EFFECTS OF MATHEMATICAL MODELING ON MATHEMATICS ACHIEVEMENT AND ATTITUDE OF PRE-SERVICE TEACHERS OF COLLEGES OF EDUCATION IN NIGER STATE, NIGERIA

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Abstract

This study investigated the Effects of Mathematical Modeling on Mathematics Achievement and Attitude of Pre-Service Teachers in Niger State, Nigeria. It was an attempt to ease students' difficulties in comprehending Mathematics. The study used randomized pretest, posttest control group design. Two Colleges of Education were purposively selected from Niger State with a sample size of 84 (42 for experimental and 42 for control group). Two research instruments Mathematical Modeling Achievement Test (MMAT) and Attitude Towards Mathematical Modeling Questionnaire (ATMMQ) were used for data collection. Pearson Product Moment Correlation (PPMC) and Cronbach alpha were used to determine the reliability coefficient of the instrument as 0.76 and 0.75. The research questions were answered using mean rank and standard deviation, while the hypotheses were tested using independent sample t-test and Mann Whitney (U) test at 0.05 level of significance. Findings revealed that students taught mathematics using Mathematical Modeling performed better than their counterparts taught using lecture method. However, there was no significant difference in the achievement scores of male and female pre- service Mathematics Teachers taught Mathematics using Mathematical Modeling. Modeling therefore, was recommended to be used by Mathematics teachers with a view to improving students' achievement in Mathematics. Also, Modeling should be taught at Nigeria Certificate in Education (NCE) level in order to prepare Pre- service teachers towards real task in the field of Mathematics.

Keywords: Mathematical Modeling, Achievement, Pre- service Teachers, Modeling.

Introduction

Mathematics is an interdisciplinary language which explains the relationships, structures, quantities, properties and forms of objects, constructs, time and space. Mathematics as a subject cuts across all areas of human learning and endeavours. An

effective learning of Mathematics is therefore, imperative, for a society to cope and compete effectively in the present world of fast changing scientific and technological development. This explains the fact that knowledge obtain from Mathematics is applicable to all areas of human activities and consequently, determines the level and rate of national development (Iji, 2010). According to Odili (2006), the objectives of teaching mathematics include to: generate interest in Mathematics and provide a solid foundation for everyday living, to develop computational skills; foster the desire and ability to be accurate to a degree relevant to the problem at hand; develop and practice logical and abstract thinking; develop ability to recognize problems and to solve them with related mathematics knowledge; provide necessary Mathematical background for further education and to stimulate and encourage creativity.

However, the reformation attempted in Mathematics education from the beginning of the 1960's with the introduction of the modern Mathematics in school curricula, did not appear to be a success (Durandt & Jacobs, 2013). The attempt to teach the fundamental facts before presenting the objects to be generalized, had as a result of stripping the curricula from examples and applications connecting Mathematics with the real situations of everyday life and the other sciences using it as a tool and giving birth to many new Mathematical problems and theories (Voskoglou, 2010). In spite of all efforts put forth by teachers to effectively teach Mathematics, at primary, secondary, and tertiary education levels, the outcomes in terms of students' achievement do not seem to be satisfactory. Eric. (2014) revealed that the prevailing poor performance by students in mathematics is as a result of misinterpretation they hold about the subject and instructional mode. Eric concluded that ordinary methodology which is broadly utilized should be integrated with technological inventions in teaching to ameliorate the problem of low enrolment and adjust to expect national quality and standard in Mathematics.

Therefore, students need mathematical modeling skills in order to perform better in mathematics at all levels of education (Sokolowski & Rackly, 2011). Mathematical modeling according to Keng, (2010) is defined as the process of representing real world problems in mathematical terms in an attempt to understand and find solutions to the problems. Mathematical Modeling as an educational development was initiated in engineering and sciences settings, and then spread to other fields. The purpose of Mathematical Modeling was to elevate the gap between reasoning in a mathematics class and reasoning about a situation in the real world (Blum, Galbraith, Henn, &Niss, 2007). Situated in contexts, mathematical modeling provides methods for analyzing data, formulating theories often expressed in symbolic mathematical forms and testing those theories, as well as, helping with contextualizing problem-solving processes. The process of Mathematical Modeling can be exercised using various learning settings; from deductively arranged authentic problem modeling activities English and Sriraman, (2010) to inductively organized inquiries leading the learners to formulating general patterns (Sokolowski & Rackly, 2011).

The Nigeria Certificate in Education (NCE) programme being a major sector of teacher education, generally aims at producing teachers with high personal and professional discipline and integrity, teachers who are dedicated, with appropriate

knowledge, skills and attitudes that would facilitate easy achievement of the national goals spelt out above (NCCE, 2012).

To achieve the fore-stated goals, authentic problem-solving is increasingly used in enhancing learners' mathematical competencies, Mathematics teachers' Pedagogical Content Knowledge (PCK) and Mathematical Content Knowledge (MCK) (Buchholtz & Mesrogli, 2013). What is especially comforting is that, the relationship between mathematical modeling and authentic learning has been proved to be effective in teaching and learning of Mathematics (Kang & Noh, 2012). Modeling has been incorporated into mathematics curricula of schools in several countries, expecting mathematics teachers and learners to operate in a "culture of mathematising as a practice" (Stillman, Kaiser, Blum & Brown, 2005). This approach is in accordance with the tradition of constructivism learning theory.

Doerr, (2011) opined that Constructivist learning theory is based on the assumption that learning is a self- regulated activity which cannot be controlled from the outside but can be encouraged at best. Driscoll (2000) added that constructivism learning theory is a philosophy which enhances students' logical and conceptual growth. The underlying concept within the constructivism learning theory is the role which experiences- or connections with the adjoining atmosphere- play in student education. It argued that people produce knowledge and form meaning based on their experiences. He concluded by saying that two of the key concepts within the constructivism learning theory which create the construction of an individual's new knowledge are accommodation and assimilation. Assimilation causes an individual to develop new outlooks, rethink what were once misunderstandings, and evaluate what is important, ultimately altering their perceptions. Accommodation, on the other hand is reframing the world and new experiences into the mental capacity already present. Individuals conceive a particular fashion in which the world operates. When things do not operate within that context, they must accommodate and reframe the expectations with the outcomes. Hence, the primary responsibility of the teacher is to create and maintain a collaborative problem- solving environment, where students are allowed to construct their own knowledge, and the teacher acts as a facilitator and guide. And these relates to the modeling activities through the six modeling process understanding the problem (constructing), simplifying (structuring), mathematizing, working mathematically, interpreting, validating and exposing. Transitioning through these stages involves observations, measurements, interactions- described together as data, coding systems, methods of sampling, and data collection.

However, Achievement in mathematics is the showcase of knowledge accomplished or skill developed by students in the subject which is usually characterized by the design of test score assigned by teachers. Singh, Granville and Dika (2002) carried out a research on the topic Mathematics modeling and science achievement effects of motivation, interest, and academic engagement of 8th grade students' achievement in Mathematics. The results supported the positive effects of the two motivation factors, attitude and academic time on Mathematics and science achievement. The strongest effects were those of academic time spent on homework. In another development, Li, Pang and Yu (2009) in their study on Influential Factors in

mathematics modeling academic achievement using path analysis method, concluded that achievement motivation, creative inclination, cognitive style, the mathematical cognitive structure and mathematics modeling self-monitoring ability, had significant correlation with mathematics modeling academic achievement.

Inaddition, Mathematics is viewed by students as a difficult subject from primary, secondary and tertiary institutions Awofala & Awolola, (2011) and Sweeting, (2011). If students show negative attitude towards mathematics, there is the possibility that they will not like the teaching method adopted by the teacher. Attitude whether positive or negative will affect learning of mathematics. Demonstrating negative attitude towards a subject can affect learning. However, helping students develop a positive attitude toward mathematics should be considered as an important way forward in science education and mathematics. The Impact of Mathematical Modeling on Students' Learning and Attitudes in America was investigated by Nicola (2011). The study reveals that students recognized a positive impact of the mathematical modeling process and how it relates to their learning; Students are better desirous and able to try new problems and are ready to take risks, only with the types of mathematical processes they have engaged in.Furthermore, Wilkins and Ma (2002)in their work titled 'Modeling change in students attitude toward the belief about mathematics in middle school reported that students who had higher initial status showed less interest than those from a lower status.

The issue of gender in teaching and learning process has attracted much attention in the research world. Looking at modeling achievement as a variable from learners' point of view has been a matter of concern in present day research. It is the satisfaction students achieve as they progress through and complete the primary secondary and tertiary education. There are quite a number of researches focused on gender differences in the school learning process.

With regard to the issue of gender differences in mathematics achievement establish that there is inconclusiveness in the research findings of researchers. Samira and Gatabi (2014) reported in their study, gender differences between Iranian students in grade six in mathematical modeling competency and students' attitudes toward mathematical modeling problem. They adopted a quasi-experimental design with two different groups. These two groups of students responded to the pre-test, the questionnaire after pre-test, and post-test. The experimental group participated in a set of intervention classes that concentrated on modeling activities and answered the questionnaire after the intervention. The results of this study showed that although girls had better performance than boys in pre-test, after intervention, boys had better performance than girls in post-test at 0.05 of significance. All students who participated in the current study considered modeling problems out of mathematics domain, but after intervention their attitude toward mathematical modeling problems was changed dramatically so that almost all students in the experimental group recognized modeling problems as mathematics problem and they were interested in solving modeling problems. Durundt and Jacob (2015) examined the Mathematics Student Teachers' Approach to, experience of and attitude towards mathematical modeling in South Africa. They observed no significant difference between the males' and females' performance in mathematical modeling using 38 third year mathematics student- teachers., the study

used the attitude towards mathematics inventory (ATMI) and the results show that male (N = 24) 63% has positive attitude towards mathematical modeling than female (N=13) with 34% . They recommended that mathematics student- teachers should formally acquire modeling knowledge and skills during their education and it should ideally happen in teaching situation.

Purpose of the Study

The purpose of this study was to investigate the effects of Mathematical Modeling on Mathematics Achievement and Attitude of Pre-service Teachers in Niger State, Nigeria. It sought to specifically find out:

(1) The impact of mathematical modeling on Pre- Service Teachers Mathematics' Achievement.
(2) Examine the influence of gender on students' achievement in mathematics when exposed to Mathematical Modeling.
(3) The attitude of Pre- Service Mathematics Teachers when exposed to mathematical modeling.

Research Questions

1. What is the difference in the mean achievement scores in Mathematics of Pre-service Teachers when expose to Mathematical Modeling and those not exposed to mathematical modeling?
2. What is the gender difference on mathematics achievement of Pre- Service Mathematics Teachers when exposed to mathematical modeling?
3. What difference in attitude of Pre- Service Mathematics Teachers exposed to mathematical modeling?

Hypotheses

HO_1: There is no significant difference in the mean achievement scores of Pre- Service Mathematics Teachers when exposed to Mathematical Modeling and those that were not expose to Mathematical modeling.

HO_2: There is no significant difference in the mean achievement scores of male and female Pre- Service Mathematics Teachers when exposed to mathematical modeling.
HO_3: There is no significant difference in the attitude of Pre- Service Mathematics Teachers exposed to mathematical modeling.

Methodology

The study adopted a randomized pre-test, post-test control group design which entails the use of two groups being measured or observed twice. The first measurement serves as the pretest, the second as the post- test. Random assignment was used to form experimental group and control group. The measurement or observations are collected at the same time for both group. The total population of the study was 311, comprising 212 male and 99 female pre-service Mathematics teachers (NCE II) from two

colleges of education in Niger State during 2016/2017 academic session (College of Education, Minna and Kontagora).

A Multi- staged sampling technique was used for the study. First Purposive sampling was used to select two colleges of education because they are the only two Colleges of Education in Niger State. At the second stage simple random sampling was used to assign schools to two groups, Experimental and Control group. The sample of the study was made up of 84 (42 for experimental and 42 for control group) NCE II mathematics students of the two colleges. The sample size was chosen based on the central limit theorem.

The instrument used for data collection was Mathematical Modeling Achievement Test (MMAT) and Attitude Towards Mathematical Modeling (ATMM). MMAT contained five mathematics questions adapted by the researcher to determine the achievement of students in mathematical modeling. Each question carried 20 marks given a total score of 100 marks covering the following content in mathematics: Statistics, geometry, simple interest and functions. The ATMM is an instrument used for gaining learner attitudes towards Mathematics as a subject. The ATMM questionnaire on Mathematical Modeling used in the study is a likert- type response scale, and contained 20 items ranging from Strongly disagree (S.D), Disagree (D), Undecided (U), Agree (A) and Strongly Agree (S.A). The items were scored on the basis of the weight of each point. That is, 5, 4, 3, 2, 1 for SA, A, U, D, SD respectively. The instrument was face and content validated by three specialists, two from Science Education Department, Federal University of Technology, Minna and the other one from Mathematics Department Niger State College of Education, Minna to ensure clarity, arrangement and suitability in addressing the purpose of the study.

The instrument were face and content validated by three specialists, two from Science Education Department, Federal University of Technology, Minna and the other one from Mathematics Department Niger State College of Education, Minna. This was to ensure clarity, proper arrangement of the items and their suitability in addressing the purpose of the study. It was trial tested at College of Education, Zuba. The data collected for the study was used for computation of the reliability index of MMAT using Pearson Product Moment Correlation Coefficient (PPMC) and Cronbach alpha for ATMMQ. A reliability coefficient of 0.76 was obtained for MMAT while 0.75 was obtained from ATMMQ at the end of computation. The instrument was administered by the researcher and the research assistants to the two groups at the same time. The respondents answered the questions to the best of their knowledge.

Data was collected in two stages. At the first stage which lasted for one week, the colleges were visited by the researcher. The mathematics lecturers of the college were trained on how to administer the instrument after which pre-test of MMAT and ATMMQ administered, at the Second Stage which lasted for 3 weeks the selected students (experimental group) were exposed to modeling activities with the aid of power point presentation and control group the lecture method. At the end of the weeks, posttest was administered on both the selected (experimental) and control groups to find out students' achievement in mathematical modeling.

The research questions were answered using mean and standard deviation, while the hypotheses were tested using independent sample t-test at 0.05 level of significance.

Results

Research Question One

What is the difference in the mean achievement scores in Mathematics of Pre- service Teachers when exposed to Mathematical Modeling and those not exposed to mathematical modeling?

Table 1: Mean, Standard Deviation of Experimental and Control Groups

Groups	N	Pretest Mean (x)	SD	Post-test Mean (x)	SD
Experimental	42	55.17	13.62	62.67	19.72
Control	42	55.28	14.60	56.48	16.06

Table 1 shows the pre-test and post-test of the mean achievement scores of students in both experimental group and control groups at the commencement of the study. The table reveals that the mean score of experimental and control is 55.17 and 55.28. The table also shows the post-test mean score of 62.67 for the experimental group and standard deviation of 19.72, which is greater than mean of control group (56.48) with standard deviation of 16.06. This shows that students exposed to mathematical modeling achieved higher mean achievement score than those not exposed.

Research Question Two

What is the difference in attitude of Pre- Service Mathematics Teachers exposed to mathematical modeling?

Table 2: Mean Rank and Standard Deviation of Experimental and Control Groups attitude towards Mathematical Modeling.

Groups	N	Pre-test Mean Rank	S.D	Post-test Mean Rank	S.D
Experimental	42	44.26	17.06	50.57	22.14
Control	42	40.74	5.72	34.43	19.49

Table 2 reveals that experimental group has (Mean Rank = 44.26 and S.D= 17.06); and Control (Mean Rank = 40.74 and S.D = 5.72), at pre-test while at post- test experimental group has (Mean Rank = 50.57 and S.D= 22.14); and Control (Mean Rank = 34.43 and S.D= 19.49). This indicates that experimental group had better attitude towards Mathematics when exposed to modeling than control group with a mean rank difference of 3.52 and 16.14.

Research Question Three

What is the gender difference on mathematics achievement of Pre- Service Mathematics Teachers when exposed to mathematical modeling?

Table 3: Mean and Standard Deviation of Male and Female in Experimental group

Groups	N	Pretest Mean (x)	SD	Post-test Mean (x)	SD
Male	25	45.72	12.63	69.12	14.46
Female	17	45.82	12.99	74.59	11.83

Table 2 shows the pretest and posttest of Male and Female achievement score in the Experimental group. Male has ($\bar{X}$ = 45.72 and SD = 12.63); and Female ($\bar{X}$= 45.82 and SD = 12.99). This table also shows the posttest score of Male and Female students from the Experimental group. Male has ($\bar{X}$ = 69.12 and SD = 14.46); and Female ($\bar{X}$= 74.59 and SD = 11.83). This show that Female students had a higher mean score than Male students before after treatment with a mean difference of 0.65 and 5.47 respectively.

Hypothesis One

There is no significant difference in the mean achievement scores of Pre- Service Mathematics Teachers when exposed to Mathematical Modeling and those that were not expose to Mathematical modeling.

Table 3: Summary of Independent t-test Analysis of Experimental and Control Groups at Post- test.

Group	N	Df	$\bar{X}$	S.D	t	P	Remark
Experimental	42	82	62.67	19.72	1.40*	0.011	Significant
Control	42		56.48	16.06			

*: Significant at $p < 0.05$

Table 3 shows the t-test analysis of mean achievement scores of pre-service teachers in both the experimental and control group at posttest. The t– value = 1.40, df = 82, p = 0.011 indicating that $p < 0.05$ therefore, Hypothesis one was rejected. This further indicates that students taught Mathematics using modeling approach significantly performed better than those exposed to lecture method.

Hypothesis Two

There is no significant difference in the attitude of Pre- Service Mathematics Teachers before and after they were exposed to mathematical modeling.

Table 4: Summary of Mann Whitney U-test analysis of Attitude of Pre- service Mathematics Teachers towards Mathematical modeling.

EXPERIMENTAL GROUP	N	df	$\bar{X}$-Rank	U	P-value	Remark
Pre-test	42		36.27			
		40		620.500	0.019	Significant
Post-test	42		48.73			

*Significant at $p < 0.05$

Table 4 shows the comparison of Mann Whitney U-test of the attitude of Pre- service Mathematics Teachers towards Mathematical modeling. The table reveals that the calculated U-value (U = 620.500, df = 40, p = 0.019). $p< 0.05$. Hence, HO_2 was rejected. Hence, there is significant difference in the mean attitude scores toward mathematics before and after exposure to mathematical modeling.

Hypothesis Three

There is no significant difference in the mean achievement scores of male and female Pre- Service Mathematics Teachers when exposed to mathematical modeling.

Table 4: Summary of independent t-test analysis by gender of Pre- service Mathematics Teachers taught Mathematics using Mathematical modeling.

Group	N	df	$\bar{X}$	S.D	t	P	Remark
Male	25		69.12	14.46			
		40			-1.29^{ns}	0.644	N/Significant
Female	17		74.59	11.83			

^{ns}: Significant at $p > 0.05$

Table 4 shows the analysis of independent sample t-test of mean achievement scores of male and female students in experimental group taught Mathematics using Mathematical modeling. It reveals that the calculated t–value = -1.29, df = 40, p = 0.644 indicating $P > 0.05$. Hence, Hypothesis two was retained. This mean, there was no significant difference in the mean achievement scores of male and female students taught Mathematics using Mathematical modeling.

Discussion

The results of hypothesis one revealed that students taught Mathematics using mathematical modeling achieved significantly better than their counterparts taught mathematics using lecture method. This discovery is in line with the previous findings of Georgia (2009), Li, Pang and Yu (2009), Nicola (2011), Baskan and Alev (2013), Sokolowski (2015) that students taught mathematics using mathematical modeling approach performed better than those taught with lecture method. Georgia (2009) in a study titled "Effects of Mathematical Modeling on Students' Affect in Greek High School

confirmed that the Experimental group performed better in mathematics than the control group due to the intervention given to them using mathematical modeling approach.

The results of the analysis on hypothesis two indicated that there was no gender influence on the academic achievement of students' taught mathematics using mathematical modeling. The result showed no significant difference between the mean achievement scores of male and female students taught mathematics using mathematical modeling approach. This finding is in line with the previous findings of Adimora, Onyishi and Nwokenna (2014) that observed and reported no significant difference between the males and females students' performance in mathematics when exposed to mathematical modeling. This also agrees with Ozken and Serkan (2012), Durundt and Jacob, 2015; the study however, disagrees with Samira and Gatabi (2014) which found that gender has effect on students' academic achievement and that male students performed better than female students after intervention on Mathematical Modeling.

These findings have strong implications for the science and mathematics teachers, government and administrators of colleges of education and curriculum planners. The findings of this study revealed that mathematical modeling improved students' achievement in mathematics than the lecture method.

One of the implications of the findings indicates that Mathematics teachers must take cognizance of the specific needs of students in the planning and the delivery of lessons.

Conclusion

The study examined the effects of mathematical modeling on mathematics achievement and attitude of pre-service teachers in Niger State, Nigeria. It revealed that Mathematical Modeling facilitates learning outcome compared to lecture method most commonly used in the classroom. It was concluded that use of mathematical modeling is an innovative package strategy capable of enhancing students' achievement in mathematics. Therefore, mathematical modeling was more effective in teaching some concepts in Geometry, statistics and interest rate, than the lecture method.

Recommendations

Mathematics Pre- service should formally acquire modeling knowledge and skills during their training as teachers. This should ideally happen in teaching contexts, which will enable them to understand that Mathematics teaching is not formula- dependent, but authentic, open- ended and thrilling approach. The curriculum planners should enshrine mathematical modeling in the syllabus of NCE mathematics course in colleges of education in Nigeria. Researchers should produce modeling text books that will serve as guide to mathematics teachers at NCE levels of education. The Federal Government of Nigeria (FGN) and state ministries of education in collaboration with teaching training institutions and professional bodies such as National Teacher Institute (NTI) and Science Teachers Association of Nigeria (STAN) should organize special re-training, workshop and seminars for Mathematics teachers on mathematical modeling and its application to real life situation.

References

Awofala, A. O. A. & Awolola, S. A. (2011). coping with new mathematics teacher's beliefs in a conflicting milieu of curriculum transform. *Proceeding of 52nd annual conference of Science teachers association of Nigeria on reforms in science, technology, engineering and mathematics* (pp. 309-315). HEBN Publishers Plc.

Baskan, Z. & Alev, N. (2013). Effects of teaching one and two dimentional motion units through mathematical modeling. *Academic Journals, 8*(6), 250-257.

Blum, W., Galbraith, P. L., Henn, H.-W., & Niss, M. (2007). Modelling and applications in Mathematics education. *The 14th ICMI study.* New York: Springer.

Buchholtz, N., & Mesrogli, S. (2013). A whole week of modelling–examples and experiences of modelling for students in mathematics education. In *Teaching mathematical modelling: connecting to research and practice* (pp. 307-316). Netherlands: Springer.

Doerr, A. (2011). *International perspectives on gender and mathematics education.* Charlotte, NC: Information Age Publishing.

Driscoll, M. P. (2000). Psychology of learning for Instruction (2nd Ed.). Needham heights, MA: Allyn & Bacon

Durandt, R. & Jacobs, G. J. (2014). Mathematics student teachers' approach to, experience of and attitudes towards mathematical modelling. *International Conference of Science, Technology and Education*, (pp. 70-80). Johannesburg, South Africa.

English, L., & Sriraman, B. (2010). Problem solving for the 21st century. In Theories of Mathematics Education. *seeking New Frontiers*, (pp. 263-290.)

Eric, O. O. (2014). Learning mathematics through mathematical modelling: A study of secondary school students in Nigeria. *publish Thesis submited to the University of Agder.* Kristiansand, Norway.

Gatabi, A.R., & Mehraein, S. . (2013). Gender and mathematical modelling competency: Primary students' performance and their attitude . *Procedia- Social nd Behavioural Sciences*, 198-263.

Georgia, P. (2009). The effect of mathematical modeling on students' affect. Unp*ublished Thesis submitted for the MSc in Mathematics and Science Education.* Amsterdam, AMSTEL Institute University van Amsterdam, Netherland.

Iji, C. O. (2010). *Effect of logo and basic program on achievement and retention in geometry of JSS II Students.* Unpublished Masters' Thesis University of Nigeria, Nsuka. Nsuka.

Ismail, N. A., & Anwang, H. (2009). Differences in mathematics achievement among eight-grade students in Malaysia. *Journal of International Education Studies, 2,* 8-11.

Khatoon, T., & Mahmood, S. (2010). Mathematics anxiety among secondary school students in India and its relationship to achievement in mathematics. *European Journal of Social Sciences, 16(1),* 75-86.

Keng, C. (2010). Teaching and Learning Mathematical Modelling with Technology. *The Mathematical Educator.*

Kang, O., & Noh, J. (2012). Teaching mathematical modelling in school mathematics. *12th International Congress on Mathematical Education,* (pp. 75-86). Soul, Korea.

Li, M., Pang, K., & Yu, P. (2009). A study on Influential factors in Mathematics Modeling Academic Achievement. *Journal of the Korea society of Mathematical Education, 13*(1), 31-48.

National Commission for Colleges of Education (2012). Nigeria certificate in education minimum standards for general education TETF project 2012

Nicola, W. (2011). The impact of mathematical modeling on student learning and attitudes. *Publish Thesis.* The Evergreen State College.

Odili, G. O. (2006). *Mathematics in Nigeria secondary schools: A teaching perspective.* Ikeja: Rex Chales & Patric Limited.

Papageorgiou, G. (2009). The effect of mathematical modeling on students' affect. *Unpublished Msc Thesis in Mathematics and Science Education submitted to AMSTEL Institute, Universiteit van ArmsterdamPostbus 94224 1090 GE Amsterdam, The Netherlands*

Schukajlow, S., & Krug, A. (2014).Are interest important for students' performance. *Proceedings of the Joint Meeting of PME 38-NA 36, 5, 129-136.*

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95(6),* 323-332.

Sokolowski, A., & Rackley, R. (2011). Teaching harmonic motion in trigonometry. *Australian Senior Mathematics Journal, 24*(2), 45-54.

Stillman, A., Kaiser, A.J., Blum, W. & Brown, J. P. (2005). *Teaching mathematical modelling: Connecting to research and practice.* London: springer.

Sweeting, P. (2011).A trend-change extension of the Cairns-Blake-Dowd model. *Annals of Actuarial Science, 5(2):* 143–162.

Voskoglou, M. G. (2010). Mathematical modelling in classrrom. *The importance of validation of the constructed model*, 263- 340. Greece: Graduate Technological Educational Institute (T.E.I), School of Technological Applications Patras.

Wilkins, J. L. M., & Ma, X. (2002). Modeling change in attitude toward and beliefs about mathematics. *Journal of Educational Research, 97(1),* 52-63