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Fourth industrial revolution model in the context of basic education in the Davao Region, Philippines

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ABSTRACT

The Philippines is among the developing countries in the world which significantly affected by the technological advancement brought about by the fourth industrial revolution (4IR). Advancing the country's manpower in the modern world requires preparedness for technological advancements. Thus, this study proposes a model in the context of basic education to better equip learners with modern approaches to education. The use of quantitative research design and factor analyses (both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA)) was carried out. A total of 550 teachers participated in the study, with 250 in EFA and 300 in CFA. The used of data reduction technique in EFA and model fit indices measures in CFA were used in the analyses. The results revealed three crucial dimensions in advancing education in the 4IR, these are: i) protection using cybersecurity; ii) use of simulation in teaching; and iii) school data management and analytics. Based on these findings, a model in basic education was developed to boost the Davao Region, Philippines' preparedness to embrace technological advancement in the modern world. Moreover, the findings of this study can also serve as baseline data for other countries with similar profiles to the Philippines on how to approach education in 4IR.

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1. INTRODUCTION

Technological and digital advancement in the modern world creates many opportunities for nation-building. Schwab [1] defined the fourth industrial revolution (4IR) as the paradigm shift governed by technological advancements, such as the rise of artificial intelligence, data analytics, cybersecurity (to name a few) that has profound effect on the nation's economy, business, global perspectives, society, and community members. Moreover, to transcend fully to the 4IR, preparation must be carried out by different global leaders. Long-term preparation includes educating every community member on the rise of the 4IR and the necessary 21st-century skills needed for holistic development [1], [2]. However, challenges in integrating this concept arise such as a lack of exposure to technological advancements [3], unequal distribution of advancements in schools [4], social injustice, and lack of clear policy [5] are among the factors that can limit the advancement. Therefore, revisiting the educational system and providing a clear model for adapting to this paradigm can help basic education institutions to produce resilient learners in the rise of this paradigm shift.

The World Economic Forum [6] published a report regarding the importance of transformative education in the context of the 4IR. In addition, the education 4.0 framework developed by the World Economic Forum [6] acts as a guide in transforming the nation by focusing on global, innovative, technological, and interpersonal skills. Moreover, technological innovation is being identified as one of the key driving forces in the global economy [7], highlighting its urgency to produce resilient community members [1]. Elayyan [8] pointed out that the rise in the use of these innovations can profoundly affect the education's learning opportunities, instructional activities, control learning, and social dynamics. Thus, education sectors have a significant role in preparing learners to acquire the necessary competencies needed to adapt to this conceptual change [9].

In the Philippines, transitioning to the 4IR in education requires careful decision planning to transcend fully as the country is currently transitioning in its basic education system. Although the country has developed several plans, such as the Philippine Development Plan 2023–2028, which highlights the significant contribution of the 4IR in making the industries in the country adaptive and resilient [10]. The Sulong EduKalidad Framework that emphasized the use of technology to support learning and administration for addressing equality and quality of education in the Philippines [11]. However, the plan and framework lack a clear discussion on the position of the department of education in the 4IR in the country, including the technological priorities, guides, and models to enhance the use and delivery of technology in basic education.

Furthermore, the Philippines experiences various challenges in integrating the innovations and products of 4IR in the education system. Among these challenges are insufficient budget, lack of skills in ICT, unmotivated to adapt [12], equity and access [5], and technical issues [13]. Although these challenges are present in the country's education system, the country continues to move forward by implementing a new curriculum in basic education that starts in the academic year 2024. This newly implemented curriculum emphasizes the use of the innovations in the 4IR and highlights its crucial role in the nation's development [14]. However, the curriculum is in the first year of full implementation and thus lacks clear models and frameworks that can guide the priority areas in the 4IR utilization. Therefore, creating a model on the use of 4IR technologies in basic education can help the country develop strategies to ensure that the education system is responsive to the needs of stakeholders and the community.

Following the literature and the gap, this study shed light on the problems of the department of education in the Philippines by creating a model that captures the current needs of basic education, specifically in Davao Region in the advent of the 4IR. As noted by Sánchez-Cabrero *et al.* [15] that education models are created to uplift the morale of education institutions to deliver effective teaching. Thus, this study addresses a crucial problem in the current basic education system in the Philippines by offering a new model that integrates the 4IR dimension to enhance teaching and learning practice. In addition, the model also captures the most important aspect of 4IR as it relates to the current situation of the country by reflecting on the priorities as identified by educators. This way, the developed model serves as a reflection of the ambition of the educators in the Philippines to move forward in the advent of technological change.

To develop the model, the study is guided by two important objectives: i) to determine the dimensions of the 4IR in basic education in the Davao Region, Philippines and ii) to determine what model can be created based on the dimensions identified. The first objective highlights the most important dimensions of 4IR as it relates to the current context in the Davao Region, Philippines. The second objective provides an input on the country's basic education by examining the most crucial dimensions of this paradigm shift. Thus, this study contributes to the literature by providing clear implications on the applications of 4IR in the context of basic education.

2. METHOD

2.1. Research design

This study used a quantitative research design to address the main objectives of the study. Specifically, this study adheres to the factor analysis inquiry. In a survey research, factor analysis design is used to create a factor loading to determine the dimensions or indicators of the chosen topic [16]. In this study, data collection started with the literature review and was followed by factor analysis. This inquiry was selected because of the limited literature pertaining to the topic [17].

2.2. Sample

This study used a single-stage cluster sampling technique to identify research respondents. In this study, the single-stage cluster sampling technique is the most appropriate because the Department of Education Regions XI is already divided into eleven divisions. Thus, the researcher is already informed how many divisions are in the Region. Moreover, in conducting the sampling frame, the following steps were considered: clustering the region based on the number of divisions (in this case, there are eleven divisions) and clustering each division based on the province they belong. Respondents will be drawn from the chosen cluster in the chosen division (randomly).

Inclusion criteria for selecting the target responding schools are the following: i) the school must fall in either a large school (with 26-100 teachers) or mega school (101 and above) category in the cluster; ii) the school must be located within the municipality/city proper; and iii) the participating school is willing to participate in the study. Moreover, the following criteria were used in randomly selecting the respondents of the study: i) must be a full-time secondary teacher; ii) must be willing to participate in the study. Exclusion criteria include: i) for public schools, volunteer teachers; ii) for private schools, not full-time teachers (teachers with multiple industries/agencies/departments); and iii) withdrawal to participate in the study. For the sample size, the researchers used the recommended sample of 250 sample size in the exploratory factor analysis (EFA) [18]. Moreover, in the confirmatory factor analysis (CFA), the researchers used the recommended sample as cited by Kyriazos [17] that 300 samples are good enough for factor analysis. Thus, in this study, a total of 550 teachers from the Department of Education Region XI participated in the study.

2.3. Research instrument

This study used a close-ended survey instrument as the main instrument. The survey instrument is a self-made instrument created from a literature review [19]. However, to ensure that each statement is deemed relevant, a minimum of at least one literature was given. In addition, in crafting the significant statements to be included, the researcher used the steps in developing or constructing an instrument by Creswell [20]. The first phase is planning; in this study, the researcher is guided by the study's objectives and the pillars of the 4IR. The second phase is construction; in this study, the researcher gathered a significant amount of literature to support the statements being included.

The third phase is quantitative evaluation; in this study, the developed questionnaire undergoes reliability tests (using a 5-point Likert scale). Moreover, for reliability tests, a pilot test with 30 respondents was implemented to determine the Cronbach alpha of the developed questionnaire. The analysis yielded a Cronbach alpha of 0.916, indicating that the developed questions have an acceptable internal consistency [21]. Finally, the fourth phase is validation; in this study, the researcher administers content validity to determine the appropriateness of the items. Content validity in this study was carried out in the form of two expert validation [22], wherein the experts determined whether the items were appropriate and served their purpose. The validation result scored a content validity index (CVI) of 1.0, meaning the developed questionnaire is good to implement [23]. Once these phases were completed, the developed questionnaire was implemented in the selected schools.

2.4. Data analysis

To interpret the data, the following data analysis was used: For EFA, the researchers used data reduction analysis, Keiser-Meyer-Olkin (KMO) measure, Bartlett's test of Sphericity, eigenvalue, Varimax rotation using Kaiser normalization, Cattell-Scree plot, and thematic analysis. Moreover, for CFA, the researchers used the Chi-square fit index, comparative fix index (CFI), Tucker-Lewis's index (TLI), standardized root mean square residual (SRMR) index, root mean square error of approximation (RMSEA), Akaike information criterion (AIC) and Bayesian information criteria (BIC).

3. RESULTS AND DISCUSSION

3.1. Findings related to EFA

In this analysis, principal axis factoring and varimax rotation were used. Varimax rotations were used to obtain a more generalizable factor structure rather than similarity with data [24]. Moreover, the principal axis component was used since this method assumed that all variables (items) belonged to the first group, and then the matrix was calculated to produce factors based on the calculation [25]. Moreover, to determine the suitability of the data for factor analysis, the KMO coefficient test and the Bartlett's Sphericity test were calculated, as seen in Table 1. The KMO obtained a value of 0.953 based on the analysis, and the Bartlett test result (Chi-square=6773.56; p=0.000) was significant. Based on Beaver *et al.* [26], this significant result shows that a KMO of above 0.60 and a significant value is appropriate for factor analysis.

Table 2 shows the initial eigenvalues, the percentage of the total variance, and the cumulative percentage of each extracted dimension. The extracted dimensions are all arranged in descending order by the amount of variance they explained. Factors with less than 1 eigenvalue are removed in the analysis. Data also shows the extraction sums of squared and rotation sum of squared loadings. Based on the analysis, there were 8 factors generated with more than 1 eigenvalue. Figure 1 shows the graph of eigenvalues of all factors. The figure shows that there is a gradual change in the scree plot graph. The graph flattened as it approached the 8th factor, thus indicating that there are 8th factors of 4IR in basic education.

Table 1. 4IR in basic education scale

KMO measure of sampling adequacy		0.953
Bartlett's test of Sphericity	Chi-square	6773.56
	df	990
	Sig.	0.000

Table 2. Total variance explained

Factor	Initial eigenvalues			Extraction sums of squared loadings			rotation sums of squared loadings		
	Total	% of variance	Cumulative (%)	Total	% of variance	Cumulative (%)	Total	% of variance	Cumulative (%)
1	18.631	41.403	41.403	18.195	40.433	40.433	6.216	13.813	13.813
2	2.112	4.693	46.096	1.668	3.706	44.139	4.564	10.143	23.956
3	1.776	3.947	50.043	1.368	3.040	47.180	4.003	8.895	32.851
4	1.494	3.320	53.363	1.062	2.360	49.540	3.759	8.353	41.204
5	1.307	2.905	56.269	0.893	1.984	51.524	3.125	6.943	48.148
6	1.158	2.573	58.841	0.727	1.615	53.139	1.857	4.126	52.274
7	1.116	2.479	61.321	0.659	1.464	54.603	.874	1.943	54.217
8	1.041	2.313	63.634	0.600	1.334	55.938	.774	1.721	55.938

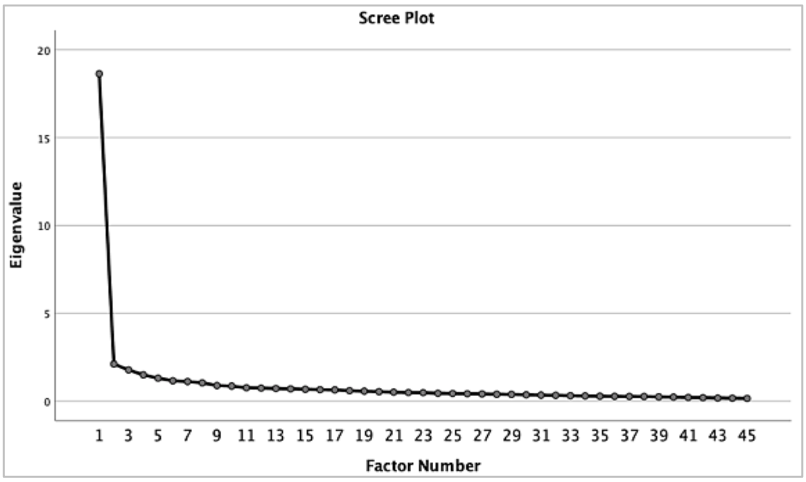

Figure 1. Scree plot of factor analysis

The researchers used rotated component analysis with 45 items using a Varimax rotation set in 25 iterations. A total of 5 factors out of 8 factors were retained based on the 0.500 absolute value threshold since the number of respondents exceeds 200; thus, items with a factor less than 0.500 value are removed [27], [28]. Other decisions include removing factors with less than 3 items [29], [30]. In addition, the five components also attained an eigenvalue of greater than 1, thus indicating that these components are appropriate [31]. Moreover, Cronbach's coefficient of reliability was also used to determine further the reliability of the five components. Based on the result of the reliability analysis, all components have achieved a very good internal consistency (0.80 to <0.90) [32]. After the analysis, a total of 28 items were retained from the original 45 items, as shown in Table 3.

The first component had a total of nine items with an internal consistency of 0.89 indicating that this component exhibited a very good internal consistency. Items included in this component are Item_35 (0.64), Item_33 (0.63), Item_34 (0.62), Item_30 (0.60), Item_31 (0.59), Item_32 (0.58), Item_28 (0.56), Item_36 (0.55), and Item_29 (0.506). Moreover, this component is named "protection using cybersecurity" after confirming the associated items in this dimension. The second component had five items with an internal consistency of 0.84, indicating that this component exhibited a very good internal consistency. Items included in this component include Item_13 (0.63), Item_12 (0.59), Item_15 (0.59), Item_14 (0.54), and Item_11 (0.51). This component is named "use of simulation in teaching" after confirming the associated items in this dimension. In the third component, a total of five items were included, and this component had an internal consistency of 0.87, indicating that this component exhibited a very good internal consistency. Items included in this component are Item_3 (0.69), Item_4 (0.67), Item_1 (0.66), Item_2 (0.65), and Item_5 (0.61). The third component is named "school data management and analytics" after confirming the associated items in this dimension.

Table 3. Dimensions of 4IR in basic education

	Statements	Indicator	Components 1	2	3	4	5
35.	Virtual security can be further enhanced if the schools invest more in data protection and technologies.	CB1	0.64				
33.	Centralized system can enhance the cybersecurity feature of schools.	CB2	0.63				
34.	Educating the users can further enhance cybersecurity features in schools.	CB3	0.62				
30.	Resources and school funds can help the use of 3D in teaching.	CB4	0.60				
31.	Firewalls, antivirus, and other software can protect the data privacy of students, teachers, and schools.	CB5	0.59				
32.	Cybersecurity can be utilized easily with proper trainings among administrators.	CB6	0.58				
28.	3D tools can increase students' motivation, interest, and self-efficacy.	CB7	0.56				
36.	Software services with strong cybersecurity can enhance the data privacy of the users.	CB8	0.55				
29.	3D teaching strategies can be easily to implement, especially if educators already have the necessary knowledge and background to implement it.	CB9	0.51				
13.	One aspect of the 4IR in the form of simulation can be incorporated into the classroom for students to become independent learners.	Sm1		0.63			
12.	One aspect of the 4IR in the form of simulation can be incorporated as a teaching strategy to enhance students' classroom engagement.	Sm2		0.59			
15.	Virtual simulation can be an effective teaching strategy compared to traditional activities.	Sm3		0.59			
14.	Activities that used prototyping in the 4IR can be used to promote holistic development among learners.	Sm4		0.54			
11.	One aspect of the 4IR in the form of simulation can be incorporated as a teaching strategy to provide a virtual-reality scenario of the concepts to be learned.	Sm5		0.51			
3.	The product of the 4IR in the form of big data analytics is useful in assessing learners' skills to match companies' needed skills.	DA1			0.69		
4.	The product of the 4IR in the form of data management is useful in improving the quality of education in general.	DA2			0.67		
1.	The product of the 4IR in the form of databases is useful in monitoring students' performance.	DA3			0.66		
2.	Data management is useful in creating plans and programs for improving schools/teachers/students' performance.	DA4			0.65		
5.	The product of the 4IR such as data management can be used to enhance data privacy and security of users.	DA5			0.61		
45.	Virtual system integration can be used to link the services of the education institutions to the stakeholders for easy access and transparency.	VSI1				0.63	
42.	Virtual system integration can enhance teachers' capabilities by allowing the teacher to share their best practices in the virtual world.	VSI2				0.59	
44.	Virtual system integration can be used to design the best learning experiences among learners without compromising their differences.	VSI3				0.59	
43.	Virtual system integration can be used to monitor the competencies of learners across and inter-discipline for the betterment of education services.	VSI4				0.58	
41.	Horizontal and vertical system integration can enhance the services offered by the education sector by centralizing the plans and programs.	VSI5				0.53	
22.	Tools that offer virtual-reality experience can be useful in developing new learning techniques among learners.	AR1					0.65
26.	Teachers can use additive manufacturing to create 3D objects to enhance students' creativity and inventiveness.	AR2					0.51
24.	Integrating virtual reality experience in the classroom can create a positive learning experience among learners.	AR3					0.51
23.	Cyberspace-related teaching activity can promote inclusivity of learning.	AR4					0.51
	Initial eigenvalues		18.6	2.11	1.78	1.49	1.31
	% Variance (rotation sums of squared loadings)		13.8	10.1	8.90	8.35	6.94
	Reliability by Cronbach's alpha		0.89	0.84	0.87	0.85	0.84

The fourth component had five items with an internal consistency of 0.85, indicating that this component exhibited a very good internal consistency. Items included in this component are Item_45 (0.63), Item_42 (0.59), Item_44 (0.59), Item_43 (0.58), and Item_41 (0.53). This component is named "support using virtual system integration" after confirming the associated items in this dimension Finally, the fifth component has 4 items with an internal consistency of 0.841, indicating that this component exhibited a very good internal consistency. Items included in this component are Item_22 (0.65), Item_26 (0.51), Item_24 (0.51), and Item_23 (0.51). This component is named "used of augmented reality in teaching" after confirming the associated items in this dimension

3.2. Findings related to CFA

In this study, an examination of the appropriateness of items within the factors is also studied; hence, this study also conducted a CFA. According to Seçer [33], CFA is conducted to determine the appropriateness of items in the factor loadings. Thus, this method is used to verify the result of EFA. The following indices (with values) are used to determine if the created questionnaire is acceptable, as seen in Table 4, thus creating the best model for the study.

Table 4. CFA fit indices

Fit indices	Value	Reference
χ^2	Low χ^2 relative to *df* and higher p-value	[34]
df	indicates better model fit.	
p-value		
CFI	>0.95	[35], [36]
TLI	>0.95	[36]
SRMR	≤0.08	[37]
RMSEA	≤0.06	[37]
AIC	Smaller AIC is better	[38]
BIC	Smaller BIC is better	[39]

Moreover, in this study, three models are tested to determine which model is the most acceptable based on the set parameters. Model_1 is the baseline model, which consists of five dimensions from the EFA; hence, this model consists of 28 items. Model_2 is the adjusted model based on the result of Model_1 analysis and consists of four dimensions with 18 items. Model_3 is the adjusted model from Model_2 with three dimensions and 11 items left. In testing the models, the JAMOVI 2.3.28 solid application for macOS was used. This software is free to download statistical software and contained the needed indices for analysis.

Table 5 shows the test of the exact fit and fit measures of Model_1, Model_2, and Model_3. Removal of items with a modification index greater than 3.84 was performed after the analysis in Model_1 and Model_2 to produce Model_3. For Model_1, the test of exact fit shows a misfit model (χ^2=711; *df*=340; *p*=<0.001). In addition, the result shows that Model_1 failed to attain the minimum threshold for model fit for the CFI (0.929), TLI (0.921), and RMSEA (0.0603) fit measures; however, its SRMR value (0.0395) is the only fit index which attained the threshold.

Table 5. Summary of CFA

Fit indices		Fit values	CFA_Model1	CFA_Model2	CFA_Model3
Test for exact fit	χ^2	Low χ^2 relative to *df* and higher p-value	713	227	45.1
	df	indicates better model fit.	340	129	41
	p-value		<0.001	<0.001	0.304
Test for fit measures	CFI	≥0.95	0.929	0.965	0.997
	TLI	≥0.95	0.921	0.959	0.996
	SRMR	≤0.08	0.0395	0.0347	0.0270
	RMSEA	≤0.06	0.0603	0.0502	0.0183
	*Lower		0.0541	0.0392	0.0000
	*Upper		0.0665	0.0608	0.0447
	AIC	Smaller AIC is better	11953	8193	5141
	BIC	Smaller BIC is better	12302	8416	5274

A modification index analysis, as seen in Table 6, was then performed to determine which items needed to be removed to improve the model. After the analysis of Model_1, items CB6 (4.05), CB8 (4.20), CB9 (4.93), DA2 (3.96), VSI2 (6.43), VSI4 (6.19), AR1 (6.80), and AR4 (10.63) are suggested to be removed in Model_2. In addition, dimension 5: use of augmented reality in teaching is suggested to be removed since this dimension will have 2 items only left after the analysis in Model_1.

Analysis of Model_2 was carried out after the removal of the suggested items and dimension in Model_1 analysis. The test of exact fit for Model_2 (χ^2=227; *df*=129; *p*=<0.001) exhibits a misfit model based on a test of exact fit result. However, the result of the model fit measures test exhibits a fit model for Model_2 with CFI=0.965, TLI=0.959, SRMR=0.0347, and RMSEA=0.0502. Though Model_2 is a fit model based on the set fit indices, but this model is not the best model for fourth industrial in basic education. Thus, a modification index analysis shown in Table 7, was used to determine which items needed removal to achieve the best model. Analysis revealed that items CB1 (7.75), CB4 (5.69), CB7 (9.58), Sm1 (4.78), and VSI1 (3.94) need to be removed to have a fit model. However, if VSI1 is to be removed, then dimension 4: use of virtual simulation in teaching will also be removed since this dimension will now consist of 2 items.

Table 6. Factor loadings–modification indices result of Model_1

Indicator	CB	Sm	DA	VSI	AR
CB1		1.83	1.68	1.31	3.19
CB2		0	0.02	1.38	0.17
CB3		0.24	3.47	0.26	0.12
CB4		0.05	3.66	0.46	1.1
CB5		0.35	1.1	0.45	0.44
CB6		4.05	0.02	1.39	0.83
CB7		0.23	2.68	0.41	2.02
CB8		4.2	8.72	0.09	0.88
CB9		4.93	2.75	6.8E-04	4.69
Sm1	3.39		1.53	3.51	0.07
Sm2	2.4E-04		3.34	0.08	0.87
Sm3	0.12		2.71	0.43	0.03
Sm4	0.18		1.57	2.01	3.04
Sm5	1.01		2.7E-05	1.51	0.74
DA1	0.66	0.03		1.54	1.16
DA2	0.31	3.96		0.55	0.75
DA3	0.55	0.39		0.05	1.13
DA4	0.27	0.16		0.07	0.08
DA5	1.33	0.58		2.48	1.39
VSI1	0.44	0.58	0.2		0.65
VSI2	5.45	2.19	3.79		6.43
VSI3	0.1	0.6	0.06		0.33
VSI4	6.19	4.04	1.5		0.74
VSI5	8.1E-04	0.8	0.25		0.09
AR1	0.68	6.81	3.56	5.92	
AR2	0.67	0.03	0.12	1.69	
AR3	3.98	1.3	0	3.51	
AR4	4.02	10.64	1.58	7.68	

CB=Protection using cybersecurity; Sm=Use of simulation in teaching; DA=School data management and analytics; VSI=Support using virtual system integration; AR=Used of augmented reality in teaching

Table 7. Factor loadings–modification indices result of Model_2

Indicator	CB	Sm	DA	VSI
CB1		1.45	0.33	7.75
CB2		0.24	0.11	2.46
CB3		0.03	0.2	0.22
CB4		0.09	5.69	0.39
CB5		0.13	0.1	0.63
CB7		1.06	9.58	1.8
Sm1	2.91		0.63	4.78
Sm2	0.04		2.52	0.12
Sm3	0		1.64	0.55
Sm4	0.33		1.6	3.8
Sm5	1.44		0.12	1.24
DtA1	1.53	0.49		2.96
DtA3	0.23	0.02		0.36
DtA4	0.27	2.5E-04		1.75
DtA5	1.44	0.31		1.15
VSI1	3.94	2.89	0.33	
VSI3	3.75	0.01	0.02	
VSI5	1.4E-04	2.52	0.17	

Following the suggestions of modification index result in Model_2, items CB1, CB4, CB7, Sm1, VSI1, and dimension 4 are removed. Analysis was then carried out for the Model_3 with 3 dimensions and 11 items left. Model fit test was first carried out for Model_3 and revealed that the model is a fit model (χ^2=45.1; *df*=41; *p*=>0.05). Analysis using the model fit measures were also carried out and found that the model has achieved acceptable based on the set parameters (CFI=0.997, TLI=0.996, SRMR=0.0270, RMSEA=0.0183). However, it can be noted that the AIC and BIC of Model_3 (AIC=8193, BIC=8416) are much lower compared to Model_2 (AIC=5141, BIC=5274). Thus, Model_3 is accepted as the best model among the three tested models. Following the analysis, Model_3 now consists of three dimensions with the following dimensions dimension1: protection using cybersecurity with 3 items CB2, CB3, and CB5; dimension2: use of simulation in teaching with 4 items Sm2, Sm3, Sm4, and Sm5; and dimension3: school data management and analytics with 4 items DA1, DA3, DA4, and DA5.

3.3. Fourth industrial revolution model in basic education

4IR is a global concept that focuses on the use of technology in daily life including automation and data exchanges in the cyber-physical world [40]–[42]. This conceptual model can profoundly affect the lives of people as well as the processes in various industries and communities. In the context of education, the notable effects of this change are primarily on the teaching-learning process [43]. Moreover, understanding further the role of the 4IR in the education sector can better set the country's direction for a better future, especially in the Philippines and other countries with similar profiles.

Figure 2 shows the developed model of the 4IR in basic education in the Davao Region, Philippines. The model shows three major dimensions: protection using cybersecurity, use of simulation in teaching, and school data management and analytics derived from the confirmed dimensions and items based on the result of CFA. Discussion on each dimension, along with their respective indicators, are further discussed.

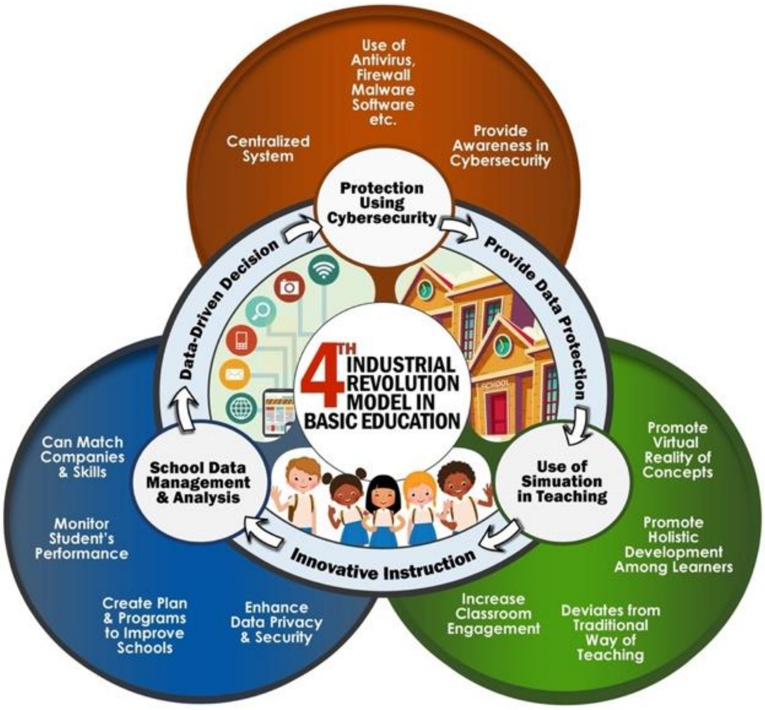

Figure 2. Model of 4IR in basic education

Protection using cybersecurity is a technology developed to defend any systems, networks, or programs from cyber-attacks or hackers [44]–[46]. This technology has become very important since it allows digital protection in schools [47]. Thus, developing a sense of security among students and the nation [48]. However, it is very crucial to raise awareness of the proper usage of cybersecurity in the digital world to avoid data losses and protect users and non-users from data breaches [49], [50]. School data can be secured by investing in software such as firewall, malware detection software, antivirus software, and other relevant software. In addition, cybersecurity in the Department of Education can be improved by creating a centralized system, thus increasing data protection and reducing data losses among schools.

Use of simulation in teaching is used to imitate an actual process or situation; this can be done in a virtual or physical environment. In education, simulations are used as a teaching strategy and technique to increase the performance and collaboration of students by allowing students to experience the real-world application of concepts [51], [52]. Evidence suggests that learning inside the classroom using virtual simulation yields high-performance results among students compared to the traditional way of teaching [53]. Further, many software offers free access to various simulations, and the topics also range from easy to difficult. These software's can offer skills such as business skill, language learning, programming, inquiry skill, and creativity [54], [55].

School data management and analytics are used as a comprehensive collection and evaluation of data from many sources [56]–[58]. The rich data in schools will be used for school improvement through a student, teacher, and staff development program by looking into trends in previous years [59], [60]. Moreover, school data can also be used to determine the competencies and skills of competencies necessary in the job market [61]. However, the challenge for schools is the proper storing of massive data. These concerns can be countered if schools have proper storage of massive amounts of data and teachers/administrators are properly oriented on the use of data [62]. This way, data breaches and data loss are prevented.

The model has made a significant contribution to the existing body of literature by providing clear information on the most crucial dimensions of technological advancements in the context of the Philippine's basic education. Previous studies in the Philippines focus on the general application of the 4IR in the country [2] but not on the country's basic education. The lack of clear policies that integrate the aspects of 4IR is also not documented in the major documents in basic education such as the Philippine Development Plan 2023-2028 [10] and Sulong EduKalidad Framework [11]. Making this model relevant in the Philippines basic education. Hence, this study offers a new perspective in addressing the gaps in the literature pertaining to preparedness toward transcending to 4IR through basic education in the country.

Further, the model being developed from the three identified dimensions guides educators, administrators, and policymakers on how to approach the 4IR in basic education. This also shows the priorities that the department of education in the country (specially in Davao Region) should follow to integrate this conceptual change properly. Through this model, basic education will become adherence to the transformative education that could lead to sustainable development and practices in the nation. Moreover, this model is not limited only to the Philippines since this model can be adapted to other countries with similar profiles to the Philippines. Thus, making this model a reflection on the pursuit of quality education in the advent of technological advancement brought by industrialization.

4. CONCLUSION

The 4IR is a conceptual change that has affected all sectors across the globe. To better prepare, education sectors must also adapt to cater to the needs of the modern world. In this study, five dimensions of the 4IR in basic education were developed based on the result of the EFA. These five dimensions are protection using cybersecurity, use of simulation in teaching, school data management and analytics, protection using cybersecurity, and use of simulation in teaching. These dimensions are seen as the foundations of the use of digitalization and the cyber-physical world in basic education. However, the CFA further revealed that only three of these dimensions are considered the most applicable in the current context. The three dimensions that are confirmed in the analysis are protection using cybersecurity, use of simulation in teaching, and school data management and analytics. In addition, the created model based on these identified dimensions is critical in addressing the country's current needs in the basic education. Policymakers, stakeholders, teachers, and administrators can utilize the identified indicators and dimensions to transcend basic education in the Davao Region and other regions of the Philippines to adapt to modern society's current needs and demands. This way, the country is responsive not just to the national needs but also to the global market. Moreover, the findings of the study are not limited only to the Philippines since other countries with similar profiles can also use the findings as baseline data. Dimensions being explored in this study (cybersecurity, simulation in teaching, and data management and analytics) are seen as the most crucial factors in the technological world. Hence, revisiting the preparedness plan of basic education in the country towards the 4IR can significantly be useful in developing a resilient workforce in the modern world.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions. The data that support the findings of this study are available from the corresponding author [TJAD], upon reasonable request.

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