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Creativity of Secondary School Students: Entrepreneurial Skills Acquisition in the Construction of Potentiometer in Physics

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Abstract

The study adopted a quasi-experimental design using a pre-test, post-test control design in order to investigate the entrepreneurial skills and creative abilities of secondary school students in Physics. The study was carried out in Obio/Akpo Local Government Area of Rivers State of Nigeria, using purposive sampling technique. Sixty (60) SS2 Physics students were drawn from a population of six hundred (600) students. The instruments for the study are Creative Ability Test (CAT) and Entrepreneurial Skill Acquisition Test (ESAT). The ESAT was use for an on the spot assessment. The reliability coefficients of the instruments are 0.95 for CAT and 0.74 for ESAT, using Kuder- Richardson Formula (K-R-21) and Cronbach Alpha respectively. The students in different groups were taught using three teaching strategies namely Demonstration, Guided-Inquiry and Cooperative strategies on the entrepreneurial skills in construction of potentiometer. The students were assessed before and after treatment on acquisition and use of entrepreneurial skills (measurement, manipulative and finger dexterity skills) in the making of potentiometer. Three research questions and hypotheses guided the study. Data collated were analysed using mean and percentage to answer the research questions while Analysis of Co-variance (ANCOVA) was used to test the null

hypotheses. Result shows that there is no significant difference in the interaction of the teaching strategies on the students of high, average and low creative abilities in their acquisition of entrepreneurial skills in the construction of potentiometer. However, the main effect of the teaching strategy is significant. Based on these findings it was recommended that Demonstration, Guided-inquiry and Cooperative innovative teaching strategies be used in instruction in Entrepreneurial skill acquisition such as the construction of potentiometer, in physics.

Key Words: Guided-Discovery, Creative Abilities, Instructional Strategies, Entrepreneurship and Skills Acquisition

Introduction

The vast application of physics concepts, theory and principles has led to advancement in technology and contributed to solving some problems such as disease, poverty and degradation of environment in the developing world (Matt, 2007). Therefore, great attention should be given to physics teaching and learning. Awotua–Efebo (2001) emphasized that teaching is an attempt to help people acquire some skills, attitude, knowledge, idea or appreciation. The process is capable of developing meaningfully some creative skills in the learners. Acquiring cognitive ability about certain concepts is not enough. Students should through apprenticeship translate their cognition of concepts to making of products which can be useful to man.

The need to teach physics to students in clear terms need to be emphasized because when students are knowledgeable about the principle of the subjects they would become enterprise themselves, and the creative abilities of the students is improved upon. A physics student that is creative will be able to cope in any situation, because the students will be able to imagine or invent something new that would be useful to the society. For example, if the students are able to construct a potentiometer, an instrument used for measuring and comparing the electromotive force of cells and determination of the resistance of conductor to electric current, the knowledge base, and entrepreneurial skill would improve and the students could earn a living out of this, while their levels of students' use of manipulative skill would eventually improve. A good knowledge of physics combined with high creativity of the individual makes him an enterprise and self-reliant. The present state of unemployment indicates that some youth have the need to become more creative and more enterprising. Vandervert, Schimp and Liu (2007), stated that the graduate is expected to be moving from content base or theoretical to more practical based creative activities, innovative, enterprising and imaginative. To Bilton (2007), creativity provides the foundation for innovation and business growth as well as impacting positively on the society. However, Onwukwe (2009) noted that the ability to use imagination and skill to produce something new is creativity. It involves the application of psychomotor and use of the brain to create things differently from the existing ones and even involves creating

something from nothing. They should be able to jettison traditional assumptions and perspectives about how things are done to adapting a new approach of doing things. Onwioduokit (2014), posited that the acquisition of creative, critical and reflective thinking skills, which are fundamental to entrepreneurship is enhanced when learners are guided to discover information for themselves as teachers provide the scaffold.

For students' interest and improvement in learning, the choice of teaching method is inevitable. Methods such as Demonstration Strategy, allows the teacher to initiate the learning process by showing the practical work to the students (Nbina, 2011). While in cooperative strategy, the students are divided into small groups, cooperate with one another to perform or complete a particular task collectively. Johnson and Johnson (1989) commended cooperative strategy due to its effect on reasoning and critical thinking skills. While the Guided-Inquiry approach is learner centred; whereby the teacher acts as a facilitator, helping to develop in the students, scientific attitude that will enable them become objective and inquisitive, about their immediate environment.

Arokoyu and Nna (2012) investigated the effect of demonstration approach of teaching and creativity level of students on acquisition of science process skills for self-reliance among senior secondary school two students (SSS2) in chemistry. It was revealed that high, average and low creative ability students performed significantly better when taught using teacher demonstration method. However, high creative ability students contributed most to the significant difference between the effects of creative abilities on students' acquisition of measurement skills in the construction of Potentiometer. Furthermore, this is at variance with Igboegwu and Egbutu (2011), who investigated the effects of cooperative learning strategy and demonstration methods on acquisition of science process skills by chemistry students of different levels of scientific literacy. The result at 0.05 (ά level) revealed that students taught using cooperative learning strategy, performed significantly better than those taught using demonstration teaching methods, hence they recommended that cooperative learning strategy should be used to enhance science process skill acquisition among chemistry students. While students with average and low creative abilities gained most, in the acquisition of manipulative skills when taught with Demonstration strategy. This could result from students' improved reasoning based on observing and participating step wisely, as the teacher carries out the demonstration.

Nevertheless, the Instructional Strategies employed by teachers in the cause of teaching and learning of physics should be interactive and student- centred in order to develop the creative and entrepreneurial skills in the individual students. Teaching strategies such as Demonstration Strategy, Guided-Inquiry and Cooperative Strategies which are students' centred strategies and highly competitive are considered in this research in order to ensure effective teaching and learning. Furthermore, Onwioduokit (2014) argued that an effective way of teaching physics is by use of practical demonstration of the concept. The making of potentiometer and other sensitive

instrument for physics instruction would require a teacher-demonstration method and use of other strategies such as the cooperative strategy.

Statement of the Problem

The need to be creative and productive is sort for as an alternative to redressing the issues of unemployment. Although teachers basically seek to impact knowledge of physics concept to enable the students excel in the internal and external examinations and sometimes not considering the creative ability of the students. However, society now attaches values to the worth of the education received as a measure of what one can produce and ideas that can translate theory to practice. However, these maybe resulting from the style and methods of pedagogy, students' low creativity with unpreparedness towards attaining the entrepreneurial status. How can the creative ability of these students be developed and are there teaching methods that could help improve the creative skills of students to enable them become productive and self-reliant? The research will therefore study the creativity of secondary school students and their entrepreneurial skill acquisition, given some concept in Physics, especially when exposed to varied teaching strategies.

Aim and Objectives of the Study

The aim of this study is to investigate the relative effects of demonstration, guided–inquiry and cooperative strategies on students' acquisition of entrepreneurial skills in the construction of potentiometer, considering their level of creativity. Specifically, the study has the following objectives:

1. to investigate the relative effects of demonstration, guided- inquiry and cooperative strategies on the students' acquisition of measurement skills in the construction of potentiometer considering their level of creativity.
2. to assess the relative effects of demonstration, guided- inquiry and cooperative strategies on students' acquisition of manipulative skills in the construction of potentiometer considering their level of creativity.
3. to investigate the relative effects of demonstration, guided-inquiry and cooperative strategies on students' acquisition of finger dexterity skills in the construction of potentiometer considering their level of creativity.

Research Questions

The following research questions guided the study:

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 level of creativity?

2. How would Demonstration, Guided- Inquiry and Cooperative strategies impact on students' acquisition of manipulative skills in the construction of potentiometer considering their level of creativity?
3. 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 level of creativity?

Hypotheses

The following null hypotheses were formulated and tested in the study.

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

Methodology

The quasi-experimental, pre-test- post-test experimental and control group design was adopted for the study. There were two experimental and one control groups. The experimental groups were taught with Cooperative and Guided- Inquiry strategies while the control group was taught with Demonstration strategy. The factors in the study were instructional strategies, and creativity; 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 Creative Ability Test (CAT). CAT, consists of 20 items. The test is expected to measure students' creative ability based on imaginative thinking. While the Entrepreneurial Skills Acquisition Test (ESAT) was expected to measure students' ability, on- the- spot during the construction of potentiometer. The questions were practical-oriented. It consisted of nine questions on construction of potentiometer, and the questions on potentiometer were broken down into six items on Measurement Skills, ten items on Manipulative Skills and four items on Finger Dexterity skill. Creative Ability Test (CAT) attracted a score of 1 mark for each correctly answered question, giving a total of 20 marks. Each question in Entrepreneurial Skills

Acquisition Test (ESAT) has a maximum score of 5marks. In the Construction of Potentiometer, six items in Measurement Skills were scored a maximum of 30 marks, ten items in Manipulative Skills were scored a maximum of 50 marks and four items in Finger Dexterity skills were scored a maximum of 20 marks giving a total score of 100 marks. Therefore, the total score for ESAT is 200 marks. The two instruments were validated for content and construct validation by three lecturers in science department. The reliability coefficient was calculated as 0.95 for CAT and ESAT 0.74 using Cronbach Alpha ($\propto$).

The Creative Ability Test (CAT) were administered by the researcher and research assistants to each of the intact classes for the three (3) different groups to enable the researcher classify the subjects' creative abilities as high, average and low. The Entrepreneurial Skill Acquisition Test (ESAT) was also administered to the subjects to assess an on- the- spot pre-test, and then they were treated with the three different teaching strategies (Guided-Inquiry, Co-operative and Demonstration Strategies). A total of twenty subjects were selected from each school giving a sample size of 60, which was used for the study. The control group was taught with Demonstration strategy, experimental group 1 was taught using Co-operative Learning Strategy, while experimental group 2 was taught using Guided-Inquiry Strategy. The treatment lasted for eight weeks. At the end of the teaching, the subjects were assessed on- the- spot with the Entrepreneurial Skill Acquisition Test (ESAT) as a post-test. Based on the data collated, the research questions were analysed using descriptive statistics such as percentages and mean scores while the 3x3 factorial Analysis of Covariance was used to test the hypotheses.

Results and Discussion

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 level of creativity?

Results in Table 1 below shows that students gained most in the acquisition of measurement skills in the construction of potentiometer irrespective of their creative abilities when taught with Demonstration strategy.

Table 1: Mean gain scores of students' acquisition of measurement, manipulative and finger dexterity skills in the construction of potentiometer classified by their Creative Abilities

Construction of Potentiometer						
Creative Abilities	Skills	Method	Pre-test $\bar{x}$	Post test $\bar{x}$	Mean gain	Mean gain%
High level	Measurement	DMS	12.85	28.71	15.85	55.21
		GIS	15.33	23.17	7.84	33.84
		CPS	12.57	23.71	11.14	46.98
	Manipulative	DMS	18.86	46.43	27.57	59.38
		GIS	18.50	40.67	22.17	54.51
		CPS	18.00	44.00	26.00	59.09
	Finger Dexterity	DMS	6.00	19.00	13.00	68.42
		GIS	5.17	16.67	11.5	68.99
		CPS	5.86	19.00	13.14	69.16
Average Level	Measurement	DMS	14.33	25.22	10.89	43.18
		GIS	14.33	21.33	7.00	32.82
		CPS	16.67	23.50	6.83	29.06
	Manipulative	DMS	18.00	46.89	28.89	61.61
		GIS	18.17	39.50	21.33	54.00
		CPS	18.50	44.17	25.67	58.12
	Finger Dexterity	DMS	5.22	18.67	13.45	72.04
		GIS	4.83	15.67	10.84	69.18
		CPS	6.50	17.83	11.33	63.54
Low Level	Measurement	DMS	12.5	25.5	13.00	50.98
		GIS	14.13	21.88	7.75	35.42
		CPS	14.00	24.29	10.29	42.36
	Manipulative	DMS	18.00	45.25	27.25	60.22
		GIS	18.38	38.75	20.37	52.57
		CPS	18.00	41.86	23.86	57.00
	Finger Dexterity	DMS	6.50	18.75	12.25	65.33
		GIS	5.00	15.25	10.25	67.21
		CPS	5.71	16.71	11.00	65.83

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

Research Question 2: How would Demonstration, Guided- Inquiry and Cooperative strategies impact on students' acquisition of manipulative skills in the construction of potentiometer considering their level of creativity?

Table 1 shows that students gained most in the acquisition of manipulative skills in the construction of potentiometer irrespective of their creative abilities when taught with Demonstration strategy.

Research Question 3: 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 level of creativity?

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

Hypotheses

Research Hypothesis 2 (H_{01}): There is no significant difference among the students of high, average and low creative 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 creative 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	335.443[a]	9	37.271	4.528	s
Intercept	309.924	1	309.924	37.654	s
Pre-test	68.509	1	68.509	8.323	s
Strategies	236.273	2	118.137	14.353	s
Creative Ability	61.888	2	30.944	3.760	s
Strategy * Creative Ability	20.568	4	5.142	0.625	ns
Error	411.541	50	8.231		
Total	35837.000	60			
Corrected Total	746.983	59			

a. R Squared = .449 (Adjusted R Squared = .350)

s = significant
ns = Not significant

Table 2 shows that the main effect of the strategy and creative ability is significant. While the interaction of strategies and creative ability is not significant. This shows that there is no significant difference in the effect of the teaching strategy on students of high, average and low creative ability 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 creative abilities

Pairwise Comparisons

Dependent Variable: Post-test scores on measurement skills

(I) Creative ability	(J) Creative ability	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1.00	2.00	2.603*	0.950	0.009	0.695	4.512
	3.00	1.287	0.942	0.178	-0.605	3.179
2.00	1.00	-2.603*	0.950	0.009	-4.512	-0.695
	3.00	-1.317	0.984	0.187	-3.293	0.659
3.00	1.00	-1.287	0.942	0.178	-3.179	0.605
	2.00	1.317	0.984	0.187	-0.659	3.293

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 students with high creative abilities contributed most to the significant difference between effects of high, average and low creative abilities in the acquisition of measurement skills in the construction of potentiometer followed by students of average creative ability then those of low creative ability.

Research Hypothesis 2 (H_{02}): There is no significant difference among the students of high, average and low creativity 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 creative abilities, using pre-test scores as covariate

Dependent Variable: Post-test scores of manipulative skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	524.775[a]	9	58.308	5.401	s
Intercept	84.454	1	84.454	7.823	s
Pre-test	11.569	1	11.569	1.072	ns
Strategy	411.172	2	205.586	19.042	s
Creative Ability	27.531	2	13.765	1.275	ns
Strategy * Creative Ability	8.387	4	2.097	.194	ns
Error	539.808	50	10.796		
Total	112435.000	60			
Corrected Total	1064.583	59			

a. R Squared = .493 (Adjusted R Squared = .402)

s = significant

ns = not significant

Table 4 shows that the main effect of strategy is significant. Creative ability and the interaction of strategies and creative ability are not significant. This shows that there is no significant difference in the effect of the teaching strategy on students of high, average and low creative ability in their acquisition of manipulative skills in the construction of potentiometer.

Research Hypothesis 3 (H_{03}): There is no significant difference among the students of high, average and low creative ability in their acquisition of finger dexterity skills when taught with Demonstration, Guided -Inquiry and Cooperative strategies in the construction of potentiometer

Table 5: Summary of 3x3 Analysis of Covariance of students' acquisition of finger dexterity skills in the construction of Potentiometer classified by strategies and creative abilities, using pre-test scores as covariate

Dependent Variable: Post-test Scores of Finger Dexterity Skills

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	121.285[a]	9	13.476	2.859	s
Intercept	279.433	1	279.433	59.278	s
Pre-test	1.480	1	1.480	.314	ns
Strategy	58.085	2	29.043	6.161	s
Creative Ability	16.849	2	8.425	1.787	ns
Strategy * Creative Ability	5.744	4	1.436	.305	ns
Error	235.698	50	4.714		
Total	18697.000	60			
Corrected Total	356.983	59			

a. R Squared = .340 (Adjusted R Squared = .221)

s = significant

ns = not significant

Table 5: This table shows that the main effect of strategy is significant, while creative ability, interaction of strategies and creative ability are not significant. This shows that there is no significant difference in the effect of the teaching strategies on students of high, average and low creative abilities in their acquisition of finger dexterity skills in the construction of potentiometer.

Table 6: 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 of 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	2.755*	0.786	0.001	1.176	4.334
	3.00	0.981	0.709	0.173	-0.444	2.405
2.00	1.00	-2.755*	0.786	0.001	-4.334	-1.176
	3.00	-1.774*	0.789	0.029	-3.359	-0.190
3.00	1.00	-0.981	0.709	0.173	-2.405	0.444
	2.00	1.774*	0.789	0.029	0.190	3.359

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 6 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

Creative Abilities of students is an important index in the acquisition of entrepreneurial skills especially for the construction of a potentiometer, despite the fact that students, gained most in the acquisition of measurement skills in the construction of potentiometer irrespective of their creative abilities when taught with Demonstration strategy. This agrees with Onwioduokit (2014), that an effective way of teaching physics is by practical demonstration of the concept involved. There is no significant difference in the effect of the teaching strategies on students of high, average and low creative abilities in their acquisition of measurement skills in the construction of potentiometer. This may have resulted from their poor creative abilities as indicated in their poor performances in the students' score on the Creative Ability Test (CAT) instrument which was administered as pre-test. The finding is at variance with Arokoyu

& Nna (2012) where high average and low creative ability students performed significantly better when taught using teacher demonstration approach in chemistry. However, high creative ability students contributed most to the significant difference between the effects of creative abilities on students' acquisition of measurement skills in the construction of Potentiometer.

The level of creativity of students affected the acquisition of manipulative skills in this study. Students, gained most in the acquisition of manipulative skills in the construction of potentiometer, irrespective of their creative abilities when taught with Demonstration strategy. However, this view is at variance with Igboegwu and Egbutu (2011), which investigated the effects of cooperative learning strategy and demonstration methods on acquisition of science process skills by chemistry students of different levels of scientific literacy. The result at 0.05 (ά level) revealed that students taught using cooperative learning strategy, performed significantly better than those taught using demonstration teaching methods, hence they recommended that cooperative learning strategy should be used to enhance science process skill acquisition among chemistry students. While students with average and low creative abilities gained most in the acquisition of manipulative skills when taught with Demonstration strategy, this could result from students improved reasoning from observing and participating as the teacher carries out demonstration.

In the acquisition of finger dexterity, students with high creative ability gained most when taught with Cooperative strategy, students with average creative ability gained most when taught with Demonstration strategy while students with low creative ability gained most when taught with Guided-Inquiry in the acquisition of finger dexterity skills in the construction of potentiometer. Students of low creative ability having improved performance in the acquisition of their finger dexterity skills when taught using Guided-Inquiry in the construction of potentiometer may have resulted from the fact that guided - inquiry involves more of learners' participation, where the learner's scientific attitude such as inquisitiveness is developed. This agreed with the views of Onwioduokit, (2014) that the acquisition of creative, critical and reflective thinking skill, which are fundamental for entrepreneurship is enhanced, since learner are guided to discover information for themselves as teachers provide little information.

Conclusion

Creativity is relevant in the entrepreneurial world. The Demonstration, Guided Inquiry and Cooperative teaching strategies enhanced students' acquisition of measurement, manipulative and finger dexterity skills and their creative abilities. It was revealed that the students' creative ability was improved upon. Students with high, average and low creative ability gained more of the measurement skills but in higher skills of manipulation and finger dexterity, students of high and average creative abilities contributed most to a better performance when taught using the demonstration method

and cooperative teaching strategy. The creative ability of students can be improved when exposed to problem solving and active participation in their acquisition of knowledge.

Recommendations

Students' creative ability can be improved when exposed to teaching strategies in which they play active role in the acquisition of knowledge hence the teaching strategies of demonstration, Guided Inquiry and Cooperative strategies should be adopted in secondary schools for students' entrepreneurial development in the construction of metering and other devices useful for physics instruction.

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