

## The Role of Pedagogical Factors in Predicting Ghanaian Student Interest in Mathematics –Principal Component Analysis Motivated Regression.

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**Abstract :** *The effect of pedagogy on student interest is very important in contemporary educational research. Factor Analysis of Teachers' Teaching Methods was carried out and how these extracted factors affect students' interest in Mathematics was investigated. Data was collected from ten (10) senior high schools in Ashanti region of Ghana with one thousand two hundred and sixty-three (1263) students' randomly selected to participate in the study. The ten factors that influence teaching methods and strategies were reduced to three principal components, and these were further used for regression analysis as predictors of student Mathematics interest. The study concluded that, pedagogical factor oriented model can predict significantly ( $p$ -value < 0.001) 12% of variance in students' interest in Mathematics. The third factor which is the use of traditional chalk and board however was found not to influence students' interest in Mathematics. The study further concludes that the teachers teaching methods can significantly predict student's interest.*

**Keywords:** *Students' Interest, Mathematics, Teaching Methods, Teaching Materials, Ghana.*

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### I. Introduction

The teachers' teaching methods are factors fundamentally known to influence students' achievement and interest. With regard to teachers' efforts in developing students' interest in Mathematics, it is crucial to ask if the teacher can undermine the interest of the students in Mathematics. Despite the awaiting answer of the earlier question, a number of either unused or abused classroom strategies have been identified to stifle growth in student interest in Mathematics and science (Flink, 1990; Turner, 2002) but the study by (Bergin, 1999; Wigfield, 1992) argues that frequent use of hands-on and applied problem solving task rather facilitates students' interest. It has been further investigated by Eccles et al 1993 that the enthusiasm and the attitude demonstrated by the teacher are likely to influence student's interest in Mathematics.

There are limitations in instructional modes as used by teachers in instructional delivery perhaps due to insufficient knowledge (Dawson, 2004). Among the available but limited instructional modes to students, their purpose of usage ranging from triggering students interest in Mathematics and Science to building students understanding, as well as discovery and introduction of concepts through demonstration approach to teaching will help improve the students' interest in Mathematics. Tajularipin, (2009). The study by many authors (Audet, 2005; Marsh, 2004; Woolfolk, 2001) argues that many teaching methods exist for disseminating knowledge and different students' may have interest in different teaching methods while different subjects may also attract different teaching methods. The fact the teacher is knowledgeable about the courses being taught also requires that varieties of teaching aids will be used in ensuring student interest sustainability and concepts understanding. (Marsh, 2004). The study by Tajularipin S, et al (2009) shows that teachers' attitude remains the main challenging part of imparting knowledge as compared to the teachers practices. By implication, the teacher characteristics remain key in developing the child interest. Let us examine what the construct interest is characterized with and how does it develop in the section.

### **Interest as a Construct**

Interest as a construct has been defined in many contemporary researches as an intrinsic motivational variable (Fredricks & Eccles, 2002) that denotes a person's involvement with a particular activity or object Frenzel et al (2010). In the study of (Frenzel et al 2010; Hidi, 1990; Krapp, 2000; Renninger, 2000 & Schiefele, 1991) three important characteristics of interest were identified, and first on their identification was the fact that interest has both state and a trait character which are able to differentiate between situational and individual interest (Hidi, 1990; Krapp, 2000; Renninger, 2000; Schiefele, 1991). In the second identified characteristics, interest was seen to be content-specific and that generalized interest does not exist in the world of interest (Hidi, 2006; Krapp, 2000; Schiefele, 1991). That an individual may be interested in Mathematics, science, English or may not have interest in any of them.

The study by Frenzel, (2010) further emphasized that in any educational investigation into the construct interest should be specific to a certain domain for which Mathematics is the domain in which this present study applies. In the finally identified characteristics of interest, (Hidi, 1990; Krapp, 2000; Renninger, 2000; Schiefele, 1991) attached importance to the value one places on activity as well as enjoyment derived from activity. The value and enjoyment was further noted to be influenced by the personal significance of the activity.

### **Research Objectives**

The study was undertaken with the following specific objectives in mind.

1. To determine the principal components of Mathematics Teaching Methods deployed by teachers in the selected senior high schools, and
2. To evaluate the effect of these factors on students' interest in Mathematics in Ghana.

### **Research Questions**

For the purposes of the objectives set out to be achieved in this study, the following research questions were proposed for operationalization. These questions were stated as follows

- i. Does the Teachers' teaching methods (TTM) constructs designed in this study pass the test for principal component analysis?
- ii. How many principal components can Teachers' teaching methods (TTM) construct be put into?
- iii. To what extent does the Teachers' teaching method (TTM) influence the prediction of students' interest in Mathematics?
- iv. How do these principal components extracted significantly influence the prediction of students' interest in Mathematics?

## **II. Research Hypothesis**

**H1:** The factors affecting teachers' teaching methods and the data collected do not meet the factor analysis criteria.

**H2:** Teachers teaching methods affect students' interest in Mathematics significantly

### **Materials and methods**

#### **Design**

The study applies a mix mode design in the sense that it explores the factors that make up the principal component of teachers' teaching methods as well as explaining the effective of these rotated component on students' interest. The study therefore examines the impact of teachers' teaching methods on students' interest in Mathematics in Ghana. The study implemented a pilot survey to validate the instruments used in this study. The pilot survey was implemented on 100 student post-secondary student in the University of Education Winneba, Kumasi campus.

#### **Population and Sampling procedure**

The study targeted all students in the senior high schools in the Ashanti region of Ghana. The study randomly selected ten (10) senior secondary school and 1263 students were randomly selected from the various participating schools to form part of the study. The study participants were made up of male and female student from various programme of students' with their ages ranging from 14 to 23 years.

#### **Instrumentation Reliability and internal consistency**

The study used a modified instrument tagged teachers' teaching methods questionnaire (TTMQ) to collect data on the student views about the pedagogy deployed in their various classrooms. The items in the instrument were adopted and modified from (Githua & Mwangi, 2003; Frenzel et al, 2010). The instrument was part of a larger instrument which was divided into three parts. The first part which was subdivided into other parts uses over eighty items for the major constructs. The instrument used the five point Likert scale type with responses ranging from strongly agree 5 to strongly disagree 1. In order to ascertain the reliability and

internal consistency of the instrument and to be assured the instrument measures what was intended to measure after the pilot study modification, reliability analysis was conducted.(anonymous 2014,Hair et al 2005).The pilot was administered to 100 post-secondary school student who have just passed out of senior high school and were not part of the participant for the main study .The internal consistency for each constructs was determined using inter-correlation and cronbach alpha.The cronbach alpha value for 84 items was 0.939 and 0.60 for the 10 items that measured teachers teaching methods questionnaire (TTMQ) were sufficient and very strong scale reliability respectively (Cronbach,1951;Suresh Chandar et al 2001;Graham et al,2014).Data on students' interest was also collected using Likert scale measured modified items with cronbach alpha value of 0.741.The second and third part deals with seventeen questions ranging from the demographic properties of the participants and general view about Mathematics

**Data Collection Procedure**

By the help of Mathematics teachers in the participating schools 1500 questionnaires were administered. The participant were given clear instructions on how to respond to the questionnaire to ensure the proper filling of the questionnaires.Out of the 1500 questionnaires administered,1263 were valid for the analysis on the study.

**Data Analysis and Results**

The data collected on the study used both descriptive and inferential statistical analysis. This included factor analysis and multiple regression analysis for the inferential techniques and the descriptive statistics include mean standard deviation and percentages.The SPSS version 16 was used in generating the various results.The study presented two major hypotheses and were both tested at 0.05 level of significance. The study presented the following results in the Table1.0 to Table 5.0.

**III. Results and Discussion**

This section of the paper focused on the demographic characteristics of the sampled students including gender, age, type of basic school attended, the grade of secondary school they are currently enrolled. There were 43.6% are males, 55.4% are females who participated in this study, nonetheless, 1% of the participants did not disclose their gender category. The result also showed that 18.8%, 44.8%, 23.3%, 12.4%, and 99.3% fall into 14-16, 17-19, 20-22, and above 23 age classification respectively. The summary of the results shows that 43.9% and 43.2% of the students surveyed are in grade A and B schools respectively while only 12.4% are in grade C schools. Even though, 54.8% of these students attended public schools whereas 41.6% attended private schools. Out of the sampled students, 200 making up 15.8% are in SHS1, 23.6% are in SHS2 and 712 representing 56.4% are in SHS3. General Art students constitute 18.2% while 8.8% are from Visual Art, 45.5% from Science, 16.2% from Business and 10.8% from the Home Economics class.

Principal component factor analysis with varimax rotation was performed to assess the underlying structure for the ten item of Mathematics teacher's teaching method adopted by Mathematics teachers in Ghanaian senior high schools from the students' perspective. Three factors were extracted and indicate that there are three construct of teaching methods applied to the teachers and these are Efficiency, Material integration, and Teaching Strategy. When the factors were rotated, the first factor accounted for 28.8% of the variance, the second factor accounted for 14.5% and the third factor 10.5% of variance. Table 3.0 displays the items and factor loadings for the rotated factors with loading less than 0.4 omitted for clarity sake.

**Table 1** Correlation Matrix

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Teachers meet course objectives	1									
Teachers develop the course systematically	0.41**	1								
Teachers outline major points clearly	0.20**	0.25**	1							
Teachers provide example and case studies	0.29**	0.39**	0.332**	1						
Teachers explain concepts clearly	0.28**	0.41**	0.309**	0.494**	1					
Teachers give deeper understanding of the concept	0.29**	0.33**	0.245**	0.367**	0.551**	1				
Teachers do not have effective teaching materials	-0.03	0.07**	-0.087	-0.023	0.022**	0.11	1			
There is coordination between what is taught in Mathematics class and Mathematics exercises given	0.12**	0.25**	0.074**	0.179**	0.112**	0.23	0.206**	1		
Teachers' focus on examination than content of syllabus	-0.02	0	-0.067	-0.12	-0.1	0.01	0.213**	0.21	1	

Teachers use the traditional way of chalk and talk method to teach	0.09**	-0.007	-0.027	-0.084	-0.079	-	0.091**	0.01	0	1
						0.08		2	0	
						1		5	2	
								*		
								*		

a. Determinant = .193

\*\* Significant at 5%

The correlation matrix shows each of the ten(10) items is associated with the nine(9) with some of the correlation values higher and significant as indicated in Table 1.0 .The highly correlated items indicate that the two items are associated and may probably be clustered by the factor analysis. The test of assumptions about the factor analytic solution was passed with the determinant (0.193)more than 0.00001.This indicates that at least one of the items can be explained as a linear combination of some of the other items. The Kaiser-Mayer-Olkin (KMO) of greater than 0.7 shows that each factor have enough items predicting it.The Bartlett test of sampling adequacy was significant  $p < 0.001$  which shows that the variables are highly correlated enough to provide the basis for factor analysis(Field 2005) as in Table 2.

**Table 2** KMO and Bartlett's Test of Sampling adequacy

Bartlett's Test of Sphericity	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.771
	Approx. Chi-Square	1872
	Df	45
	Sig.	0.000

**Table 3** Rotated Component Matrixes

Factor loading for rotated factors	Rotated factors			communalities
	1	2	3	
Teachers meet course objectives	0.573			0.532
Teachers develop the course systematically	0.68			0.523
Teachers outline major points clearly	0.551			0.341
Teachers provide example and case studies	0.734			0.548
Teachers explain concepts clearly	0.775			0.619
Teachers give deeper understanding of the concept	0.691			0.556
Teachers do not have effective teaching materials		0.705		0.497
There is coordination between what is taught in Mathematics class and Mathematics exercises given		0.624		0.482
Teachers' focus on examination than content of syllabus		0.688		0.497
Teachers use the traditional way of chalk and talk method to teach			0.885	0.799
EIGENVALUES	2.863	1.481	1.051	
%OF VARIANCE	28.631	14.806	10.511	

a. Rotation converged in 4 iterations.

**Table 4** Mean, Standard Deviation, and Inter-Correlation between Principal Components and Interest.

Principal Components and Interest Correlational Analysis		M	SD	INTEREST	FAC3	FAC2	FAC1
Pearson Correlation	INTEREST	3.6322	0.943		-0.021	0.246**	0.261**
	PREDICTOR VARIABLES						
	Traditional Teaching Method(TTM)	2.6129	1.434			0.071**	-0.034
	Effective Teaching Materials(ETM)	3.4771	0.891				0.088**
	Systematics teaching(ST)	3.5189	0.857				

\*\*P<0.001

**Table 5** Summaries of Regression Coefficients

	Unstandardized Coefficients		Standardized Coefficients		Sig.
(Constant)	1.915	0.144			0.000
Traditional Teaching Method(TTM)	-	0.017	-0.029		0.28
	0.019				
Effective Teaching Materials(ETM)	0.24	0.028	0.227		0.00
Systematics teaching (ST)	0.264	0.029	0.24		0.000

$$R^2 = 12\%; F(3, 1254) = 56.59, P < 0.001,$$

The multiple regression analysis conducted to determine the best linear rotated teacher's teaching methods component that best predict students' interest in Mathematics. Table 1 shows the means, standard deviation and inter-correlation between students' interest and rotated factors from the principal component analysis of factors affecting teachers teaching methods. The results of this study indicates that student interest correlates positively and significantly with the teaching materials used and the systematics teaching strategies, however, the results found negative correlation between student interest in the traditional method of teaching Mathematics. This combination of variables significantly predicted student interest  $R^2 = 12\%; F(3, 1254) = 56.59, P < 0.001$  with systematics teaching and effective material component significantly contributing to the prediction. The adjusted R squared value of 0.12 indicating that 12% of the variance in Mathematics interest was explained by the rotated factors of the teachers teaching methods which is small effect according to Cohen(1988).The results indicate that the student interest is highly dependent on the teachers' qualities and the teaching methods and strategies adopted by the teacher. The systematic Mathematics teacher is the teacher that meets course objectives, develops his Mathematics teaching systematically, outline major point clearly for students provides examples and case studies and finally provides deeper understanding for students. The effective teacher provides effective teaching and learning material and is able to coordinate what is taught in classroom with the exercise as well as not focusing all their teaching on examination, but deliver on the syllabus provide for the course to increase interest and understanding of mathematical concepts. The third factor known as teaching methods does not contribute to building student interest in Mathematics. The traditional chalk and board method was found to contribute insignificantly to building students interest in Mathematics. This finding requires a new dimension to teaching Mathematics in Ghana other than the traditional chalk and board method which although cannot be eradicated completely, yet, introduction of new techniques of teaching will improve the student's interest.

#### IV. Conclusion

The study has presented the three constructs which made up the Ghanaian teachers' teaching methods. The constructs are as follows: Systematic Teaching (ST), Effective Teaching Material(ETM), and Traditional Teaching Methods (TTM). These constructs were made up of six, three and one manifest variables as indicated in the Table 3. The teacher's systematic way of teaching and effective integration of teaching material positively influence student interest in Mathematics. Thus students' interest is significantly predicted by the teachers' teaching methods as indicated by (Tajularipin, et al. 2009; Marsh, 2004). This brings confirmation to the fact that students interest in Mathematics is significantly influenced by the teaching methods adopted by Mathematics teachers. The study recommends that the method of structural equation modeling should be used to confirm the relationship between students' interest and the three extracted construct in this study.

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