EFFECT OF TEACHER ENTHUSIASM ON MATHEMATICAL ACHIEVEMENT; THE IMPACT OF MATHEMATICAL CREATIVITY

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Abstract

Mathematical achievement is an end result of teaching and learning at the basic levels of schooling. A student is expected to have at least a credit pass in Mathematics to proceed to higher levels of education. To contribute meaningfully to a rapidly changing world of technological advancement mathematical knowledge is very vital. Over the years it has been a source of concern to stakeholders in the education industry that students have low interest and achievement in mathematics. Hence, research is always ongoing on ways and methods for combating and reversing this problem. Mathematical creativity and Teacher enthusiasm are two constructs that have been examined independently in relation to mathematical achievement in developed countries. Nevertheless, studies that link mathematical creativity to teacher enthusiasm have not been explored. In addition, studies on the area of mathematical creativity have not been seen particularly in the area of secondary school education in Nigeria, where mathematical achievement has seen a steady decline. This study seeks to examine the relationship that exists between mathematical creativity, teacher enthusiasm and mathematical achievement of students at the senior secondary level in Federal Unity Colleges in North-Central Nigeria using structural equation modeling. Measurement items, which comprise of a self-report questionnaire for teacher enthusiasm (TEN), tests for Mathematical Creativity (MC) and test for Mathematical Achievement (MA) were administered to 2041 students in senior secondary sections in Federal Unity Colleges in North Central Nigeria. Exploratory and confirmatory analyses were carried out using the Analysis of moment structure (AMOS) tool. The findings of the study showed that MC had a total mediating effect on TEN to MA, while the direct relationship between TEN and MA had an infinitesimal coefficient weight. This study contributes to the growing research on the need for Mathematical creativity in our classroom and its effect on students' mathematical achievement and teacher enthusiasm.

Introduction

Mathematics is a core subject offered by students all over the world at the basic levels of education. Without a credit pass in mathematics, a student will find it difficult to proceed to tertiary education. A disconnect seems to exists between mathematics as taught in the classroom and the mathematics needed for everyday life. Teaching strategies and methodologies used in teaching mathematics in our schools mostly do not encourage our students to think independently (Mann, 2005). This makes students develop fear and anxiety towards mathematics as a subject, leading to loss of interest, and hinders their achievement in Mathematics. This is a source of concern to all stakeholders in the education sector; hence, the continuous research on strategies to combat this phenomenon. In the twenty-first century, skills such as creativity have been advocated as necessary for students to be able to contribute

meaningfully to technological development in the larger society beyond the classroom (Plucker & Esping, 2015).

Students often describe mathematics as a rigid subject that gives few opportunities for them to think and express themselves. Their perceptions about mathematics are connected to their mathematics teachers and their mode of instruction (Kunter et al, 2011). Students rated enthusiasm as very important when they were asked to list characteristics they felt were necessary for their teachers to be highly effective (Keller et al, 2013). Teacher enthusiasm is said to foster students learning and motivation. From previous research on teacher enthusiasm, there has been a call for studies with regard to mediators or moderators that influence the relationship between teacher enthusiasm and student achievement in order to determine the effects as well as the direction of causation (Keller et al, 2016).

In this study, mathematical creativity is proposed as a mediator between teacher enthusiasm and mathematical achievement based on the premise that enthusiastic teachers are more likely to foster theirstudent's mathematical creativity and their mathematical achievement in the end.

The present study aims at exploring the effect of mathematical creativity on teacher enthusiasm and mathematical achievement of students in federal unity college, north-centralNigeria**.** Based on this theoretical framework the study posits that (i) teacher enthusiasm has a significant relationship with the mathematics creativity of students (ii) mathematical creativity of students mediates the relationship between teacher enthusiasm and mathematical achievement of students.

Theoretical Background

Teacher enthusiasm is described in instruction as lively nonverbal behaviours that show the excitement and joy of a teacher in teaching a particular subject (Keller et al, 2016). From prior research carried out particularly at the tertiary level, students opined that enthusiastic teachers encouraged their students to participate actively in class, which motivated them to learn (Freudenberg &Samarkovski, 2014). The enthusiasm of a Teacher can spread to students and ignite their interest in the subject area leading to students' achievement. An enthusiastic teacher is expected to be an effective teacher with in-depth knowledge of the requisite subject area (Freudenberg &Samarkovski, 2014). The mathematical creativity of students is defined as the process of forming new questions that that would result in a novel, insightful and useful solutions to a problem (Shirki, 2010). At the schoollevel, mathematical creativity is usually identified with problem posing or problem-solving (Posamentier, Smith &Stepelman, 2010). To develop students who are mathematically creative, mathematics teachers have a vital role to play the creative mathematics experiences of the teachers themselves and their beliefs about creativity would determine how much effort they would put into creative mathematical activities in their classrooms for the development of mathematical thinking of their students (Sinitsky, 2008).

Social cognitive theories and the systems theory of creativity provide a theoretical framework for how enthusiastic teaching and creativity of the students could be related towards the better mathematical achievement of students(Starko, 2005; Frenzel et al,2009; Gras, Bordoy, Ballesta&Berna,2010; Pekrun et (,2009). Empirical evidence supports the relationship between teacher enthusiasm and students learning (Aschenbrener, 2008) other studies have discovered the relationshipbetween mathematical creativity and mathematical achievement (Mann, 2005;

Lev & Leikin, 2013). However, there is a lack of empirical evidence documenting relationships between teachers' enthusiasm and mathematical creativity of the students and between teacher enthusiasm, mathematical creativity, and mathematical achievement.

Methodology

A quantitative non-experimental causal-comparative research design was adopted for this study. The use of this design is supported by the assertion that a substantial proportion of quantitative educational research is non-experimental because many important variables of interest in educational research cannot be manipulated (Belli, 2008). The study depicts a complex causal model of direct and indirect causal relationship between teacher enthusiasm, mathematical creativity, and mathematical achievement. Students in the first year of Senior Secondary School (SS1) in Federal Unity Schools in North Central Nigeria, represent the population used in this study. 2041 students from 12 secondary schools participated in the study. These schools all fall within the North Central Zone of Nigeria. The age of the students ranges from 12 years to 19 years with an average age of 14 years. Summary of the research instruments is presented in Table 1.

Table 1: Description of the Research Instruments

Construct and Sources	Description
Mathematical Creativity (Adapted questions from mathematics creativity scale Akgul,2016)	1 convergent thinking question and 4 divergent thinking questions requiring multiple solutions
Teacher Enthusiasm (Adapted from enthusiasm awareness index)(Gabryś-Barker,2014)	My teacher maintains eye contact with us while teaching
	My teacher's facial expression while teaching is pleasant
	My teacher demonstrates with hand gesture while teaching
	My teacher does not read directly from notes or books while teaching
	My teacher is active and excited about what is being taught
	My teacher immediately notices when we stop paying attention
Mathematical Achievement (Adopted questions from past question papers of NECO& WAEC examinations councils.)	10 questions on number and numeration,8 questions on algebraic processes and 2 questions on geometry

A pilot test on the instruments was carried out to obtain the reliability of the instruments. A 5-point Likert scale was used for the questionnaire items. Two tests were used: the mathematics achievement test and the mathematical creativity test. The mathematical creativity test included one convergent and four divergent open-ended multiple-solution mathematical tasks, in which the students were asked to, provide multiple solutions which were different from each other; and different from the answers given by their peers.

Mathematical achievement as used in this study was measured using the students' results in standardized questions set by the external examination bodies National Examinations Council (NECO) and West African Examinations Council (WAEC) in Nigeria. Each student was given 50-minutes, and 30-minutes to complete the mathematical creativity test, and the mathematical achievement test respectively. All statistical analyses were conducted with a significance level of 0.05. In order to evaluate the measurement and structural model, the analysis of the moment structure (AMOS) tool version 18 was used. Metrics of evaluation include the comparative fit indices (CFI), the goodness of fit indices (CMIN/DF), and the root mean square error of approximation (RMSEA). These metrics are the generally utilized metrics for evaluating the structural model.

Result and Analysis

The technique utilized to address missing data in the data collection was the Missing Completely At Random (MCAR) technique. This technique provided a baseline for data imputation and the data collection satisfied the conditions for data input. A descriptive statistic of the data is shown in Table 3. The responses on the Teacher Enthusiasm (TEN) questionnaire showed a higher mean-score when compared to the mean score of the mathematical creativity test (MCT). However, most items in the TENwere negatively skewed relative to the MCT item skewness. The reliability of the teacher enthusiasm and mathematical creativity test (MCT) items were observed to be 0.779 and 0.6113 respectively. One item in the MCT was observed to negatively affect the reliability scale during the exploratory factor analysis. Further evaluation of this observation was performed during the structural analysis.

Table 2: Descriptive Statistics

Items	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
TEN1	2041	1	11	3.665	1.2299	1.513	-0.678	0.054	0.247	0.108
TEN2	2041	1	5	3.659	1.1341	1.286	-0.802	0.054	0.015	0.108
TEN3	2041	1	5	4	1.0493	1.101	-1.234	0.054	1.107	0.108
TEN4	2041	1	5	3.952	1.0486	1.1	-1.158	0.054	1.036	0.108
TEN5	2041	1	5	4.047	1.1274	1.271	-1.327	0.054	1.07	0.108
MCTI1	2041	1	5	1.643	0.9482	0.899	1.127	0.054	0.037	0.108
MCTI2	2041	1	5	1.974	1.2638	1.597	1.083	0.054	-0.075	0.108
MCTI3	2041	1	74	3.535	1.9756	3.903	22.064	0.054	793.11	0.108
MCTI4	2041	1	5	2.307	1.5525	2.41	0.65	0.054	-1.21	0.108
MCTI5	2041	1	5	1.332	0.7864	0.618	2.84	0.054	8.152	0.108

Using the thumb rule for the goodness of fit indices as defined in Hair et al (2010) the proposed structural model was evaluated. The result, as shown in Table 4, revealed that the proposed model satisfies the goodness of fit indices thumb rule. Based on this observed result, the structural model, as shown in Figure 2, was developed. The standardized regression weight, with coefficient of 0.04, showed a statistically insignificant direct relationship between teacher enthusiasm (TEN) and mathematical achievement (MAT). However, a statistically significant

relationship was observed between teacher enthusiasm and mathematical achievement through mathematical creativity. The observed standardized regression weight for the significant relationship (TEN to MAT through MCT) was 0.49. Generally, a factor loading lesser than 0.3 is considered poor in a structural model (Hair et al, 2010). As shown in Figure 2, two items, MCT item-1 and item-3, are lower than 0.3. The authors observed that deleting the item from the model made no significant impact on the overall outcome of the model. Thus, the items were kept in the structural model. The factor loading of other items remains above the 0.3 benchmarks. This further suggests that the model has a good fit.

Table 3: Measurement Model evaluation

Indices	**Thumb rule (N>=250, m<=30)**	**Obtained result**
CMIN/DF	≤3.000	1. 830
CFI	≥0.920	0.990
RMSEA	≤0.070	0.020

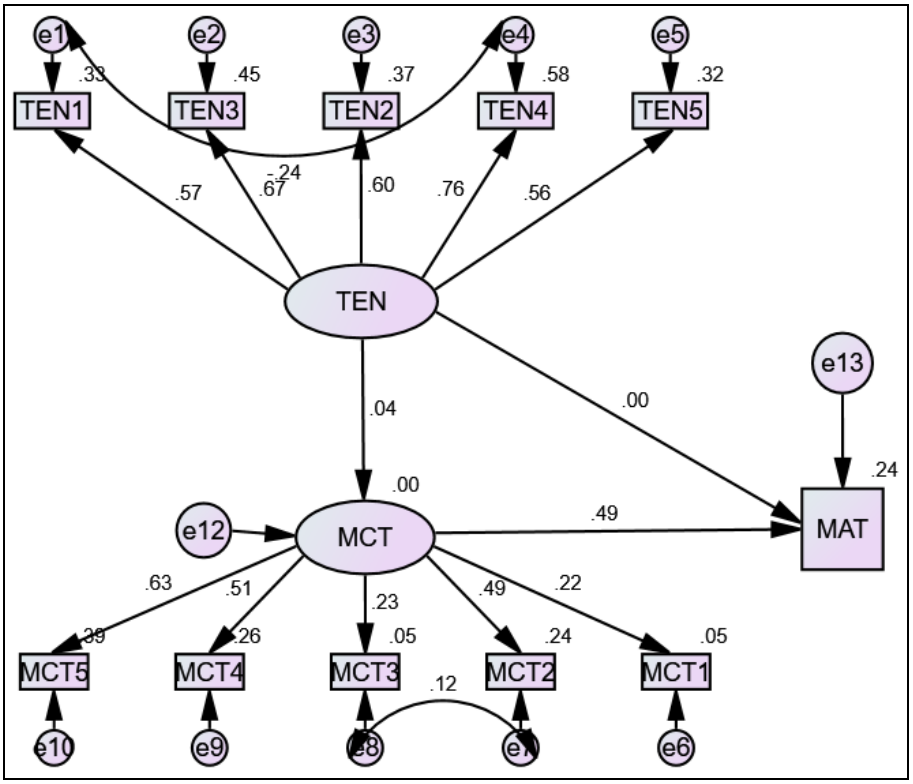

Figure 2: Structural Model for TEN, MCT and MAT Relationship

Discussion

Leveraging the theoretical supposition from studies on the relationship between mathematical achievement and Mathematical creativity, this study asserts that mathematical creativity (MC) can mediate the effect of Teacher enthusiasm (TEN) on mathematical achievement (MA). This underlying assumption is further established in this study. The result presented in Table 4 shows that the suggested relationship among the observable variables; MA, MC, and TEN, can be structurally modelled to reveal either causation or indirect relationship. From the result shown in Figure 2, there was no direct relationship between Teacher enthusiasm and

mathematical achievement of students in Federal Unity Colleges in North-Central Nigeria. This observation contrasts observation in existing studies, as further highlighted. However, the converse was observed for the indirect relationship through mathematical creativity. MC provided a complete mediation in the relationship between the TEN and MA. This further suggests that the integration of creativity into mathematics in public schools in North-Central Nigeria could be a potential approach to enhancing Mathematical achievement of students.

The observation from this study supports the findings from previous studies, such as Nami et al (2014), where creativity was asserted to influence mathematical achievement. Furthermore, the result supports the assertion in Mann (2005) where a significant relationship between creativity and achievement was found. However, the result contrasts the finding in Kunter et al (2008) where teachers' enthusiasm had a significant relationship with higher quality instructional behaviour. Although in the review of previous research on the relationship between teacher enthusiasm and academic achievement by Keller et al (2016) they discovered that research outcomes about the relationship between teacher enthusiasm and academic achievement was mixed, some studies found positive effects while others found no significant effect. In summary, the current study attempted to explore the relationship between mathematical achievement, mathematical creativity, and Teacher enthusiasm. Unlike other studies, this study utilized structural equation modeling approach to validate the theoretical underpinning and discovered the mediating effect of mathematical creativity on the relationship between mathematical achievement and teacher enthusiasm. The use of structural equation modeling presents a logic for extracting causal relationships among observable variables. Though Mathematical Creativity cannot be affirmed to be a causal factor for Mathematical Achievement, it can be stated that the incorporation of Mathematical creativity into our classrooms would be a measure for enhancing MA. This is necessary for most developing nations, particularly in North Central Nigeria where the decline in MA presents a major problem for educators. If the critical thinking skills and problem-solving abilities of the students are fostered, it will help learners to understand and actively participate in today's global perspectives and dynamics. The concept of mathematical creativity can be contextually designed to fit into the existing national curriculum without discarding the existing curriculum. In addition, a learner-centered method of teaching with enthusiastic teaching being encouraged should be used. Furthermore, the relationship observed in this study can be enhanced. Whilst in this study, the mathematical achievement test was based on uncategorized mathematical questions; another approach would be to categorize the mathematical test items into a group of knowledge-areas in mathematics, which can be used to create a robust construct for mathematical achievement. The construct; Teacher enthusiasm, could also be considered from both the perception of the students and a questionnaire for the teachers as well.

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