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STRUCTURAL EQUATION MODELLING VIA ANALYSIS OF MOMENT STRUCTURE - PROPELLER SHAFT

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ABSTRACT

Structural Equation Modelling (SEM) of propeller shaft via analysis of moment of structure represents a system of the shaft that helps students to know, understands, or stimulates a particular learning. As an instructional model, it was developed based on the items that were considered significant of the shaft items. Four out of nine items of the shaft were scrutinised through the SEM via the Analysis of Moment Of Structure (AMOS). It relied absolutely on the concept maps assessment test through which data was gathered and structured questionnaire developed by the researcher. The duo was believed suitable to determine students' academic performance. Four of the propeller shaft items denoted as (PSH1, 3, 5 and 6) out of ten were considered most significant for the system are: PLS1 (outer shaft connection to the gearbox), PLS3 (Flange assembly), PLS5 (Inner and outer shaft housing assembly), and PLS6 (functions of yoke shaft). These were verified after thorough AMOS. The findings discovered that students' academic performance after introducing the model for instruction was significantly improved. This article developed a prototype of propeller shaft for instruction in Automobile Engineering showing the most important items of the model as illustrated in a pictorial form Fig 1.

KEYWORDS: Structural Equation Modelling, Analysis of Moment of Structure, Academic performance, Concept Maps, Structured Questionnaire.

1.0 INTRODUCTION

Academic performances or knowledge are acquired through successful experimental practices and is full of learner-centred activities that have direct association with the learner's intellectual development. This has been the major focus of Automobile Engineering (AE) as a discipline. Experimental learning practices have proven to be very important in AE from its emergence to date. This may suggest why employers of labour are in dare needs of graduates from tertiary institutions who are well equipped to function effectively in contributing to the development of the society.

Propeller shaft therefore, as a concept in this context refers to the transmission system used for the instruction. Today, the world has been transformed into economy nations. That is why employers of labour need graduates that are well trained for the development of their work force. This considerable shift has posed serious challenges to educational institutions. Well-informed based economy workforce implies and requires sound preparation of higher education graduates to work. In addition, tertiary institutions must reinforce personal and social responsibility inside and outside of institutions and simultaneously seek opportunity for students to participate in educational activities that is relevant in the changing world (Lungu *et al.*, 2012). It is therefore, agreed that it is the capacity and ability of the higher institutions to generate and transform new ideas, methods and products that can change these into monetary value or wealth.

Evidence with this development, AE at the forefront of economic, social and technological development must strive to provide viable opportunities to change the structural systems of teaching and learning. This will prepare the students to enter into a competitive global workforce. It is because students' academic and skill achievements have always been argued upon among the educators and researchers in order to meet the learning conditions of this preparation (Nasri and El-Shaarawi, 2006).

2.0 MATERIAL AND METHODS

SEM as a technique was specifically used to analyze the initial measurement models of the propeller shaft items and was further modified through AMOS. During the analyses, jointly the number of factors and their indicators were explicitly specified as described by Kline (2005). The purpose of AMOS was to determine the factor structure within a measurement model and to confirm how well the model fits the data according to Bollen (1989). Several researchers have provided established procedure on the proposed sequence of steps for SEM via AMOS. The model evaluation started with an evaluation of parameter estimates, such as square multiple correlations (R^2), followed by the examination of model fit as described by Joreskog and Sorbom (1996). When the model fit was poor, various diagnostic indicators such as standardized residuals, regression weights, and the modification indices according to Koufteros (1998) were properly determined. According to the scholar, most standardized residuals should be less than 2.0 in absolute value for correlation models. Besides, other indicators also affected the fit performance of the proposed model. This included multivariate normal distribution and covariances. Multivariate normality of all observed variables was standard distribution assumptions in the SEM. A sample was considered to be multivariate when normality distributed at 0.05 level of significance and the critical ratio was smaller than 1.96, indicating that the coefficient of multivariate kurtosis was not significantly different from zero according to Mardia (1970). However, the multivariate Kurtosis can be large and multivariate non-normality can be extreme (critical ratio >1.96) even if univariate skewness and/or Kurtosis range between (-1.00 to +1.00) recommended by Muthen and Kalpan (1985) was obtained from most of variables in data. Based on the value of critical ratio of 1.96, some multivariate might be included in the sample, and therefore, should not be used as the standard value (Gao *et al*., 2007; and Kline, 2005). Therefore, modified measurement model, which complied and fit well to the data based on the default indices were considered as an appropriate answer for specific research question.

2.1 Brief Description of the Study Area

This article was produced based on the data obtained from the North-East geopolitical zone of Nigeria. The zone comprised of six (6) states namely: Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States. It was produced based on the data collected in only three states of the region, particularly in the institutions that are offering Automobile Engineering (AE) courses (see Table 1).

Table 1: List of selected Federal Universities offering AE in the North-Eastern Nigeria.

Abbreviation	Name of institution	Location
ATBU	Abubakar Tafawa Balewa University, Bauchi	Bauchi State
FUTY	Federal University of Technology, Yola	Adamawa State
UNIMAID	University of Maiduguri, Maiduguri	Borno State

Table 2 below presents the designed questionnaire used to assess the students' academic performance at B. Eng and B. Tech. Eng levels in an automobile transmission systems through the propeller shaft, while same students constructed the concept map as presented in Figure 1 of propeller shaft using randomly arranged propeller shaft items.

Table 2: What do you understand about a propeller shaft as a transmission system?

1		Connect
2		Spider
3		Spider bearing
4		Spider ring
5	Propeller Shaft	Connect
6		Consist of
7		Consist of
8		Connect
9		Sleeve Yoke

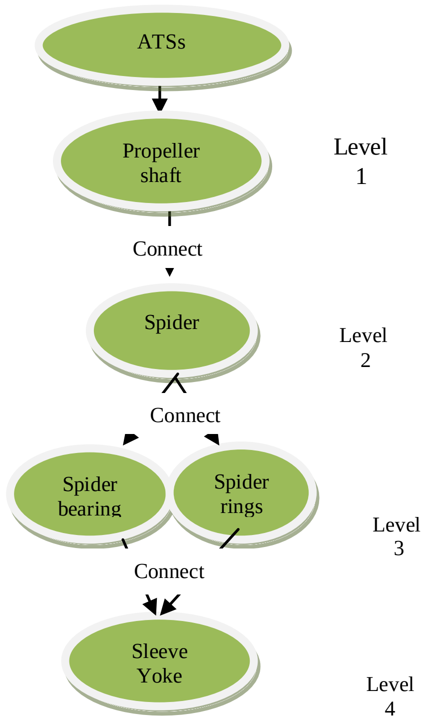

Figure 1: CMAP Structure of propeller shaft as a Transmission System.

Based on the results in Table 3.0, in accordance to the default model fit indices the model satisfies goodness of fit. The Table shows the computed values for model fit indices of the modified model of propeller shaft. The model satisfied the goodness of fit indices with 2.86 for (χ^2)/df, GFI (0. 97), TLI (0.91), CFI (0.96), IFI (0.96), RMR (0.02), and RMSEA (0.04) at P < .05. Therefore, the hypothesis which states that there is no significant relationship between areas considered important on the topic of propeller shaft for learning ATS in Nigeria is hereby rejected, and the structural model in Figure 2 was generated.

Table 3: Modified measurement model fit indices of propeller shaft.

Model Fit Indices	Computed Values	Range Values	P
Chi-square (χ^2)/df	2.86	< 3.00	
Goodness of Fit (GFI)	0.97	≥ 0.90	
Tucker-Lewis Index (TLI)	0.91	≥ 0.90	
Comparative Fit Index (CFI)	0.96	≥ 0.90	.000
Incremental Fit Index (IFI)	0.96	≥ 0.90	
Root Mean Square Residual (RMR)	0.02	≤ 0.05	
Root Mean Square Error of Approximation (RMSEA)	0.04	≤ 0.05	

4.0 RESULT AND DISCUSSION

The findings discovered through the clutch as a topic for learning AE after SLR analyses were redressed through AMOS for the model developed. This was because all the findings focused on a specific research questions that targeted the objective for the model developed. In addition, findings obtained from the research questions were all Propeller shaft as a transmission system. However, the discussion on the Propeller shaft submerged in the research question was to develop the conceptual model of clutch prototype for learning in automobile engineering courses. Table 4 presents the default model fit evaluation parameters on which model development relies as specified by various researchers.

Table 4: Default model fit evaluation indices (Kenny *et al.*, 2014).

Model Fit Indices	Range Values
Chi Square (χ^2)/df	< 0.30
Goodness of Fit (GFI)	≥ 0.90
Incremental Fit Index (IFI)	≥ 0.90
Tucker-Lewis Index (TLI)	≥ 0.90
Comparative Fit Index (CFI)	≥ 0.90
Root Mean Square Residual (RMSR)	≤ 0.05
Root Mean Square Error of Approximation (RMSEA)	≥ 0.05

Base on redressing the SEM analysis through the AMOS, Table 5 shows the computed values for model fit indices of the modified mode of Propeller shaft. Based on the result, the modified model satisfied Goodness of Fit (GOF) indices with 2.45 for (χ^2)/df, GFI (0.95), TLI (0.93), CFI (0.95), IFI (0.94), RMR (0.02) and RMSEA (0.04) at $P < .05$ as specified in the table.

Table 5: Modified measurement model fit indices of Propeller shaft.

Model Fit Indices	Computed values	Range Values	P
Chi-square (χ^2)/df	2.86	< 3.00	
Goodness of Fit (GFI)	0.97	≥ 0.90	
Tucker-Lewis Index (TLI)	0.91	≥ 0.90	
Comparative Fit Index (CFI)	0.96	≥ 0.90	.000
Incremental Fit Index (IFI)	0.96	≥ 0.90	
Root Mean Square Residual (RMR)	0.02	≤ 0.05	
Root Mean Square Error of Approximation (RMSEA)	0.04	≤ 0.05	

The values presented in Table 6 shows the assessment of univariate normality distribution of the modified measurement model of Propeller shaft. The skewness and kurtosis of the six observed factors variables are between the ranges of -1 and +1. This has supported the application of the observed factors for developing the propeller shaft model for teaching AE courses.

Table 6: Normality of the modified measurement model of Propeller shaft.

Variable	Min	Max	Skew	C.R.	Kurtosis	C.R.
PLS6	1.000	5.000	-.501	-3.007	.725	-.174
PLS5	1.000	5.000	-.925	-5.547	.554	-.662
PLS4	1.000	5.000	-.724	-4.343	.295	-.884
PLS3	1.000	5.000	-.770	-4.621	.055	-.166
PLS2	1.000	5.000	-1.132	-6.794	.811	-.434
PLS1	2.000	5.000	-.772	-4.630	.936	-.808
Multivariate					11.342	8.507

Figure 2 shows a structure of the significant relationship between four areas considered important using L1 instruction on the topic - propeller shaft for learning in Nigeria. From the modified model in Figure 2 and the fit indices in Table 4 above, it can be concluded that four important areas such as PLS1 (outer shaft connection to the gearbox), PLS3 (Flange assembly), PLS5 (Inner and outer shaft housing assembly), and PLS6 (functions of yoke shaft) should be given due consideration for instruction purpose.

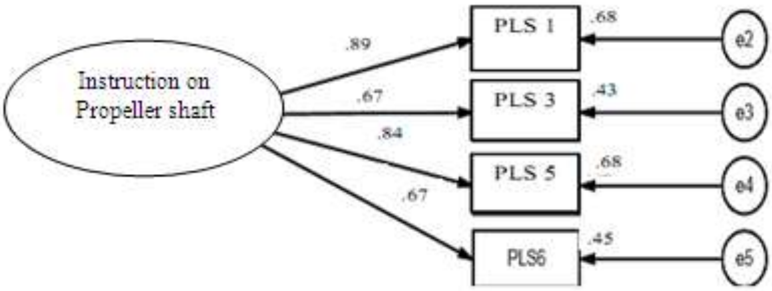

Figure 2: Modified Structural Measurement Model of Propeller Shaft.

Finally, based on the analysis of the data, after redressing the SEM through AMOS, the model Figure 3 was developed. The figure shows a conceptual model of the Propeller shaft areas or items considered most important on the Propeller shaft shown in the figure, the areas of the findings are presented based on their level of importance. The triangular shape indicated by the arrow represents top-down hierarchy of the areas after instruction on the Propeller shaft areas of AE course.

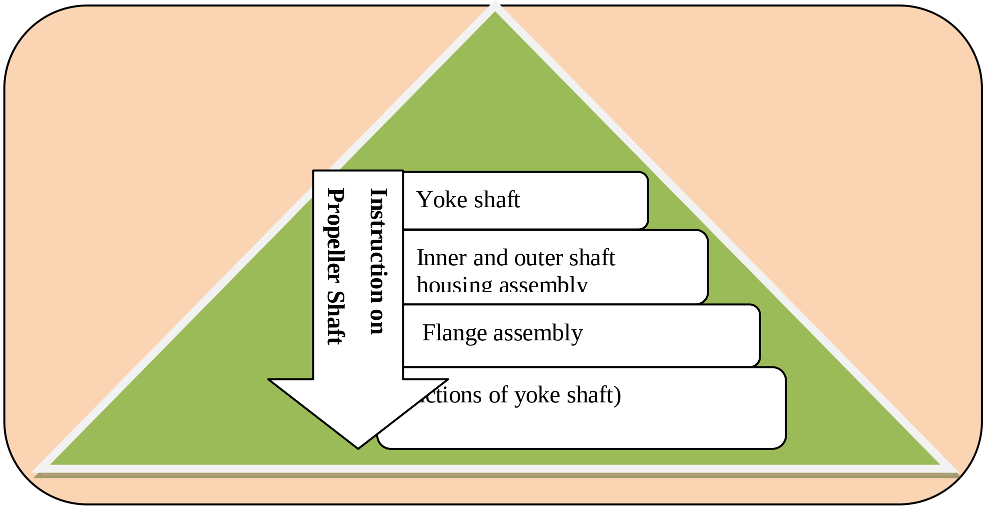

Figure 3: SEM of propeller shaft.

4.0 CONCLUSION

In conclusion, quality education is an essential element for economic and social security of any nation (Babalola *et al.*, 2007), in which Nigeria is not an exception. If the motives of provision of excellence teaching and learning and research are to be actualized in the 21st century, education in tertiary institutions, its important transformation must be considered in such a way that it attend to real world practices through experimental learning using a conceptual model for instruction. Concept mapping in engineering through which the data was collected, has proved to be a successful instructional approach for developing students' knowledge of understanding (Acharya and Sinha,2015); (Gurupur*et al.*(2015).

Based on the identified areas of PSH model, it implies that AE has direct benefits to the faculty, students, community members, automobile engineering service agencies as well as tertiary institutions. These qualities of AE services are conceivably enunciated in many of the automobile research studies. In this regard, the concluded results using the developed model for learning in AE proved that students' academic performance and skill development improved. Therefore, the model could serve as a legitimate instrument for steering academic performance in tertiary institutions. Implementation of the model could serve in finding a strong and reliable AE practices in the Nigerian tertiary institutions for developing a holistic and skilled-minded AE graduates that are needed in the 21stcentury.

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