MATHEMATICAL ABILITIES OF SECONDARY SCHOOL STUDENTS AND ACQUISITION OF ENTREPRENEURIAL SKILLS IN PHYSICS

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Abstract

The study investigated Mathematical abilities of secondary school students and acquisition of entrepreneurial skills in Ikwerre Local Government Area of Rivers State. Sixty physics senior secondary school students were purposively sampled from a population of nine hundred students. Quasi-experimental pre-test post-test design was used for the study. Purposive sampling technique was used to select three schools from the target population. The instruments for this study are Entrepreneurial Skills Acquisition Test (ESAT) and Mathematical Ability Test (MAT). The reliability indices are 0.74 and 0.90, using Cronbach Alpha and Kuder-Richardson formula (K-R-21) respectively.Two experimental and one control group with each group taughtwith a different instructional methods. Data obtained were analysed using mean and percentage for the research questions while 3×3 Multivariate Analysis of Covariance was used to test the hypotheses. The results showsthat students with high, average and low Mathematical abilities gained most in the acquisition of measurement, manipulative and finger dexterity skills in the construction of potentiometer when taught with Demonstration strategy. However, there is no significant difference in the effect of the teaching strategies on students of high, average and low mathematical abilities in their acquisition of measurement, manipulative and finger dexterity skills in the construction of potentiometer. It was therefore recommended thatstudents should be encouraged to improve their mathematical ability since this is a key to the acquisition of entrepreneurial skills in physics.While students- centred interactive strategy should be employ by teachers during teaching and learning.

Introduction

The core subject for technology advancement in any country hinges on Mathematics and Physics. These two are interrelated and inseparable and that is while Adesoji (2008) opined that the relationship between mathematics and physics are so interwoven and this is expressed in the physical sciences which displaysmathematical equations. Also, Tzanakis (2001) posited that mathematics and physics have always been closely interwoven in the process such that

mathematics methods are used in physics, and also act as a tool for expressing, handling and developing concept and theories. Mathematics however, makes use ofphysics concept and mode of thinking. Imoko and Anyaphy (2011), emphasized that a good mathematical knowledge of any students can be a key to the development of entrepreneurial skill which is the foundation for national development.

The knowledge of Mathematics is needed in the construction and calibration of potentiometera physics apparatus. The construction and calibration of any scientific equipmentinvolves deliberate and conscious effect with high potency for calculation.Therefore it is necessary to involve high learning of activities that allow students to articulate, visualize, imagine, manipulate and synthesize any problem. Abakpa and Igwue (2013) noted that Mathematics is the bases for scientific discoveries and inventions which is very important in entrepreneurship. As entrepreneurship is the process in which an entrepreneur undertakes to establish an enterprise (Adekunle,2012).

Jeffrey (2011) emphasized that the operations of addition, subtraction, multiplication, division and geometry taught to children is very important in the construction of electrical equipment.This suggests that students' understanding of mathematical concept will greatly influence their application of it in problem solving.A lot of teaching methods have been advocated for in the teaching and learning of entrepreneurship. Methods considered in this study are demonstration, guided –inquiry and cooperative strategies. Awotua-Efebo (2001) noted that demonstration method is most suited for modelling correct technique and better procedure for doing something. While Akinbobola and Afolabi (2009),emphasized that a good demonstration exercise helps students to understand the lesson very clearly as it involves the combination of sense of sight, hearing and touching. Onwioduokit (2014) argued that guided inquiry promotes critical thinking and creative abilities on entrepreneurs. Schwarz, Bransford and Sears (2005) observed with cooperative strategy, two students working together can gain knowledge in learning even though, the students entered the peer learning situation with low levels of competence.

The skills to be acquired are measurement, manipulative and finger dexterity skills.On the relationship between teaching strategies and mathematical abilities, Obafemi and Ogunkunle, 2014 studied the mathematical abilities of secondary school physics students and performance in sound

waves. The findings revealed that, there is no significant difference among the performances of students with high,average and low Mathematical abilities with respect to understanding of sound waves, considering the instructional methods.

Problem of the Study

Entrepreneurship is very important in nation building.It equips a man and makes him useful to himself and the society.However, the knowledge of mathematicsis needed to become a successful entrepreneur. It cannot be excluded from our everyday life. The mathematical ability of the students is of great necessity to help in the manipulation and construction of scientific equipment. However, some studies have shown that students are deficient in Mathematics.The teaching methodsimply by the teacher during lesson could also affect the acquisition of students' entrepreneurial skill. Can the different teaching methods andmathematical ability of the students have any effect on the students' entrepreneurial skill in the construction of potentiometer?This study is out to investigate the mathematical abilities of secondary school students and acquisition of entrepreneurial skills in physics.

Aim and Objectives of the Study

The aim of this study is to investigate the effect of mathematical abilities of secondary school students and acquisition of entrepreneurial skills in the construction of potentiometer.Specifically the objectives of the study were to :

i. determine the effects of Demonstration, Guided- Inquiry and Cooperative strategies on students' acquisition of measurement skills in the construction of potentiometer considering their mathematical abilities?

ii. investigate the effect of Demonstration, Guided- Inquiry and Cooperative strategies impact on student's acquisition of manipulative skills in the construction of potentiometer, considering their mathematical abilities?

iii. Ascertain the effect of Demonstration, Guided- Inquiry and Cooperative strategies on student's acquisition of finger dexterity skills in the construction of potentiometer considering their mathematical ability?

Research Questions

i. What are the effects of Demonstration, Guided- Inquiry and Cooperative strategies on students' acquisition of measurement skills in the construction of potentiometer considering their mathematical abilities?

ii. How would Demonstration, Guided-Inquiry and Cooperative strategies impact on students' acquisition of manipulative skills in the construction of potentiometer considering their mathematical abilities?

iii. What is the relative effect of Demonstration, Guided- Inquiry and Cooperative strategies on students' acquisition of finger dexterity skills in the construction of potentiometer considering their mathematical abilities?

Research Hypotheses

H_{01} There is no significant difference among the students of high, average and low mathematical ability in their acquisition of measurement skills when taught with Demonstration, Guided-Inquiry and Cooperative strategies in the construction of potentiometer.

H_{02} There is no significant difference among the students of high, average and low mathematical ability in their acquisition of manipulative skills when taught with Demonstration, Guided-Inquiry and Cooperative strategies in the construction of potentiometer.

H_{03} There is no significant difference among the students of high, average and low mathematical ability in their acquisition of finger dexterity skills when taught with Demonstration, Guided- Inquiry and Cooperative strategies in the construction of potentiometer.

Methodology

The study adopted a quasi-experimental, pre-test- post-test control group design. There were two experimental and one control. The factors in the study were instructional strategies, and mathematical ability and acquisition of skills and each existing at three (3) levels. Purposive sampling technique was used to select three schools from the target population. The instruments for this study are Entrepreneurial Skills Acquisition Test (ESAT) and Mathematical Ability Test (MAT). They were validated for content and construct validity.The reliability

indices are 0.74 and 0.90, using Cronbach Alpha and Kuder-Richardson formula (K-R-21) respectively.ESAT is expected to measure students' ability, on- the- spot during the construction of the potentiometer, which consisted of six items in measurement skills scored a maximum of 30 marks, ten items in Manipulative skills scored a maximum of 50 marks and four items in finger dexterity scored a maximum of 20 marks giving a total score of 100marks. The MAT test consisted of 40 items each attracted 1 mark. The test is expected to measure students' mathematical ability based on reasoning and problem solving. The subjects' Mathematical abilities were classified as high, average and low after the MathematicalAbility Test was administered to the different groups. They were treated with the three different teaching strategies (Guided-Inquiry, Co-operative and Demonstration Strategies). A sample size of sixty students was used for the study. Based on the data collated, the research questions were analysed using descriptive statistics such as percentages and mean scores while the hypotheses were tested with 3x3 factorial Analysis of Covariance (ANCOVA).

Results and Discussion

Table 1: Mean gain scores of the acquisition of measurement, manipulative and finger dexterity skills in the construction of potentiometer by students of high, average and low mathematical abilities.

		Construction of Potentiometer				
MAT Ability	Skills	Method	Pre test$\bar{x}$	Post test$\bar{x}$	Mean gain	Mean gain%
High Level	Measurement	DMS	13.10	26.50	13.4	102.29
		GIS	15.00	22.50	7.5	50.00
		CPS	14.60	24.30	9.7	66.44
	Manipulative	DMS	18.60	46.10	27.5	147.85
		GIS	18.50	38.83	20.33	109.89
		CPS	18.11	42.50	24.39	134.68
	Finger Dexterity	DMS	6.20	18.20	12.00	193.55
		GIS	5.30	16.33	11.03	208.11
		CPS	6.11	18.20	12.09	197.87
Average Level	Measurement	DMS	14.00	24.25	10.25	73.21
		GIS	14.14	22.29	8.15	57.64
		CPS	13.20	22.80	9.60	72.73
	Manipulative	DMS	18.00	45.25	27.25	151.39
		GIS	18.43	39.29	20.86	113.19
		CPS	18.00	42.20	24.20	134.44
	Finger Dexterity	DMS	5.75	19.25	13.50	243.78
		GIS	4.71	15.43	10.72	227.60
		CPS	4.40	17.20	12.80	290.91
Low Level	Measurement	DMS	13.67	28.33	14.66	107.24
		GIS	14.57	21.57	7.00	48.04
		CPS	14.67	24.00	9.33	63.60
	Manipulative	DMS	18.00	47.67	29.67	164.83
		GIS	18.14	40.43	22.29	122.88
		CPS	18.33	45.33	27.00	147.30
	Finger Dexterity	DMS	5.00	19.50	14.50	290
		GIS	5.00	15.71	10.71	214.2
		CPS	6.17	17.83	11.66	188.98

Note: DMS = Demonstration strategy, GIS = Guided Inquiry Strategy
CPS = Cooperative strategy

Research Question 1

What are the effects of Demonstration, Guided- Inquiry and Cooperative strategies on students' acquisition of measurement skills in the construction of potentiometer considering their mathematical abilities?

Results in Table 1

Table 1 showed that students with high, average and low Mathematical abilities gained most in the acquisition of measurement skills in the construction of potentiometer when taught with Demonstration strategy.

Research Question 2

How would Demonstration, Guided-Inquiry and Cooperative strategies impact on student's acquisition of manipulative skills in the construction of potentiometer, considering their mathematical abilities?

Table 1 alsoshowed that students with high, average and low Mathematical abilities gained most in the acquisition of manipulative skills in the construction of potentiometer when taught with Demonstration strategy.

Research Question 3

What is the relative effect of Demonstration, Guided- Inquiry and Cooperative strategies on student's acquisition offinger dexterity skills in the construction of potentiometer considering their mathematical abilities?

Table 1 again showed that students with high mathematical ability gained most when taught with Guided Inquiry strategy, students with average mathematicalability gained most when taught with Cooperative strategy while students with low mathematical ability gained most when taught with Demonstration strategy in the acquisition of finger dexterity skills in the construction of potentiometer.

Hypotheses

H_{01} There is no significant difference among the students of high, average and low mathematical ability in their acquisition of measurement skills when taught with Demonstration, Guided-Inquiry and Cooperative strategies in the construction of potentiometer.

Table 2: Summary of 3x3 Analysis of Covariance of students' acquisition of measurement skills in the construction of Potentiometer classified by strategies and mathematical abilities, using pre-test scores as covariate.

Dependent Variable: Post-test scores on measurement skills

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	297.641[a]	9	33.071	3.680	s
Intercept	502.435	1	502.435	55.908	s
Pre-test	40.684	1	40.684	4.527	s
Strategy	193.472	2	96.736	10.764	s
Mathematical Ability	17.147	2	8.573	.954	ns
Strategy * Mathematical Abiity	37.904	4	9.476	1.054	ns
Error	449.343	50	8.987		
Total	35837.000	60			
Corrected Total	746.983	59			

a. R Squared = .398 (Adjusted R Squared = .290)

Table 2 shows that the main effect of strategy is significant, since its calculated $F_{2,50}$ value is 10.764 at degree of freedom of 2,50 and probability level of 0.05 against the $F_{2,50}$ critical value of 3.15.Mathematical ability is not significant since its calculated $F_{2,50}$ value is 0.954 at degree of freedom of 2,50 and probability level of 0.05 against critical value of 3.15. The interaction of strategies and mathematical ability isnot significant since its calculated $F_{4,50}$ value is 1.054 at degree of freedom of 4,50 and probability level of 0.05 against the $F_{4,50}$ critical value of 2.530.This shows that there is no significant difference in the effect of the teaching strategies on students of high, average and low mathematical abilities in their acquisition of measurement skills in the construction of potentiometer.

Table 3: Post hoc analysis of students' acquisition of measurement skills in the construction of Potentiometer based on the teaching strategies.

Pairwise Comparisons

Dependent Variable: Post-test scores on measurement skills

(I) STRATEGY	(J) STRATEGY	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1.00	2.00	4.609*	0.999	0.000	2.603	6.615
	3.00	2.870*	1.002	0.006	0.858	4.882
2.00	1.00	-4.609*	0.999	0.000	-6.615	-2.603
	3.00	-1.739	0.966	0.078	-3.680	0.201
3.00	1.00	-2.870*	1.002	0.006	-4.882	-0.858
	2.00	1.739	0.966	0.078	-0.201	3.680

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

The Post-hoc analysis on Table 3.indicates that strategy 1, which is Demonstration strategy contributed most to the significant difference between the effects of the teaching strategies on students' acquisition of measurement skills in the construction of potentiometer followed by Cooperative strategy and then Guided Inquiry strategy.

H_{02} There is no significant difference among the students of high, average and low mathematical ability in their acquisition of manipulative skills when taught with Demonstration, Guided-Inquiry and Cooperative strategies in the construction of potentiometer.

Table 4: Summary of 3x3 Analysis of Covariance of students' acquisition of manipulative skills in the construction of Potentiometer classified by strategies and Mathematical abilities, using pre test scores as covariate.

Dependent Variable: Post-test scores on manipulative skills

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	547.604[a]	9	60.845	5.885	s
Intercept	81.669	1	81.669	7.899	ns
Pre-test	16.336	1	16.336	1.580	ns
Strategy	450.078	2	225.039	21.765	s
Mathematical Ability	60.196	2	30.098	2.911	ns
Strategy * Mathematical Ability	4.197	4	1.049	.101	ns
Error	516.979	50	10.340		
Total	112435.000	60			
Corrected Total	1064.583	59			

a. R Squared = .514 (Adjusted R Squared = .427)

Table 4 shows that the main effect of strategy is significant, since its calculated $F_{2,50}$ value is 21.765 at degree of freedom of 2,50 and probability level of 0.05 against the $F_{2,50}$ critical value of 3.15. Mathematical ability is not significant since its calculated $F_{2,50}$ value is 2.911 at degree of freedom of 2,50 and probability level of 0.05 against critical value of 3.15. The interaction of strategies and Mathematical ability isnot significant since its calculated $F_{4,50}$ value is 0.101 at degree of freedom of 4,50 and probability level of 0.05 against the $F_{4,50}$ critical value of 2.530.This shows that there is no significant difference in the effect of the teaching strategies on students of high, average and low Mathematical abilities in their acquisition of manipulative skill in the construction of potentiometer.

Table 5: Post-hoc analysis of students' acquisition of manipulative skills in the construction of potentiometer based on the teaching strategies.

Pairwise Comparisons

Dependent Variable: Post-test scores on manipulative skills

(I) STRATEGY	(J) STRATEGY	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1.00	2.00	6.938*	1.059	0.000	4.810	9.065
	3.00	2.938*	1.069	0.008	0.790	5.086
2.00	1.00	-6.938*	1.059	0.000	-9.065	-4.810
	3.00	-4.000*	1.041	0.000	-6.090	-1.909
3.00	1.00	-2.938*	1.069	0.008	-5.086	-0.790
	2.00	4.000*	1.041	0.000	1.909	6.090

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

The Post-hoc analysis on Table 5 indicates that strategy 1, which is Demonstration strategy contributed most to the significant difference between the effects of the teaching strategies on students' acquisition of manipulative skills in the construction of potentiometer followed by Cooperative strategy and then Guided Inquiry strategy.

H_{03} There is no significant difference among the students of high, average and low mathematical ability in their acquisition of finger dexterity skills when taught with Demonstration, Guided- Inquiry and Cooperative strategies in the construction of potentiometer.

Table 6: Summary of 3x3 Analysis of Covariance of students' acquisition of finger dexterity skills in the construction of Potentiometer classified by strategies and mathematical abilities, using pre test scores as covariate.

Dependent Variable: Post-test scores on finger dexterity skills

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	111.975[a]	9	12.442	2.539	s
Intercept	261.203	1	261.203	53.305	s
Pre-test	4.507	1	4.507	0.920	ns
Strategy	71.778	2	35.889	7.324	s
Mathematical ability	1.352	2	.676	0.138	ns
Strategy * Mathematical ability	13.891	4	3.473	0.709	ns
Error	245.008	50	4.900		
Total	18697.000	60			
Corrected Total	356.983	59			

a. R Squared = .314 (Adjusted R Squared = .190)

Table 6, shows that the main effect of strategy is significant, since its calculated $F_{2,50}$ value is 7.324 at degree of freedom of 2,50 and probability level of 0.05 against the $F_{2,50}$ critical value of 3.15.Mathematical ability is not significant since its calculated $F_{2,50}$ value is 0.138 at degree of freedom of 2,50 and probability level of 0.05 against critical value of 3.15. The interaction of strategies and mathematical ability isnot significant since its calculated $F_{4,50}$ value is 0.709 at degree of freedom of 4,50 and probability level of 0.05 against the $F_{4,50}$ critical value of 2.530.This shows that there is no significant difference in the effect of the teaching strategies on students of high, average and low mathematical abilities in their acquisition of finger dexterity skills in the construction of potentiometer

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Table 7: Post-hoc analysis of students' acquisition of finger dexterity skills in the construction of Potentiometer based on the teaching strategies.

Pairwise Comparisons

Dependent Variable: Post-test scores on finger dexterity skills

(I) STRATEGY	(J) STRATEGY	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1.00	2.00	2.927*	0.765	0.000	1.390	4.464
	3.00	1.344	0.745	0.077	-0.153	2.841
2.00	1.00	-2.927*	0.765	0.000	-4.464	-1.390
	3.00	-1.583	0.797	0.052	-3.183	0.017
3.00	1.00	-1.344	0.745	0.077	-2.841	0.153
	2.00	1.583	0.797	0.052	-0.017	3.183

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

The Post-hoc analysis on Table 7 indicates that strategy 1, which is Demonstration strategy contributed most to the significant difference between the effects of the teaching strategies on students' acquisition of finger dexterity skills in the construction of Potentiometer followed by Cooperative strategy and then Guided Inquiry strategy.

Discussion

There is no doubt that the knowledge of Mathematics is needed in entrepreneurship. More especially as emphasized by Ekwueme (2013), that Mathematics knowledge enables students to think and reason in a more logical manner. Thinking is very important when it comes to construction of ideals and developing new innovations.

The result and findings of this study revealed that students with high, average and low Mathematical abilities gained most in the acquisition of measurement, manipulative and finger dexterity skills in the construction of potentiometer when taught with Demonstration strategy. This could result from the fact that students benefit more when demonstration method is used as emphasised by Awotua-Efebo (2001), that demonstration method is most suited for modelling correct technique and better procedure for doing something.However, students with high mathematical ability gained most when taught with guided- inquiry strategy, which implies that high reasoning ability due to high mathematical knowledge allows them to cope with guided- inquiry

strategy which involves more of critical thinking, this agrees with the views of Onwioduokit (2014) that guided inquiry promotes critical thinking and creative abilities on entrepreneurs. Students with average mathematical ability gained most when taught with Cooperative strategy, probably because cooperative strategy involves small grouping of students were they could interact freely among themselves.

However, there is no significant difference in the effect of the teaching strategies on students of high, average and low mathematical abilities in their acquisition of measurement, manipulative and finger dexterity skills in the construction of potentiometer. This agrees with Obafemi and Ogunkunle, 2014 in the studied of mathematical abilities of secondary school physics students and performance in sound waves, that there is no significant difference among the performances of students with high, average and low Mathematical abilities with respect to understanding of sound waves, considering the instructional methods.

Meanwhile, the Post-hoc analysis indicates that Demonstration strategy contributed most to the significant difference between the effects of the teaching strategies on students' acquisition of measurement, manipulative and fingerdexterity skills in the construction of potentiometer followed by Cooperative strategy and then Guided Inquiry strategy.This support the views of Akinbobola and Afolabi (2009), that a good demonstration exercise helps students to understand the lesson very clearly as it involves the combination of sense of sight, hearing and touching.

Conclusion and Recommendations

The knowledge of mathematics is very essential to the acquisition of entrepreneurial skills more especially in the construction of potentiometer. However, the teaching method implied by the teacher during lesson cannot be over emphasized. The study revealed that demonstration method strategy is most facilitating in enhancing students'acquisition of entrepreneurial skills.(measurement, manipulative and finger dexterity skills). It is therefore recommended that

1. Students should be encouraged to improve their mathematical ability since this is a key to the acquisition of entrepreneurial skills in physics.
2. Interactive and students centred learning instructions such as demonstrations, guided-inquiry and cooperative learning strategies should

3. be adopted by teachers during teaching andlearning of skills.

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