

Structural equation modeling and implication to educational management of dataset on attitudes, opinions, and behaviors related to COVID-19

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ABSTRACT

This quantitative study utilized R, specifically RStudio, as statistical analysis program in analyzing the dataset on attitudes, opinions, and behaviors with respect to COVID-19. The variables in the dataset are focused on survey items that ask respondents to describe their feelings, physical reaction, perception, attitudes and behaviors towards various issues and aspects that concerns the current pandemic. The study intends to determine dimensionality of the dataset through Principal Component Analysis (PCA) and factor analysis, find out the factor loadings about observed variables and latent variables in the dataset, generate a model through Structural Equation Modeling (SEM), and interpret how the findings relate to educational leadership and management in the new normal. Principal Component Analysis (PCA) reveals that there are four components with most significant representation in the dataset which was confirmed by the scree plots and factor analysis that four factors are sufficient to analyze the dataset. Loadings revealed that these four factors are media, spiritual, political, and cultural aspects. A model that can guide interpretation and future related studies about attitudes, opinions, and behaviors with respect to COVID-19 has been generated through Structural Equation Modeling. It was implied by the findings that the four factors and their observable variables may be used as bases by educational leaders in gathering and analyzing data about attitudes, opinions, and behaviors of school stakeholders towards COVID-19 which can guide them in crafting and implementing responses, innovations and policies that are parallel to pandemic context).



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1. Introduction

The COVID-19 pandemic is a game changer. It has caused unexpected and swift shifts in various aspects of human lives throughout the world. Specifically, it has direct link to the status of education sector as it changed the landscape of teaching and learning from the curriculum to utilization of educational technology. In the context of the United States, the Center for Disease Control and Prevention (CDC), a federal agency of the United States responsible for health promotion and disease prevention in the US, reported a total of 94, 973, 074 COVID-19 cases as of September 9, 2022 and identified COVID-19 variants and low vaccination rates in several states as responsible factors on the surge of active cases, hospitalization, and death rate [1]. The emergence of COVID-19 pandemic has highlighted sociological issues in the US education system in terms of equity during the implementation of remote learning and a more centralized education [2]. The pandemic also triggered racism in the country. In terms of education, the inequality in access to education also makes Blacks and Americans with Hispanic origins graduate with lower level of human capitals resulting to their low economic capabilities [3]. In a study about inequality in education in the US during the pandemic, it was claimed that the education sector, particularly the higher education, has a great responsibility

to lead a transformative change to implement justice and equity both in education and in health aspects [4]. In an Asian country like the Philippines, on the hand, the Department of Education (DepEd) Basic Education Learning Continuity Plan as well as the flexible learning in the higher education of the country made the delivery of instructional service to learners different in terms of learning modality, learning materials, work arrangement of teachers and school personnel, curriculum, assessment, and technology utilization. It is only during school year 2022-2023 that the country has implemented blended classes through the combination of modular and face-to-face modalities since the onset of the pandemic. Though already in low risk of COVID-19 pandemic, it was reported that the country's national capital region COVID-19 reproduction rate has increased [5] which is a manifestation that COVID-19 issues are still of great concern in educational management.

How COVID-19 endangers health equally creates anxieties among people since it has caused changes in their environments, ways of living, works and studies, and the list goes which, as an impact, made people change as well. Social distancing due to stay-at-home mandate and required personal distancing has a direct correlation to negative mental health [6]. Experiencing social distancing itself has caused people new emotions, perceptions, and attitudes towards various aspects of life. Different forms and causes of anxiety have been arising also since the onset of the pandemic. It is explained that human attitudes are developed based on cognitive and emotional experiences of people towards their experiences and, when attitudes are developed, they became the bases for human behavior [7]. For instance, the current trend of human socialization and information dissemination is through social media. A study on the attitude change and social media revealed that positive information overload created positive attitudes while negative information overload creates negative attitudes as well [8]. This implied that technology is so much in use as means to disseminate information during the COVID-19 pandemic which has possibly contributed a lot in the formation of human attitudes, opinions, and behaviors in relation to the pandemic. Therefore, new manifestations of people's attitudes, opinions and behaviors must be determined and understood based from the new context as primary consideration in understanding and studying societal activities and concerns like what learning modality can better deliver quality education; how businesses can directly address clients' needs of products and services; how work settings can still deliver quality outputs and efficient performance despite various pandemic-related constraints to work industry; or how policies must be made, amended and implemented in order to address the current context and bounce forward. This made the pandemic a pebble which created many ripples in every corner of the society.

Responding to the pandemic is a cycle or a process which core is understanding people's attitudes, perceptions and behaviors related to COVID-19. One study concluded that the crisis in COVID-19 had adverse consequence both on one's mental well-being as well as to self-rated health; thereby, suggesting that interventions which are contextualized or situation specific must be implemented [9]. Also, it was suggested that the response to the pandemic must be adapting to the culture that it created through examination of the context and locating the culture which demands adaptations [10]. A report on 2022 global learning poverty 2022 highlights the need for political commitment and evidence-based approaches to address the learning crisis manifested in poor reading comprehension of learners, schools' closures and disruptions, and inequality in education that endanger human capital without urgent action specifically from education leaders [11]. On the other hand, to better analyze the implication to future environmental education research of the relationship between attitude and behavior, there is a need to scrutinize and report significant factors to balance the reliance to theoretical assertions [12]. There have been many scientific studies conducted about COVID-19 mostly are medically related yet the need to understand how the pandemic has influenced human behavior is unexplored yet [13]. Many agencies also provided surveys on how humans and the society were affected by COVID-19 and welcome researchers' interpretations of data collected. The current context demands that further studies regarding the present attitudes, opinions, and behaviors with respect to the pandemic be conducted. With these premises, the researcher sought to find out how people's attitudes, opinions, and behaviors with respect to COVID-19 can specifically be assessed and understood to accurately address societal issues caused by the pandemic. The study intends to provide a lens or a model that will help various sectors of our society, especially the education sector, understand what concerns people most in relevance to the pandemic. This paper presents an analysis of a survey on attitudes, opinions, and behaviors with respect to COVID 19 and treat the dataset primarily through PCA, factors analysis and structural equation modeling. The aim of this quantitative study for the said dataset is to determine the observed variables that significantly measures citizens' attitudes, opinions, and behavior with respect to COVID- 19 and group them according to latent variables towards developing a model that describes the concerned phenomenon. As an output, this

analysis correlates the findings and its implications leadership and management in education sector. This paper specifically intends to answer the following research questions; (1) How may the dimensionality of the dataset on attitudes, opinions, and behaviors with respect to COVID-19 be limited through Principal Component Analysis (PCA) and Factor Analysis?; (2) What does factor loadings reveal about observed variables and latent variables in the dataset on attitudes, opinions, and behaviors with respect to COVID-19?; (3) What model can be generated based on the dataset on attitudes, opinions, and behaviors with respect to COVID-19 through Structural Equation Modelling? What are the implications of the findings to educational management?.

2. Method

This is a quantitative study that utilized the descriptive research design to understand and develop a model about the underlying concept regarding attitudes, opinions, and behaviors with respect to COVID-19. Descriptive research is a method that only observe and measure one or more variables about a certain population and phenomenon without influencing them in any way [14]. The dataset used in this study was based on the survey conducted by Pew Research Center, a nonpartisan source of data on issues and trends through polls, demographic profiling, content analysis and other data-based social science research that releases datasets to the public for secondary analysis. The dataset was originally titled Dataset for 4-2020 Pew Research on US citizens attitudes, opinions, and behavior with respect to COVID-19 [15]. It was freely downloaded from the website of XLDA Pro (XL Data Analyst Professional Edition), which provided not only datasets for free downloads but also offered analysis system of datasets through XLDA Pro statistical analysis program based on Basic Marketing Research textbook authored in 2012 by Alvin Burns and Ronald Bush. The researcher explored the manual in the site to confirm the free use of the dataset for secondary analysis of other researchers [15]. The dataset used in this study has 10, 139 respondents and 114 variables. The variables are focused on survey items that ask respondents to describe their feelings physical reaction, perception, attitudes and behaviors towards the following with respect to COVID-19: news and other media discussing pandemic status, knowledge level on facts about COVID-19, COVID- related political issues and the Election 2020, worship houses and participation on religious activities of the respondents during pandemic, the US economic aid system, trends on COVID rates, government officials and respondents' profile. To analyze and treat the dataset, the researcher converted the dataset into comma-separated values (CSV) file and run the dataset to R program, specifically to RStudio for more convenient interface of the program. R is a free statistical analysis program, and RStudio is an integrated development environment for R that is more convenient to use for many researchers due to its simpler interface and easily accessible commands and controls. In RStudio, the researcher primarily used the following quantitative and data analysis measures using the said program: principal component analysis, factor analysis, structural equation modeling and model fit measures. The researcher also used commands in scree plot, biplot, scores of components, and varimax and promax rotations.

3. Results and Discussion

The primary rationale of the data analysis conducted is to show through a model the attitudes, opinions, and behaviors with respect to COVID-19 and interpret its implication to educational leadership and management in the new normal. This part presents logically how research problems were answered in the study.

3.1. Dimensionality of the dataset on attitudes, opinions, and behaviors with respect to COVID 19 through Principal Component Analysis (PCA) and Factor Analysis

The following tables and graphs show how the dataset's significant components were determined through the three common criteria for component selection after running the data through Principal Component Analysis (PCA) in R. The dataset on attitudes, opinions, and behaviors with respect to COVID 19 when run through Principal Component Analysis (PCA) in RStudio leads to the data in Fig. 1 which shows the importance of each component in the dataset. There are several methods to reduce the dimensionality of the data gathered which include determining the eigenvalues of standard deviation and considering the proportion of variance [16]. To initially determine the number of important components, choose components with eigenvalues of standard deviation ≥ 1 . Fig. 1 shows that the data to be analyzed can be limited to 27 components only since the 28th component has a standard deviation of only 0.996701512. Second, the proportion of variance which is connected to cumulative proportion may also be considered. As shown in Fig. 1, 50% of the total variability can be

explained by components 1 to 22. This means that there might be 22 to 27 important components in the data set that represent and can serve as determinants of attitudes, opinions, and behaviors with respect to COVID-19. However, 22 to 27 components must be filtered and be minimized only to components with significant representation in the dataset that really represent the attitudes, opinions, and behaviors of the respondents with respect to COVID-19. More than twenty components are too many to be able to accurately separate the most significant and non-signification components from the dataset. That's why, the researcher used the scree plots that follow, in line and in bar graphs, to finalize the number of components to focus on for the next steps in dataset analysis.

	Comp.1	Comp.2	Comp.3	Comp.4
Standard deviation	3.13460414	2.51600639	2.45548785	1.97708589
Proportion of Variance	0.08619073	0.05552884	0.05288965	0.03428832
Cumulative Proportion	0.08619073	0.14171957	0.19460923	0.22889755
	Comp.5	Comp.6	Comp.7	Comp.8
Standard deviation	1.86165141	1.73003655	1.5603519	1.43040041
Proportion of Variance	0.03040128	0.02625462	0.0213570	0.01794777
Cumulative Proportion	0.25929883	0.28555345	0.3069104	0.32485821
	Comp.9	Comp.10	Comp.11	Comp.12
Standard deviation	1.40980586	1.33399517	1.29472718	1.2824899
Proportion of Variance	0.01743467	0.01561003	0.01470455	0.0144279
Cumulative Proportion	0.34229288	0.35790291	0.37260746	0.3870354
	Comp.13	Comp.14	Comp.15	Comp.16
Standard deviation	1.23810183	1.21404494	1.21009608	1.18279294
Proportion of Variance	0.01344646	0.01292899	0.01284502	0.01227192
Cumulative Proportion	0.40048181	0.41341081	0.42625583	0.43852775
	Comp.17	Comp.18	Comp.19	Comp.20
Standard deviation	1.1588985	1.14012594	1.13375897	1.08391443
Proportion of Variance	0.0117811	0.01140252	0.01127552	0.01030588
Cumulative Proportion	0.4503089	0.46171137	0.47298689	0.48329277
	Comp.21	Comp.22	Comp.23	Comp.24
Standard deviation	1.067682833	1.064466266	1.058061119	1.040941318
Proportion of Variance	0.009999532	0.009939372	0.009820117	0.009504902
Cumulative Proportion	0.493292306	0.503231678	0.513051795	0.522556697
	Comp.25	Comp.26	Comp.27	Comp.28
Standard deviation	1.032405439	1.017666030	1.008581813	0.996701512
Proportion of Variance	0.009349658	0.009084598	0.008923134	0.008714157
Cumulative Proportion	0.531906355	0.540990953	0.549914087	0.558628244

Fig. 1. Importance of Components in the Dataset when run through PCA in RStudio

The third method to determine the significant number of components to be considered in a dataset, which is through the Scree Plot, suggests the use of “find the elbow” method. Fig. 2 shows that the elbow of the line graph is at component 4.

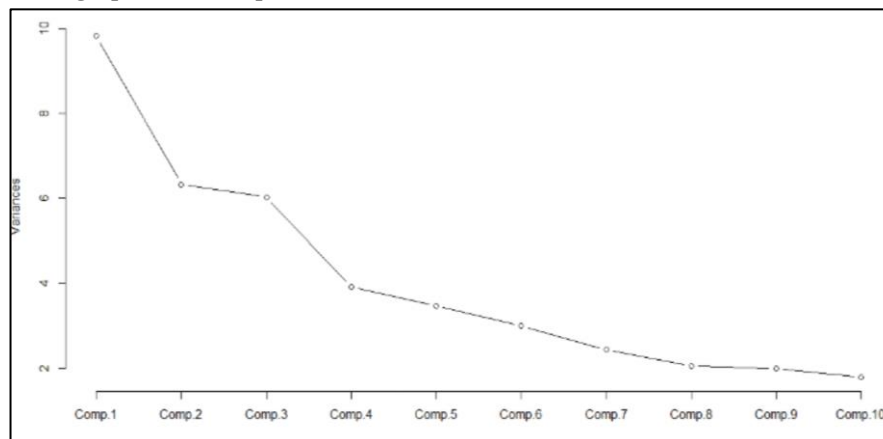


Fig. 2. Scree Plot in Line Graph of Important Components in the Dataset

Fig. 3, on the other hand, shows a graph that components 1 to 4 composed the most significant representation in the dataset. Through the mentioned measures to determine the number of most significant components from the dataset, it was finalized that only four components must be retained as the determinants of the attitudes, opinions, and behaviors of respondents in relation to COVID-19. To test if those four components are enough to represent the significant information from the data gathered using R, the data set was run through factor analysis. Factor analysis is a technique in statistics to determine the dimensionality among survey items and assess the relationship between survey items either through exploratory factor analysis (EFA) or confirmatory factor analysis (CFA) [17]. When the dataset on the attitudes, opinions, and behaviors related to COVID-19 was run through factor analysis, the results are below which confirms that 4 components or factors can be retained and are enough to represent the dataset.

*Test of the hypothesis that 4 factors are sufficient.
The chi square statistic is 196472.5 on 5991 degrees of freedom.
The p-value is 0.*

To interpret the result, the higher chi square statistics over degrees of freedom supported that the hypothesis is true [18]. Though the p-value is 0, it still suggests value of < 0.001 and that hypothesis is true; it's just that the statistical tool limits the length of value to display and displayed p-value as zero instead [19]. Therefore, in this study, the researcher decided to retain only four components in the further analysis of the data.

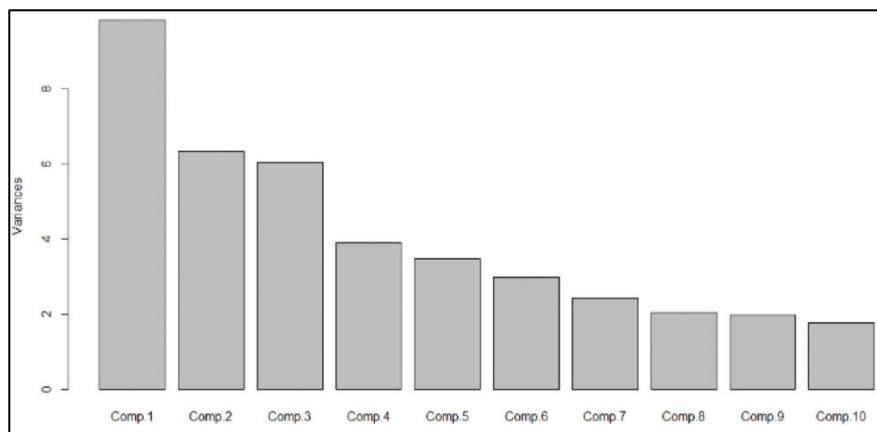


Fig. 3. Scree Plot in Bar Graph of Important Components in the Dataset

3.2. Factor loadings, observed variables and latent variables in the dataset on attitudes, opinions, and behaviors with respect to COVID 19

Factor analysis with varimax rotation for the dataset was used to finally determine the loadings of the four factors. Table 1 presents the first three loadings or observed variables for each factor. Based on the loadings, it was revealed that factors one to four represent media, spiritual, political, and cultural as latent variables, respectively. News about hospital's capacities, people's health, and COVID-19 tests loaded very high for Factor 1 (Media) while worship house services, religion and ideology loaded very high for Factor 2 (Spiritual). Additionally, political news, presidential election candidates and Political Knowledge Index loaded very high for Factor 3 (Political) while race, Hispanic origin, and length of stay in the US loaded very high for Factor 4 (Cultural). These data represent the latent variables and the observed variables in the dataset.

Table 1. Summary of Factor Analysis Loadings on the Dataset with Varimax Rotation

Latent Variable	Code	Description	Factor 1	Factor 2	Factor 3	Factor 4
MEDIA	HOSP	Watch news about hospitals' capacities	0.672			
	HEALTH	Watch news about people's health	0.663			
	COVTEST	Watch news about COVID-19 tests	0.661			
SPIRITUAL (SPIR)	CHURCH	Perception on worship house services		0.520		
	REL	Religion		0.570		
	IDEOL	Ideology (Very conservative, Conservative, Moderate, Liberal, Very Liberal)		0.666		
POLITICAL (POL)	CAND	Watch news about 2020 presidential election candidates			0.555	
	NEWS	Watch political news			0.668	
	PKI	Political Knowledge Index			0.673	
CULTURAL (CULT)	RACE	Hispanic, Latino, or Spanish origin, such as Mexican, Puerto Rican or Cuban				0.928
	ORIGIN	Hispanic Origin (Mexican, Puerto Rican, Cuban, Spanish, All others, non-Hispanic)				0.871
	LOS	Length of stay in the US				0.916

3.3. Model generated from the dataset on attitudes, opinions, and behaviors with respect to COVID 19 through Structural Equation Modelling (SEM)

Fig. 4 finally presents the model from the dataset of the study. The model reveals that attitudes, opinions, and behaviors with respect to COVID 19 can be significantly determined through four latent variables such as media, spiritual, political, and cultural aspects. The model also shows how each latent variable correlates with one another as measure of citizens' attitudes, opinions, and behaviors with respect to COVID-19. Firstly, in terms of media, respondents' attitudes, opinions, and behaviors can be measured through engagement on news about hospitals (HOSP), people's health (HEALTH), and COVID-19 test (COV TEST). Different media as sources of information about COVID-19 have been found out to result on different attitudes and preventive behaviors during a pandemic crisis context [20]. For example, a study on the use of social media revealed that its use during the pandemic can predict health-related behaviors such as self-efficacy, perceived threat of the virus, and preventive behaviors [21]. Several studies also found out that various ways of presenting pandemic-related information through media as well as the level of exposure of the people can influence whether people's attitudes will be positive or negative. Alarming information tend to be ineffective as compared to how calming information is associated to healthy behaviors [22]; Vaccination rates relates to degree of social media exposure also [23], and positive information overload leads to positive attitudes while negative information overload lead to bias attitudes to the subject concerned [8].

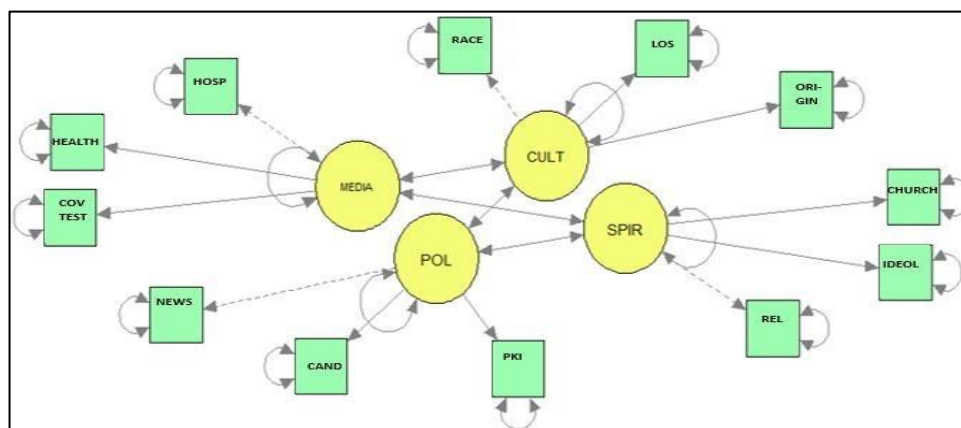


Fig. 4. Model generated through Structural Equation Modeling (SEM)

Secondly, attitudes, opinions, and behaviors with respect to COVID-19 in relation to spiritual aspect can be measured in terms of worship house services (CHURCH), religion (REL), and ideology (IDEOL) whether conservative or liberal. It was found out that various forms of religiosity, be internal or external, are associated with stress level and illness perceptions during the COVID-19 pandemic [24]. It is also claimed that religious activities are protective factors for one's mental health and physical well-being because one's spirituality helps the person to grasp the situation and not get lost due to radical changes caused by the pandemic [25]. Faith, which facilitates sense of hope and security, is one of the survival strategies that humans employ when faced with the threats of the pandemic [26]. Thirdly, this study revealed that in terms of political aspect as a latent variable, the presidential election candidates (CAND), political news (NEWS), and political knowledge index (PKI) can be used as measures. During the global pandemic and implementation of strict guidelines in various countries to secure everyone's health and safety against the virus, people have been hopeful and reliant to every decision, action, and plan of the government on mitigating the adverse effects of the pandemic to the health and sustainability of the people and their households. Due to decisions made by the government to prioritize citizen's health rather than the economy, democracy and its institutions have received support from the people [27]. Also, the government has always been hopeful that higher vaccination rate can solve pandemic-related crises. The correlation between vaccination intention and its perceived high risk with voting, trust to authorities, and information from health authorities has been observed [28]. Political orientation is one of the influencing factors on attitudes and behavior during COVID-19 pandemic [29] while divergence among health authorities and politicians are just reinforcing the perception regarding the division in the society.

Finally, in terms of how respondents react to COVID-19 in the cultural aspect depends significantly on their race (RACE), Hispanic origin (ORIGIN), and their length of stay in the country (LOS). Indeed, the pandemic has caused numerous cultural changes to many people. There is a

significant relationship between cultural differences and positivity rate [30]. Additionally, previously and newly practiced culture are shaping the people's attitudes, opinions, and behaviors in relation to COVID-19 which are manifested in their responses. For instance, studies found out that cultural factors such as collectivism, prior experience with a respiratory illness, usage of mask, and information seeking behavior are driving one's personal protective behavior against the virus [31] while number of confirmed cases are influenced by individualism, uncertain avoidance, and masculinity [30]. Another highlight, as shown in Table 2, is how the model fit the dataset through fit measures indexes. TLI and CFI of the model resulted both to ≥ 0.90 while the RMSEA and the SRMR resulted both to value that is ≤ 0.08 . These all suggest that the model is fit for the dataset and may be used for further interpretation of the data collected and for other related future studies.

Table 2. Summary of Model's Fit Measure Index

Measures	Fit Measure Results for the Data	Cut-off for Good Fit
Tucker Lewis Index (TLI)	0.964	NNFI ≥ 0.95
Comparative Fit Index (CFI)	0.974	CFI ≥ 0.90
Root Mean Square Error of Approximation (RMSEA)	0.051	RMSEA ≤ 0.08
(Standardized) Root Mean Square Residual - (S) RMR	0.047	SRMR ≤ 0.08

3.4. Implication of the findings to school leadership and management

Based on the results of the analysis of the data on attitudes, opinions, and behaviors with respect to COVID-19 and from various readings of related literature, it can be implied that school leaders and managers must employ the theory and practices of a transformative leadership and systems thinking to successfully adapt to the new educational landscape imposed by the COVID-19 pandemic. Transformative leadership is a leadership that fosters equity and justice in the education system [32]. It is a leadership of creative collaboration among members of the organization regardless of their positions [33]. It also a leadership through systems thinking theory believing that the whole must be seen through each part to see patterns like that of culture and behavior [34]. In relation to the data set which is tremendously comprehensive and large due to the numbers of respondents and concern variables, the process of generating a model out of those great number explains how systems thinking works – that the thoughts, feelings, and experiences of individuals must be considered to see a pattern which will become the basis for policies, programs that must be newly implemented or sustained.

This study presents that aspects to greatly consider when understanding how people respond to the pandemic are media, spiritual, political, and cultural. This means that school leaders must consider how these aspects have influenced the attitudes, opinions, and behaviors of schools' external and internal stakeholders. The different latent variables and their observed variables also shows that leadership and management must be guided with patterns or models and lead with principles based on research. The equity and justice which is being highlighted by transformative leadership was revealed by how cultural variables loaded highly as among the indicators of attitudes, opinions, and behaviors with respect to COVID-19. It has been a trending issue recently how the emergence of the pandemic lead to racism and imbalance of power in which education sector must work on as they adjust their policies, programs, core values and kind of leadership to the current needs as revealed by valid research. Also, the proper utilization of media and kind of information where schools' stakeholders are exposed to have to critically checked and considered also.

As of now, schools are already gearing towards an education system that is sustainable and adaptive to post pandemic context. Some schools are bouncing backward while others are bouncing forward. Like in the utilization of educational technology in education after the pandemic. There are two contradictory vision: pre-digital reconstruction means going back to normal education and post digital view means utilizing lessons learned from the pandemic to reform educational system [35]. Education leaders, therefore, need to decide first whether to bounce back or bounce forward in the coming school years. This will determine what curriculum, learning modality, educational technology, policies, budget allocation and trainings will be prioritized. And no matter what they choose, the first consideration in planning is looking at how stakeholders' attitudes, opinions, and behaviors with respect to COVID-19 matter to achieve the education goals.

4. Conclusion

Referring to the analysis of the significant information revealed by the data through running them through statistical treatment, it can be concluded that attitudes, opinions, and behaviors with respect to COVID-19 are relatively affected by various aspects that concern not only their health but also other aspects of life and community living like their perceptions and experiences on media, spiritual, political and cultural aspects which were revealed in this study as the dominant latent variables from the datasets. In connection to how these findings are useful to the education system, it is concluded that school leaders and managers must see and lead the new normal education or post-pandemic education through the lenses of individuals' attitudes, opinions, and behaviors with respect to COVID-19 and through the lenses of research-based principles. This will make innovations, new educational policies, and other measures employed and implemented by the educational system parallel to the demands and context of the pandemic. The integration of the knowledge, values and skills on curriculum, policies, and program to be implemented and sustained in the new normal or post-pandemic education are recommended to be based on relevant datasets and their interpretations. It is also recommended that future studies on related phenomenon consider the model developed in this study to focus their data gathering and findings to factors that significantly measures attitudes, opinions, and behaviors with respect to COVID 19.

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- Conflict of interest** : The author declares no conflict of interest.
- Additional information** : No additional information is available for this paper.

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