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Creating Entrepreneurs Using Physics and Mathematics: Implications for Economic Developments in South-East Nigeria

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ABSTRACT:

Most activities in the world presently rotate around physics and mathematics and their applications. The mathematical calculations, electricity, communications and household equipments are facilitated using physics and mathematics principles. It was on this premise that a study was carried on creating entrepreneurs using physics and mathematics: Implications for economic developments in South-East Nigeria. The study was conducted in Enugu State, Nigeria. Three research questions guided the study. A total of 40 students constituted the sample of the study. The experimental research design was applied in carrying out the study. The researchers constructed a test instrument titled physics achievement test. This test was used for data collection. The instrument was validated by two experts each in measurement and evaluation, physics and mathematics. The internal consistency reliability of the instrument was 0.89 using split-half method. The research data were analysed using mean, standard deviation and ANCOVA. The result of the study revealed that students taught physics using self-made instructional materials performed significantly better than those using imported materials. The implication of the findings of this study is that the students are gaining experience while developing the instructional materials and can transfer same to their learning and skills to become entrepreneurs. Based on the result of the study, it was suggested that efforts should be made by public spirited individuals to assist these students setup small industries based on their skills for economic development and wealth creation in South-East Nigeria.

INTRODUCTION

According to Oxford Advanced learner's Dictionary, science is defined as "a systematic knowledge of the physical or material world gained through observation and experimentation" (Hornby, 2011). By this definition, the people of the South-East Nigeria (Anambra, Enugu, Imo, Abia and Ebonyi states), much like other African people, were scientists in the true sense of the word. They were master observers, able to pick up the minutest of details as well as things right in plain view that often go overlooked by most people. They were able to develop all they needed to survive in the South-East Nigeria before, during and after the civil war in Nigeria from 1967 – 1970. The people of the South-East Nigeria were also practical people who adopted traditions after they had been tested and found to produce results that could be reproduced. They did not have time for theories that had not been demonstrated or for blind faith in anything. However, there were two major differences between their view of science and the Western view. Those are, the fact that they did not separate the spiritual from the physical, and that they were also intelligent enough to never claim to have discovered anything (Nwa-Ikenga, 2010).

Nwa-Ikenga (2010) also states that what they call the physical world is matter that is vibrating at a lower frequency. When the frequency increases, things can become unperceivable to them, even though they are still there. An example of this would be radio and television waves. Matter at a higher vibration is what the ancients Igbos (people from the South-East Nigeria) called spirit. The understanding of the science of spirit is what they call metaphysics, which is defined as "the theoretical or first principles of a particular discipline." In other words, metaphysics is the first cause of everything in the physical.

In this study, physics and mathematics are used as a case study of science in the South-East Nigeria. The entire activities in the world presently rotate around physics and mathematics and their applications. The measurements, geometrical shapes, optical equipments, electricity, communications and other household equipments are facilitated using physics and mathematics principles. The general objectives of Physics and mathematics are to: provide basic numeracy and calculation knowledge, provide basic literacy for functional living in the society, acquire basic concepts and principles as a preparation for further studies, acquire essential scientific and entrepreneurial skills and attitudes as a preparation for technological application and stimulate and enhance creativity (FME, 2008).

The knowledge of physics and mathematics helps to transform the world. The numerous applications to which their concepts are being put to improve man's environment makes them occupy unique positions among other science subjects (Ogunneye, 2003). However, many problems beset physics and mathematics teaching at the secondary school level in the south-east Nigeria where physics is introduced as a separate subject area and the scope of mathematics expanded to cover more contemporary areas. Some of the problems reported in studies carried out in Nigeria are insufficient number of quality physics and mathematics teachers, poor methods of teaching physics and mathematics, poor motivation of students resulting in low enrolment and achievement in physics and poor interest of students in mathematics (Achor, 2001). According to Busari (2003), the researchers adopted the demonstration and guided-discovery teaching methods. The problem of physics teaching and learning can be linked to the teaching methods or teaching approaches adopted by the physics teachers; learner variables such as poor skills development, poor attitude and low numerical aptitude.

The performances of students in physics have been on the decline (Utibe, 2009). The statistics from WASSCE reveals that the failure rate in physics in the South-east in 2011 was 41.2%, 2012 was 52.9%, 2013 was 55.9% and 2014 was 65.0% (WAEC, 2014). The statistics from NECO SSCE reveals that the failure rate in mathematics in the South-east in 2011 was 51.32%, 2012 was 54.91%, 2013 was 58.19% and 2014 was 61.30% (NECO, 2014).This steady increasing failure rate in the two major external examinations in Nigeria could arise from difficulties students have in various aspects of physics and mathematics especially optics and mathematical calculations.

The concept optics which mirror is a part is considered in this study. Mirror is an object that reflects light in a way that preserves much of its original quality subsequent to its contact with the mirror. Some mirrors also filter out some wavelengths, while preserving other wavelengths in the reflection (Mark, 2003). This is different from other light-reflecting objects that do not preserve much of the original wave signal other than color and diffuse reflected light. The most familiar type of mirror is the plane mirror, which has a flat

surface. Curved mirrors are also used, to produce magnified or diminished images or focus light or simply distort the reflected image (Melchior-Bonnet, 2001).

Mirrors are commonly used for personal grooming or admiring oneself (in which case the archaic term looking-glass is sometimes still used), decoration, and architecture. Mirrors are also used in scientific apparatus such as telescopes and lasers, cameras, and industrial machinery. Most mirrors are designed for visible light; however, mirrors designed for other types of waves or other wavelengths of electromagnetic radiation are also used, especially in non-optical instruments (Mahmoud and Al-Haitham, 2004).

From the applications of mirrors it could be seen that everybody needed mirror for one reason or the other. The number of people using mirror is over 150M in Nigeria (National Population Commission, 2006). Hence, the need for adoption of effective teaching methods in physics and mathematics instruction is evident. Some of the methods recommended for effective teaching and learning of physics and mathematics are the demonstration and guided-discovery (FME, 2008). The demonstration method involves teacher-student interaction, through activity, talk and chalk in which the teacher provides all the necessary procedures and facts on physics concepts in question to the students. The teacher gives facts and opinions and gives overviews of materials and opinions about the subject matter being discussed, poses problems and goes further to solve the problems for students. Students are made to repeat procedures, facts and principles which they learn during the demonstration. As a result of the activities, application of knowledge, facts and principles learned in this way many students retained the knowledge gained for a longer period (Uyoata, 2002).

Guided-discovery is a learner-centred approach to teaching and learning of physics with learner centred activities to actively involve the learners. In this method, the teacher arranges some activities which would help the students on a step-by-step exercise to learn the physics concepts (Eniayeju, Eniayeju and Lakpini, 2004).

Since the major aim of physics and mathematics teaching is to promote the understanding of the physics and mathematics concept being taught with a view to applying knowledge of such understanding to real life situations, the consistent poor performance in and negative attitude towards physics and mathematics attest to the fact that physics and mathematics teaching has not been properly done. Hence, the concepts being taught are not properly understood. This improper physics and mathematics teaching has led to a vigorous search for appropriate teaching method that would best achieve the aim of physics and mathematics teaching such as the guided-discovery, demonstration methods and skills development used in this study.

STATEMENT OF THE PROBLEM

As concerned academics from South-East Nigeria, the researchers have personally observed a consistent poor performance of students in optics concepts, mathematical calculations and the general physics as highlighted in the background of this study. The researchers have also observed that the graduating students leave the school complaining of poor teaching methods and skills development of their physics and mathematics teachers despite the many methods available in the senior secondary school physics and mathematics curricula. Another glaring issue is that of low students' entrepreneurial skills in physics and mathematics despite the importance of physics and mathematics to man as outlined in the background of this study. It

is on the bases of these observations that the researchers are motivated to carry out this study on creating entrepreneurs using physics and mathematics: Implications for economic developments in South-East Nigeria with a view of teaching and preparing students that would apply the concepts of mathematics and optics to improve on their performances in physics examinations and entrepreneurial skills acquisition.

PURPOSE OF THE STUDY

The purpose of this study was on creating entrepreneurs using physics and mathematics: Implications for economic developments in South-East Nigeria. The study specifically was designed to:

1. Compare the mean achievement scores of students taught physics using guided-discovery and demonstration methods.
2. Determine the difference between the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in guided-discovery group.
3. Determine the difference between the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in demonstration group.

SIGNIFICANCE OF THE STUDY

The results of this study would be significant to the students, parents, government, curriculum planers, teachers and researchers. The students would benefit from the teaching and improve on their achievements in physics and entrepreneurial skills acquisition. The parents would be relieved as the students would improve on their achievement levels in physics and entrepreneurial skills acquisition.

Poor achievement pressure on the government would be reduced as most of the students would have to pass the physics examinations and also acquire entrepreneurial skills. It would suggest to the curriculum planners the need to enforce the use of guided-discovery, demonstration teaching methods and entrepreneurial skills development to teach physics.

Teachers in the schools would be acquainted with relevant teaching methods and entrepreneurial skills capable of enhancing students' achievements in physics. Researchers would find the research reports as a source of reference materials in their research work.

RESEARCH QUESTIONS

In order to guide the researchers in the study, the following research questions were posed:

1. What are the mean achievement scores of students taught physics using guided-discovery and those taught using demonstration methods?
2. What are the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in guided-discovery group?
3. What are the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in demonstration group?

HYPOTHESES

To guide the researchers in the conduct of the study, the following null hypotheses were tested at 0.05 level of significance:

Ho1. There is no significant difference between the mean achievement scores of students taught physics using guided-discovery and those taught using demonstration methods.

Ho2. There is no significant difference between the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in guided-discovery group.

Ho3. There is no significant difference between the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in demonstration method group.

SCOPE OF THE STUDY

This study was delimited to the Senior Secondary two (SS2) physics students in public secondary schools in Enugu State because this concept in optics is scheduled for this category of students in the Federal Ministry of Education Senior Secondary School Curriculum for Physics (FME, 2008). This study covers the concept of optics (mirror: reflection, types, formation of images, laws of reflection and their calculations) as contained in the National Curriculum, guided discovery, demonstration teaching methods and entrepreneurial skills development: (Design of mirrors, measurements, cutting, framing and presentation) as recommended for use in the teaching of physics concepts.

METHODS

The research design used is the experimental design, which is aimed at exposing students to two closely related teaching methods, entrepreneurial skills development and testing their achievement at the end of the treatment, to determine the effect of the treatment on the characteristics features or facts about a given population. Nworgu (2006) in a publication supports the use of experiment for the study involving the use of two different teaching methods and skills development. This study was conducted in secondary schools in Enugu State, South-East Nigeria.

This study consists of all senior secondary two (SS2) physics students for the 2013/2014 academic session in all the secondary schools in South-East Nigeria. The population is 21451 students. A total of 40 students was used for the study. 20 students each in both the guided-discovery method and demonstration method groups were selected. Each of the groups contains 10 students who used self-made instructional materials and 10 students who used standard instructional materials. The sampling technique used in this research work was simple random sampling. The researchers used one instrument, Physics Achievement Test (PAT). The test contains 25 objective questions with options lettered A-D, one correct option and three distracters. The test was in optics and related concepts designed to test students' achievement in physics.

The instrument was faced validated by one physics lecturer in the department of Science Education, one lecturer in measurement and evaluation in the University of Nigeria, Nsukka and one physics teacher in one of the selected schools used for the study. The three validates were expected to assess the appropriateness of the items in the instrument in providing

correct responses to the research questions. Their comments were incorporated into the final production of the instrument. To further strengthen the validity of the instrument, copies of PAT were subjected to a trial testing on 12 physics students who were not part of the main subjects for the study but who were found to be equivalent in all respects to the subjects in the study.

The researchers made use of two secondary schools in Nsukka local government area of Enugu state that met the criteria for sampling but were not used for the main study. The result obtained in this administration using split-half method was 0.84. On the basis of this reliability index the instrument was deemed suitable for use in conducting the research.
The researchers personally visited the schools and taught the students the topics in optics and entrepreneurial skills (Design of mirrors, measurements, cutting, framing and presentation) for four weeks using the school physics time-table. At the end of the teaching for four weeks the PAT was administered to the students within standard examination conditions. The scripts were instantly collected after the test from them to avoid lost of the scripts. The scripts were marked and result collated for analyses as shown in the results. The data collected at the course of the study were analyzed using mean, standard deviation and analysis of covariance. All hypotheses were tested at 0.05 level of significance.

RESULTS

Table 1: Summary of descriptive statistics of the mean achievement scores of students taught physics using guided-discovery and demonstration methods

Methods	Total	N	Std. Deviation	Mean
Guided-discovery	1263	20	8.62	63.15
Demonstration	1408	20	5.41	70.40

As shown in Table 1 above, the mean achievement score for guided-discovery teaching method is 63.15 while the mean achievement score for demonstration teaching method is 70.40. The difference between them (demonstration and guided-discovery methods) is 70.40 – 63.15 = 7.25. From the analysis there exists a difference between the mean achievement scores of students taught physics using guided-discovery and demonstration methods with a calculated value of 7.25 in favour of the demonstration method.

Table 2: Summary of descriptive statistics of the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in guided-discovery group

Instructional materials Used	Total	N	Std. Deviation	Mean
Self-made	646	10	6.53	64.60
Standard	617	10	10.47	61.70

As shown in Table 2, the mean achievement score for students using self-made instructional material is 64.60 while the mean achievement score for students using standard instructional material is 61.70. The difference between them (self-made and standard instructional materials in guided-discovery group) is 64.60 – 61.70 = 2.90. From the analysis there exists a difference between the mean achievement scores of students using self-made instructional material and students using standard instructional material in guided-discovery group with a calculated value of 2.90 in favour of the self-made instructional materials.

Table 3: Summary of descriptive statistics of the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in demonstration group

Instructional materials Used	Total	N	Std. Deviation	Mean
Self-made	780	10	5.00	70.80
Standard	700	10	6.03	70.00

As shown in Table 3, the mean achievement scores for students using self-made instructional material is 70.80 while the mean achievement score for students using standard instructional material is 70.00. The difference between them (self-made and standard instructional materials in demonstration group) is 70.80 – 70.00 = 0.80. From the analysis there exist a difference between the mean achievement scores of students using self-made instructional material and students using standard instructional material in demonstration group with a calculated value of 0.80 in favour of the self-made instructional materials.

Table 4: Summary of analysis of covariance (ANCOVA) of the achievement scores of students taught physics using guided-discovery and those taught using demonstration methods

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	613.71(a)	2	306.85	6.02	.01
Intercept	25274.58	1	25274.58	496.56	.00
Pretest	88.08	1	88.08	1.73	.19
Teaching method	550.19	1	550.19	10.81	.00
Error	1883.26	37	50.89		
Total	180853.00	40			
Corrected Total	2496.97	39			

R Squared = .246 (Adjusted R Squared = .205)

As shown in Table 4 above, the calculated value of F = 10.81with associated probability value of 0.00. The associated probability value is lower than 0.05 level of significance set by the researchers; therefore the null hypothesis was rejected. This implies that there is significant difference between the mean achievements scores of students taught physics using guided-discovery and those taught using demonstration methods in favour of the demonstration method.

Table 5: Summary of analysis of covariance (ANCOVA) of the achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in guided-discovery group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	134.45(a)	2	67.2	.89	.42
Intercept	11143.18	1	11143.18	147.98	.00
Pretest guided-discovery	92.40	1	92.40	1.22	.28
Type of instructional	64.65	1	64.65	.85	.36

materials used			
Error	1280.09	17	75.30
Total	81173.00	20	
Corrected Total	1414.55	19	

R Squared = .095 (Adjusted R Squared = -.011)

As shown in Table 5, the calculated value of F = 0.85with associated probability value of 0.36. The associated probability value was higher than 0.05 level of significance set by the researchers; therefore the null hypothesis was upheld. This implies that there is no significant difference between the mean achievements scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in guided-discovery group.

Table 6: Summary of analysis of covariance (ANCOVA) of the achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in demonstration group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	26.21(a)	2	13.10	.42	.66
Intercept	13277.96	1	13277.96	425.42	.00
Pretest demonstration method	23.01	1	23.01	.73	.40
Type of instructional materials used	.17	1	.17	.00	.94
Error	530.59	17	31.21		
Total	99680.00	20			
Corrected Total	556.80	19			

R Squared = .047 (Adjusted R Squared = -.065)

As shown in Table 6 above, the calculated value of F = 0.00 with associated probability value of 0.94. The associated probability value is higher than 0.05 level of significance set by the researchers; therefore the null hypothesis was upheld. This implies that there is no significant difference between the mean achievements scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in demonstration group.

SUMMARY OF FINDINGS

1. There exists a difference between the mean achievement scores of students taught physics using guided-discovery and demonstration methods in favour of the demonstration method.
2. There exists a difference between the mean achievement scores of students using self-made instructional materials and students using standard instructional materials in guided-discovery in favour of self-made group.

3. There exists a difference between the mean achievement scores of students using self-made instructional materials and students using standard instructional materials in demonstration in favour of self-made group.
4. There is significant difference between the mean achievement scores of students taught physics using guided-discovery and those taught using demonstration methods in favour of the demonstration method.
5. There is no significant difference between the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in both guided-discovery and demonstration groups.

DISCUSSION OF FINDINGS

From Table 4 it is evident therein that there is significant difference between the mean achievement scores of students taught physics using guided-discovery and those taught using demonstration methods in favour of demonstration method. This finding supports the recommendation of the FME, (2008) which recommends that physics should be taught using guided-discovery and demonstration methods among other methods. This finding also shows that among the methods available for physics teaching, demonstration ranks the more effective, as it guaranteed high performance of students.

From Tables 5 and 6 it is evident therein that there is no significant difference between the mean achievements scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in both guided-discovery and demonstration groups. This finding supports the work of Olagunju (2002). This now shows that the use of self-made instructional material is as effective as the standard instructional material in learning physics. Hence, to create entrepreneurs, students should be encouraged to develop and use the self-made instructional materials in conjunction with standard instructional materials if available and with good teaching method such as guided-discovery and demonstration methods. This would enable the students to acquire the much needed entrepreneurial skills.

IMPLICATIONS OF THE STUDY FOR ECONOMIC DEVELOPMENT IN SOUTH-EAST NIGERIA

From the result of the study, it can be seen that the two teaching methods guaranteed high performance in physics with demonstration being higher than the guided-discovery. The methods can also be used to develop entrepreneurial skills. The students are gaining experience while developing the instructional materials and can transfer same to their learning and skills to become entrepreneurs. The knowledge gained by the students in the course of developing the instructional materials can be applied on graduation for wealth creation and economic development. There would be reduction in unemployment in the South-East Nigeria. The curriculum planners would enforce the self-development and use of instructional materials which can help in wealth creation among students and teachers resulting in economic development. Other members of the academic community would find the data very useful for research purposes on means of wealth creation and economic development.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

i. Since teaching/learning skills development and achievement in physics can be enhanced through the use of these teaching methods, the researchers strongly recommend them for use in the school system.

ii. To reduce unemployment and create wealth, the researchers strongly recommend that teachers should involve students in the development and use of instructional materials employed in physics teaching and learning in the schools.

SUMMARY

This study was on creating entrepreneurs using physics and mathematics: Implications for economic development in South-East Nigeria. It was an experimental study. The population of the study covers all the SS2 physics students in 2013/2014 session in public secondary schools in South-East Nigeria. From the population a total of 40 physics students were randomly selected for the study.

The instrument for data collection was a researchers' made physics achievement test. Three research questions and three research hypotheses were posed to guide the study. The results show that there was significant difference in the achievement of students' in physics when taught using guided-discovery and demonstration methods. There was no significant difference between the mean achievement scores of students taught physics using self-made instructional materials and those taught physics using standard instructional materials in both guided-discovery and demonstration groups.

The implications of the study is that it helps in involving students in the development and use of instructional materials and create acquisition of entrepreneurial skills by students in the secondary schools physics. The recommendation made in the study amongst others includes, the use of guided-discovery, demonstration teaching methods and involvement of students in instructional development and use in teaching physics in secondary schools to enhance general achievement in physics.

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