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HYPOTHETICAL MODEL OF A CLUTCH SYSTEM FOR INSTRUCTION OF AUTOMOBILE ENGINEERING CONCEPTS

V.M. Dagala[1],
Department of Mechanical Engineering, University of Maiduguri, Maiduguri, Nigeria

Z. A. Mshelia[2]
Department of Technical and Engineering Education, University Teknologi Malaysia, Malaysia

Abstract
Theoretical Model of the clutch represents a system that consist of automobile transmission concepts used to help students know , understand , or stimulates a particular subject. This paper developed a theoretical model of clutch for learning in Automobile Engineering. The model was developed based on the areas that were considered most important on clutch that, is from clutch one to clutch five areas after scrutiny through structural equation modeling via analysis of moment of structure. It relied absolutely on the concept maps assessment test and structured questionnaire instruments developed by the researcher that believed suitable for students' academic performance. Five clutch denoted as (CLH) areas out of eight that were considered important for the model are:(CLH1) mounting of clutch plate and disc on main shaft, (CLH5) adjustment of release bearing, (CLH6) function of clutch linkages, (CLH7) disc and pressure plate alignment, and (CLH8) working principles of clutch. This was confirmed by the use Structural Equation Modelling (SEM) via modification through Analysis of Moment Of Structure (AMOS).The findings discovered that students' academic performance after introducing the model for instruction improved. The most important areas of the model were further illustrated clearly in a pictorial form.

Keywords: Theoretical Model, Clutch, Learning, Concept Map, Structured Questionnaire.

1.0 Introduction

Wisdom of knowledge through learning is facilitated through a successful experimental practice and is full of learner-centred activities that have direct association with the learner's intellectual development. Thisis the major focus of Automobile Engineering (AE). 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.

Clutch 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 the 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 are 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

Structural Equation Modelling (SEM) technique was specifically used to analyze the initial measurement models of the CLH items and was further modified via Analysis of Moment Of Structure (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 also 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 starts 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 scholars, 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 appropriate for developing the model.

2.1 Brief Description of the Study Area

The 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 Table 1.

Table 1: List of selected Federal Universities offering AE Courses 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 that assessed the students' academic performance at B. Eng and B. Tech. Eng levels in automobile transmission systems (ATS) on the concepts of clutch, while same students constructed Concept Map (CMap) as presented in Figure1 of clutch using the randomly arranged clutch items.

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

1		Fixed on
2		Pressure plate
3		Clutch disc
4		Engine
5	Clutch	Input shaft
6		Consist of
7		Consist of
8		Splinned to
9		Splinned to

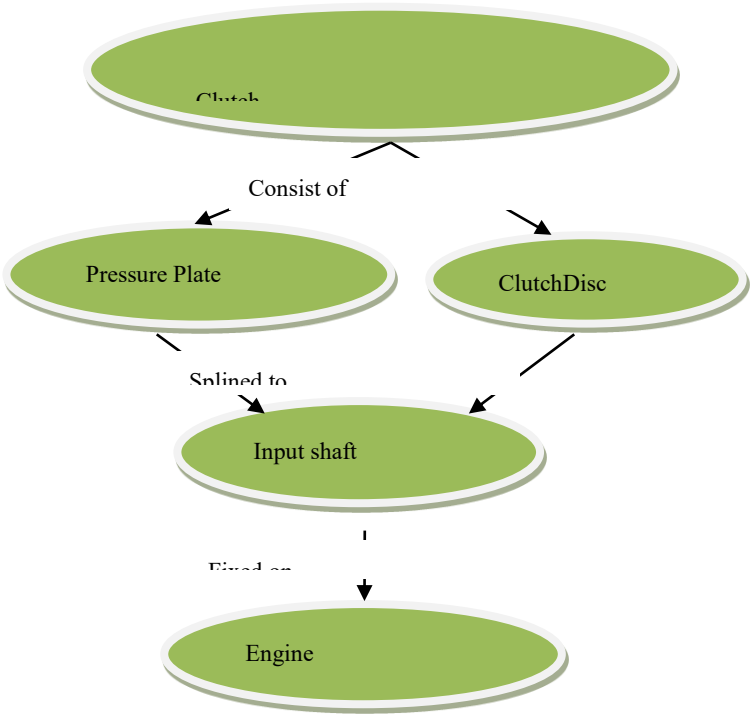

Figure 1: CMAP Structure of theoretical model of the clutch system

Table 3 presents the summary of the eight areas considered important of clutch through stepwise Linear Regression Analysis (SLR).The model presents eight observed areas such as:mounting of clutch on the flywheel, hydraulic pipelines faults diagnose, function of the clutch release, functions of pilot bush bearings, adjustment of the release bearing, function of clutch linkages, disc and pressure plate alignment and working principle of the clutch with the corresponding R-square (regression index) of .980, 986, 989, 990, 991, 992, 992 and .992 respectively. This means that eight of the observed areas were considered important on clutch for learning automobile transmission system.The correlation coefficients (R) are presented in descending order starting from the observed areas that were considerably most important. The observed areas are presented following the order of the significant coefficients. The correlation coefficients indicated linear relationships between the eight observed areas. The highest value of adjusted R^2 of .980 indicates that, the model account for 98.0% variance of the areas considered important for developedthe clutch model.

Table 3: Model summary of important areas of clutch System

Areas Considered Important on Clutch			Adjusted	R^2	Std. Error
	R	R^2			
	.990[a]	.980		.98	.549
1 Mounting of clutch plate and disc on main	.993[c]	.986	0		.457
Shaft	.995[d]	.989		.98	.420
2 Hydraulic pipelines fault diagnose	.995[e]	.990	6		.386
3 Function of the clutch release	.996[f]	.991		.989	.372
4 Functions of Pilot bush bearings	.996[g]	.992		.990	.362
5 Adjustment of the release bearing	.996[h]	.992		.991	.357
6 Functions clutch linkages	.996[i]	.992		.991	.353
7 Disc and pressure plate alignment				.99	
8 Working principle of the clutch			2		
				.99	
			2		

4.0 Result and Discussion

The findings discovered through the clutch as a topic for learning AE after SLR analyses were redressed through AMOS and five items out of the eight was finally used to develop the model. 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 on clutch as a transmission system. However, the discussion on the clutch submerged in the research question was to develop the theoretical model of clutch 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 model for clutch model. 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 < .05as specified in the table.

Table 5: Modified measurement model fit indices of the clutch system

Model Fit Indices	Computed values	RangeValues	P
Chi-square (χ^2)/df	2.45	< 3.00	
Goodness of Fit (GFI)	0.95	≥ 0.90	
Tucker-Lewis Index (TLI)	0.93	≥ 0.90	
Comparative Fit Index (CFI)	0.95	≥ 0.90	.000
Incremental Fit Index (IFI)	0.95	≥ 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 clutchmodel. 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 theoretical model of the clutch for teaching AE courses.

Table 6: Normality of the modified measurement model of the clutch

Variable	min	max	skew	c.r.	Kurtosis	c.r.
CLH8	1.000	5.000	.835	5.011	.879	-.638
CLH7	2.000	5.000	.555	3.328	.711	-.134
CLH6	2.000	5.000	.538	3.230	.592	1.776
CLH5	1.000	5.000	.749	4.496	.178	.533
CLH1	1.000	5.000	.473	2.837	-.362	-1.087
Multivariate					4.570	6.014

As presented in Fig.2, the structural prototype model of the clutch shows the significant relationship between five areas considered most important on the items of clutch as a transmission system. Therefore, based on the modified measurement, it is concluded that for the theoretical modeldeveloped for learningthrough AMOS, the most important areas CLH1 (mounting of clutch plate and disc on main shaft), CLH5 (adjustment of release bearing), CLH6 (function of clutch linkages) and CLH7 (disc and pressure plate alignment) and CLH8 (working principles of clutch) were considered most important.

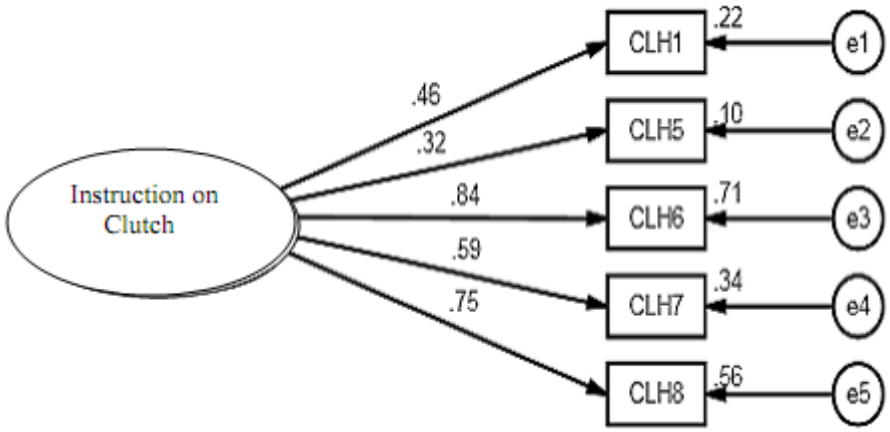

Figure 2: Modified Measurement model of Clutch System

Finally, based on the analysis of the data, after redressing SEM through AMOS, the prototype model Fig.3 was developed. The figure shows a theoretical model of the clutch areas or items considered most important on the clutch. 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 clutchareas of AE course.

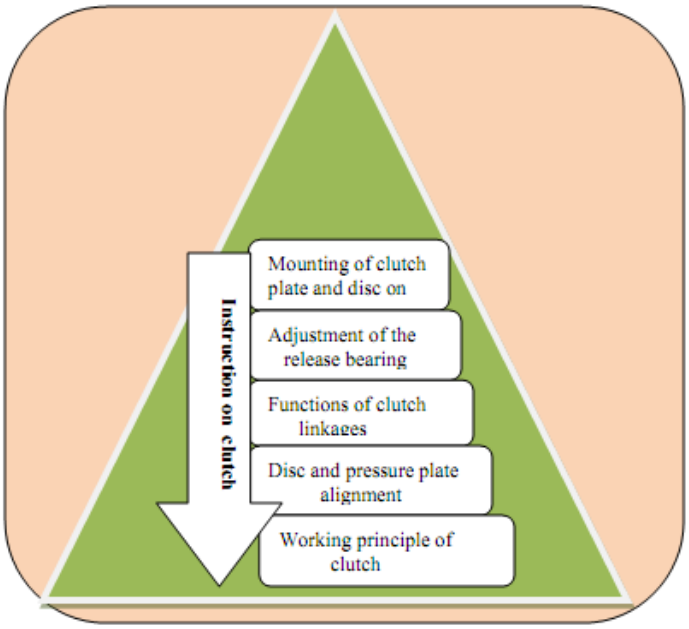

Figure 3: Theoretical Model of Clutch System.

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 theoreticalmodel 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 CLH of the model, it implied that AE has direct benefits to the ffaculty, 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 AEproved 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 founding 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 21st century.

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