19 [3].

COVID-19 has spread across most countries. As of February 2022, COVID-19 has continued to wreak havoc on lives of people, as the number of deaths caused by the novel virus has continued to rise. In Nigeria, as of 18th January 2022, 163 new confirmed cases and six deaths have been reported while a total of 251,341 cases have been confirmed and 3,116 deaths have been recorded across the 36 states and Federal Capital Territory [4]. A lot of measures have been put in place to curb the spread of the novel virus in Nigeria. One of the first steps taken by the Federal Government of Nigeria during the initial spread of the disease was borders closures, which was aimed to stop the importation of the virus in the country. However, the use of the borders closure could not stop the virus from being imported into Nigeria. Consequently, the government resorted to the adoption of the preventive guidelines in the prevention of COVID-19. Some of the practices include physical distancing, avoiding crowded places, frequent use of facemask, avoiding touching of the face, and sneezing into the elbow or tissue. These practices are an integral part of the guidelines for prevention of the COVID-19 disease.

Despite the laid down guidelines for prevention of COVID-19, there seems to be poor compliance by the general public. The reason could not be unconnected with the beliefs that COVID-19 pandemic is more of a deception than reality [5]. These false beliefs may likely to affect not just Nigerians' compliance to the COVID-19 preventive measures, but also the acceptance of COVID-19 vaccine. The development of COVID-19 vaccines was one of the major breakthroughs in the prevention of corona-virus disease. It so, because a safe and efficacious vaccine is noted to be a powerful weapon to control of COVID-19 pandemic [6]. Initially, it was a mere hope for development of COVID-19 vaccine [7] and it is expected that individuals should be enthusiastic about the vaccine. However, there was a less than optimal towards accepting of COVID-19 vaccine by the general public given the successful actualization and rapidity in the development of COVID-19 vaccine [7].

The rapidity at which the COVID-19 vaccine was developed, as compared to other previous vaccines, might be attributed to increase in technology, human and material resources and concerted efforts by scientists and government. Given the evidence that COVID-19 vaccine is highly effective in preventing both infectious and severe illness from COVID-19 [8] it is expected that there should be high acceptancy of the vaccine, especially in Africa countries that often depend on developed countries for vaccines.

Unfortunately, evidence has shown that there is high vaccine hesitance among university undergraduate students in Nigeria [9]. If university undergraduates that are supposed to have better knowledge of scientific processes could show high COVID-19 vaccine hesitancy, it could imply that majority of Nigerians mighty share similar feelings. This therefore calls for an urgent investigation into the factors that influence COVID-19 vaccine acceptance in Nigeria. A further breakdown of COVID-19 acceptance also showed that low rate of COVID-19 vaccine acceptance occurred in Africa, while the highest acceptancy rate occurred in Ecuador, Malaysia, Indonesia, and China [10]. The differential level of COVID-19 vaccine acceptance among countries might be attributed to people attitude towards science generally and Mathematics in particular.

Mathematics is the bedrock of science. Mathematics serves as master and servant to other science disciplines. Hence, students who have the interest to pursue careers in sciences are expected to develop interest in mathematics. There has been evidence of students' poor interest and attitude towards mathematics [11]. The students' poor attitude towards mathematics seems to be one the major factors that bring about the poor achievement in mathematics and other related science subjects, and the overall backwardness in accepting scientific evidence. Unless Nigerian students, especially secondary school students develop positive attitude towards science and mathematics, the country will continue to depend on developed countries for virtually, everything needed to survive. Of course, it may not be surprising that Nigeria, which is seen as the giant of Africa, has continued to depend on developed countries for COVID-19 vaccine, instead of producing the vaccine for its teaming population. The inability of Nigerian and other African countries to commence the production of COVID-19 vaccine might be as a result of the attitude the Nigerian citizens toward scientific projects.

Attitude is the measure of individuals' behavior towards object, event, or phenomenon. It is the predisposition to classify objects and events and to react to them with evaluative mentalities [12]. Individuals develop attitude towards something as a result of learning experience; good and positive learning experience enhances positive attitude [13]. One could say that attitude of students towards COVID-19 vaccine could be formed by the information students have received regarding the pandemic or what the students have learnt over the years. COVID-19, although, could be

one the most nontrivial diseases in recent decades, the students' attitude towards the vaccine could be expected to be formed by students' knowledge of scientific principle and not just false and fake news surroundings the disease. Given the scientific and rigorous processes involved in the production of the vaccine, one might expect that students' who have positive attitude towards science and mathematics would show better COVID-19 vaccine acceptance.

Vaccine acceptance is the willingness to get vaccinated when vaccines for a given disease outbreak is available. While trust in national health authorities, personal heath, and scientists are predictor of vaccine acceptance in developed countries [14], not much is known as regard to the predictor of COVID-19 vaccine acceptance in Nigeria, where attitude toward science and mathematics seem to be low. Therefore, research is needed to fill the gap in the knowledge. This is in line with the recommendation that research needs to be carried out to detect specific reasons surrounding vaccine acceptance in a particular country for enhancement of high and equitable vaccine coverage. Beside attitude toward science and mathematics, there could be other factors, such as knowledge of COVID-19 pandemic, that influence secondary school students' vaccine acceptance.

In low-income countries, where many families do not have access to televisions and internet services for better information and knowledge on COVID-19, fake news is often accepted and circulated. Secondary school are expected to have good knowledge of COVID-19 pandemic. The students should be able to explain to their less informed parents and relatives on how the disease is contracted, and how to preventive the disease from spreading.

It might not be a coincidence that low COVID-19 vaccine acceptance is being reported in Africa, given the fact that, the level of development of any nation is dependent on the level of scientific knowledge held by the citizens of the nation [15]. Unfortunately, it has been opined that Nigeria, as well as, other African countries, is still in prescientific age: highly uniformed, and untouched by edifying power of science [16]. There is a gap in knowledge, as to whether, attitude towards science, and by extension, mathematics has any influence on the students' acceptance of COVID-19 vaccine. Hence, assessing the influence of attitude toward science and mathematics and knowledge of COVID-19 pandemic on secondary school students' COVID-19 vaccine acceptance is not only imperative but also timely for preventions of all variants of COVID-19 diseases.

Statement of the Problem

Individuals are expected to live their normal lives and enjoy their fundamental human rights, such as freedom of movement and association. Unfortunately, the outbreak of COVID-19, since 2019, has brought a new normal; people are now advised to avoid social gathering while government at all levels are imposing restrictions on people's movement in effort to prevent the spread of COVID-19 disease. The implication is that teaching and learning, especially in developed and developing countries, where face-to-face interaction has been the order of the day, is in serious threat. The situation would be worsened as facilities to embark on full-scale online learning are lacking. Nevertheless, the spread of corona virus must be stopped, especially now that omicron and delta variants are being confirmed in different countries, including, Nigeria. It has been shown that the most effective measure to prevent any pandemic is to get vaccinated. Interestingly, the COVID-19 vaccine has been developed, within shortest possible time, However, it has been noted that there is high COVID-19 vaccine hesitance in Nigeria. Countries have been advised to focus on finding the factor influencing COVID-19 vaccine hesitancy for effective preventive measures. However, there exist a gap in the knowledge as to whether attitude towards science and mathematics and knowledge of COVID-19 pandemic are predictors of COVID-19 vaccine acceptance. Hence, the problem of this study is what are the roles of attitude towards science and mathematics and knowledge of COVID-19 pandemic in the prediction of COVID-19 vaccine acceptance among secondary school students in Nsukka Education Zone, Enugu State, Nigeria.

Purpose of the Study

The general purpose of the study was the determine whether students' attitude towards science and mathematics and knowledge of COVID-19 are significant predictors of COVID-19 vaccine acceptance among secondary school students in Nsukka Education Zone, Enugu State, Nigeria.

Specifically, the study sought to determine whether:

1. attitude towards science and mathematics is a predictor of COVID-19 vaccine acceptance among secondary school students in Nsukka Education Zone, Enugu State, Nigeria,

2. knowledge of COVID-19 pandemic is a predictor of COVID-19 vaccine acceptance among secondary school students in Nsukka Education Zone, Enugu State, Nigeria, and

3. attitude towards science and mathematics and knowledge of COVID-19 pandemic can jointly predict COVID-19 vaccine acceptance among secondary school students in Nsukka Education Zone, Enugu State, Nigeria.

Hypotheses

The following hypotheses were tested in this current study:

1. Attitude towards science and mathematics does not significantly predict students' COVID-19 vaccine acceptance.

2. Knowledge of COVID-19 pandemic is not a significant predictor of students' COVID-19 vaccine acceptance.

3. Attitude towards science and mathematics and knowledge of COVID-19 vaccine are not significant predictors of COVID-19 vaccine acceptance.

MATERIALS AND METHODS

Design of the Study

The study employed a correlational research design. A correlational design is a research design concerned with determination of relationship between two or more variables in the same population or between the same variable in different population [17]. The design is considered appropriate and adequate as the intention of the study is to determine the relationship between attitude toward science and mathematics and, and knowledge of COVID-19 pandemic and COVID-19 vaccine acceptance.

Participants

The respondents in this study were senior secondary school three (SS3) students distributed in the 62 public secondary schools in Nsukka Education Zone, Enugu State. The choice for using SS3 students assumes that SS3 being the highest level of secondary education, the students in this level can be sought for information by the junior ones. Some of the students at this level have better access information as they prepare for external examination than their junior counterparts. The students ages ranged from 15 to 18 years.

Sample and Sample Technique

The sample size for the study was 350 respondents. The sample size is considered adequate as it was above the minimum recommended sample size of 200 for a prediction study of [18]. The respondents were selected using multi-stage sampling procedure. The first stage was the selection of 15 secondary schools out the total 62 public secondary schools in the education zone through simple random

sampling by balloting without replacement. The second stage was the selection of one intact class each from the selected schools in the first stage using balloting. The final stage was the selection of 24 students from each of the sampled intact classes using simple random sampling by balloting.

Measures

Three adapted instruments were used for data collection in this study. The first instrument measures students' attitude towards science and Mmathematics (ATSM). The items of the ATSM were adapted from [19]. The ATSM comprised 6 items that were scored on a 4-point Likert type scale. The minimum and maximum scores on the ATSM are six and 24, respectively. The second instrument was titled "knowledge of COVID-19 pandemic questionnaire (KCPQ)". The KCPQ comprised 10 items that measure students' knowledge of knowledge of COVID-19 pandemic. The items of the instrument were adapted from [20]. The minimum and maximum scores that could be obtained by a student on the KCPQ are one and 10, respectively. The third instrument was titled "COVID-19 vaccine acceptance questionnaire (CVAQ)". The items comprised six items adapted from participants' willingness to take COVID-19 vaccine developed by [6]. The items of the CVAQ were scored on a 4-point Likert type scale. The items of the ATSM, KCPQ, and CVAQ were validated by three experts in education research, measurement and evaluation, from the Department of Science Education, University of Nigeria, Nsukka. The estimate of internal consistence of the three instruments was determined using Cronbach's alpha. The obtained reliability coefficients of ATSM, KCPQ, and CVAQ were 0.78, 0.89, and 0.91, respectively.

Method of Data Collection

On-the-spot administration and retrieval was adopted in administration of the instruments on the respondents. This was to ensure high percentage return of the instrument. The collected data were analyzed using the statistical package for the social sciences (SPSS) version 25. Simple and multiple regression were performed to test the hypotheses. Significant of the hypotheses were tested at 0.05 level of significance using R, R^2, and regression analysis of variance (ANOVA).

Hypothesis One: Significantly Predict Students' COVID-19 Vaccine Acceptance

Table 1 shows that the value of the parameters of the simple linear regression analysis between attitude towards science and mathematics and students' COVID-19 vaccine

Table 1. Regression analysis of attitude towards science and mathematics as predictors of students' COVID-19 vaccine acceptance

Model	R	R-square	Adjusted R-square	Standard error of the estimate	
1	.340[a]	.115	.113	2.82909	
ANOVA[a]					
Model	Sum of squares	df	Mean square	F	Sig.
1	Regression	362.964	1	362.964	45.349	.000[b]
	Residual	2,785.310	348	8.004		
	Total	3,148.274	349			

Note. [a]Dependent variable: Vaccine acceptance & [b]Predictors: (Constant), science and mathematics attitude

Table 2. Regression analysis of knowledge of COVID-19 pandemic as predictors of students' COVID-19 vaccine acceptance

Model	R	R-square	Adjusted R-square	Standard error of the estimate	
1	.348[a]	.121	.119	2.81945	
ANOVA[a]					
Model	Sum of squares	df	Mean square	F	Sig.
1	Regression	381.926	1	381.926	48.045	.000[b]
	Residual	2,766.348	348	7.949		
	Total	3,148.274	349			

Note. [a]Dependent variable: Vaccine acceptance & [b]Predictors: (Constant), knowledge of COVID-19

acceptance whose prediction equation for regression line is y=10.44+0.19 (attitude towards science and mathematics).

From **Table 1**, students' attitude towards science and mathematics when taken against students' COVID-19 vaccine acceptance, yielded a coefficient of multiple correlation (R) of 0.340 and a multiple correlation square of (R^2) of 0.11. The R^2 value indicates that 11% of the total variance in students COVID-19 vaccine acceptance is attributed students' attitude towards science and mathematics. **Table 1** also shows that the F-value of 45.349 is significant at an alpha level of 0.05 (F=45.349, df=1, 348, p<0.05). The result implies that students' attitude towards science and mathematics is a significant predicator of students' COVID-19 vaccine acceptance. Therefore, the null hypothesis, which states that attitude towards science and mathematics is not a significant predictor of students' COVID-19 vaccine acceptance is rejected.

Hypothesis Two: Knowledge of COVID-19 Pandemic Is Not a Significant Predictor of Students' COVID-19 Vaccine Acceptance

Table 2 shows that the value of the parameters of the simple linear regression analysis between knowledge of COVID-19 pandemic and students' COVID-19 vaccine acceptance whose prediction equation for the regression line is y=11.55+0.32 (knowledge of COVID-19 pandemic).

From **Table 2**, students' knowledge of COVID-19 pandemic when taken against students' COVID-19 vaccine acceptance, yielded a coefficient of multiple correlation (R) of 0.35 and a multiple correlation square of (R^2) of 0.12. The R^2 value

indicates that 12% of the total variance in students COVID-19 vaccine acceptance is attributed students' Knowledge of COVID-19 pandemic. **Table 2** also shows that the F-value of 48.045 is significant at an alpha level of 0.05 (F=48.045, df=1, 348, p<0.05). The result implies that students' knowledge of COVID-19 pandemic is a significant predicator of students' COVID-19 vaccine acceptance. Therefore, the null hypothesis, which states that knowledge of COVID-19 pandemic is not a significant predictor of students' COVID-19 vaccine acceptance is rejected.

Hypothesis Three: Attitude Towards Science and Mathematics and Knowledge of COVID-19 Vaccine Are Not Significant Predictors of COVID-19 Vaccine Acceptance

Table 3 shows that the value of the parameters of the multiple regression analysis among attitude towards science and mathematics (X_1) and knowledge of COVID-19 pandemic (X_2) as predictors of COVID-19 vaccine acceptance. The prediction equation is y=6.36+0.18X_1+0.31X_2.

From **Table 3**, the two predictors when taken against students' COVID-19 vaccine acceptance, yielded a coefficient of multiple correlation (R) of 0.47 and a multiple correlation square of (R^2) of 0.23. The R^2 value indicates that 23% of the total variance in students COVID-19 vaccine acceptance is attributed to both students' attitude towards science and mathematics and students' knowledge of COVID-19 pandemic. **Table 3** also shows that the F-value of 48.045 is significant at an alpha level of 0.05 (F=50.289, df=2, 347, p<0.05). The result implies that students' attitude

Table 3. Multiple regression analysis of attitude towards science and mathematics and knowledge of COVID-19 pandemic as predictors of students' COVID-19 vaccine acceptance

Model		R	R-square	Adjusted R-square	Standard error of the estimate	
1		.474[a]	.225	.220	2.65218	
ANOVA[a]						
Model		Sum of squares	df	Mean square	F	Sig.
	Regression	707.465	2	353.733	50.289	.000[b]
1	Residual	2,440.809	347	7.034		
	Total	3,148.274	348			

Note. [a]Dependent variable: Vaccine acceptance & [b]Predictors: (Constant), knowledge of COVID-19, science and mathematics attitude

towards science and mathematics and students' knowledge of COVID-19 pandemic are significant predicators of students' COVID-19 vaccine acceptance. Therefore, the null hypothesis, which states that attitude towards science and mathematics and knowledge of COVID-19 pandemic are not significant predictors of students' COVID-19 vaccine acceptance is rejected.

DISCUSSION

The findings of the study revealed that students' attitude towards science and mathematics is a significant predictor of the students' COVID-19 vaccine acceptance. The findings are similar to [14] who noted that lack of COVID-19 vaccine acceptance is associated with distrust in authorities and scientists, and the thinking that there is a conspiracy surrounding COVID-19 pandemic. The reason behind the significant prediction of COVID-19 vaccine acceptance by students' attitude towards science and mathematics could be that students with positive attitude towards science and mathematics might have better knowledge of science and science related concepts such as viruses. The students with positive attitude towards science and mathematics might be more inclined to studying of science and might be aspiring to become future scientists. On the other hand, students with negative attitude towards science and mathematics mighty have poor knowledge of science surrounding virus diseases. The students may be more likely to accept false evidence and fake news on COVID-19 pandemic.

The findings of the study also revealed that students' knowledge of COVID-19 pandemic is a significant predictor of students' COVID-19 vaccine acceptance. These findings agree with [7] who noted that knowledge of COVID-19, among others, is associated with the vaccine acceptance. The reason could be that students who are properly informed about COVID-19 pandemic are in better position to make right decision regarding COVID-19 vaccine acceptance. This point to fact that right and timely information is an inevitable tool in prevention of COVID-19.

CONCLUSION

Based on the findings of the study, it is concluded that attitude towards science and mathematics and knowledge of COVID-19 pandemic are significant predictors of students' COVID-19 vaccine acceptance. The total variance in students' COVID-19 vaccine acceptance that was attributed to students' attitude towards science and knowledge of COVID-19 pandemic was 23% while the total variance in students' COVID-19 vaccine acceptance that was attributed to other factors not considered in this study was 77%.

Recommendation

Based on findings, following recommendations were made:

1. Science teachers should increase the efforts to ensure that positive attitude towards mathematics and science are inculcated in the students.

2. Teachers, media, nongovernmental organizations, and members of the task force on COVID-19 prevention should carry out aggressive campaign to increase knowledge of COVID-19 pandemic in the public domain.

3. Teachers should seek to organize competition, in form of essay, quiz, and debate on COVID-19 pandemic for students. This would enable students have a better knowledge of COVID-19 pandemic.

4. The use of forces to get people vaccinated, rather, stakeholders in the society should be integrated to help give members of the society proper information about COVID-19.

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